wheras the section at South Ringabella (the Robert's Cove Sandstone Formation of Naylor *et al.* 1969; Naylor 1969), records 243m in total.

The Cuskinny Member is distinguished from the equivalent Narrow Cove Member in the higher proportion of sandstone and sand-dominant heterolithic bedded facies. MacCarthy *et al.* (1978) describe the member as composed of relatively thick (0 - 2.65m) sometimes conglomeratic sandstone units (54%), alternating with thin sandstone laminated mudstones (3%), massive claystone (8%) and heterolithic sediments (35%).

North and east of the type section it is difficult to map due to poor outcrop. The member dies out in the region of Knockadoon Head north of which it is laterally replaced by the Crows Point Formation.

MacCarthy *et al.* (1978) and Cotter (1985) describe the member as a regressional phase representing a shallow coastal marine environment with storm generated offshore gravel-topped barrier bar and beach facies.

Pig's Cove Member
The member is distinguished from the underlying Narrow Cove Member by a general lack of sandstones. At the type section (397m thick, Grid Ref. 16200 04005) the lowermost 66m are characterised by silt and fine sand lenses (linsen) within a parallel laminated mud-siltstone sequence. The next 68m of the member consists of undifferentiated highly cleaved massive mudstones and the following 70m are similar to the basal 66m (Naylor 1966). The uppermost 195m, originally designated as the Coosduff Member (Naylor 1966), is sandier than the underlying beds. There is a high proportion of sand-lensed mudstones and thin (less than 0.15m) sandstone beds with rare thick sandstones. Small discoid silicophosphatic nodules are common throughout the mudstones (Naylor 1966; Naylor and Reilly 1981).

The member reaches a maximum thickness in the Kinsale - Ringabella area where Naylor (1969) recorded 709m (Doonavanig Formation) and Sleeman (1987) recorded a similar thickness in Tracton Wood. Further north, however, the member rapidly thins (340m - Paulgorm Formation of Naylor (1969) at North Ringabella) and is probably laterally replaced by the upper part of the Cuskinny Member north of the Cloyne Syncline (Sleeman 1987). In the Cork Harbour area the member is recorded by MacCarthy *et al.* (1978) from the core of the syncline at Whitebay and from the Inch and Ballyshane (east of Gyleen) area (see also MacCarthy 1988 -map). A section at Halfway (between Cork and Bandon), at the western end of the Cloyne Syncline, exposes about 200m through the member, but this sequence appears to thin rapidly eastwards towards Ballea Gorge (north of Carrigaline), where only 75m is recorded (Sleeman 1987). At Raffeen, where the member is no more than 50m thick, it is seen to pass up to the Courtmacsherry Formation. The member has not been found further north and east of Raffeen. While available evidence points to eastward thinning of the member, post Kinsale Formation erosion, suggested by the absence of the BP Miospore Biozone in the Ballea area (Sleeman *et al.* 1986), and strike parallel faulting may both have contributed to the apparent thinning and absence of the member through much of the Cloyne Syncline (Sleeman 1987).

MacCarthy and Gardiner (1987) suggest that the member represents deposition on an offshore wave influenced muddy shelf.

Courtmacsherry Formation
Naylor (1966) recorded a thickness of about 343m from the type section on the west side of the Old Head of Kinsale, between Ringalurisky Point and Well Cove. The formation is informally divided into four units at the type section (Naylor 1966; Matthews and Naylor 1973; Naylor *et al.* 1985), the base of which is taken at the incoming of the first calcareous mudstone. The first unit is characterised by crinoidal debris in beds and lenses inserted into a sequence of calcareous and non-calcareous grey nodular mudstones. Above this the second member is composed of non calcareous siltstones with fine-sand cross-laminae. The third unit comprises interbedded calcareous and non-calcareous mudstones with fewer thicklimestone beds than the basal unit. The topmost unit contains dark-grey mudstones with up to 20% ferroan carbonate as rhombs or concretions[8].

While this description suffices for the formation in the Old Head - Seven Heads area, at Ringabella and Inishannon there is a significant increase in limestone incorporated into the formation (equivalent to member 2).

[8] Away from the Old Head, the boundary between the Courtmacsherry and Lispatrick Formations is rather difficult to define (Naylor *et al* 1987 - Seven Heads).

Elsewhere only member 1 appears to be present. The formation on the basin margin is much less calcareous and less fossiliferous than the equivalent formation on the North Munster Shelf, at Whiting Bay and Mallow for instance (i.e. the Ringmoylan Formation - Campbell 1988; Sevastopulo and Sleeman, unpublished).

The most notable locality is Ringabella Bay where the lower part of the formation (The Fountainstown Member) is succeeded by the limestone rich Ringabella Limestone Member (Naylor 1969; Sleeman 1987). Here the member comprises alternations of 0.1-0.2m thick crinoidal biomicritic limestones and black siliceous and in some cases calcareous, and commonly phosphatic, mudstones. The limestones also contain quartz sand whose origin is difficult to establish. The presence of reworked conodonts in these limestones, however, lends support to the argument that the carbonates found in the Ringabella Limestone Member are derived by removal of material from an intrabasinal uplifted fault block to the north as a result of local intra Courceyan slumping and erosion (Naylor *et al.* 1983).

The Ringabella Limestone Member cannot be mapped away from the coast. Inland adjacent to the old National School at Minane Bridge the Geological Survey drilled a short hole which encountered calcareous mudstones (Sleeman 1987).

The second area where limestones are a significant proportion of the Courtmacsherry sequence is at Rag Bridge east of Inishannon. Here boreholes drilled by Riofinex penetrated a succession comparable to that at Ringabella, but about 1/10th the thickness: the succession is still poorly known and is referred to here informally as the "Inishannon Limestone" (Naylor *et al.* 1983). Again, thin limestones present in the sequence contain quartz sand and reworked conodonts.

The Courtmacsherry Formation has been mapped by one of us (AGS) recently in the area between Upton, Kilpatrick and to the west of Mishells House. A particularly interesting section has been noted in the old Bandon and South Coast Railway cutting at Rockfort House, Brinny (see Key Localities), where the formation as measured is about 200m thick (true thickness) and passes up to the Lispatrick Formation. The section exposes silty and variably calcareous mudstones with thin crinoidal **bioclastic** limestones and dolomitised calcisiltites. The upper part of the sequence is dominated by blocky, nodular, cherty, dolomitised, calcisiltites and **argillaceous** decalcified and cleaved mudstones (Sleeman unpublished). This passes up gradationally to bedded cherts assigned here to the Lispatrick Formation (cf the Minane Chert Member - Naylor 1969; Sleeman 1987).

Further east in the Cloyne Syncline, the formation thins rapidly and passes northwards laterally into the Ringmoylan Formation. The 24m thick sequence exposed between faults at Golden Rock, Ringaskiddy (Sleeman *et al.* 1978, 1986) is transitional to the Ringmoylan Formation; it resembles the Fountainstown Member at Ringabella but is considerably more fossiliferous and was probably more calcareous originally (the mudstones are all weathered and decalcified). At Ballygarvan and Kilnahone Mill the formation is only 3 - 5m thick.

At Broadstrand (Seven Heads), the formation can be divided into four members as at the Old Head but is only 208m thick. The basal beds contain conodonts of the *Siphonodella* Biozone while in member 4 specimens of *Gnathodus cuneiformis*, similar to those recovered from the Ringabella Limestone, have been found. At Ringabella these are known to be of earliest *Polygnathus communis carina* Biozonal age (Naylor *et al.* 1988). Thus the Courceyan age for the top of the Courtmacsherry Formation, as at Ringabella is confirmed at Seven Heads.

At Ballinglanna, on the west side of Seven Heads, the formation is only 7 - 17m thick and lithologically is only slightly different from the underlying Kinsale Formation. It comprises silty mudstones with thin linsen laminae and siliceous and pyritic bullions up to 0.5m across (Naylor *et al.* 1988). The formation here is of early Courceyan (PC Biozone) age.

At Galley Head, only 10km further west, the Courtmacsherry Formation is equivalent to, at most, 8.25m of chert and mudstone (but assigned by Naylor *et al.* (1985) to the Lispatrick Formation). Alternatively and more probably, equivalents of the Courtmacsherry are not present, or are to be found within the 2.15m of cherty mudstone just above the Kinsale Formation (Naylor *et al.* 1985).

Lispatrick Formation

The Lispatrick Formation, 67m thick at the Old Head (Naylor *et al.* 1985), comprises a sequence of fissile and blocky dark-grey to black mudstones, often extremely pyritic, with interbedded bands of ferroan dolomite. The mudstones often weather to a pale ash-grey colour. Bands of black chert are common.

The distinction between the upper part of the Courtmacsherry Formation and the Lispatrick Formation is subtle; while the base of the Lispatrick Formation in Well Cove (Old Head of Kinsale) is satisfactory, the overall nature of the transition between the two formations presents problems in regional correlation (Naylor *et al.* 1985).

The Brigantian bivalve *Posidonia becheri* is found between 13 - 21m above the base of the formation and goniatites of the Brigantian P1d Subzone occur higher up (Naylor *et al.* 1985). However, conodonts (Naylor *et al.* 1985) suggest a late Courceyan to Arundian age for the base of the formation, although reworking from older levels (as for example is known from the Ringabella Limestone Member) cannot be discounted yet.

At Seven Heads the formation is exposed in a small cove east of Meelmane (Naylor *et al.* 1988) where it is 40m thick. At Ballinglanna it is 32.8m thick and **palynological** data (VF Biozone) and conodont data (*Gnathodus girtyi*) confirm the Brigantian age here (Naylor *et al.* 1988). At Galley Head the base of the formation rests on the Kinsale Formation. Here a 2.15m thick sequence of cherty mudstone is present. Its basal 0.2m contains abundant, angular granules and moulds of crinoid ossicles. It is lithologically distinct from typical mudstone of the Lispatrick but is included in the formation by Naylor *et al.* (1988) to avoid introducing another stratigraphical term unique to the locality. Mudstones containing P1c subzonal goniatites (Brigantian) occur 8.25m above the base.

In the Cloyne Syncline the formation is poorly exposed. It has been recorded, however, in boreholes at Meadstown House (Grid. Ref. 16781 06280, Sleeman 1987). Here the sequence comprises very dark-grey pyritic mudstones interdigitating with brecciated **calcilutites** and dolomitised **calcarenites** of Asbian age (Little Island Formation). This is considered to reflect a position on the basin slope margin. Elsewhere the formation appears to pass up to the Namurian White Strand Formation.

Further south, in the Ringabella Syncline, bedded cherts and dark-grey phosphatic and pyritic mudstones at Minane Bridge (plate 5) are assigned to the formation (Minane Chert Member - Naylor 1969; Sleeman 1987). The discovery of a goniatite (*Ammonellipsites*) from Minane Quarry (Naylor *et al.* 1983) suggest a Courceyan age for the base of the Lispatrick Formation here. The possibility of a similar age for the base of the formation at the Old Head has already been noted.

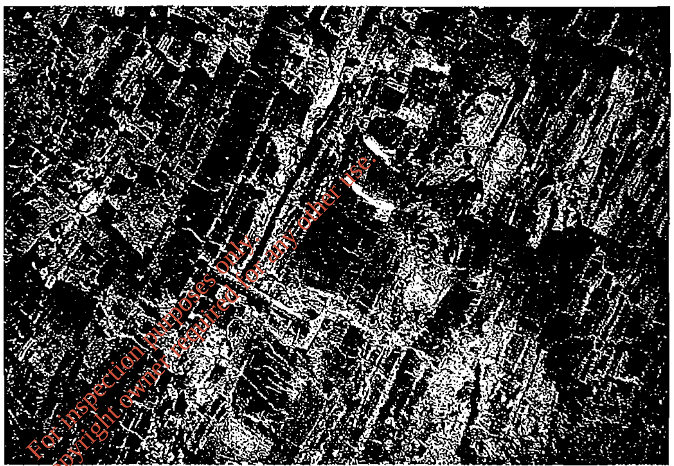

Plate 5. Bedded cherts from Minane Quarry (at Minane Bridge), Lispatrick Formation. These rocks are the basinal down-slope equivalents of the cherty Loughbeg Formation on the shelf edge (photo by A.G. Sleeman).

At Rag Bridge, southeast of Innishannon, the Lispatrick Formation has been drilled fairly extensively by Riofinex. Here black cherty shales interbedded with limestone breccias (similar to those at Meadstown) rest on limestones and calcareous shales of the "Innishannon Limestones" (Courtmacsherry Formation)[9]. Only about 4km further eastwards, however, the Lispatrick Formation mudstones are in juxtaposition with the Kinsale Formation due to strike parallel faulting.

White Strand Formation

The Namurian White Strand Formation is 44m thick at the Old Head of Kinsale, where the top is not reached. At Ballinglanna, however, Naylor *et al.* (1988) record a thickness of 346m. The outcrop of

[9] Work in progress (Naylor, Sevastopulo and Sleeman). Northwest of Inishannon itself, in the Kilpatrick Syncline, the Lispatrick Formation may occupy the centre of the syncline (Sleeman unpublished).

the formation in the Cloyne Syncline (between Meadstown and Inishannon) is probably of the same order of thickness.

This formation is the youngest formation present on the South Cork mapsheet and is of Pendleian or Arnsbergian age (E1 - ?H goniatite subzone).

At the type section the formation consists of sandstones up to 0.7m thick, interbedded with brittle, commonly pyritic, grey mudstones. The ratio of sandstone to mudstone is approximately 1:3. Much of the lower part of the formation is strongly slumped. Its base istaken at the abrupt entry of sandstones on the southern side of White Strand Point.

In the Cloyne Syncline, the formation is poorly exposed, but comprises a mixed sequence of grey silty mudstones and dark-grey to khaki or greeny-grey medium to coarse grained sandstones; it is easily mistaken in the field for the Cuskinny Member of the Kinsale Formation (Sleeman 1987). Outcrops at Ballyheady Church west of Ballinhassig have yielded Namurian miospores of the NC Biozone (Sleeman 1987) and Coelacanth fish remains (Huxley 1866).

At Ballinglanna miospores belonging to the NC Biozone have been found 41m above the base and miospores of the SO Biozone at the top of the formation as exposed (Naylor *et al.* 1988).

Carboniferous Limestones

"THE LOWER LIMESTONE SHALE"

The standard succession through the "Lower Limestone Shales" on the North Munster Shelf to the north of this mapsheet comprises the Mellon House, Ringmoylan and Ballyvergin Shale Formations respectively (table 2). The northern half of mapsheet 25 is geographically in a transitional position between the basinal succession of the South Munster Basin and the shallow water North Munster Shelf succession outlined above. Consequently aspects of both sequences can be seen in juxtaposition in the Cork, Riverstown, Ardmore and Clashmore Synclines. The shelf succession is also laterally very variable, so a series of laterally equivalent units have been proposed in different areas (e.g. Sleeman *et al.* 1978; MacCarthy *et al.* 1978; Campbell 1988; Tietzsch-Tyler *et al.* 1994).

Crows Point Formation

The Crows Point Formation, restricted to the Youghal, Ardmore and Helvick Head areas of East Cork and Waterford, is the lateral equivalent on the southern edge of the North Munster Shelf of the Cuskinny and Pig's Cove Members (Kinsale Formation) further south. The formation differs from the Kinsale Formation in being sandstone dominant (92% at the type section - MacCarthy *et al.* 1978). It probably equates with part of the Mellon House Formation further north on the shelf.

At the type section, at Helvick Head just northeast of this mapsheet, the formation is 73m thick (although the bottom contact is faulted and the top is not seen). The formation here comprises mainly thick, parallel-sided, massive and epsilon cross-stratified grey sandstones, interbedded with minor thin cross-stratified grey sandstones, grey mudstones and heterolithic lithologies (MacCarthy *et al.* 1978; MacCarthy 1979).

Plate 6. Megaripples developed on a bedding surface of grey sandstones in the Crows Point Formation, Whiting Bay, Co. Waterford (photo by A.G. Sleeman).

At Crushea (Ballyquinn, north of Ardmore) and Whiting Bay, however, where only the presumed top of the formation is exposed, sandstones with interbedded burrowed weathered mudstones and decalcified sandstones occur. These sequences also contain appreciable quantities of quartz-pebble conglomerates lining the bases of sandstones

Appendix 4C

Geological Heritage Correspondence

Mott MacDonald

From: Sarah Gatley [Sarah.Gatley@gsi.ie]
Sent: 09 July 2007 15:34
To: Freyne, Orla
Subject: RE: 234541 (A5670 Cork Lower Harbour WWTP EIS) - Geological Heritage

Dear Orla,

With reference to your enquiry on geological heritage sites in the Cork Harbour region, I have attached an xls. showing 3 sites of geological heritage interest in the area. I do not see any potential impacts from your proposed Waste Water Treatment Plant development; this is mostly for your information. As you can see from the 'Cork Harbour' entry, details of the extent of the raised beach feature have not been resolved, but I see that few of your proposed pipes are mapped for the foreshore areas.

I am sure that you are already aware of the biodiversity NHAs in this area; namely Loughbeg, Monkstown Creek and Owenboy River (?proposed foreshore pipe runs along the north bank).

If development does proceed (all other factors considered), GSI would much appreciate a copy of reports detailing site investigations undertaken. The data would be added to GSI's national database of site investigation boreholes, implemented to provide a better service to the civil engineering sector.

We would also appreciate notification of any ground excavations etc. carried out that might provide good geological exposures for our examination and enhance our understanding of the area. This would allow recording, fossil or rock sample collecting and gathering of new data.

Should any significant bedrock cuttings be created, we would request that they be designed to remain available as rock exposure rather than covered with soil and vegetated.

I hope that these comments will be of assistance, and if the GSI can be of any further help, please contact me.

Kind regards

Sarah

Dr Sarah Gatley
Senior Geologist, Head IGH Programme
Geological Survey of Ireland
Beggars Bush
Haddington Road
Dublin 4
Tel(Dir) +353-1/01 6782837
Fax: +353-1/01 6782559
Email: <mailto:sarah.gatley@gsi.ie>
Website: www.gsi.ie
Latest GSI Newsletter: www.gsi.ie/newsletters/

Theme Site No.	Site Name	County	Sheet No. 6 inch	Sheet No. 1:50,000	Easting	Northing	Principal characteristics Critical feature(s) key words	Townland(s)/district	Grid Ref.	Nominated by or ex-ASI site?	Summary description	definite NHA	NHA?	Definite CGS	Key references	IGH Theme - Primary	IGH Theme - Secondary	IGH Theme- Tertiary	Comments	Possible site report author bold red means agreed to do it	Age/Type	Colour Code
IGH8	Lough Beg Section	Cork		87	178000	063000		Loughbeg, Curraghbinny	W 78 63		Coastal section. Armour stone		NHA?		Sleeman, A.G., Thombury, B. and Sevastopulo, G.D. The Stratigraphy of the Courceyan (Carboniferous; Dinantian) Rocks of the Cloyne Syncline, West of Cork Harbour. *Irish Jnl. Earth Sci.* 8, 1986, 21-40.	IGH8 Lower Carboniferous					Carboniferous	
IGH8	Ringaskiddy, Golden Rock	Cork	87	87	179000	064000		Ringaskiddy	W 79 64					CGS		IGH8 Lower Carboniferous					Carboniferous	
IGH13	Cork Harbour	Cork		87, 81	181000	061000	ORS, structural features, raised beaches		N/A		On the western side of Cork Harbour is the Crosshaven Peninsula, where the Old Red Sandstone comes up in a Southern Anticline trending east-west, exposed on Weaver's Point, flanked by Carboniferous Limestone to the north. An emerged ("raised") beach can be traced around the shores of Cork Harbour, but there are discrepancies in the levels of Late Quaternary sediment sequence levels on either side of the harbour which could result from Holocene warping (Devoy). Near Rostellan on the eastern side of the bay a dolmen (megalithic tomb) a dolmen built 3000-4000 years ago is submerged at high tide.				Farrington, A. 1966 The early glacial raised beach in County Cork. Sci Proc Roy Dublin Soc A, 2: 197-219.	IGH13 Coastal Geomorphology			grs refer to Weaver's Point, W.Cork harbour -sg			

Appendix 4D

Well Search Results

Mott MacDonald

GEOLOGICAL SURVEY OF IRELAND

GROUNDWATER DATABASE

List of abbreviations

GSIHolename. 1:25,000 sheet Number and number of the well on that sheet

EASTING (E) & NORTHING (N) Grid Reference of the well

Grid Acc or Acc Accuracy level, refers to the accuracy of the grid reference.

1 = 10m	5 = 200m	9 = 5km
2 = 20m	6 = 500m	10 = 10km
3 = 50m	7 = 1km	
4 = 100m	8 = 2km	

Schemename Name of the person or organisation who own the well.

Townland Name of the area where the well is located

Co. County i.e. DO = County Donegal

Six or Six" 1:10,560 sheet number (6" sheet number)

InvType Well Type:

WD = Dug Well	WB = Bored Well
WS = Spring	WU = Unknown

U Usage:

A = Agricultural use only	B = Agricultural & Domestic use
D = Domestic use only	G = Group Scheme
I = Industrial use	P = Public Supply
O = Other	

Y or Yield Class Yield:

F = Failure	P = Poor (<40m^3/d)
M = Moderate (40 – 100m^3/d)	G = Good (100 – 400m^3/d)
E = Excellent (>400m^3/d)	U = Unknown

Depth Total depth of the well in metres

DTB Depth to bedrock in metres

Yield Usually yield obtained during initial well testing in m^3/day

SpeCap_Abstract Discharge/ Drawdown m^3/day/ m (from yield test or abstraction data)

MainAquifer Lith. General description of the geological unit supplying water to the well.

AveDailyAbstract m^3/day

WaterStrike Metres below dipping reference – ground level unless stated otherwise

[illegible]HOLENAME	EASTING	NORTHING	GRID_ACCURACY	TOWNLAND	TOWN	SIXINCH	INVTYPE	USAGE	STARTDATE	DTB	DEPTH	DTB_CONFID	COMPANYHOLE NAME	SCHEMENAME	CASING1DIAMETER	YIELD	YIELD CLASS
[illegible]5SWW047	17393	6305	8	BALLINDEASIG		113	WB	U	01/04/1963	3.7	15.2	Bedrock Met				28	P
1705NWW077	17627	6468	3	BALLINTAGGART		87	WB	U	01/10/1995	17	25	Bedrock Met	C2				
1705NWW078	17628	6463	3	BALLINTAGGART		87	WB	M	01/10/1995	14	23	Bedrock Met	C1				
1705NWW079	17629	6459	3	BALLINTAGGART		87	WB	M	01/10/1995	18.5	23.5	Bedrock Met	C3				
1705NWW006	18213	6835	8	BALLYDANIEL MORE		74	WB	U	01/07/1967	3.7	30.5	Bedrock Met		WTB/CK 2372		32.7	P
1705NWW017	18106	6819	6	BALLYDULEA		87	WB	U	01/06/1973	4.3	30.5	Bedrock Met				32.7	P
1705NWW100	17924	6817	1	BALLYLEARY		87	WB		28/08/2001	6	6	Bedrock Met	1705NW D12				
1705NWW021	18238	6763	7	BALLYMORE		88	WB	U	01/06/1970	3	23.5	Bedrock Met		WTB/CK 5971		32.7	P
1705NWW018	18238	6769	7	BALLYMORE		87	WB	U	01/10/1971	5.5	27.4	Bedrock Met				32.7	P
1705NWW116	18264	6791	3	BALLYMORE	Cobh	87	WB	B		3.7	56.4	Bedrock Met	DWG 1918		165	16.4	P
1705NWW005	18002	6880	7	BALLYNACRUSHA		74	WB	U	01/04/1971	3.7	24.7	Bedrock Met				38.2	P
1705NWW040	18032	6855	2	BALLYNACRUSHA		87	WB	D	03/07/1998	4.3	46.6	Bedrock Met				43.6	M
1705NWW115	18231	6273	4	CARLISLE FORT	Whitegate	87	WB	B	03/08/2001	6	44.2	Bedrock Met	DWG 2653		165	43.6	M
1705NWW020	17345	6321	9	CARRIGALINE		87	WB	U	01/01/1966	3.1	45.7	Bedrock Met				28	P
1705NWW032	17532	6328	3	CARRIGALINE EAST		87	WB	B	01/11/1983		45.7	Bedrock Not Met				300	G
1705NWW029	17380	6170	7	COMMEEN		99	WB	U	01/05/1971	3.4	25.6	Bedrock Met				32.7	P
1705NWW028	17382	6169	7	COMMEEN		99	WB	U	01/05/1971	3.7	19.5	Bedrock Met				32.7	P
1705NWW087	17740	6257	5	CURRAGHBINNY		87	WB	I	12/12/1999	1	20	Bedrock Met	1979/TW-2		150	272.5	G
1705NWW086	17846	6261	5	CURRAGHBINNY		87	WB	I	09/12/2000	1.5	15	Bedrock Met	1979/TW-1		150		
1705NWW016	18155	6743	6	CUSKINNY		87	WB	U	01/05/1971	2.1	22.9	Bedrock Met				32.7	P
1705NWW004	18063	6902	7	FANICK		74	WB	U	01/07/1961	1.8	19.2	Bedrock Met				10.9	P
[illegible]05NWW007	17827	6935	8	MARINO		74	WB	U	01/05/1970		27.4	DTB Unknown				21.8	P
[illegible]5NWW019	17356	6793	7	OLD COURT		87	WB	U	01/10/1970	2.4	35.1	Bedrock Met				43.6	M
[illegible]05NWW068	17431	6552	4	RAFFEEN		87	WB	D	19/05/1998	6.1	50.3	Bedrock Met				49.1	M
1705NWW082	17442	6472	8	RAFFEEN		87	WB	O	22/05/1986	10	30	Bedrock Met	BH3	CORK CO CO			
1705NWW083	17442	6477	8	RAFFEEN		87	WB	O	20/05/1986	0	13.5	Bedrock Met	BH2	CORK CO CO			
1705NWW081	17443	6482	8	RAFFEEN		87	WB	O	19/05/1986	1	10	Bedrock Met	BH1	CORK CO CO			
1705NWW080	17443	6485	8	RAFFEEN		87	WB	O	01/05/1986	2	36.5	Bedrock Met	BH4	CORK CO CO			
1705NWW015	17444	6490	7	RAFFEEN		87	WB	U	01/08/1973	2.4	54.9	Bedrock Met				43.6	M
1705NWW098	17453	6367	1	RAFFEEN		87	WB		03/09/2001	5	5	Bedrock Met	1705NW D10				
1705NWW036	17521	6542	3	RAFFEEN		87	WB	O	21/11/1997	0	26	Bedrock Met	B3	CORK CO CO	150		
1705NWW038	17522	6539	3	RAFFEEN		87	WB	O	20/01/1998	0	13.9	Bedrock Met	F3	CORK CO CO			
1705NWW037	17527	6529	3	RAFFEEN		87	WB	O	20/11/1997	0	26	Bedrock Met	B4	CORK CO CO	150		
1705NWW039	17538	6526	3	RAFFEEN		87	WB	O	23/01/1998	0	18	Bedrock Met	F4	CORK CO CO			
1705NWW072	17670	6310	4	RAHEENS EAST		87	WB	O	01/11/1985	2.5	91	Bedrock Met		WHEAT INDUSTRIES			U
1705NWW092	17617	6732	1	RATHANKER		87	WB		08/08/2001	2	2	Bedrock Met	1705NW D4				
1705NWW048	17877	6305	5	RINGASKIDDY		87	WB	O	01/07/1997	11.8	15.3	Bedrock Met		G/T WARNER LAMBERT			
1705NWW047	17877	6312	5	RINGASKIDDY		87	WB	O	01/02/1998	7.3	10.5	Bedrock Met	WD3A	G/T WARNER LAMBERT			
1705NWW049	17879	6302	5	RINGASKIDDY		87	WB	O	01/07/1997	9.5	14.5	Bedrock Met		G/T WARNER LAMBERT			
1705NWW045	17879	6303	2	RINGASKIDDY		87	WB	O	01/02/1998	1.5	7	Bedrock Met	WD1	G/T WARNER LAMBERT			
1705NWW046	17880	6316	5	RINGASKIDDY		87	WB	O	01/02/1998	2	6	Bedrock Met	WD2	G/T WARNER LAMBERT			
1705NWW050	17883	6298	5	RINGASKIDDY		87	WB	O	01/07/1997	6	9	Bedrock Met	WD3	G/T WARNER LAMBERT			
[illegible]05NWW041	17883	6304	2	RINGASKIDDY		87	WB	O	01/07/1997	15	21	Bedrock Met	RC1	G/T WARNER LAMBERT			
[illegible]5NWW042	17883	6306	2	RINGASKIDDY		87	WB	O	01/07/1997	4	10.5	Bedrock Met	RC2	G/T WARNER LAMBERT			
[illegible]05NWW051	17885	6293	5	RINGASKIDDY		87	WB	O	01/07/1997	1.5	4.5	Bedrock Met	WD11	G/T WARNER LAMBERT			
1705NWW044	17888	6315	2	RINGASKIDDY		87	WB	O	01/07/1997	12.5	17.5	Bedrock Met	RC9	G/T WARNER LAMBERT			
1705NWW052	17889	6319	5	RINGASKIDDY		87	WB	O	01/07/1997	4.5	7.5	Bedrock Met	WD34	G/T WARNER LAMBERT			
1705NWW053	17892	6315	5	RINGASKIDDY		87	WB	O	01/07/1997	1.5	5	Bedrock Met	WD35	G/T WARNER LAMBERT			
1705NWW056	17893	6303	5	RINGASKIDDY		87	WB	O	01/07/1997	12.3	15.5	Bedrock Met	WD41	G/T WARNER LAMBERT			
1705NWW055	17894	6306	5	RINGASKIDDY		87	WB	O	01/07/1997	4.5	8	Bedrock Met	WD40	G/T WARNER LAMBERT			
1705NWW054	17894	6311	5	RINGASKIDDY		87	WB	O	01/07/1997		19	Bedrock Not Met	WD39	G/T WARNER LAMBERT			
1705NWW043	17895	6305	2	RINGASKIDDY		87	WB	O	01/07/1997	5.1	11	Bedrock Met	RC5	G/T WARNER LAMBERT			
1705NWW058	17897	6296	5	RINGASKIDDY		87	WB	O	01/07/1997	4.5	7.5	Bedrock Met		G/T WARNER LAMBERT			
1705NWW057	17898	6299	5	RINGASKIDDY		87	WB	O	01/07/1997	5.5	10	Bedrock Met	WD42	G/T WARNER LAMBERT			
1705NWW113	17528	6938	3	ROCHESTOWN	Passage West	75	WB	B		1.5	68.6	Bedrock Met	DWG 2498		162.5	10.9	P
1705NWW097	18095	6978	1	ROSSLAGUE		75	WB		16/08/2001		10.3	Bedrock Not Met	1705NW D9				
1705NWW096	18121	6991	1	ROSSLAGUE		75	WB		16/08/2001		10	Bedrock Not Met	1705NW D8				
1705NWW095	18126	6913	1	ROSSLAGUE		75	WB		16/08/2001	0.5	0.5	Bedrock Met	1705NW D7				
1705NWW111	18126	6965	3	ROSSLAGUE	Cobh	75	WB	B			13.1	Bedrock Not Met	DWG 2385		165	65.5	M
1705NWW076	17493	6458	3	SHANBALLY		87	WB	I	01/01/1973	6.1	61	Bedrock Met		PFIZERS CHEMICALS (WELL 5A)		802	E
1705NWW067	17530	6390	5	SHANBALLY		87	WB	O	01/10/1997		12.8	Bedrock Not Met	BH8	IDA NEPTUNE PROJECT (SEAGATE)			
1705NWW066	17530	6396	5	SHANBALLY		87	WB	O	01/10/1997		9.7	Bedrock Not Met	BH7	IDA NEPTUNE PROJECT (SEAGATE)			
1705NWW065	17530	6402	5	SHANBALLY		87	WB	O	01/10/1997	6.5	6.5	Bedrock Presumed	BH6	IDA NEPTUNE PROJECT (SEAGATE)			
1705NWW060	17530	6418	5	SHANBALLY		87	WB	O	01/10/1997	14	14.1	Bedrock Met	BH1	IDA NEPTUNE PROJECT (SEAGATE)			
1705NWW061	17530	6423	5	SHANBALLY		87	WB	O	01/10/1997		7.2	Bedrock Not Met	BH2	IDA NEPTUNE PROJECT (SEAGATE)			
[illegible]5NWW062	17530	6428	5	SHANBALLY		87	WB	O	01/10/1997		14.3	Bedrock Not Met	BH3	IDA NEPTUNE PROJECT (SEAGATE			
[illegible]5NWW064	17531	6406	5	SHANBALLY		87	WB	O	01/10/1997		7.6	Bedrock Not Met	BH5	IDA NEPTUNE PROJECT (SEAGATE)			
1705NWW063	17531	6412	5	SHANBALLY		87	WB	O	01/10/1997		14.1	Bedrock Not Met	BH4	IDA NEPTUNE PROJECT (SEAGATE)			
1705NWW075	17535	6450	3	SHANBALLY		87	WB	I	01/01/1973	7	56.4	Bedrock Met		PFIZERS CHEMICALS (WELL 14A)		632	E
1705NWW014	17548	6458	3	SHANBALLY		87	WB	I	01/03/1980	5.5	49.7	Bedrock Met	Well 15B	PFIZER LTD		1374.7	E

GSIHOLENAME	PROD_CLASS	ABSTRACTDDOWN	WATERSTRIKE_1	MAINAQUIFER_MLITH	WATERSTRIKE_2	WATERSTRIKE_3	SPECAP_ABSTRACTION	COMMENTS	COMMENTS	CWCOMMENTS
[illegible]5SWW047				ORS				w/ck 7209		
[illegible]705NWW077								b/hole c2		
1705NWW078				GRAVEL/SILT/LIMESTONE				b/hole c1		
1705NWW079								b/hole c3		
1705NWW006				RED SANDSTONE						
1705NWW017				BROWN SANDSTONE				wtb/ck 10487		
1705NWW100										
1705NWW021				BROWN SANDSTONE						
1705NWW018				BROWN SANDSTONE				wtb/ck 9644		
1705NWW116	V	45.7	9.1	SANDSTONE	19.8	45.7	0.36	Drilled by Southern Pumps Ltd□□Chemical data available	Rotary.□□Location from site r	Clear and good quality
1705NWW005										
1705NWW040								Drilled by Dominick Harte		
1705NWW115	IV	11.3	13.7		36.6		3.87	DtB inferred from casing□□Drilled by Southern Pumps Ltd	Rotary.□□Location from site r	Clear
1705NWW020								wtb/ck 3394		
1705NWW032				SAND				another well on site drilled to 27m, no other info		
1705NWW029				BROWN SANDSTONE						
1705NWW028				SANDSTONE				wtb/ck 8997		
1705NWW087			18	LIMESTONE	26					
1705NWW086			12	LIMESTONE						
1705NWW016				BROWN SANDSTONE				wtb/ck 9337		
1705NWW004				ORS				w/ck 1668		
[illegible]705NWW007				SANDSTONE				lined 9.14m		
[illegible]5NWW019								wtb/ck 8696		
[illegible]705NWW068								Drilled by Southern Pumps Ltd		
1705NWW082								drilled by dunnes/bhole no3		
1705NWW083				MUDSTONE				drilled by dunnes/b/hole no 2		
1705NWW081								drilled by dunnes b/hole no1		
1705NWW080				MUD & SANDSTONE				drilled by dunnes/b/hole no.4		
1705NWW015				BROWN SANDSTONE				wtb/ck 10271		
1705NWW098										
1705NWW036								site invest & monitoring @ raffeen landfill bh-b3	Raffeen Landfill Site	casing surrounded by pea gravel from 2.5 to 26m□
1705NWW038				SHALE				site invest & monit @ raffeen landfill bh-f3	Raffeen Landfill Site	
1705NWW037								site invest & monitor @ raffeen landfill Site bh-b4	Raffeen Landfill Site	Pea gravel 2.5 to 26m
1705NWW039				SHALE				site invest & monit @raffeen landfill bh-f4	Raffeen Landfill Site	
1705NWW072			5.5	LIMESTONE				see file 3.1.4 v. little water		
1705NWW092										
1705NWW048				LIMESTONE				site invest petits rotary percussive bhole wd1		
1705NWW047								site invest petits rotary percussive bhole wd3a (bh3 on map)		
1705NWW049				LIMESTONE				site invest petits rotary percussive bhole wd2		
1705NWW045				LIMESTONE				site invest by Pettits rotary percussive b/hole wd1 (bh1)		
1705NWW046				LIMESTONE				site invest by petits rotary percussive b/hole wd2 (bh2)		
1705NWW050				LIMESTONE				site invest by petits rotary percussive bhole wd3		
[illegible]705NWW041				LIMESTONE				site invest report by Pettits rotary coring b/hole c1		
[illegible]5NWW042				LIMESTONE				site invest by Pettits rotary coring- bhole c2		
[illegible]05NWW051				LIMESTONE				site invest by petits rotary percussive bhole wd11		
1705NWW044				LIMESTONE				site investigation by Pettits rotary coring b-hole c9		
1705NWW052				LIMESTONE				site invest by petits rotary percussive bhole wd34		
1705NWW053								site invest by petits rotary percussive bhole wd35		
1705NWW056								site invest by petits rotary percussive bhole wd41		
1705NWW055								site invest by petits rotary percussive bhole wd40		
1705NWW054								site invest by petits rotary percussive bhole wd39 (skipped 38)		
1705NWW043				LIMESTONE				site invest by Pettits rotary coring b/hole c5		
1705NWW058				LIMESTONE				site invest by petits rotary percussive bhole wd_		
1705NWW057								site invest by petit's rotary percussive b/hole wd42		
1705NWW113	V		48.77	MUDSTONE	60.96		0.22	unknown□□Drilled in Sept 2001□□Chemical data available	Rotary.□□Location from site r	Ok quality
1705NWW097										
1705NWW096										
1705NWW095										
1705NWW111			13.1	GRAVEL				Chemical data available	Rotary.□□Location from site r	OK quality; 72 hr test
1705NWW076	I	8.5		LIMESTONE			94.35	from files in Core room -log and Q and ddwn		
1705NWW067								SITE INVEST BY GEOTECH SHELL & AUGER BH8		
1705NWW066								SITE INVEST BY GEOTECH SHELL & AUGER BH7		
1705NWW065								SITE INVEST BY GEOTECH SHELL & AUGER BH6		
1705NWW060								site invest by geotech shell & auger BH-1		
1705NWW061								site investigation by geotech shell & auger bh2		
[illegible]5NWW062								site invest by geotech shell & auger bh3		
[illegible]5NWW064								SITE INVEST BY GEOTECH SHELL & AUGER BH5		
1705NWW063								site invest by geotech shell & auger bh4		
1705NWW075	II	13.7		LIMESTONE			46.13	from files in Core room-logs including Q and ddwn		
1705NWW014	I	7.3					188.32	new" well located on map from reg of abs AB/9/81"		

Appendix 5A

Air Quality Report

Mott MacDonald

ODOUR monitoring IRELAND

ODOUR & ENVIRONMENTAL ENGINEERING CONSULTANTS

Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath

Tel: +353 46 9437922
Mobile: +353 86 8550401
E-mail: info@odourireland.com
www.odourireland.com

AIR QUALITY CHAPTER FOR THE PROPOSED CORK HARBOUR MAIN DRAINAGE SCHEME TO BE LOCATED IN CORK CITY AND ENVIRONS.

PREPARED BY ODOUR MONITORING IRELAND ON BEHALF OF MOTT MACDONALD CONSULTING ENGINEERS,

PREPARED BY:	Dr. Brian Sheridan,
ATTENTION:	Ms. Orla Freyne
DATE:	16th Jan 2007
REPORT NUMBER:	2007.A393(4)
DOCUMENT VERSION:	Document Ver. 004
REVIEWERS:	Ms. Orla Freyne & Mr. Paul Kelly

TABLE OF CONTENTS

Document Amendment Record

Client: ***Mott MacDonald Consulting Engineers Ltd***

Title: Air quality environmental impact assessment of proposed Cork Harbour Main Drainage Scheme Cork Harbour Main Drainage Scheme to be located in Cork city and Environs.

Project Number: 2007.A393(4)			**Document Reference:** Air quality environmental impact assessment of proposed Cork Harbour Main Drainage Scheme Cork Harbour Main Drainage Scheme to be located in Cork city and Environs.		
2007A393(1)	Document for review	BAS	JWC	BAS	13/11/2007
2007A393(2)	Minor edits	OF	BAS	BAS	20/12/2007
2007A393(3)	Minor edits	OF & PK	BAS	BAS	07/01/2008
2007A393(4)	Minor edits	OF & PK	BAS	BAS	16/01/2008
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

ODOUR monitoring IRELAND

11.1. Air quality environmental assessment

11.1.1 Introduction

Odour Monitoring Ireland were commissioned to undertake a baseline air quality survey in order to assess the potential impact to air quality from the proposed Cork Harbour Main Drainage Scheme to be located in Cork city and Environs. This study will identify, describe and assess the impact of the development in terms of its impact on air quality.

The objective of the Cork Harbour Main Drainage Scheme is to provide wastewater treatment for the towns and villages in the lower Cork Harbour area. The main population centres to be served by the scheme include Cobh, Passage West/Glenbrook, Monkstown, Ringaskiddy (including Shanbally and Coolmore), Carrigaline and Crosshaven.

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. In addition, baseline speciated Volatile organic compound survey was performed in the vicinity of five major pumping stations located along the drainage network. These included Raffeen, West Beach, Monkstown, Church road and Carraigaloe 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.

This section should be read in conjunction with the site layout plans for the site.

11.1.2 Study methodology-Assessment Criteria

The EU has introduced several measures to address the issue of air quality management. In 1996, Environmental Ministers agreed a Framework Directive on ambient air quality assessment and management (Council Directive 96/62/EC). As part of the measures to improve air quality, the European Commission has adopted proposals for daughter legislation under Directive 96/62/EC. The first of these directives to be enacted, 1999/30/EC, has set limit values which replaced existing limit values under Directives 80/779/EEC, 82/884/EEC and 85/203/EEC in April 2001. The new directive, as relating to limit values for sulphur dioxide, lead, PM_{10} and nitrogen dioxide, is detailed in *Table 11.1.1* EU Council Directive 2000/69/EC defines limit values for both carbon monoxide and benzene in ambient air and is presented in *Table 11.1.2.*

The National Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002) transpose those parts of the "Framework" Directive 92/30/EC on ambient air quality assessment and management not transposed by Environment Protection Agency Act 1992 (Ambient Air Quality Assessment and Management) Regulations 1999 (S.I. No. 33 of 1999). The 2002 Regulations also transpose, in full, the 1st two "Daughter" Directives 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air and 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air.

Table 11.1.1. Irish and EU Ambient Air Standard (SI 271 of 2002 and 1999/30/EC).

Pollutant	Regulation	Limit Type	Margin of Tolerance	VALUE
Nitrogen Dioxide	1999/30/EC SI 271 of 2002	Hourly limit for protection of human health - not to be exceeded more than 18 times/year-1 hour average	50% until 2001 reducing linearly to 0% by 2010 for 199/30/EC 40% from the date of entry into force of these Regulations, reducing on 1 January 2003 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010 for SI 271 2002	200 μg/m^3 NO_2
		Annual limit for protection of human health-Annual	50% until 2001 reducing linearly to 0% by 2010 for 1999/30/EC 40% from the date of entry into force of these Regulations, reducing on 1 January 2003 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010 for SI 271 2002	40 μg/m^3 NO_2
		Annual limit for protection of vegetation-Annual	None	30 μg/m^3 NO + NO_2
Lead	1999/30/EC	Annual limit for protection of human health-Annual average	100% until 2001 reducing linearly to 0% by 2005	0.5 μg/m^3
Sulphur Dioxide	1999/30/EC SI 271 of 2002	Hourly limit for protection of human health – not to be exceeded more than 24 times/year-1 hour average	43% until 2001 reducing linearly until 0% by 2005 for 199/30/EC 90 μg/m^3 from the date of entry into force of these Regulations, reducing on 1 January 2003 and every 12 months thereafter by 30 μg/m^3 to reach 0 μg/m^3 by 1 January 2005 for SI 271 of 2002	350 μg/m^3
		Daily limit for protection of human health – not to be exceeded more than 3 times/year-24hr average	None	125 μg/m^3
		Annual & Winter limit for the protection of ecosystems-Annual	None	20 μg/m^3

Table 11.1.1 continued. Irish and EU Ambient Air Standard (SI 271 of 2002 and 1999/30/EC).

Particulate Matter Stage 1	1999/30/EC SI 271 of 2002	24-hour limit for protection of human health - not to be exceeded more than 35 times/year-24 hour average	50% until 2001 reducing linearly to 0% by 2005 for 1999/30/EC 30% from the date of entry into force of these Regulations, reducing on 1 January 2003 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2005 for SI 271 of 2002	50 µg/m^3 PM_{10}
		Annual limit for protection of human health-Annual	20% until 2001 reducing linearly to 0% by 2005 for 1999/30/EC 12% from the date of entry into force of these Regulations, reducing on 1 January 2003 and every 12 moths thereafter by equal annual percentages to reach 0% by 1 January 2005	40 µg/m^3 PM_{10}
Particulate Matter Stage 2	1999/30/EC SI 271 of 2002	24-hour limit for protection of human health - not to be exceeded more than 7 times/year-24 hour average	To be derived from data and to be equivalent to Stage 1 limit value for 1999/30/EC Not to be exceeded more than 28 times by 1 January 2006, 21 times by 1 January 2007, 14 times by 1 January 2008, 7 times by 1 January 2009 and zero times by 1 January 2010 for SI 271 of 2002	50 µg/m^3 PM_{10}
		Annual limit for protection of human health-Annual	50% until 2005 reducing linearly to 0% by 2010 for 1999/30/EC and SI 271 of 2002	20 µg/m^3 PM_{10}

Table 11.1.2. Irish and EU Ambient Air Standard (SI 271 of 2002 and 2000/69/EC).

Pollutant	Regulation	Limit Type	Margin of Tolerance	VALUE
Benzene	2000/69/EC SI 271 of 2002	Annual limit for protection of human health	100% until 2003 reducing linearly to 0% by 2010 for 2000/69/EC 100% from the date of entry into force of these Regulations, reducing on 1st January 2006 and every 12 months thereafter by 1 µg/m³ to reach 0 µg/m³ by 1st January 2010	5 µg/m³
Carbon Monoxide	2000/69/EC SI 271 of 2002	8-hour limit (on a rolling basis) for protection of human health	50% until 2003 reducing linearly to 0% by 2005 for 2000/69/EC 6 mg/m³ from the date of entry into force of these Regulations, reducing on 1st January 2003 and every 12 months thereafter by 2 mg/m³ to reach 0 mg/m³ by 1st January 2005	10 mg/m³

11.2. Receiving environment-Air

11.2.1 General

The objective of the Cork Harbour Main Drainage Scheme is to provide wastewater treatment for the towns and villages in the lower Cork Harbour area. The main population centres to be served by the scheme include Cobh, Passage West/Glenbrook, Monkstown, Ringaskiddy (including Shanbally and Coolmore), Carrigaline and Crosshaven.

The proposed development includes for the construction of a wastewater treatment plant, which will include for sludge treatment, and a collection system to convey the waste water to the new plant. The proposed scheme also includes for upgrading the existing drainage network to modern standards and expanding the network in order to cater for the future needs of the area. The Scheme will be designed to meet the needs of the Cork Harbour Area to the year 2030. This section describes the existing drainage system, and the characteristics of the proposed development.

The proposed wastewater treatment plant is likely to be constructed using the Design/Build/Operate (DBO) procurement system. A Contractor will be appointed to Design, Build and Operate the wastewater treatment plant for a period of 20 years to achieve the required standards within defined design constraints. Therefore the exact details of the proposed development are not available at this stage.

Nevertheless, it is possible to describe the necessary level of treatment to be provided to achieve the required effluent treatment standards. The treatment requirements and treatment options are discussed in *Section 2.5*. In order to assess the environmental impact of the development indicative designs of the proposed Cork Harbour Waste Water Treatment Plant have also been undertaken. The indicative designs achieve the required discharge standards and described in detail in *Section 2.5.5*.

The proposed site consists of portions of two large agricultural fields located on sloping ground and currently used for pasture. The land has been zoned for industrial development (South Cork County Development Plan, 2005). The site has an area of approximately 7.35 hectares.

With the exception of a small Bord Gais substation, which adjoins the south-west corner of the site, the site is bordered on all sides by adjoining agricultural fields. The boundaries of the two fields consist primarily of managed, immature to semi-mature hedgerow. A large ESB substation is situated circa 200 metres west of the site and a sports field is located circa 100 metres to the northeast of the site.

According to the South County Cork Development Plan (2005), the site has been zoned for industrial development. It is also noted that there are proposals to construct a branch of the National Primary Route N28 to by-pass the villages of Shanbally and Ringaskiddy on lands immediately north of the site.

There are no existing site services. Access to the site will be provided via an existing access road to the Bord Gais substation currently bordering the site. The proposed site is located approximately 380 metres east of the minor road (locally known as Cogan's Road), which links to the N28 National Primary Route just east of Raffeen Bridge.

The proposed new route for the upgraded N28 from Cork to Ringaskiddy, which will run directly north of the site, will provide a buffer between the site and industrial lands to the north.

There is an area zoned for residential use ~140m east of the proposed WWTP site boundary. Planning applications for residential development have been granted in this area.

11.2.2 Baseline air quality

A total of ten 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 11.2.1* and presented in *Figure 11.7.1.*

Table 11.2.1. Description of air monitoring locations.

Reference	X cord (Irish National Grid)	Y cord (Irish National Grid)	Description of monitoring
A1-WWTP	174861	63796	NO2, SO2, BTEX, PM10, Total depositional dust, H2S-Monitored using passive diffusion tubes, Partisol PM10 analyser, Jerome analyser and Bergerhoff gauges.
A2-WWTP	175341	63619	NO2, SO2, BTEX, Total depositional dust, H2S-Monitored using passive diffusion tubes, Jerome analyser and Bergerhoff gauges.
A3-WWTP	175267	63938	NO2, SO2, BTEX, Total depositional dust, H2S-Monitored using passive diffusion tubes, Jerome analyser and Bergerhoff gauges.
A4-WWTP	175071	63891	NO2, SO2, BTEX, Total depositional dust, H2S-Monitored using passive diffusion tubes, Jerome analyser and Bergerhoff gauges.
A5-WWTP	174850	63999	NO2, SO2, BTEX, Total depositional dust, H2S-Monitored using passive diffusion tubes, Jerome analyser and Bergerhoff gauges.
A6-WWTP	174907	63837	Speciated VOC's and H2S-Monitored using pumped sorbent tube and Jerome analyser.
A7-WWTP	175257	63805	Speciated VOC's and H2S-Monitored using pumped sorbent tube and Jerome analyser.
A8-Raffeen PS	175442	65188	Monitored using pumped active sorbent tube. Monitoring of H2S using Jerome metre at 5 locations around the Pumping station.
A9-West beach PS	179799	66426	Monitored using pumped active sorbent tube. Monitoring of H2S using Jerome metre at 5 locations around the Pumping station.
A10-Monksland PS	176977	66081	Monitored using pumped active sorbent tube. Monitoring of H2S using Jerome metre at 5 locations around the Pumping station.
A11-Carrigaloe PS	177607	67511	Monitored using pumped active sorbent tube. Monitoring of H2S using Jerome metre at 5 locations around the Pumping station.
A12-Church Rd PS	174405	62628	Monitored using pumped active sorbent tube. Monitoring of H2S using Jerome metre at 5 locations around the Pumping station.

As a result of the existing site conditions and the potential for traffic, residential and amenity-derived pollution, the following parameters were monitored:

11.2.2.1 Benzene, Toluene, Ethyl benzene and ortho and para Xylene (BTEX)

Benzene, Toluene, Ethyl benzene, p/o xylene (BTEX) and other aromatic/alkanes are most likely derived from petrol driven vehicle exhausts. Heavier semi-volatile organic compounds are frequently derived from diesel-powered engines. Benzene is a known carcinogen, poisonous by inhalation and a severe eye and moderate skin irritant.

At each of the five monitoring locations (A1 to A5) (*see Figure 11.7.1 and Table 11.2.1*), the air quality was monitored for BTEX, over a 29-day period, using BTEX diffusion tubes. The sample tubes were analysed for BTEX at a UKAS accredited laboratory (ISO 17025) using gas chromatography flame ionisation detector. The results are presented in *Table 11.2.2.*

Table 11.2.2. Average BTEX concentrations at each location as measured by passive diffusion tubes.

Location	Benzene ($\mu g/m^3$) [1, 3]	Toluene ($\mu g/m^3$) [1,3]	Ethyl benzene ($\mu g/m^3$) [1,3]	p-Xylene ($\mu g/m^3$) [1,3]	o-Xylene ($\mu g/m^3$) [1,3]
A1[2]	0.695	0.256	0.183	0.256	0.121
A2[2]	0.143	0.361	0.428	0.312	0.224
A3[2]	0.270	0.233	0.418	0.249	0.186
A4[2, 7]	-	-	-	-	-
A5[2]	0.329	0.282	0.471	0.576	0.248
EPA value-Old station rd hourly median value[6]	0.20	-	-	-	-
Limit Value	**5[4]**	**4700[5]**	**10,875[5]**	**5525[5]**	**5525[5]**

Notes: [1] *denotes the lower limit of detection was 5.91 ηg of sorbed compound per tube;*
[2] *denotes sampling period July to August 2007;*
[3] *denotes Lower limit of detection 2.88 ng;*
[4] *denotes Irish and EU Ambient Air Standard (SI 271 of 2002 and 1999/30/EC);*
[5] *denotes No specific ambient air limits. Rule of thumb is using 1/40th of the 8-hour Occupational Exposure Limit as stated in the National Authority for Occupational Safety and Health 2002 "Code of Practice for the Safety, Health and Welfare at Work (Chemical Agents) Regulations".*
[6] *denotes Air Quality Monitoring Report, 2006-Old station Rd monitoring site;*
[7] *denotes location lost to vandalism.*

The results illustrated in *Table 11.2.2* for BTEX at A1 to A5 are all in compliance with Irish and EU limit values (i.e. SI 271 of 2002 and EU Directive 2000/69/EC) for Benzene. Average Benzene concentrations were up to 93% lower than the Irish and EU directive limit values. The rule of thumb for guidelines for ambient air quality of volatile organic compounds without legislative limit values is using 1/40th of the 8-hour Occupational Exposure Limit as stated in the National Authority for Occupational Safety and Health 2002 "Code of Practice for the Safety, Health and Welfare at Work (Chemical Agents) Regulations". Toluene, Ethyl benzene and Xylene isomers are well within their respective fractional exposure limit values.

11.2.2.2 Nitrogen dioxides (NO_2)

Nitrogen is a constituent of both the natural atmosphere and of the biosphere. When industrial metabolism releases nitrogen to the environment it is considered a "pollutant" because of its chemical form: NO, NO_2, and N_2O. These oxides of nitrogen can be toxic to humans, to biota, and they also perturb the chemistry of the global atmosphere. In the transportation sector, the NOx emissions result from internal combustion engines. In power plants and industrial sources, NOx is produced in boilers. The overwhelming fraction of nitrogen oxide emissions arises from the high temperature combustion of fossil fuels; emissions from metal-processing plants and open-air burning of biomass are insignificant.

Nitrogen dioxide is classed as both a primary pollutant and a secondary pollutant. As a primary pollutant NO_2 is emitted from all combustion processes (such as a gas/oil fired boiler or a car engine). Potentially, the main sources of primary NO_2 for the proposed development will be from vehicle exhausts.

As a secondary pollutant NO_2 is derived from atmospheric reactions of pollutants that are themselves, derived mainly from traffic sources (e.g. volatile organic compounds). Secondary pollution is usually derived from regional sources and may be used as an indicator of general air quality in the region. Nitrogen dioxide has been shown to reduce the pulmonary function of the lungs. Long-term exposure to high concentrations of NO_2 can cause a range of effects, primarily in the lungs, but also in the liver and blood.

At each of the five monitoring locations (A1 to A5) (*see Figure 11.7.1 and Table 11.2.1*), levels of NO_2 were measured using diffusion tubes, which were left on site for a 29-day period. The tubes were then analysed using UV spectrophotometer, at a UKAS accredited laboratory (ISO 17025), giving an average concentration over the 29-day period. The results are presented in *Table 11.2.3.*

Table 11.2.3. Average NO_2 concentrations at each location as measured by passive diffusion tubes.

Location	Sampling Period	Average NO_2 conc. ($\mu g/m^3$)[2]
A1	July to Aug 2007	6.00
A2	July to Aug 2007	4.82
A3	July to Aug 2007	4.86
A4	July to Aug 2007	6.06
A5	July to Aug 2007	6.76
EPA value-Old station Rd hourly max value[2]	2006	111
EPA value-Old station Rd Annual mean value[2]	2006	26
Limit value-Annual average	-	**40**
Limit value 1 hour average	-	**200**

Notes:[1] *denotes Lower limit of detection 0.003 µgNO_2;*
[2] *denotes Air Quality Monitoring Report, 2006-Wexford station;*

The dominant source of NO_2 in the area appears to be from motor vehicle exhausts and the burners/boiler of space heating of local light industry and business units. The measured concentrations of NO_2 at all monitoring locations are within the Irish and EU Ambient Air Standards. Monitoring locations A1 to A5 are an average 83% lower than currently established Irish and European ambient air regulatory levels for annual averages.

11.2.2.3 Sulphur dioxide (SO_2)

Sulphur dioxide is a colourless gas, about 2.50 times as heavy as air, with a suffocating faint sweet odour. Sulphur dioxide occurs in volcanic gases and thus traces of sulphur dioxide are present in the atmosphere. Other sources of sulphur dioxide include smelters and utilities, electrical generation, iron and steel mills, petroleum refineries, pulp and paper mills, metallurgical processes, chemical processes and the combustion of the iron pyrites, which are contained in coal. Small sources include residential, commercial and industrial space heating.

SO_2 can be oxidised to sulphur trioxide, which in the presence of water vapour is readily transformed to sulphuric acid mist. SO_2 is a precursor to sulphates, which are one of the main components of respirable particles in the atmosphere. Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, changes in the lung's defences, and worsening respiratory and cardiovascular disease. People with asthma or chronic lung or heart disease are the most sensitive to SO_2. It also damages trees and crops. SO_2, along with nitrogen oxides, are the main precursors of acid rain. This contributes to the acidification of lakes and streams, accelerated corrosion of buildings and reduced visibility. SO_2 also causes formation of microscopic acid aerosols, which have serious health implications as well as contributing to climate change.

At each of the five monitoring locations (A1 to A5) (*see Figure 11.7.1 and Table 11.2.1*), levels of SO_2 were measured using diffusion tubes, which were left on site for a 29-day period. The tubes were then analysed using Ion chromatography, at a UKAS accredited laboratory (ISO 17025), giving an average concentration over the 29-day period. The results are presented in *Table 11.2.4.*

Table 11.2.4. Average SO_2 concentrations at each location as measured by passive diffusion tubes.

Location	Sampling Period	Average SO_2 conc. ($\mu g/m^3$)[1]
A1	July to Aug 2007	1.64
A2	July to Aug 2007	1.75
A3	July to Aug 2007	1.32
A4	July to Aug 2007	1.60
A5	July to Aug 2007	1.18
EPA value-Old station Rd hourly max value[2]	2006	58
EPA value-Old station Rd daily max value[2]	2006	24
EPA value-Old station Rd Annual mean value[2]	2006	4
Limit value-Annual average		**20**
Limit value-Daily average		**125**
Limit value-Hourly average		**350**

Notes:[1] *denotes lower limit of detection 0.060 µgSO_4;*
[2] *denotes Air Quality Monitoring Report, 2006-Old station Rd,*

The dominant source of SO_2 in the area appears to be from motor vehicle exhausts and the burners/boiler/solid fuel heating local single residences and industrial units. The measured concentrations of SO_2 at all monitoring locations are within the Irish and EU Ambient Air Standards. Monitoring locations A1 to A5 are an average 91% lower than currently established Irish and European ambient air regulatory annual levels.

11.2.2.4 Carbon monoxide (CO)

Carbon monoxide is produced as a result of incomplete burning of carbon-containing fuels including coal, wood, charcoal, natural gas, and fuel oil. It can be emitted by combustion sources such as un-vented kerosene and gas heaters, furnaces, woodstoves, gas stoves, fireplaces and water heaters, automobile exhaust from attached garages, and tobacco smoke. Carbon monoxide interferes with the distribution of oxygen in the blood to the rest of the body. Depending on the amount inhaled, this gas can impede coordination, worsen cardiovascular conditions, and produce fatigue, headache, weakness, confusion, disorientation, nausea, and dizziness. Very high levels can cause death. The symptoms are sometimes confused with the flu or food poisoning. Foetuses, infants, elderly, and people with heart and respiratory illnesses are particularly at high risk for the adverse health effects of carbon monoxide.

Due to power and equipment safety issues existing baseline monitoring data from EPA monitoring sites was used for assessment of baseline Carbon monoxide air quality. The EPA monitoring location and results are presented in *Table 11.2.5.*

Table 11.2.5. Average ambient baseline CO concentrations for the proposed site development.

Location	Sampling Period	Ambient CO conc. (mg/m^3)
EPA - Annual mean - Old station Rd[1]	2006	0.50
EPA - 8 hour median value - Old station Rd[1]	2006	0.40
EPA-Maximum 8 hourly value - Old station Rd[1]	2006	2.80
Limit value-8 hour average[2]	**-**	**10**

Notes: *[1] denotes Air Quality Monitoring Report, 2006-Old station Rd,*
[2]denotes Irish and EU ambient air standard (SI 271 of 2002 and 2000/69/EC) as an 8 hour running average;

CO monitoring is also very limited in Ireland. Data sets developed by the EPA indicate 8 hour running average CO levels of between 0.10 and 0.80mg m^{-3} for 8 hour rolling averages, respectively for urban areas in Ireland. The dominant source of CO in this area would appear to be vehicle emissions, boilers (i.e. Home heating and Industrial heating), industrial processes and construction activities. The CO emissions measured in Old Station Road would be considered worst case in comparison to the proposed site location. CO emissions are on average 78% lower than Irish and EU ambient air limit values, which would be considered worst case in terms of exposure for the area (*see Table 11.2.5*).

11.2.2.5 Particulate matter (PM_{10})

Major sources of particulates include industrial/residential combustion and processing, energy generation, vehicular emissions and construction projects. The particulate matter created by these processes is responsible for many adverse environmental conditions including reduced visibility, contamination and soiling, but also recognised as a contributory factor to many respiratory medical conditions such as asthma, bronchitis and lung cancer. PM_{10} (Particulate Matter 10) refers to particulate matter with an aerodynamically diameter of 10 μm. Generally, such particulate matter remains in the air due to low deposition rates. It is the main particulate matter of concern in Europe and has existing air quality limits. In order to obtain a baseline PM_{10} for the proposed work area, a PM_{10} analyser was used to monitor the PM_{10} ambient concentration levels at one location (A1) within the vicinity of the proposed works. Continuous monitoring was performed over a 2-day period. The monitoring location is presented in *Figure 11.7.1 and Table 11.2.1.* Results are presented in *Table 11.2.6.*

Table 11.2.6. Average ambient PM_{10} concentrations in the vicinity of the proposed development.

Location	Sampling Period	Ambient PM_{10} conc. ($\mu g/m^3$)
A1-24 hour average	July 2007	22
A1-24 hour average	July 2007	31
EPA measured conc. – Old Station Rd, annual mean value [4]	2006	16
Limit Value at 98.07th percentile	-	50[1, 2]
Limit Value-annual mean Stage 1		40
Limit value-annual mean Stage 2		20[3]

Notes: *[1]denotes Irish and EU ambient air standard (SI 271 of 2002 and 1999/30/EC) as a 24-hour average;*
[2] denotes maximum number of exceedence 7 times in a one-year period;
[3] denotes annual limit value for Stage 2 implementation 2010;

[4] *denotes Air quality Monitoring Report, 2006-Old Station Rd.*

PM_{10} monitoring in Ireland is limited to continuous monitoring stations operated by the Local Authorities and the Irish EPA, mainly in large urban centres. Average 24-hour ambient air concentrations monitored at Old Station Rd, Cork would be considered worst case in this area. The EPA measured an annual mean of 16 $\mu g\ m^{-3}$ at this monitoring station. The dominant source of PM_{10} in the area appears to be vehicle emissions, boilers (i.e. Home heating and Industrial heating), industrial processes and construction activities. The average ambient PM_{10} concentrations are higher to those monitored by the EPA. Maximum-recorded ambient PM_{10} concentrations were on average 38% lower than the Irish and EU 24 hour ambient air quality limit value.

11.2.2.6 Total Depositional Dust

Total dust deposition was measured at the site using Bergerhoff gauges specified in the German Engineering Institute VDI 2119 entitled "Measurement of Dustfall Using the Bergerhoff Instrument (Standard Method)." Samples were collected at five locations (i.e. A1 to A5) over a 30-day period, as shown in *Figure 11.7.1*. The purpose of these monitors is to assess the baseline total depositional dust impact in the vicinity of the current site. The glass jars containing the dust were submitted to an accredited test house for analyses. The results are presented in *Table 11.2.7*.

Table 11.2.7. Total depositional dust levels at each monitoring location.

Sample Reference	Sampling period	Total Dust Deposition (Summer sampling period) (mg/m^2day)
A1	July to Aug 2007	66
A2	July to Aug 2007	78
A3	July to Aug 2007	94
A4	July to Aug 2007	62
A5	July to Aug 2007	87
EPA recommended Limit value	-	350

Currently in Ireland there are no statutory limits for dust deposition, however, EPA guidance suggest, "a soiling of $10mg/m^2/hour$ is generally considered to pose a soiling nuisance" (TA Luft 2002). This equates to $240mg/m^2/day$ of Total Depositional Dust. The EPA recommend a maximum level of $350mg/m^2day$ of dust deposition when measured according to TA Luft standard, which includes both soluble and insoluble matter (i.e. EPA compliance monitoring is based on the TA Luft Method). This value was not exceeded at any of the sample locations with all measured values at least 73% lower than the maximum recommended limit value.

11.2.2.7 Hydrogen sulphide

H_2S is commonly associated with wastewater handling operations. It is used as an indicator gas for the assessment of significant odour nuisance in the vicinity of waste water facilities. The current California Ambient Air Quality standard for hydrogen sulphide, based on a 1-hour averaging time, is 42 $\mu g\ m^{-3}$ (30 ppb). On this basis, the proposed REL of 10 $\mu g\ m^{-3}$ (8 ppb) is likely to be detectable by many people under ideal laboratory conditions, but it is unlikely to be recognized or found annoying by more than a few. It is therefore expected to provide reasonable protection from odour annoyance in practice. Based on a review of 26 studies, the average odour detection threshold ranged from 0.00007 to 1.4 ppm (Amoore, 1985). Hydrogen sulphide is noted for its strong and offensive odour. The geometric mean of these studies is 0.008 ppm. In general, olfactory sensitivities decrease by a factor of 2 for each 22 years of age above 20 (Venstrom and Amoore, 1968); the above geometric mean is based on the average age of 40. Laboratory experiments performed by Sheridan (2003) in California measured H_2S detection threshold at 2 $\mu g\ m^{-3}$ while the recognition odour threshold was 22 $\mu g\ m^{-3}$. At the current California Ambient Air Quality Standard (CAAQS) of 30 ppb, the level would be detectable by 83% of the population and would be discomforting to 40% of the population. These estimates have been substantiated by odour complaints and reports of nausea and headache (Reynolds and Kauper 1985) at 0.030 ppm H2S exposures from geyser emissions. The World Health Organization (WHO) recommends that in order to avoid substantial complaints about odour annoyance among the exposed population, hydrogen sulphide concentrations should not be allowed to exceed 0.005 ppm (5 ppb; 7 μg m^{-3}), with a 30-minute averaging time. The OEHHA (2000) adopted a level of 8 ppb (10 μg m^{-3}) as the chronic Reference Exposure Level (cREL) for use in evaluating long-term emissions from hot spots facilities. The only instrument capable of providing comparison with such reference levels is a Jerome meter analyser. These are real time data-logging H_2S analyser for the measurement of ambient hydrogen sulphide concentration levels (Sheridan, 2003).

An ambient H_2S profile monitoring exercise was carried out in the vicinity of the proposed WWTP site and five pumping stations using a pre-calibrated H_2S analyser (Jerome metre). Samples were taken approximately 1.2 meter above ground level. The analyser is a real time analyser with a range of detection from 3 ppb to 50 ppm. Samples were collected at twelve locations (i.e. A1, to A12). *Figures 11.7.1, to 11.7.6 and Table 11.2.1* illustrate each monitoring location. In order to maintain clarity within the document all 5 individual monitoring locations in the vicinity of the pumping stations are presented as one value as the ambient H_2S concentration were below instrumental limits of detection. The purpose of this monitoring is to assess the baseline H_2S in the vicinity of the sites. The results are presented in *Table 11.2.8.*

Table 11.2.8. Hydrogen sulphide levels at each monitoring location.

Monitoring location	Sampling period	Ambient air conc (μg/m3)
A1-WWTP	July 2007	<4.50
A2-WWTP	July 2007	6.0
A3-WWTP	July 2007	6.0
A4-WWTP	July 2007	7.50
A5-WWTP	July 2007	<4.50
A6-WWTP	July 2007	<4.50
A7-WWTP	July 2007	<4.50
A8-Raffeen PS	July 2007	<4.50
A9-West beach PS	July 2007	<4.50
A10-Monksland PS	July 2007	<4.50
A11-Carrigaloe PS	July 2007	<4.50
A12-Church Rd PS	July 2007	<4.50
Recommended limit	-	**7.50**

Currently in Ireland, there are no statutory limits for hydrogen sulphide concentrations in ambient air, however, guidance from the California Air Resources Board suggest an ambient air concentration level of less than 7.50 μg/m^3 to limit odour nuisance. This value was not exceeded at any of the sample locations. Elevated ambient concentrations above the lower limits of detection of the instrument method were detected at location A2, A3 and A4. There were no scheduled point emissions of Hydrogen sulphide in the vicinity of the site although; concentrations could be attributed to traffic movement on the nearby main road. Hydrogen sulphide is generated from side product reactions of exhaust emissions with the catalytic converter on diesel engines.

11.2.2.8 Speciated Volatile organic compounds (VOC's)

Speciated VOC's to include alkanes, Mercaptans, organic acids, aromatics and nitrogen containing organics in ambient air at elevated concentrations can lead to the formation of odours. In order to ascertain the baseline levels of speciated VOC's in the vicinity of the proposed site location, ambient pumped sampling of VOC's was performed in order to ascertain the baseline profile of such compounds in order to generate a baseline profile during no operation of the WWTP.

In order to pre-concentrate speciated VOC upon each sorbent, a pre-calibrated controlled volume of sample air was drawn through each tube by a pre-calibrated SKC constant flow sampling pump for a period range of 180 minutes (i.e. Active sampling/pumped sampling). Each SKC pump was pre-calibrated with their specific sorbent using a Bios Primary flow calibrator (NIST traceable certified) with calibration flow checked following the completion of the sample run. Each pump was calibrated to a flow rate of between 71 and 200 ml min^{-1} depending on the sample, sample pump and sorbent tube as recommended by the sorbent manufacturer, analysing laboratory and sampling/test methodology. When sampling was completed all tubes were sealed and stored in flexible air tight containers and transported to the gas chromatography laboratory and analysed by means of thermal desorption GCFID/GCMS in a UKAS accredited laboratory.

Samples were taken approximately 1.20 meter above ground level using two-bed silcosteel packed sorbent tubes on the 12th July 2007. Samples were collected at two locations across the proposed WWTP site (i.e. A6 and A7), and at one location in the vicinity of each of the five pumping stations (i.e. A8 to A12) as shown in *Figures 11.7.1 to 11.7.6 and Table 11.2.1*. The purpose of this monitoring is to assess the baseline speciated VOC concentration level and profile in the vicinity of the proposed site. The results are presented in *Tables 11.2.9 to 11.2.15*.

Table 11.2.9. Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A6-WWTP.

Compound identity	Ambient air conc. (μg/m³)
3-Butyn-1-ol	1.75
Benzaldehyde	0.58
Acetophenone	0.63
Nonanal	0.38
Decanal	0.40
Cyclododecane	0.56
Hexadecanal	0.99
Cyclohexadecane	13.20
Total VOC's	**26.02**

Table 11.2.10. Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A7-WWTP.

Compound identity	Ambient air conc. (μg/m³)
Benzaldehyde	0.65
Acetophenone	0.65
Nonanal	0.84
Decanal	0.66
Tetradecane	0.65
1-Hexadecene	0.57
Oxirane, tetradecyl-	1.49
Cyclohexadecane	4.09
Total VOC's	**25.64**

Table 11.2.11. Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A8-Raffeen PS.

Compound identity	Ambient air conc. ($\mu g/m^3$)
2,5-Furandione, dihydro-3-methylene-	7.43
3(2H)-Thiophenone, dihydro-2-methyl-	1.02
2,2-Dichlorocyclopropanecarboxamide	6.05
Cyclohexan-1,4,5-triol-3-one-1-carboxylic acid	1.61
2,4-Diethyl-6-methyl-1,3,5-trioxane	12.20
1-Tetradecene	2.03
Cyclohexadecane	5.54
Oxirane, heptadecyl-	1.45
1-Nonadecene	16.90
Total VOC's	**74.03**

Table 11.2.12. Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A9-West beach PS.

Compound identity	Ambient air conc. ($\mu g/m^3$)
2,5-Furandione, dihydro-3-methylene-	5.62
Formamide, N,N-dimethyl-	2.54
Ethanol, 2-butoxy-	2.19
Benzaldehyde	1.26
Acetophenone	0.82
Cyclotetradecane	1.03
1-Decanol, 2-hexyl-	19.44
1-Hexacosene	1.11
1-Heptadecanol	4.93
Total VOC's	**64.95**

Table 11.2.13. Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A10-Monkstown PS.

Compound identity	Ambient air conc. ($\mu g/m^3$)
2,5-Furandione, dihydro-3-methylene-	4.23
Nonanal	3.32
Ethanol, 2-butoxy-	1.19
2-Propanol, 1-[2-(2-methoxy-1-methylethoxy)-1-methylethoxy]-	1.16
Acetophenone	1.25
Cyclotetradecane	1.20
1-Decanol, 2-hexyl-	6.89
2,4-Diethyl-6-methyl-1,3,5-trioxane	5.42
1-Heptadecanol	2.23
Total VOC's	**54.23**

Table 11.2.14. Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A11-Carrigaloe PS.

Compound identity	Ambient air conc. (μg/m^3)
2,5-Furandione, dihydro-3-methylene-	5.42
2-Octanamine	0.66
Benzaldehyde	1.42
Acetophenone	1.22
2-Propanol, 1-[2-(2-methoxy-1-methylethoxy)-1-methylethoxy]-	1.17
2,4-Diethyl-6-methyl-1,3,5-trioxane	2.43
Cyclohexadecane	5.05
1-Hexadecanol	2.38
Total VOC's	**36.78**

Table 11.2.15. Speciated VOC profile and concentrations in the vicinity of the proposed site location at monitoring location A12-Church Road PS.

Compound identity	Ambient air conc. (μg/m^3)
Propane, 1-(ethenylthio)-	0.72
Benzaldehyde	1.03
Acetophenone	0.84
Nonanal	1.11
Decanal	1.18
Cyclohexadecane	6.20
Hexadecanal	3.39
Cyclohexadecane	6.45
Eicosane	0.52
Total VOC's	**49.37**

Currently in Ireland, there are no statutory limits for total volatile organic compound concentrations in ambient air, however, research data gathered by Odour Monitoring Ireland suggest an ambient air concentration level of less than 250 μg/m^3 to limit odour impact. The compounds detected in ambient air would be typical of emissions detected close to busy roadways and in agricultural locations. No background concentrations of Mercaptans or Sulphur containing organics were detected and the absence of such compounds suggests in general that odour air quality is good in the vicinity of the site. The profiles can be compared with any additional profiles measured when the facilities are operational in order to ascertain any increases in ambient air concentrations of speciated VOC's. The overall background level of speciated VOC's as total VOC's is generally low in the vicinity of all site locations.

11.3. Characteristics of the proposal

The proposed development consists principally of the construction of a large sized urban wastewater treatment plant to serve the population centres of Cork Lower Harbour and its' environs. The proposed wastewater treatment plant is an essential element of the Cork Lower Harbour Main Drainage Scheme. Associated works, which will be carried out as part of the proposed development, include:

- The widening of sections of the minor road to the west of the site
- The widening and upgrading of the site access road
- Marine crossing
- New wastewater pumping stations

- The laying of rising mains, surface water sewers and gravity wastewater sewers to direct the wastewater to the new treatment works
- New wastewater treatment works-

The treated wastewater will be discharged to Cork Lower Harbour via the existing IDA outfall. The overall area of the two fields on which this proposed wastewater treatment plant will be constructed is approximately 17.5 hectares. However, the fields are traversed by overhead high voltage electrical cables. By providing sufficient clearance from these power lines a suitable area of approx. 7.35 ha is available between the power lines. This area is considered adequate for the construction of the proposed wastewater treatment plant, including facilities for organic-material removal, nutrient removal, basic sludge treatment (if required) and appropriate landscaping measures.

The principal elements of a treatment plant of the type and scale proposed include preliminary, primary and secondary treatment of the wastewater stream with further provision for treatment of surplus sludge arising from the primary and biological stages of the treatment process. The specific details of each process are contained elsewhere within the EIS.

11.4. Potential Impacts of the Proposal

11.4.1 Construction Phase

There is the potential for a number of emissions to atmosphere during the construction of the development with wind blown dust been most significant. Wind blown dust emissions may arise during the construction phase of the proposed development, which may impact upon the surrounding environment. The deposition of dust and mud on the local roads is both unsightly and dangerous. Dust may be a particular problem during periods of dry windy weather.

Potential sources of dust from construction and operation include the following:

- Vehicles carrying dust on their wheels,
- Un-vegetated stockpiles of construction materials,
- The handling of construction materials for the construction phase of the development,
- The generation of dust from the recycling activities to be carried out indoors within the facility.

The construction and operation vehicles, generators, etc., will also give rise to petrol and diesel exhausts emissions, although this is of minor significance compared to dust.

11.4.2 Operation Phase

11.4.2.1 Scheduled Emissions

Regarding operations at the proposed development, the activities to be located in the development are waste water treatment activities. All equipment generating dust emissions will contain localised dust abatement equipment where necessary in order to prevent the release of dust to atmosphere. Scheduled emission point from odour control units will occur to atmosphere from the WWTP and pumping stations. Emissions of odour will be dealt with in detail in *Section 12*.

11.4.2.2 Climate

There is a potential for impacts to climate as a result of any development that requires fuel and energy. These impacts are the generation of greenhouse gas emissions (principally carbon dioxide and oxides of nitrogen) from traffic and electrical supply.

The potential effects of climate change on a global scale have been investigated by the Intergovernmental Panel on Climate Change (IPCC). The resulting impacts in Ireland are outlined in the National Climate Change Strategy and recently by the EPA and include the following:

- Significant increases in winter rainfall, of the order of 10% in the southeast, with a corresponding increase in the water levels in rivers, lakes and soils. Serious flooding more frequent than at present.
- Lower summer rainfall, of the order of 10% in the southern half of the country. Less recharge of reservoirs in the summer leading to more regular and prolonged water shortages than at present. Loss of bog land due to regular water deficits.
- Increased agricultural production, with new crops becoming more viable and potentially reduced agricultural costs. Grass growth could enjoy beneficial effects with an increase in 20% possible with higher temperatures and changes in rainfall patterns.
- The development will be designed to take account of changes in rainfall intensity and mean sea level rise.

These figure for climate change refer to year 2100. The specimen design is for up to 2030.

It is recognised that Ireland cannot, on its own, prevent or ameliorate the impacts of climate change. However, the National Climate Change Strategy states that Ireland must meet its responsibilities with regard to reducing CO_2 emissions in partnership with the EU and the global community. In terms of this specimen design, the generation of biogas and utilisation of generated biogas in a gas utilisation engine/boiler will offset CO_2 eq. emissions generated by the WWTP.

11.4.3"Do-nothing" Scenario

The baseline survey results suggest that air quality in the vicinity of the proposed development is average/good and shows typical levels for a rural and suburban area with all pollutants within the relevant Irish and EU limits. The air quality may improve slightly in future years due to improvements in engine technology and greater controls on petrol, diesel, coal and gas composition and purity. If the proposed development were not to take place, the current air pollutant concentrations will remain unchanged followed by potential decreases in future years for the reasons outlined above. In relation to dust, non-development of the site would result in no movement of soils/sands and no construction activity and therefore no dust creation as a result of construction works. Impacts associated with odours as demonstrated in *Section 12* are considered negligible as a result of the mitigation measures to be used at the proposed WWTP and Pumping stations. This will be discussed in more detail in *Section 12*.

11.4.4 Remedial or Reductive Measures

11.4.4.1 Construction Phase

Construction activities are likely to generate some dust emissions. The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speed and wind direction. In order to ensure that no dust nuisance occurs, a series of measures will be implemented. Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface as a result of the development. Any un-surfaced roads shall be restricted to essential site traffic only. Furthermore, any road in the vicinity of the development that has the potential to give rise to dust may be regularly watered, as appropriate, during extended dry and/or windy conditions.

A full traffic management plan and dust management plan will be implemented into the Construction Environmental Management Plan (CEMP) in order to minimise such emission as a result of the construction phase of the development. This will be generated specifically for the development when detailed design is completed.

Vehicles using site roads shall have their speed restricted, and this speed restriction must be enforced rigidly. On any un-surfaced site road and on hard surfaced roads that site management dictates speed shall be restricted to 20 km per hour.

Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind. Water misting or sprays shall be used as required if particularly dusty activities are necessary during dry or windy periods.

In relation to the completion of the proposed development, the hard standing surface, and all roads will be tarmacadamed/concreted. In periods of dry weather when dust emission would be greatest, a road sweeper, which would also dampen the road, may be employed in order to prevent the generation of dust.

11.4.4.2 Operation Phase

It is not anticipated that dust will be a significant problem during the operation of the development. All sources generating dust will operate dust management equipment as required.

Emissions of pollutants from road traffic can be controlled by either controlling the number of road users or by controlling the flow of traffic. For the majority of vehicle-generated pollutants, emissions rise as speed drops. Emissions are also higher under stop-start conditions when compared with steady speed driving. Since the development will generate only small volumes of traffic, emissions from such activities were predicted to be minimal.

It is envisaged that the proposed development will not have a significant impact on the surrounding air quality. However, as discussed previously a number of mitigation measures have been suggested. Moreover, dust monitoring could be carried out during the construction phase of the development if deemed necessary by the planning authority. If the level of dust is found to exceed 350 mg/m^2/day in the vicinity of the site, further mitigation measures will be incorporated into the construction and operation of the proposed development. Odour control techniques for the proposed development are discussed in more detail in *Section 12*.

11.4.4.3 Climate

Road traffic and power usage would be expected to be the dominant sources of greenhouse gas emissions as a result of the proposed development. Vehicles and power used to operate the plant will give rise to CO_2 and N_2O emissions as a result of the proposed development. It is expected that the number of vehicles accessing the site when operational will be a weekly maximum of 12 vehicles for truck movements and approximately 60 vehicle movements per week for small vehicles such as passenger cars. This will lead to the emission of 139 tonnes of CO_2 per annum, which is equivalent to 0.00000175% of the National Emissions in Ireland in 2008 to 2012 assuming a driving radius of 30 Km from the facility and a payload of 13 tonnes.

With reference to relevant evaluation criteria such as the Kyoto Protocol, which has set objectives to be achieved by 2008 – 2012, GHG emissions as a result of this proposal will be imperceptible.

11.5. Predicted Residual Impacts of the development

11.5.1.1 Construction Phase

The effect of construction of the facility on air quality will not be significant following the implementation of the proposed mitigation measures. The main environmental nuisance associated with construction activities is dust. However, it is proposed to adhere to good working practices and dust mitigation measures to ensure that the levels of dust generated will be minimal and are unlikely to cause an environmental nuisance. A series of such good working practices and mitigation measures are outlined earlier in this chapter (*see Section 11.4.4.1*).

11.5.1.2 Operation Phase

Traffic

The predicted increases in traffic volumes as a result of the development along the existing road network are expected to be very low. The information on traffic provided in the traffic section of the Statement has been used to identify whether any significant impact on sensitive receptors will occur. The traffic information has been input into the Design Manual for Roads and Bridges (DMRB), Volume 11 (February 2003) model. This model was prepared by the United Kingdom Department of Transport, the Scottish Office of Industrial Development, the Welsh Office and the Department of Environment for Northern Ireland as a screening tool to assess worst-case air quality impact associated with roads developments.

The screening model uses a worst-case scenario in calculating emissions. The emission factors used for each pollutant are intentionally biased to overestimate the actual emission rate. Also, wind speeds are assumed to be 2 m s^{-1} (approximately 3.9 knots compared to a mean wind speed of between 4 to 5 m s^{-1} from nearest Met stations (Cork met station). In addition to this, the background concentrations incorporated into the model are worst-case scenario concentrations. For these reasons, it can be assumed with confidence that a project will not produce air pollution from traffic if this model identifies none.

Traffic figures have been assessed using the Annual Average Daily Traffic (AADT) figures. The overall predicted increase in air pollutants as a result of the development was assessed utilising the predicted traffic generation figures for the facility when in operation. The predicted impact of traffic on air quality during the construction phase of the development are more difficult to predict since this is only a specimen design and the actual DBO plant could be a little different. The overall emissions as a result of traffic during the construction phase of the project will be short term. In terms of emissions, as the average speed of vehicles has a significant effect on the generation of pollutants, calculations are carried out for two different traffic speed scenarios. The speeds are 20 km hr^{-1}, to represent gridlock conditions and 50 km hr^{-1}, to represent free-flowing traffic conditions in the area. The growth rate per annum assumed for the area is based on NRA future traffic forecasts for non-national roads.

The DMRB only assesses the potential impacts from traffic up to and including the year 2023. Even though the development design period goes beyond this date, this is not considered significant since impacts are expected to be even lower beyond this date due to improvements in engine technology etc. The impacts associated with the proposed development are well within the ground level impact concentrations in year 2023 (as predicted by the model). Using the model, concentrations of Carbon Monoxide, Benzene, Oxides of Nitrogen and PM_{10} (particulate matter with an average 10 μm aerodynamic diameter), have been determined for a receptor point road along the road L2490 (Fernhill Rd). The results of these calculations are presented in *Tables 11.5.1* (J1). It is assumed that a total of 4 ADDT movements per day for HGV's and a maximum 12 ADDT movements per day for LGV/cars (i.e. to and from the site).

Table 11.5.1. Screening Air Quality Assessment, Cork Harbour Main Drainage Scheme WWTP operation phase for WWTP traffic.

Scenarios	Traffic Speed Km hr^{-1}	Carbon Monoxide (mg/m^3)	Benzene ($\mu g/m^3$)	Oxides of Nitrogen ($\mu g/m^3$)	Particulates (PM_{10}) ($\mu g/m^3$)
	-	Annual Average-Traffic component	Annual Average-Traffic component	Annual Average NO_2-Traffic component	Annual Average-Traffic component
2010 "Do something Scenario"	20	0.01	0.01	0.08	0.01
	50	0.01	0.01	0.06	0.01
2023 "Do Something" Scenario	20	0.01	0.01	0.05	0.01
	50	0.01	0.01	0.03	0.01
Irish and EU Standards	-	-	**5**	**40**	**40**

For carbon monoxide (CO) under all traffic scenarios at both speeds, the predictions indicate that even under worst-case scenario conditions the maximum CO level combined with the baseline figures will not breach the EU limit as a result of traffic movements to and from the WWTP during operation.

The predicted results for benzene at the two speed scenarios indicate that the concentrations are below the relevant Irish and EU limit at both locations. Again, the predicted levels drop with increases in speed. As with the CO results, the predicted levels actual remain relative equal over the development years. When added to baseline the overall ambient air concentrations of Benzene are well within the Irish and EU limit values during the operation phase of the development.

The predicted levels of nitrogen dioxide (NO_2) at the two speed scenarios for the operation phase of the development will cause negligible increases NO_2 on the surrounding area. There is a general overall improvement in the NO_2 levels as the development proceeds from 2010 to 2023 due to improvements in engine technology. When added to baseline the overall ambient air concentrations of NO_2 are well within the Irish and EU limit values for the operation phase of the development.

For particulate matter (PM_{10}) the predictions indicate that even under worst-case scenario conditions the annual average will not breach the Irish and EU limit as a result of traffic movement during the operation phase of the WWTP. The predictions show a variation with speed resulting in lower levels of particulates produced under normal traffic conditions (50 km/hr). There is no significant difference on air quality impact whether the development proceeds or not.

The computer model predictions indicate the following findings:

- Ambient concentrations will, in general, decrease due to legislation driven improvements in engine technology and fuel content. Any increases will be slight.
- There will be negligible increases in NO_2 and PM_{10} concentrations as the development phase is implemented.
- The net impact of the proposed development will be a slight negative for NO_2 and PM_{10} but will remain well within the Irish and EU legislative limit values.

11.5.1.3 Climate

The effect of the proposed WWTP is not considered to be significant in term of air quality impact from traffic emissions.

All space heating and energy requirements for the proposed development should be designed in accordance with best practice. The Building Regulations 2002 "Technical Guidance Document Part L – Conservation of Fuel an Energy Dwellings" should be used as a reference for best practice in order to reduce the impact of the proposed development on greenhouse gas emissions.

11.5.1.4 "Worst Case" Scenario

For traffic-derived pollutants, the "worst-case" scenario consists of gridlock conditions with large volumes of traffic on the road, simultaneously. This has been accounted for within the model whereby it is predicted that traffic movements will occur simultaneously on the road network. In addition gridlock is also assessed.

The DMRB predictive model employed is a screening model that is used to generate worst-case scenario predictions for air quality. If this model indicates that pollutant levels will not breach the Irish and EU limits, then it can be assumed with some confidence that a project will not produce air pollution problems if none are identified by this method. There are no predicted breaches of Irish and EU legislation for design year and 2023. As a result of these model predictions it may be concluded that the worst-case impact of the traffic alterations associated with the proposed development are predicted to be a slight negative.

11.5.2 Monitoring

11.5.2.1 Construction Phase

It is envisaged that the proposed development will not have a significant impact on the surrounding air quality. However, as discussed previously a number of dust mitigation measures have been suggested. Moreover, dust monitoring could be carried out during the construction phase of the development if deemed necessary by the planning authority. If the level of dust is found to exceed 350mg/m^{2}day in the vicinity of the site (using Bergerhoff gauges), further mitigation measures will be incorporated into the construction of the proposed site.

11.5.2.2 Operational phase

In terms of odours, the exhaust emission point of the odour control systems will be monitored for odours using both onsite subjective assessment and biannual monitoring, if this is deemed necessary. Greater detail on the assessment of odours can be found in *Section 12*.

Process equipment responsible for dust generation will be fitted with dust abatement equipment and monitored continuously in accordance with EN14181.

Depositional dust monitoring will be carried out during the operation phase of the development if deemed necessary by the regulatory authority. If the level of dust is found to exceed 350mg/m^{2}day in the vicinity of the site, further mitigation measures will be incorporated into the operation of the proposed site.

11.5.3 Reinstatement

Not Applicable

11.6. Non-Technical Summary

A baseline ambient air quality survey was carried out in the vicinity of the proposed Cork Lower Harbour. Currently the air quality is average to good with levels of criteria and baseline odour pollutants for traffic, industrial and residential derived pollution (BTEX, NO_2, NO, CO, PM_{10}, H_2S and Speciated VOC's) below the relevant Irish and European Union limits. The main source of air pollution in the area is from motor vehicle exhausts, construction and industrial activities, and associated suburban emissions. There is the risk that emissions from dust could result in air quality impacts in the vicinity of the proposed WWTP site location. Since focused dust extraction and abatement will be applied to the dust generation equipment as necessary, then it is anticipated that no associated impacts will occur with the proposed development.

11.7. Appendix I-Monitoring and predictive traffic emission modelling location

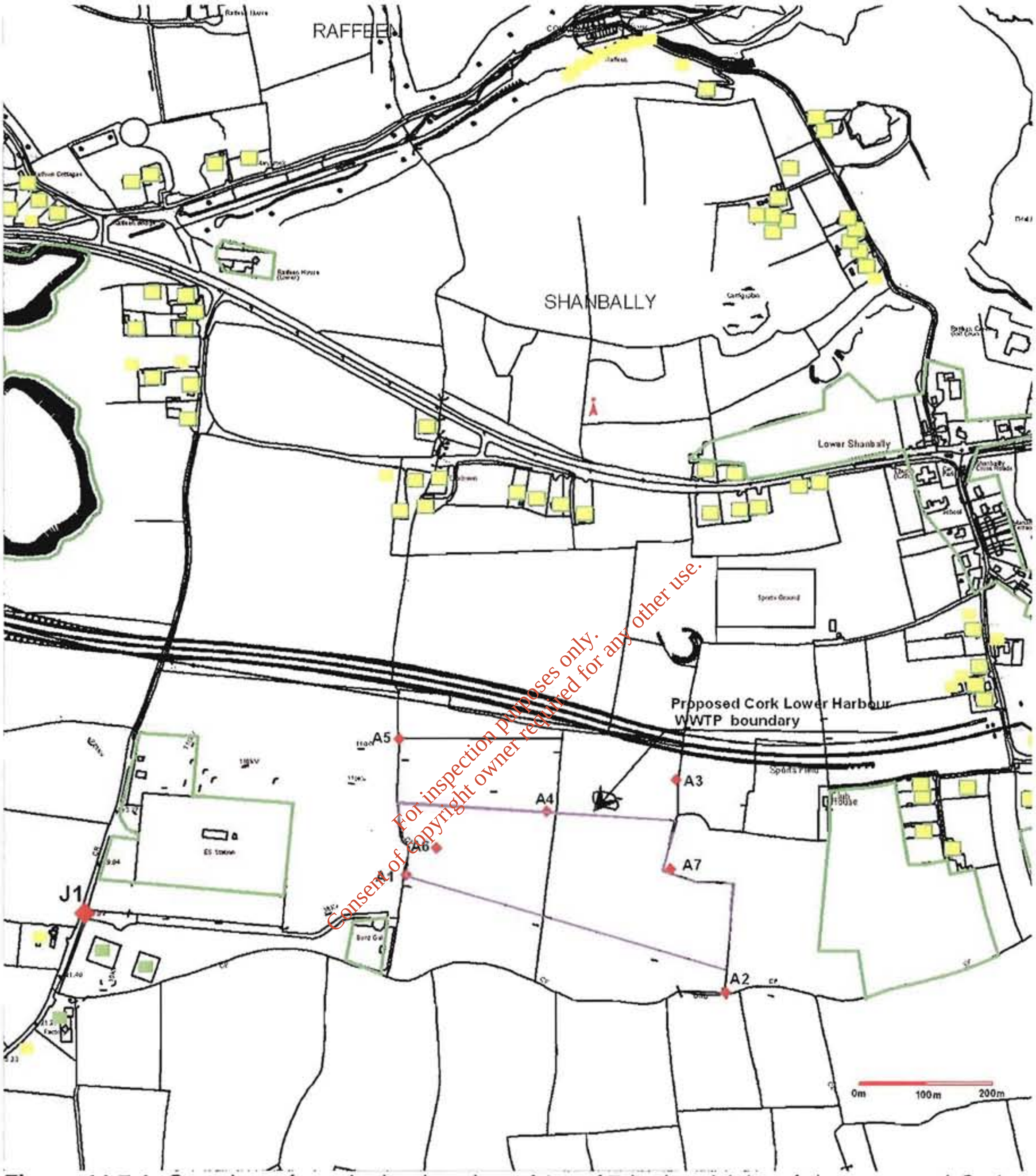

Figure 11.7.1. Overview of monitoring locations A1 to A7 in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP and receptor location J1 (used for assessing the maximum predicted emissions associated with traffic generation as a result of the WWTP operation phase).

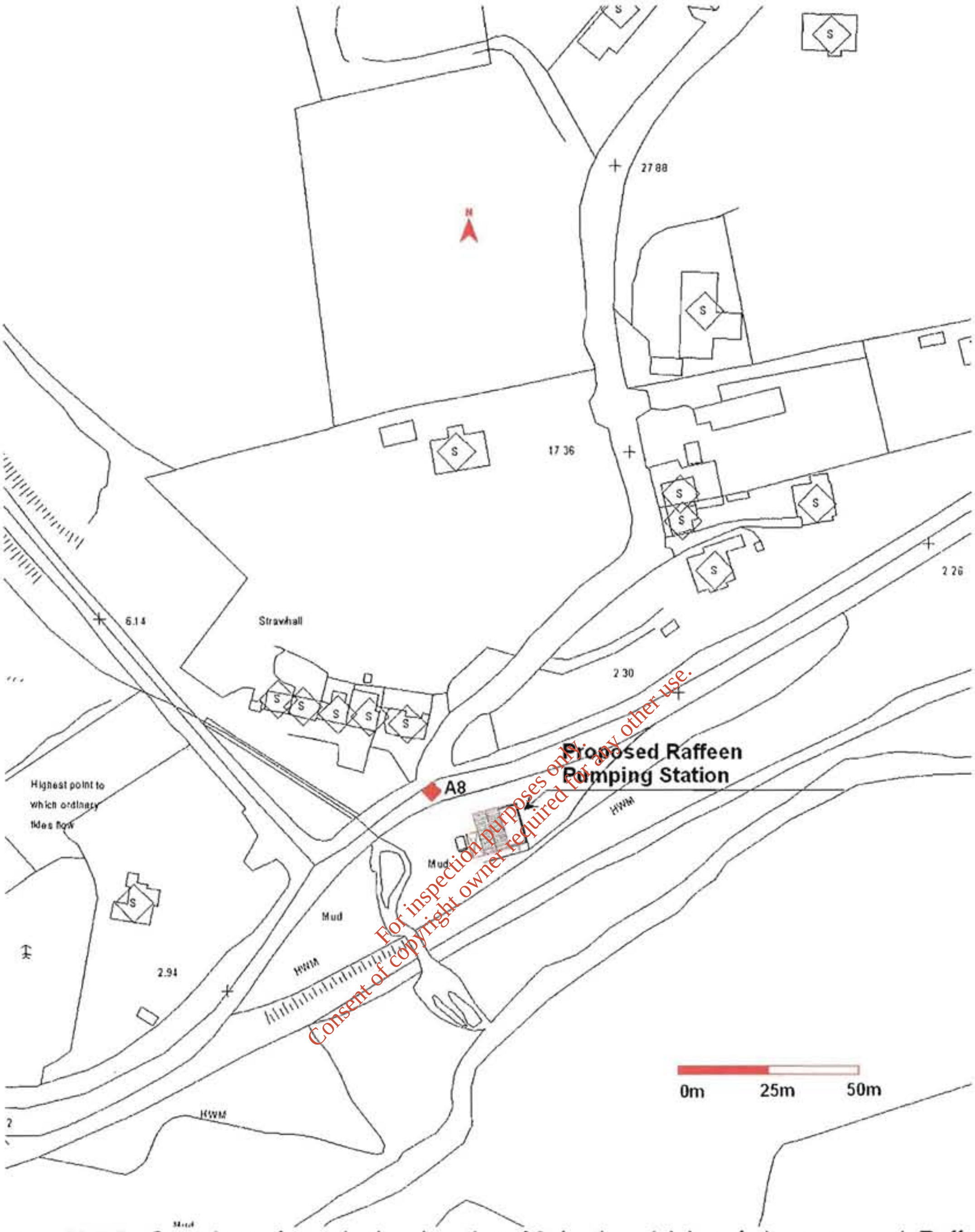

Figure 11.7.2. Overview of monitoring location A8 in the vicinity of the proposed Raffeen Pumping Station.

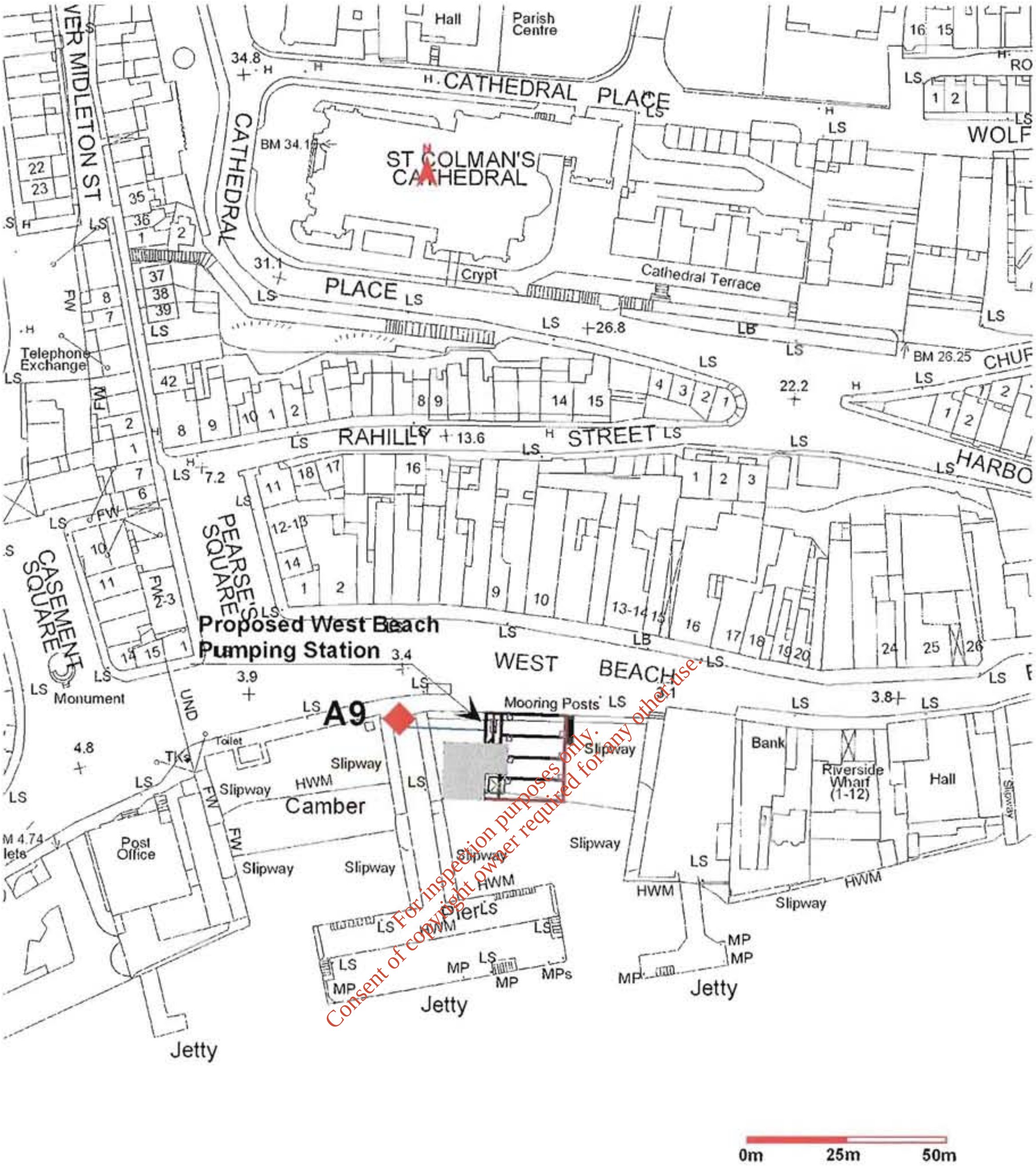

Figure 11.7.3. Overview of monitoring location A9 in the vicinity of the proposed West beach Pumping Station.

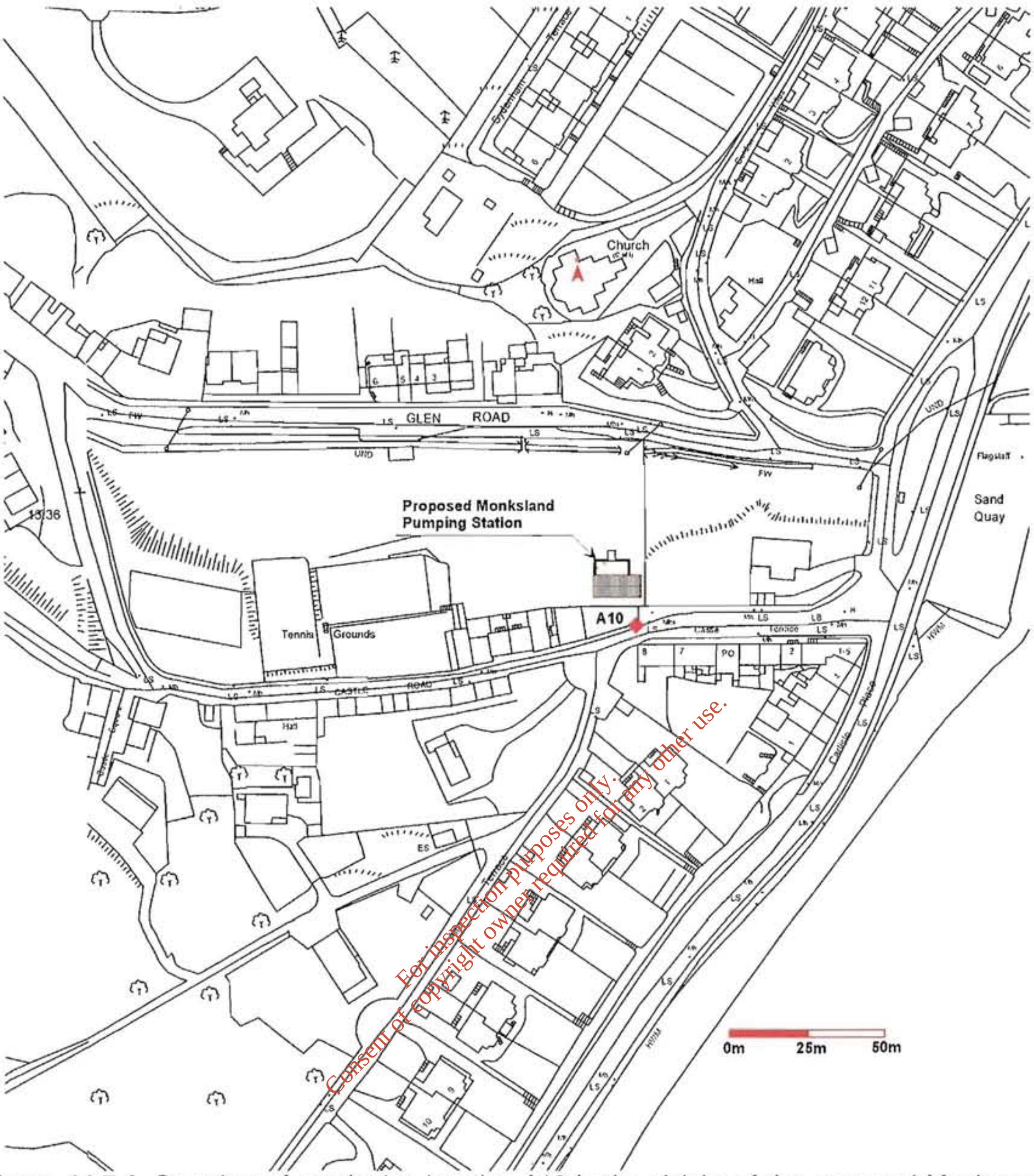

Figure 11.7.4. Overview of monitoring location A10 in the vicinity of the proposed Monkstown Pumping Station.

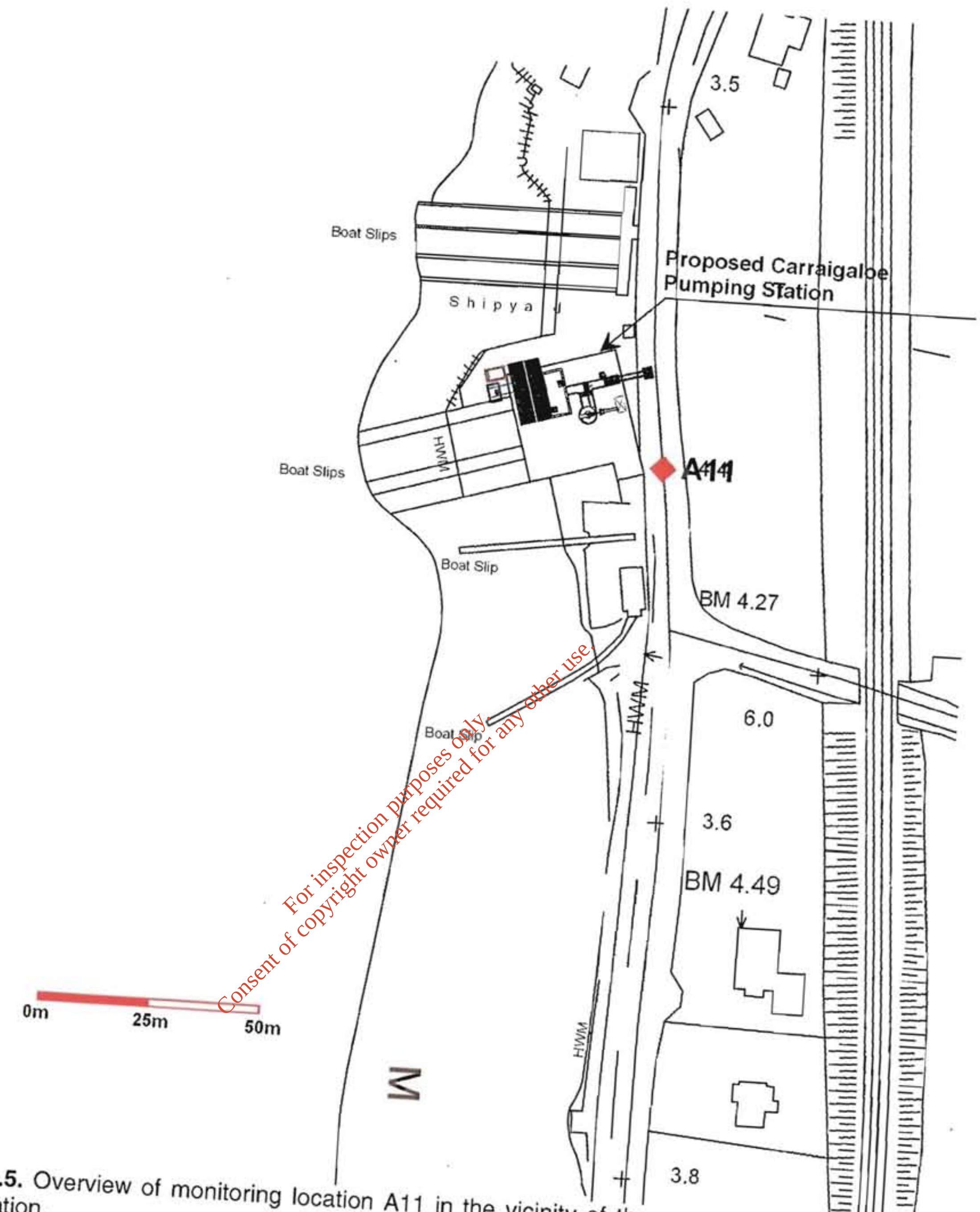

Figure 11.7.5. Overview of monitoring location A11 in the vicinity of the proposed Carrigaloe Pumping Station.

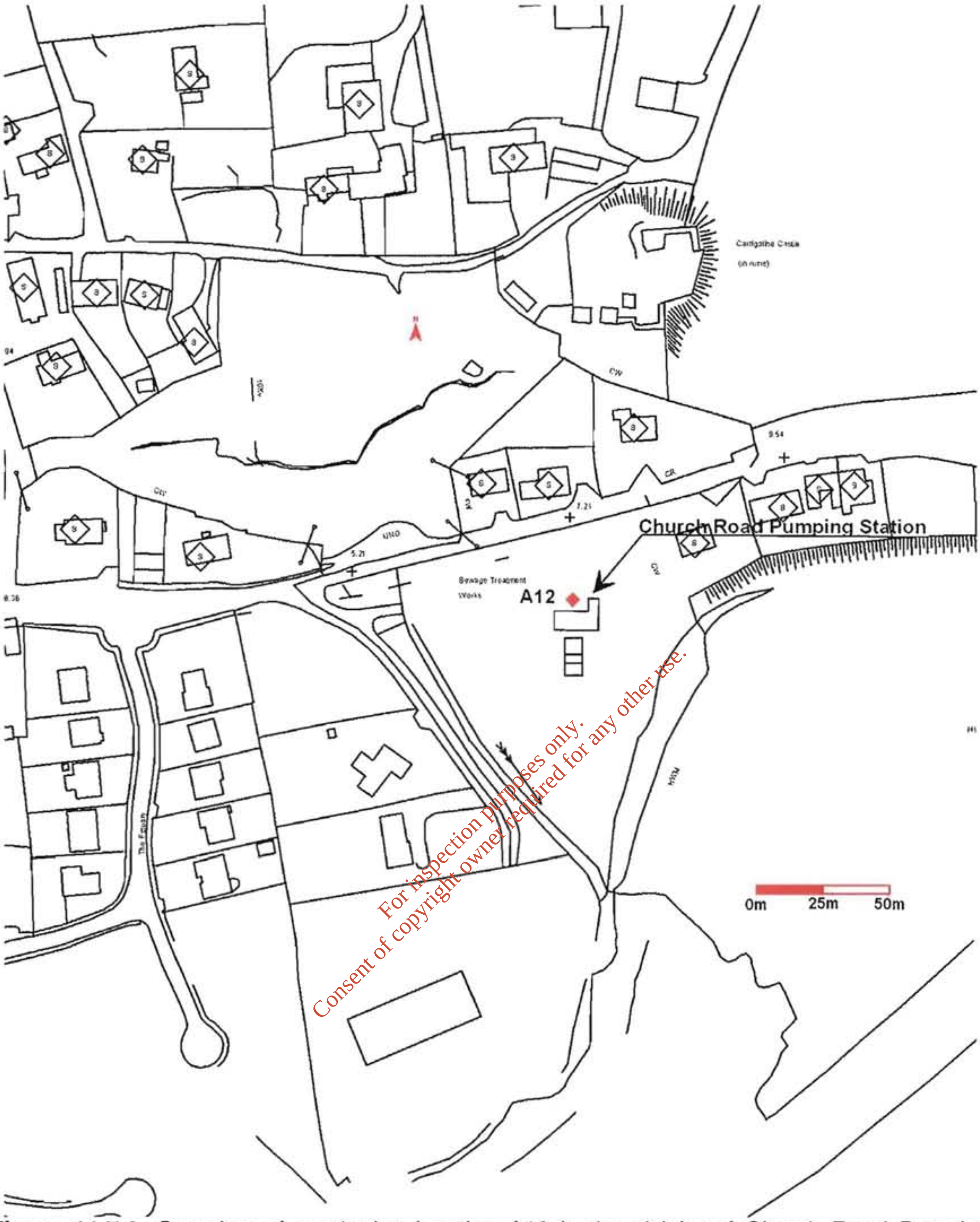

Figure 11.7.6. Overview of monitoring location A12 in the vicinity of Church Road Pumping Station.

12. Appendix II-References

1. Amoore JE. The perception of hydrogen sulfide odor in relation to setting an ambient standard. California Air Resources Board Contract A4-046-33. April 1985.
2. Environment Protection Agency Act 1992 (Ambient Air Quality Assessment and Management) Regulations 1999 (S.I. No. 33 of 1999).
3. Irish EPA 2006-Air quality monitoring report Old Station Road.
4. Irish EPA 2006-Air quality monitoring report Wexford station.
5. OEHHA. 2000. Office of Environmental Health Hazard Assessment. Air Toxics Hot Spots Program Risk Assessment Guidelines. Part III. Technical Support Document for the Determination of Non-cancer Chronic Reference Exposure Levels.
6. Reynolds R L, Kamper RL. Review of the State of California Ambient Air Quality Standard for Hydrogen Sulfide (H2S). Lakeport (CA): Lake County Air Quality Management District; 1984.
7. S.I. No. 271/2002 — Air Quality Standards Regulations 2002
8. TALuft air Quality Guidelines, Federal Air Pollution Control Act" (*"Bundes–Immissionsschutzgesetz"*), 2002.
9. VDI 2119 (1986) "Measurement of Dustfall Using the Bergerhoff Instrument (Standard Method)."
10. Venstrom P, Amoore JE. Olfactory threshold in relation to age, sex or smoking. J Food Sci 1968;33:264-265.
11. WHO, World Health Organization. Hydrogen sulfide. Environmental Health Criteria No. 19. Geneva: WHO; 1981.

Appendix 5B

Odour Report

Mott MacDonald

ODOUR monitoring IRELAND

ODOUR & Environmental Engineering Consultants

Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath

Tel: +353 46 9437922
Mobile: +353 86 8550401
E-mail: info@odourireland.com
www.odourireland.com

ODOUR IMPACT ASSESSMENT OF THE PROPOSED CORK HARBOUR MAIN DRAINAGE SCHEME, CORK CITY AND ENVIRONS.

PERFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF MOTT MACDONNELL PETTIT CONSULTING ENGINEERS

PREPARED BY:	Dr. Brian Sheridan
DATE:	15th Jan 2008
REPORT NUMBER:	2007. A394 (5)
DOCUMENT VERSION:	Document Ver. 005
REVIEWERS:	Ms. Orla Freyne & Mr. Paul Kelly

TABLE OF CONTENTS

Document Amendment Record

Client: ***Mott MacDonnell Pettit Consulting Engineers***

Title: Odour impact assessment of proposed Cork Harbour Main Drainage Scheme Cork Harbour Main Drainage Scheme, Cork City and Environs.

Project Number: 2006.A394(5)			**Document Reference:** Odour impact assessment of proposed Cork Harbour Main Drainage Scheme Cork Harbour Main Drainage Scheme, Cork City and Environs.		
2006A394(1)	Document for review	B.A.S.	JWC	BAS	13/11/2007
2006A394(2)	Minor edits	OF	BAS	BAS	20/12/2007
2006A394(3)	Minor edits	OF & PK	BAS	BAS	07/01/2008
2006A394(4)	Minor edits	OF & PK	BAS	BAS	09/01/2008
2006A394(5)	Minor edits	OF	BAS	BAS	15/01/2008
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

ODOUR monitoring IRELAND

1. Executive Summary

Odour Monitoring Ireland was commissioned by Mott MacDonnell Pettit Consulting Engineers to carry out an odour impact assessment of the proposed Cork Harbour Main Drainage Scheme Waste Water Treatment Plant (WWTP) specimen design and five major Pumping stations (4 proposed and 1 existing) to be located in Cork City and environs. The purpose of this assessment was to determine the potential for the generation of odour impact on the surrounding population from the proposed wastewater treatment plant and five pumping stations specimen design. The WWTP will have a Population Equivalent (PE) of 80,000 PE.

Potential odour sources were identified and were used to construct the basis of the modelling assessment. Odour emission rates/fluxes were calculated from library olfactometry data. Odour dispersion modelling was used to perform an impact assessment of the proposed WWTP specimen design and five major pumping stations to be located in Raffeen, West Beach, Monkstown, Church Road (existing) and Carrigaloe. Minor pumping stations were not assessed as it was anticipated that impacts predicted for the major pumping stations would be greater than that for minor pumping stations.

Following measurement and development of odour emission rates/fluxes, two data sets for odour emission rates were calculated to determine the potential odour impact of the Cork Harbour Main Drainage Scheme WWTP specimen design and five pumping stations during their proposed operation.

These included:

Ref Scenario 1: Predicted overall odour emission rate from proposed Cork Harbour Main Drainage Scheme WWTP specimen design with the incorporation of odour mitigation protocols (*see Table 4.1*).

Ref Scenario 2: Predicted overall odour emission rate from proposed five pumping stations with the incorporation of odour management systems (e.g. good design in terms of odour minimisation, tight fitting covers, etc.) (*see Table 4.2*).

Aermod Prime was used to determine the overall odour impact of the proposed Cork Harbour Main Drainage Scheme WWTP and five pumping stations operation located in Cork Harbour Main Drainage Scheme as set out in odour impact criteria presented in *Table 2.1* and *2.2*. The output data was analysed to calculate:

Ref Scenario 1:

- Predicted odour emission contribution of overall proposed Cork Harbour Main Drainage Scheme WWTP operation to surrounding population (*see Table 4.1*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.1*).
- Predicted odour emission contribution of overall proposed Cork Harbour Main Drainage Scheme WWTP operation to surrounding population (*see Table 4.1*), to odour plume dispersal at the 99.5th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (*see Figure 8.2*).
- Predicted odour emissions contribution of individual grouped Odour control units 1 to 5 to surrounding population (*see Table 4.1*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 0.30 Ou_E/m^3 (*see Figure 8.3*).
- Predicted odour emissions contribution of individual grouped Aeration, Secondary settlement and Storm water tankage sources to surrounding population (*see Table 4.1*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E/m^3 (*see Figure 8.4*).

These odour impact criterions were chosen for the existing WWTP in order to ascertain the level of proposed impact to the surrounding residential and industrial population in the vicinity of the proposed WWTP.

Ref Scenario 2:

- Predicted odour emission contribution of overall proposed Raffeen Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.5*).
- Predicted odour emission contribution of overall proposed West Beach Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.6*).
- Predicted odour emission contribution of overall proposed Monkstown Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.7*).
- Predicted odour emission contribution of overall proposed Church Road Pumping Station (existing) operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.8*).
- Predicted odour emission contribution of overall proposed Carrigaloe Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.9*).

Since the predicted odour emission rate from the pumping stations is low following the implementation of odour management systems (e.g. tight fitting covers, etc.), odour isopleths suitable for reporting clarity were chosen (i.e. those isopleths presented were lower than the 1.50 Ou_E/m^3 isopleths since the overall odour emission rate from the pumping stations were low due to the nature of the odour source and hence the subsequent odour impact was low). All odour impact criterions chosen were in accordance with the guideline value presented in *Section 3.3.4.*.

These computations give the odour concentration at each Cartesian grid receptor location that is predicted to be exceeded for 0.5% (44 hours) and 2% (175 hours) of five years of meteorological data. Additionally, individual sensitive receptors and 20 five metre spaced boundary receptors were established within the modelling assessment.

It was concluded that:

<u>Cork Harbour Main Drainage Scheme WWTP</u>

- In accordance with odour impact criterion in *Table 2.2*, and in keeping with current recommended odour impact criterion in this country, no odour impact will be perceived by sensitive receptors in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP following the installation of proposed odour management, minimisation and mitigation protocols assuming specimen design. As can be observed, the overall odour emission rate from the new proposed Cork Harbour Main Drainage Scheme WWTP will be no greater than 6,611 Ou_E/s based on the specimen design.
- All residents/industrial neighbours in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP will perceive an odour concentration at or less than 1.50 Ou_E m^{-3} for the 98th percentile and less than 3.0 Ou_E/m^3 for the 99.5th percentile for five years of meteorological data (*see Figures 8.1 and 8.2*). Those odour sources considered most offensive (inlet works, primary treatment and holding tanks, centrate, filtrate, sludge, RAS/WAS pump sumps, flow splitting chambers and all sludge handling processes including tankage will be effectively contained and ventilated to an odour control system

and therefore the overall risk of any resident/industrial neighbours detecting odour will be negligible since the major odour sources contributing to the remaining odour plume are considered low risk in term of odour. These sources include the aeration tankage, secondary settlement tankage and storm water tankage (*see Figures 8.3 and 8.4*).

- Those management and mitigation strategies discussed through this document should be considered and implemented in the design of the proposed Cork Harbour Main Drainage Scheme WWTP. Any deviations from the proposed mitigation strategies will require reassessment in order to ensure no odour impact in the vicinity of the proposed facility.

Pumping Stations

- In accordance with odour impact criterion in *Section 3.3.4*, and in keeping with current recommended odour impact criterion in this country, no odour impact will be perceived by sensitive receptors in the vicinity of the major Pumping stations Raffeen, West Beach, Monkstown, Church Road and Carrigaloe following the implementation of good design in terms of odour management (e.g. tight fitting covers, etc.).
- All residents/industrial neighbours in the vicinity of the proposed pumping stations will perceive an odour concentration at or less than 1.50 Ou_E m^{-3} for the 98^{th} percentile for five years of meteorological data (*see Figures 8.5 to 8.9*). All pumping station (both minor and major) will incorporate the use of an odour management system (e.g. good design in terms of odour, tight fitting covers etc.) to ensure no fugitive release of odours from each pumping station. In addition, each pumping station will be regularly visited so as to ensure efficient operation of the odour management system.
- It is acknowledged that many of the pumping stations are located in populous areas. For this reason the design of the collection system will include best practice and adequate odour management systems to prevent odour complaint and impact.
- The pumping stations will be covered/sealed to allow for containment of odours. The implementation of odour management systems within each pumping station (both minor and major) will minimise the uncontrolled release of fugitive odour emissions.
- Pumping stations will be subject to Part 8 Planning *(Planning and Development Regulations 2001)* at detailed design. It will be the responsibility of the designer and contractor to review the PS location and the odour management systems proposed to prevent odour complaints and impact.

The following recommendations were developed during the study:

1. Odour management, minimisation and mitigation procedures as discussed within this document in general will be implemented at the proposed Cork Harbour Main Drainage Scheme wastewater treatment plant and each Pumping Station in order to prevent any odour impact in the surrounding vicinity.
2. The maximum allowable odour emission rate from the overall proposed WWTP should not be greater than 6,611Ou_E s^{-1} (*see Table 4.1*) inclusive of the odour emission contribution from the abatement systems installed on the primary treatment, pumping and sludge handling processes. The maximum overall odour emission rate from the odour control units shall be no greater than 2,314 Ou_E s^{-1} and an exhaust stack concentration of less than 300 Ou_E/m^3 for OCU 1, 2, 4 and 5 and less than 500 Ou_E/m^3 for OCU 3, respectively. The specimen design suggests the use of three OCU's. As long as the total odour emission rate for the WWTP (i.e. 6,611Ou_E s^{-1}) is achieved along with the total minimum odour treatment volume (i.e. 6.20 m^3/s) and a total odour emission rate from the OCU's of less than or equal to 2,314 Ou_E s^{-1} is similar, then the number of OCU's utilised onsite is not important. The hedonic tone of this odour should not be considered unpleasant (Scale greater than –2) as assessed in accordance with VDI 3882:1997, part 2; ('Determination of Hedonic) for all emission points.
3. The odour management systems to be installed upon Raffeen, Carrigaloe, West Beach, Monkstown and Church road should be sufficient to prevent any uncontrolled fugitive odours escaping from the system. In addition any odour management system

incorporated into the design and upgrade of the pumping station should be capable of achieving less than 1.5 Ou_E/m^3 at the 98th percentile and less than 3.0 Ou_E/m^3 at the 99.5th percentile of hourly averages.

4. Maintain good housekeeping practices (i.e. keep yard area clean, etc.), closed-door management strategy (i.e. to eliminate puff odour emissions from sludge dewatering building), maintain sludge storage within sealed airtight containers and to implement an odour management plan for the operators of the WWTP and all Pumping station. All odourous processes such as inlet works, primary treatment, and thickening will be carried out indoors/enclosed tankage.
5. Avoid accumulation of floating debris and persistent sediments in channels and holding tanks by design (i.e. flow splitters and secondary sedimentation tanks, etc.). Techniques to eliminate such circumstances shall be employed.
6. Enclose and seal all primary treatment, wet wells and sludge handling processes.
7. Operate the proposed WWTP within specifications to eliminate overloading and under loading, which may increase septic conditions within the processes.
8. Odour scrubbing technologies employing will be implemented within the proposed Cork Harbour Main Drainage Scheme WWTP. An odour management system (e.g. tight fitting covers, etc.) will be implemented upon each pumping station (both minor and major). All other odour management, minimisation and mitigation strategies contained within this document where necessary will be implemented within the overall design.
9. When operational, it is recommended that the contractor should provide evidence through the use of dispersion modelling (Aermod Prime) and olfactometry measurement (in accordance with EN13725:2003), that the as built WWTP and Pumping stations are achieving the overall mass emission rate of odour and emission limit values for the installed odour management systems.

2. Introduction

Odour Monitoring Ireland was commissioned by Mott MacDonald Consulting Engineers to perform a desktop odour impact assessment of the proposed Cork Harbour Main Drainage Scheme Waste Water Treatment Plant (WWTP) and five major Pumping stations (4 proposed and one existing) utilising dispersion modelling software Aermod Prime. Like the majority of industries, the operation of the proposed WWTP and pumping stations in Cork Harbour Main Drainage Scheme is faced with the issue of preventing odours causing impact to the public at large.

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 Cork Harbour Main Drainage Scheme WWTP and five pumping stations.

It was concluded from the study, it is predicted all residential/commercial neighbours in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP will perceive an odour concentration less than or equal to 1.50 Ou_E m^{-3} at the 98th percentile and less than or equal to 3.0 Ou_E m^{-3} at the 99.5th percentile, respectively for five years of meteorological data (*see Figures 8.1 and 8.2*). The overall remaining odour plume spread from the proposed WWTP will be predominately made up from odours from the aeration tankage, secondary settlement tankage and storm water tankage. Emissions from such processes are generally not offensive and based on experience do not cause odour impact if operated correctly (*see Figures 8.3 and 8.4*). The overall odour emission rate from the proposed specimen design Cork Harbour Main Drainage Scheme WWTP will be approximately 6,611 Ou_E/s following the implementation of odour mitigation strategies. The ability of process upset to cause odour impact is greatly reduced as those sources generally responsible for such process upset will be enclosed and negatively extracted to an odour control unit. Two stages of odour treatment (only if biological is first stage) have been recommended to provide confidence in the treatment options for the WWTP and to achieve the strict odour concentration levels from the odour control unit stacks 1 to 5. Three odour control units were included in the specimen design. Five odour control units were assessed in the impact assessment. In terms of the number of odour treatment units, the contractor will be required to ensure that odour emission rates does not exceed 2,314 Ou_E s^{-1} whether 3, 4 or 5 OCU's are utilised within the design (i.e. must achieve the total odour emission from the WWTP (i.e. 6,611 Ou_E/s) and also at minimum the total treatment volume 6.20 m^3/s and a total odour emission rate of less than or equal to 2,314 Ou_E s^{-1} from the odour control units.

In terms of odour impact from the five major pumping stations to be located at Raffeen, West beach, Monkstown, Church Road (existing) and Carrigaloe, the predicted odour impact will be less than or equal to 1.50 Ou_E/m^3 at the 98th percentile odour impact criterion (*see Figures 8.5 to 8.9*). An odour management system (e.g. tight fitting covers, etc.) will be provided on both minor and major pumping stations to ensure there is no uncontrolled escape of fugitive odour emissions.

This assessment was performed in accordance with currently recommended international guidance for the assessment of odour impact criterion to limit odour complaint.

3. Materials and Methods

This section will describe the materials and methods used throughout the study period.

3.1. Site

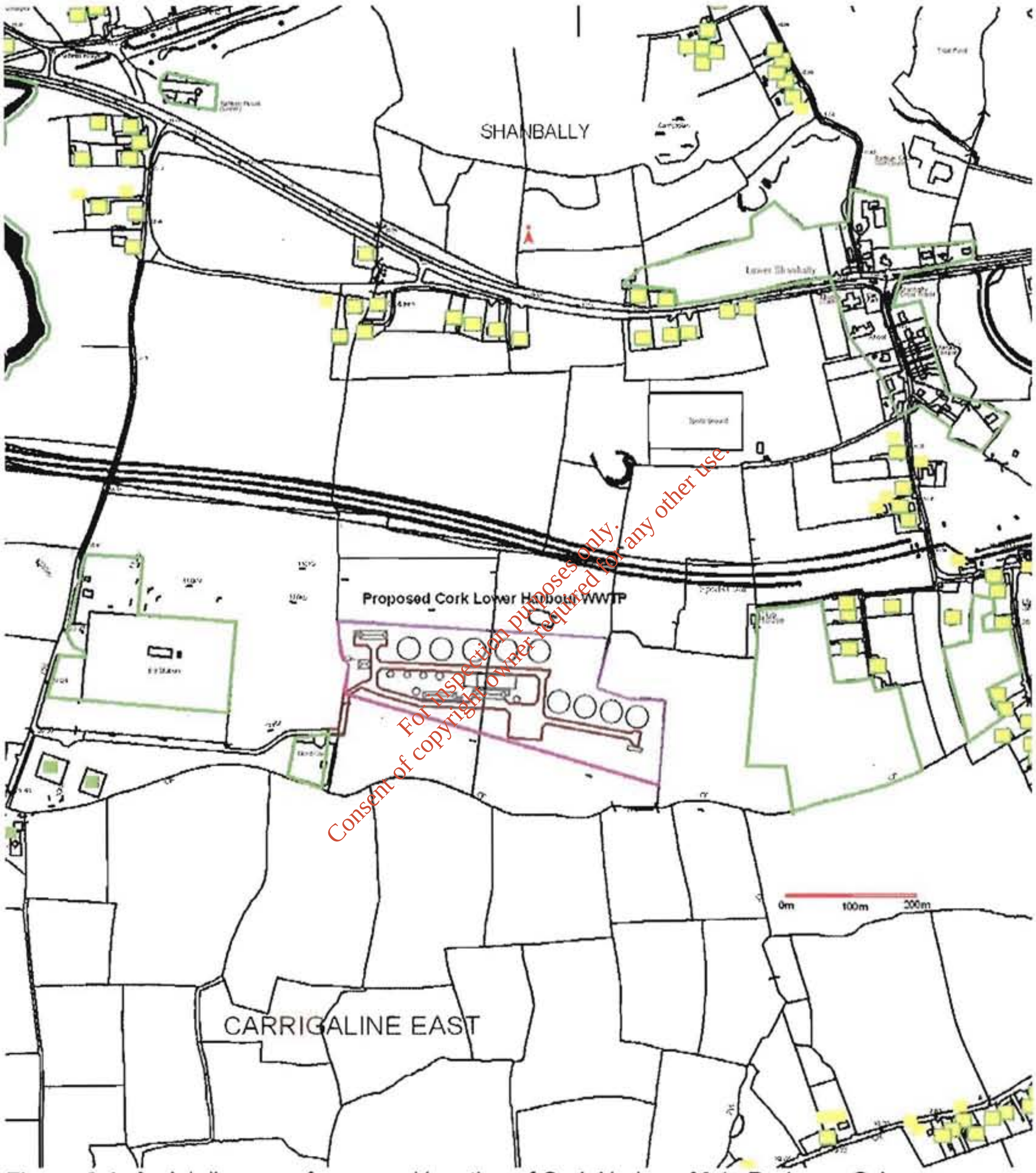

Figure 3.1. Aerial diagram of proposed location of Cork Harbour Main Drainage Scheme WWTP, boundary (▬) and sensitive receptor locations (▬).

The different distances and directions that the proposed Cork Harbour Main Drainage Scheme WWTP is located from the neighbouring sensitive receptors are presented in *Figure 3.1*. As can be observed, a number or commercial and residential receptors are in close proximity to the proposed WWTP. This includes a proposed new development to be located approximately 134 metres from the eastern boundary of the WWTP. Existing sensitive receptors include the ESB substation located approximately 200 metres to the west, a sports field located approximately 100 metres to the northeast and a number of residential properties located from a minimum distance of 250 metres from the boundary.

3.2. Odour emission rate calculation.

The measurement of the strength of a sample of odourous air is, however, only part of the problem of quantifying odour. Just as pollution from a stack is best quantified by a mass emission rate, the rate of production of an odour is best quantified by the odour emission rate. For a chimney or ventilation stack, this is equal to the odour threshold concentration ($Ou_E\ m^{-3}$) of the discharge air multiplied by its flow-rate ($m^3\ s^{-1}$). It is equal to the volume of air contaminated every second to the threshold odour limit ($Ou_E\ s^{-1}$). The odour emission rate can be used in conjunction with dispersion modelling in order to estimate the approximate radius of impact or complaint (Hobson et al, 1995).

Area source mass emission rates/flux were calculated as either $Ou_E\ m^{-2}\ s^{-1}$ or $Ou_E\ s^{-1}$ depending if they are being represented as discrete point sources or area sources in the atmospheric dispersion model.

3.3. Dispersion modelling overview

3.3.1. Atmospheric dispersion modelling of odours: What is dispersion modelling?

Any material discharged into the atmosphere is carried along by the wind and diluted by wind turbulence, which is always present in the atmosphere. This process has the effect of producing a plume of air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation. Atmospheric dispersion modelling has been applied to the assessment and control of odours for many years, originally using Gaussian form ISCST 3 and more recently utilising advanced boundary-layer physics models such as ADMS and AERMOD (Keddie et al. 1992). Once the odour emission rate from the source is known, ($Ou_E\ s^{-1}$), the impact on the vicinity can be estimated. These models can effectively be used in three different ways: firstly, to assess the dispersion of odours and to correlate with complaints; secondly, in a "reverse" mode, to estimate the maximum odour emissions which can be permitted from a site in order to prevent odour complaints occurring; and thirdly, to determine which process is contributing greatest to the odour impact and estimate the amount of required abatement to reduce this impact within acceptable levels (McIntyre et al. 2000). In this latter mode, models have been employed for imposing emission limits on industrial processes, odour control systems and intensive agricultural processes (Sheridan et al., 2002).

3.3.2. AERMOD Prime

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).

AERMOD is a Gaussian steady-state model which was developed with the main intention of superseding ISCST3 (NZME, 2002). The AERMOD modeling system is a significant departure from ISCST3 in that it is based on a theoretical understanding of the atmosphere rather than depend on empirical derived values. The dispersion environment is characterized by turbulence theory that defines convective (daytime) and stable (nocturnal) boundary layers instead of the stability categories in ISCST3. Dispersion coefficients derived from turbulence theories are not based on sampling data or a specific averaging period. AERMOD was especially designed to support the U.S. EPA's regulatory modeling programs (Porter at al., 2003)

Special features of AERMOD include its ability to treat the vertical in-homogeneity of the planetary boundary layer, special treatment of surface releases, irregularly-shaped area sources, a three plume model for the convective boundary layer, limitation of vertical mixing in the stable boundary layer, and fixing the reflecting surface at the stack base (Curran et al., 2006). A treatment of dispersion in the presence of intermediate and complex terrain is used that improves on that currently in use in ISCST3 and other models, yet without the complexity of the Complex Terrain Dispersion Model-Plus (CTDMPLUS) (Diosey et al., 2002).

3.3.3. Establishment of odour impact criterion for WWTP and pumping station odours

Odours from WWTP's / Pumping station operations arise mainly from the volatilisation of odourous gases from:

- The surfaces of non-quiescence processes including overflow weirs, returned pumped centrate/liquor above the working height of the tank/channel, etc,
- Positive displacement of odours from tankage as a result of inlet waste water flow and pressure effects induced by wind flows,
- Anaerobic decay of floating organic debris upon quiescence surfaces including organic matter attached to grit and rags, organic matter carryover to secondary tanks, etc,
- Sludge handling operations including dewatering, thickening, digestion, drying, storage and transport of raw/processed sludges offsite,
- Anaerobic digestion processes and emissions of sour gas,
- Turbulent processes within the inlet works and storage of screens (i.e. grit and rags removal),
- Inefficient odour control/abatement equipment operation and design including loose fitting covers, inefficient extraction and odour control unit failure.

Some of the compounds emitted are characterised by their high odour intensity and low odour detection threshold (*see Section 9.5*). A sample of a report carried out in the Netherlands, United Kingdom and USA ranking generic and environmental odours according to the like or dislike by a group of people professionally involved in odour management is illustrated in *Table 2.1* (EPA, 2001, Environment Agency, 2002). Although not scientifically based, it is interesting to observe the results of such studies.

Table 2.1. Ranking of environmental odours according to like and dislike (i.e. similar odour hedonic tone).

Generic odours	Hedonic score[1] Dravnieks, 1994	Ranking[2]	Ranking[2]	Ranking[2]	Environmental odours	Ranking[2]	Ranking[2]	Ranking[2]
Descriptor	**USA**	**UK median**	**UK mean**	**NL mean**	**Descriptor**	**NL mean**	**UK mean**	**UK Median**
Roses	3.08	4	4.4	3.4	*Bread Factory*	**1.7**	**2.5**	**1**
Coffee	2.33	3	4.5	4.6	Coffee Roaster	4.6	3.9	2
Cinnamon	2.54	4	4.9	6	Chocolate Factory	5.1	4.6	3
Mowed lawn	2.14	4	4.9	6.4	Beer Brewery	8.1	7.7	6
Orange	2.86	4	5.2	5.8	Fragrance & Flavour Factory	9.8	8.5	8
Hay	1.31	7	6.9	7.5	Charcoal Production	9.4	9.2	8
Soap	0.96	8	7.8	7.3	**Green Fraction composting**	**14**	**10.3**	**9**
Brandy		9	8.8	7.8	Fish smoking	9.8	10.5	9
Raisins	1.56	8	8.8	7.9	Frozen Chips production	9.6	11	10
Beer	0.14	9	9.5	9.3	Sugar Factory	9.8	11.3	11
Cork	0.19	10	10	10.5	Car Paint Shop	9.8	11.7	12
Peanut Butter	1.99	10	10.4	11.1	**Livestock odours**	**12.8**	**12.6**	**12**
Vinegar	-1.26	14	13.3	14.8	Asphalt	11.2	12.7	13
Wet Wool	-2.28	14	14	14.1	**Livestock Feed Factory**	**13.2**	**14.2**	**15**
Paint	-0.75	15	14	14.4	**Oil Refinery**	**13.2**	**14.3**	**14**
Sauerkraut	**-0.6**	**15**	**14.6**	**12.8**	Car Park Bldg	8.3	14.4	15
Cleaning Agent	**-1.69**	**15**	**14.7**	**12.1**	**Wastewater Treatment**	**12.9**	**16.1**	**17**
Sweat	-2.53	18	16.6	17.2	Fat & Grease Processing	15.7	17.3	18
Sour Milk	-2.91	19	18	17.5	Creamery/milk products		17.7	10
Cat's Pee	-3.64	19	18.8	19.4	Pet Food Manufacture		17.7	19
Sewer odour	**-3.68**	-		-	Brickworks (burning rubber)		17.8	18
-	-	-	-	-	**Slaughter House**	**17**	**18.3**	**19**
-	-	-	-	-	**Landfill**	**14.1**	**18.5**	**20**

Notes: *Source: Draft Odour H4-Part 1, Integrated Pollution Prevention and Control (IPPC). (2004). Environment Agency, Bristol, UK.*
[1] The higher the positive "value", the more pleasant the odour descriptor and similarly below, the greater the negative value, the more unpleasant the odour descriptor
[2] Ranking in order of dislike ability.