Appendix 17

Groundwater Analysis Report – 03/12/2015

ALcontrol Laboratories

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Hawarden
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Fehily Timoney
3rd Floor
North Park Offices
North Park Business Park
North Road
Dublin
Dublin 11

Attention: Barry Donovan

CERTIFICATE OF ANALYSIS

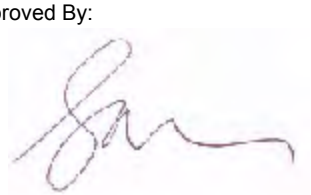
Date:	03 December 2015
Customer:	D_FTIM_DUB
Sample Delivery Group (SDG):	151120-53
Your Reference:	LW15-247-01
Location:	Kilquade Waste Soils Recovery Facility
Report No:	340537

We received 4 samples on Friday November 20, 2015 and 4 of these samples were scheduled for analysis which was completed on Thursday December 03, 2015. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

All chemical testing (unless subcontracted) is performed at ALcontrol Hawarden Laboratories.

Approved By:



Sonia McWhan

Operations Manager

CERTIFICATE OF ANALYSIS

SDG:	151120-53	**Location:**	Kilquade Waste Soils Recovery Facility	**Order Number:**	6115
Job:	D_FTIM_DUB-234	**Customer:**	Fehily Timoney	**Report Number:**	340537
Client Reference:	LW15-247-01	**Attention:**	Barry Donovan	**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
12480868	GW2		0.00 - 0.00	19/11/2015
12480878	GW3		0.00 - 0.00	19/11/2015
12480847	GW1D		0.00 - 0.00	19/11/2015
12480858	GW1S		0.00 - 0.00	19/11/2015

Only received samples which have had analysis scheduled will be shown on the following pages.

CERTIFICATE OF ANALYSIS

SDG:	151120-53	**Location:**	Kilquade Waste Soils Recovery Facility	**Order Number:**	6115
Job:	D_FTIM_DUB-234	**Customer:**	Fehily Timoney	**Report Number:**	340537
Client Reference:	LW15-247-01	**Attention:**	Barry Donovan	**Superseded Report:**	

LIQUID

Results Legend

X **Test**

N **No Determination Possible**

Lab Sample No(s)	12480868	12480878	12480847	12480858
Customer Sample Reference	GW2	GW3	GW1D	GW1S
AGS Reference				
Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
Container	1000ml glass bottle	1000ml glass bottle	1000ml glass bottle	1000ml glass bottle
	1plastic (ALE221)	1plastic (ALE221)	1plastic (ALE221)	1plastic (ALE221)
	Dissolved Metals Pr	Dissolved Metals Pr	Dissolved Metals Pr	Dissolved Metals Pr
	H2SO4 (ALE244)	H2SO4 (ALE244)	H2SO4 (ALE244)	H2SO4 (ALE244)
	NaOH (ALE245)	NaOH (ALE245)	NaOH (ALE245)	NaOH (ALE245)

Alkalinity as CaCO3	All	NDPs: 0 Tests: 4		X					X					X				X		
Ammoniacal Nitrogen	All	NDPs: 0 Tests: 4				X					X					X				X
Anions by Kone (w)	All	NDPs: 0 Tests: 4		X					X					X				X		
BOD True Filtered	All	NDPs: 0 Tests: 4		X					X					X				X		
COD Unfiltered	All	NDPs: 0 Tests: 4		X					X					X				X		
Coliforms (W)	All	NDPs: 0 Tests: 4		X					X					X				X		
Conductivity (at 20 deg.C)	All	NDPs: 0 Tests: 4		X					X					X				X		
Cyanide Comp/Free/Total/Thiocyanate	All	NDPs: 0 Tests: 4					X					X					X				X
Dissolved Metals by ICP-MS	All	NDPs: 0 Tests: 4		X					X					X				X		
Dissolved W, Nb and Zr by ICP-MS	All	NDPs: 0 Tests: 4		X					X					X				X		
Fluoride	All	NDPs: 0 Tests: 4		X					X					X				X		
Mercury Dissolved	All	NDPs: 0 Tests: 4			X					X					X				X	
Metals by iCap-OES Dissolved (W)	All	NDPs: 0 Tests: 4		X					X					X				X		
Neutralised Suspended Solids	All	NDPs: 0 Tests: 4		X					X					X				X		
Nitrite by Kone (w)	All	NDPs: 0 Tests: 4					X					X					X				X

CERTIFICATE OF ANALYSIS

SDG:	151120-53	**Location:**	Kilquade Waste Soils Recovery Facility	**Order Number:**	6115
Job:	D_FTIM_DUB-234	**Customer:**	Fehily Timoney	**Report Number:**	340537
Client Reference:	LW15-247-01	**Attention:**	Barry Donovan	**Superseded Report:**	

LIQUID

Results Legend

X **Test**

N **No Determination Possible**

			Lab Sample No(s)	Customer Sample Reference	AGS Reference	Depth (m)	Container
			12480868	GW2		0.00 - 0.00	1000ml glass bottle
							1plastic (ALE221)
							Dissolved Metals Pr
							H2SO4 (ALE244)
							NaOH (ALE245)
			12480878	GW3		0.00 - 0.00	1000ml glass bottle
							1plastic (ALE221)
							Dissolved Metals Pr
							H2SO4 (ALE244)
							NaOH (ALE245)
			12480847	GW1D		0.00 - 0.00	1000ml glass bottle
							1plastic (ALE221)
							Dissolved Metals Pr
							H2SO4 (ALE244)
							NaOH (ALE245)
			12480858	GW1S		0.00 - 0.00	1000ml glass bottle
							1plastic (ALE221)
							Dissolved Metals Pr
							H2SO4 (ALE244)
							NaOH (ALE245)
pH Value	All	NDPs: 0 Tests: 4		X			X
							X
							X
Phenols by HPLC (W)	All	NDPs: 0 Tests: 4			X		
							X
							X
							X
Settleable Solids 5 Mins	All	NDPs: 0 Tests: 4		X			X
							X
							X
Silicon Dissolved by ICP-OES	All	NDPs: 0 Tests: 4		X			X
							X
							X
Suspended Solids	All	NDPs: 0 Tests: 4		X			X
							X
							X
Total Organic and Inorganic Carbon	All	NDPs: 0 Tests: 4	X			X	
							X
							X

CERTIFICATE OF ANALYSIS

SDG:	151120-53	**Location:**	Kilquade Waste Soils Recovery Facility	**Order Number:**	6115
Job:	D_FTIM_DUB-234	**Customer:**	Fehily Timoney	**Report Number:**	340537
Client Reference:	LW15-247-01	**Attention:**	Barry Donovan	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	GW2	GW3	GW1D	GW1S		
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00		
			Sample Type	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)		
			Date Sampled	19/11/2015	19/11/2015	19/11/2015	19/11/2015		
			Sample Time	.	.	.	.		
			Date Received	20/11/2015	20/11/2015	20/11/2015	20/11/2015		
			SDG Ref	151120-53	151120-53	151120-53	151120-53		
			Lab Sample No.(s)	12480868	12480878	12480847	12480858		
			AGS Reference						
Coliforms, Total*	CFU/100ml	SUB		8160	13000	>242000	>242000		
Coliforms, Faecal*	CFU/100ml	SUB		47	>100	>100	68		
Suspended solids, Neut. 5 mins. non-settleable	<2 mg/l	TM022		567	3140	192	1730		
Suspended Solids, Total neutralised	<2 mg/l	TM022		829	6970	246	2260		
Suspended solids, Neutralised 5 mins.	<2 mg/l	TM022		262	3830	54	530		
Suspended solids, Total	<2 mg/l	TM022		236 #	40400 #	1260 #	381 #		
Alkalinity, Total as CaCO3	<2 mg/l	TM043		150 #	600 #	160 #	225 #		
BOD, filtered	<1 mg/l	TM045		<1	<1	<1	<1		
Organic Carbon, Total	<3 mg/l	TM090		<3 #	<3 #	<3 #	20.3 #		
Ammoniacal Nitrogen as N	<0.2 mg/l	TM099		<0.2 #	0.644 #	<0.2 #	0.713 #		
Fluoride	<0.5 mg/l	TM104		<0.5 #	<0.5 #	<0.5 #	<0.5 #		
COD, unfiltered	<7 mg/l	TM107		49.1 #	230 #	51.2 #	180 #		
Conductivity @ 20 deg.C	<0.005 mS/cm	TM120		0.396 #	0.437 #	0.388 #	0.424 #		
Silicon (diss.filt)	<0.05 mg/l	TM129		5.62	5.54	4.11	3.47		
Aluminium (diss.filt)	<2.9 µg/l	TM152		<2.9 #	11 #	5.16 #	72.6 #		
Antimony (diss.filt)	<0.16 µg/l	TM152		<0.16	0.565	<0.16	<0.16		
Arsenic (diss.filt)	<0.12 µg/l	TM152		<0.12 #	0.988 #	1.91 #	2.53 #		
Barium (diss.filt)	<0.03 µg/l	TM152		1.91 #	5.39 #	13 #	54 #		
Beryllium (diss.filt)	<0.07 µg/l	TM152		<0.07 #	<0.07 #	<0.07 #	<0.07 #		
Boron (diss.filt)	<9.4 µg/l	TM152		9.65 #	10.4 #	16.2 #	63.1 #		
Cadmium (diss.filt)	<0.1 µg/l	TM152		<0.1 #	<0.1 #	<0.1 #	0.116 #		
Chromium (diss.filt)	<0.22 µg/l	TM152		1.3 #	1.43 #	1.37 #	3.45 #		
Cobalt (diss.filt)	<0.06 µg/l	TM152		<0.06 #	1.29 #	1.21 #	6.84 #		
Copper (diss.filt)	<0.85 µg/l	TM152		<0.85 #	1.35 #	0.903 #	2.4 #		
Lead (diss.filt)	<0.02 µg/l	TM152		<0.02 #	0.035 #	<0.02 #	0.156 #		
Manganese (diss.filt)	<0.04 µg/l	TM152		0.607 #	1480 #	926 #	8500 #		
Molybdenum (diss.filt)	<0.24 µg/l	TM152		<0.24 #	3.25 #	1.48 #	1.02 #		
Nickel (diss.filt)	<0.15 µg/l	TM152		0.506 #	3.28 #	1.65 #	4.54 #		
Phosphorus (diss.filt)	<6.3 µg/l	TM152		<6.3 #	<6.3 #	<6.3 #	15.3 #		
Selenium (diss.filt)	<0.39 µg/l	TM152		<0.39 #	1.2 #	0.68 #	1.09 #		
Tellurium (diss.filt)	<2 µg/l	TM152		<2	<2	<2	<2		
Thallium (diss.filt)	<0.96 µg/l	TM152		<0.96	<0.96	<0.96	<0.96		

CERTIFICATE OF ANALYSIS

SDG:	151120-53	**Location:**	Kilquade Waste Soils Recovery Facility	**Order Number:**	6115
Job:	D_FTIM_DUB-234	**Customer:**	Fehily Timoney	**Report Number:**	340537
Client Reference:	LW15-247-01	**Attention:**	Barry Donovan	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample R	GW2	GW3	GW1D	GW1S		
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00		
			Sample Type	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)		
			Date Sampled	19/11/2015	19/11/2015	19/11/2015	19/11/2015		
			Sample Time	.	.	.	.		
			Date Received	20/11/2015	20/11/2015	20/11/2015	20/11/2015		
			SDG Ref	151120-53	151120-53	151120-53	151120-53		
			Lab Sample No.(s)	12480868	12480878	12480847	12480858		
			AGS Reference						
Tin (diss.filt)	<0.36 µg/l	TM152		3.68 #	4.28 #	2.17 #	4.17 #		
Uranium (diss.filt)	<1.5 µg/l	TM152		<1.5	<1.5	3.18	<1.5		
Titanium (diss.filt)	<1.5 µg/l	TM152		<1.5 #	<1.5 #	<1.5 #	<1.5 #		
Vanadium (diss.filt)	<0.24 µg/l	TM152		0.413 #	0.54 #	0.718 #	1.1 #		
Zinc (diss.filt)	<0.41 µg/l	TM152		2.21 #	0.67 #	1.29 #	2.28 #		
Mercury (diss.filt)	<0.01 µg/l	TM183		<0.01 #	<0.01 #	<0.01 #	<0.01 #		
Sulphate	<2 mg/l	TM184		32.8 #	16.4 #	26.7 #	32.6 #		
Chloride	<2 mg/l	TM184		26.4 #	30.2 #	41.1 #	29.2 #		
Nitrite as N	<0.0152 mg/l	TM184		<0.0152 #	<0.0152 #	0.0167 #	<0.0152 #		
Phosphate (ortho) as PO4	<0.05 mg/l	TM184		<0.05 #	<0.05 #	0.053 #	<0.05 #		
Total Oxidised Nitrogen as N	<0.1 mg/l	TM184		6.46 #	8.68 #	1.7 #	0.341 #		
Cyanide, Total	<0.05 mg/l	TM227		<0.05 #	<0.05 #	<0.05 #	<0.05 #		
Calcium (diss.filt)	<0.012 mg/l	TM228		42.9 #	53 #	54 #	57.4 #		
Sodium (diss.filt)	<0.076 mg/l	TM228		23.1 #	16.7 #	20.9 #	21.6 #		
Magnesium (diss.filt)	<0.036 mg/l	TM228		13.6 #	13.2 #	9.49 #	5.64 #		
Potassium (diss.filt)	<1 mg/l	TM228		1.24 #	3.47 #	2.3 #	6.04 #		
Iron (diss.filt)	<0.019 mg/l	TM228		<0.019 #	<0.019 #	<0.019 #	0.493 #		
pH	<1 pH Units	TM256		8.02 #	7.82 #	7.82 #	7.31 #		
Phenol	<0.002 mg/l	TM259		<0.002 #	<0.002 #	<0.002 #	<0.002 #		
Cresols	<0.006 mg/l	TM259		<0.006 #	<0.006 #	0.01 #	<0.006 #		
Xylenols	<0.008 mg/l	TM259		<0.008 #	<0.008 #	<0.008 #	<0.008 #		
Phenols, Total Detected monohydric	<0.016 mg/l	TM259		<0.016 #	<0.016 #	<0.016 #	<0.016 #		
Silver (diss.filt)	<1.5 µg/l	TM283		<1.5	<1.5	<1.5	<1.5		

CERTIFICATE OF ANALYSIS

SDG:	151120-53	**Location:**	Kilquade Waste Soils Recovery Facility	**Order Number:**	6115
Job:	D_FTIM_DUB-234	**Customer:**	Fehily Timoney	**Report Number:**	340537
Client Reference:	LW15-247-01	**Attention:**	Barry Donovan	**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description	Wet/Dry Sample [1]	Surrogate Corrected
PM095	Standard Methods for the examination of waters and wastewaters 16th Edition, APHA, Washington DC, USA. ISBN 0-87553-131-8.	Preparation of Water Samples for Analysis		
SUB		Subcontracted Test		
TM022	Method 2540D, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part120 1981;BS EN 872	Determination of total suspended solids in waters		
TM043	Method 2320B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part109 1984	Determination of alkalinity in aqueous samples		
TM045	MEWAM BOD5 2nd Ed.HMSO 1988 / Method 5210B, AWWA/APHA, 20th Ed., 1999; SCA Blue Book 130	Determination of BOD5 (ATU) Filtered by Oxygen Meter on liquids		
TM090	Method 5310, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 415.1 & 9060	Determination of Total Organic Carbon/Total Inorganic Carbon in Water and Waste Water		
TM099	BS 2690: Part 7:1968 / BS 6068: Part2.11:1984	Determination of Ammonium in Water Samples using the Kone Analyser		
TM104	Method 4500F, AWWA/APHA, 20th Ed., 1999	Determination of Fluoride using the Kone Analyser		
TM107	ISO 6060-1989	Determination of Chemical Oxygen Demand using COD Dr Lange Kit		
TM120	Method 2510B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part 9:1970	Determination of Electrical Conductivity using a Conductivity Meter		
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer		
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS		
TM183	BS EN 23506:2002, (BS 6068-2.74:2002) ISBN 0 580 38924 3	Determination of Trace Level Mercury in Waters and Leachates by PSA Cold Vapour Atomic Fluorescence Spectrometry		
TM184	EPA Methods 325.1 & 325.2,	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers		
TM227	Standard methods for the examination of waters and wastewaters 20th Edition, AWWA/APHA Method 4500.	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate		
TM228	US EPA Method 6010B	Determination of Major Cations in Water by iCap 6500 Duo ICP-OES		
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978. ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLpH pH Meter		
TM259	by HPLC	Determination of Phenols in Waters and Leachates by HPLC		
TM283		Determination of Dissolved Niobium, Tungsten, and Zirconium in Water Matrices by ICP-MS		

[1] Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

CERTIFICATE OF ANALYSIS

SDG:	151120-53	**Location:**	Kilquade Waste Soils Recovery Facility	**Order Number:**	6115
Job:	D_FTIM_DUB-234	**Customer:**	Fehily Timoney	**Report Number:**	340537
Client Reference:	LW15-247-01	**Attention:**	Barry Donovan	**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	12480868	12480878	12480847	12480858
Customer Sample Ref.	GW2	GW3	GW1D	GW1S
AGS Ref.				
Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
Type	LIQUID	LIQUID	LIQUID	LIQUID
Alkalinity as CaCO3	27-Nov-2015	30-Nov-2015	27-Nov-2015	30-Nov-2015
Ammoniacal Nitrogen	24-Nov-2015	24-Nov-2015	24-Nov-2015	24-Nov-2015
Anions by Kone (w)	28-Nov-2015	28-Nov-2015	28-Nov-2015	28-Nov-2015
BOD True Filtered	26-Nov-2015	26-Nov-2015	26-Nov-2015	26-Nov-2015
COD Unfiltered	24-Nov-2015	24-Nov-2015	24-Nov-2015	24-Nov-2015
Coliforms (W)	03-Dec-2015	03-Dec-2015	03-Dec-2015	03-Dec-2015
Conductivity (at 20 deg.C)	24-Nov-2015	24-Nov-2015	27-Nov-2015	24-Nov-2015
Cyanide Comp/Free/Total/Thiocyanate	24-Nov-2015	24-Nov-2015	24-Nov-2015	24-Nov-2015
Dissolved Metals by ICP-MS	26-Nov-2015	26-Nov-2015	26-Nov-2015	26-Nov-2015
Dissolved W, Nb and Zr by ICP-MS	30-Nov-2015	01-Dec-2015	01-Dec-2015	01-Dec-2015
Fluoride	26-Nov-2015	26-Nov-2015	30-Nov-2015	26-Nov-2015
Mercury Dissolved	25-Nov-2015	24-Nov-2015	24-Nov-2015	24-Nov-2015
Metals by iCap-OES Dissolved (W)	25-Nov-2015	24-Nov-2015	24-Nov-2015	24-Nov-2015
Neutralised Suspended Solids	27-Nov-2015	27-Nov-2015	27-Nov-2015	27-Nov-2015
Nitrite by Kone (w)	25-Nov-2015	25-Nov-2015	25-Nov-2015	25-Nov-2015
pH Value	27-Nov-2015	27-Nov-2015	27-Nov-2015	27-Nov-2015
Phenols by HPLC (W)	23-Nov-2015	23-Nov-2015	23-Nov-2015	23-Nov-2015
Settleable Solids 5 Mins	27-Nov-2015	27-Nov-2015	27-Nov-2015	27-Nov-2015
Silicon Dissolved by ICP-OES	25-Nov-2015	23-Nov-2015	23-Nov-2015	23-Nov-2015
Suspended Solids	26-Nov-2015	27-Nov-2015	27-Nov-2015	26-Nov-2015
Total Organic and Inorganic Carbon	25-Nov-2015	25-Nov-2015	25-Nov-2015	25-Nov-2015

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www.cityanalysts.ie

Customer

Lucinda

Alcontrol Laboratories
C/O Aramex
Bellinstown
Ballyboughal
Co Dublin

Certificate Of Analysis

Job Number: 15-12065
Issue Number: 1
Report Date: 23 November 2015

Site: SDG 151120-53
PO Number: Not Supplied
Date Samples Received: 20/11/2015

Please find attached the results for the samples received at our laboratory on 20/11/2015.

Should you have any queries regarding the report or require any further services, we would be happy to discuss your requirements. For additional information about the company please log-on to our website at the above address.

Thank you for choosing City Analysts Limited. We look forward to assisting you again.

Authorised By: Shane Wilmoth

Authorised Date: 23 November 2015

Shane Wilmoth
Chemistry Technical Manager

Notes:

Results relate only to the items tested.
Information on methods of analysis and performance characteristics is available on request.
Any opinions or interpretations indicated are outside the scope of our INAB accreditation.
This test report shall not be reproduced except in full or with written approval of City Analysts Limited.

City Analysts Limited
Environmental Laboratories

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Certificate Of Analysis

Customer

Lucinda

Alcontrol Laboratories
C/O Aramex
Bellinstown
Ballyboughal
Co Dublin

Report Reference: 15-12065

Report Version: 1

Site: SDG 151120-53

Sample Description: Kilquade GW2

Sample Type: Ground

Lab Reference Number: 305471

Date of Sampling: 19/11/2015

Date Sample Received: 20/11/2015

Site / Method Ref.	Analysis Start Date	Parameter	Result	Units	PV Value (Drinking Water Only)
D/D1201#	20/11/2015	Coliforms	8164.0	MPN/100ml	-
D/D3221	20/11/2015	Faecal Coliforms	47	cfu/100ml	-

= INAB Accredited, U = UKAS Accredited, * = Subcontracted

Note:
PV Value is the parametric value, taken from European Communities, (Drinking Water) Regulations, 2014. S.I. No. 122 of 2014 and relates only to drinking water samples.
For queries on results, please contact us within two weeks of the report date to ensure that we can accommodate your query as samples cannot be stored indefinitely.
NAC & ATC - No abnormal change and acceptable to customers.
TVC - Total viable count
Site D = Analysed at City Analysts Dublin. Site S = Analysed at City Analysts Shannon

City Analysts Limited
Environmental Laboratories

City Analysts Limited,
Pigeon House Road,
Ringsend,
Dublin 4.

Tel: (01) 613 6003
Fax: (01) 613 6008

Email:
reports@cityanalysts.ie

www.cityanalysts.ie

Certificate Of Analysis

Customer

Lucinda

Alcontrol Laboratories
C/O Aramex
Bellinstown
Ballyboughal
Co Dublin

Report Reference: 15-12065

Report Version: 1

Site: SDG 151120-53

Sample Description: Kilquade GW3

Sample Type: Ground

Lab Reference Number: 305472

Date of Sampling: 19/11/2015

Date Sample Received: 20/11/2015

Site / Method Ref.	Analysis Start Date	Parameter	Result	Units	PV Value (Drinking Water Only)
D/D1201#	20/11/2015	Coliforms	12997.0	MPN/100ml	-
D/D3221	20/11/2015	Faecal Coliforms	> 100	cfu/100ml	-

= INAB Accredited, U = UKAS Accredited, * = Subcontracted

Note:
PV Value is the parametric value, taken from European Communities, (Drinking Water) Regulations, 2014. S.I. No. 122 of 2014 and relates only to drinking water samples.
For queries on results, please contact us within two weeks of the report date to ensure that we can accommodate your query as samples cannot be stored indefinitely.
NAC & ATC - No abnormal change and acceptable to customers.
TVC - Total viable count
Site D = Analysed at City Analysts Dublin. Site S = Analysed at City Analysts Shannon

City Analysts Limited
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Certificate Of Analysis

Customer

Lucinda

Alcontrol Laboratories
C/O Aramex
Bellinstown
Ballyboughal
Co Dublin

Report Reference: 15-12065

Report Version: 1

Site: SDG 151120-53

Sample Description: Kilquade GW1S

Sample Type: Ground

Lab Reference Number: 305473

Date of Sampling: 19/11/2015

Date Sample Received: 20/11/2015

Site / Method Ref.	Analysis Start Date	Parameter	Result	Units	PV Value (Drinking Water Only)
D/D1201#	21/11/2015	Coliforms	> 241960.0	MPN/100ml	-
D/D3221	20/11/2015	Faecal Coliforms	68	cfu/100ml	-

= INAB Accredited, U = UKAS Accredited, * = Subcontracted

Note:
PV Value is the parametric value, taken from European Communities, (Drinking Water) Regulations, 2014. S.I. No. 122 of 2014 and relates only to drinking water samples.
For queries on results, please contact us within two weeks of the report date to ensure that we can accommodate your query as samples cannot be stored indefinitely.
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Alcontrol Laboratories
C/O Aramex
Bellinstown
Ballyboughal
Co Dublin

Report Reference: 15-12065

Report Version: 1

Site: SDG 151120-53

Sample Description: Kilquade GW1D

Sample Type: Ground

Lab Reference Number: 305474

Date of Sampling: 19/11/2015

Date Sample Received: 20/11/2015

Site / Method Ref.	Analysis Start Date	Parameter	Result	Units	PV Value (Drinking Water Only)
D/D1201#	21/11/2015	Coliforms	> 241960.0	MPN/100ml	-
D/D3221	20/11/2015	Faecal Coliforms	> 100	cfu/100ml	-

= INAB Accredited, U = UKAS Accredited, * = Subcontracted

Note:
PV Value is the parametric value, taken from European Communities, (Drinking Water) Regulations, 2014. S.I. No. 122 of 2014 and relates only to drinking water samples.
For queries on results, please contact us within two weeks of the report date to ensure that we can accommodate your query as samples cannot be stored indefinitely.
NAC & ATC - No abnormal change and acceptable to customers.
TVC - Total viable count
Site D = Analysed at City Analysts Dublin. Site S = Analysed at City Analysts Shannon

SDG:	151120-53	**Location:**	Kilquade Waste Soils Recovery Facility	**Order Number:**	6115
Job:	D_FTIM_DUB-234	**Customer:**	Fehily Timoney	**Report Number:**	340537
Client Reference:	LW15-247-01	**Attention:**	Barry Donovan	**Superseded Report:**	

Appendix

General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICS and SVOC TICS.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALcontrol Laboratories reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as “Not detected”. If no asbestos fibre types are found all will be reported as “Not detected” and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible. The quantity of asbestos present is not determined unless specifically requested.

7. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

8. If appropriate preserved bottles are not received preservation will take place on receipt . However, the integrity of the data may be compromised.

9. NDP -No determination possible due to insufficient/unsuitable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals -total metals must be requested separately.

11. Results relate only to the items tested.

12. LODs for wet tests reported on a dry weight basis are not corrected for moisture content.

13. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%, they are generally wider for volatiles analysis, 50-150%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment . Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect .

14. **Product analyses** -Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors employed.

15. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).

16. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

20. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

21. For all leachate preparations (NRA, DIN, TCLP, BSEN 12457-1, 2, 3) volatile loss may occur, as we do not employ zero headspace extraction.

22. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill /made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

23. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5 -C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

Sample Deviations

1	Container with Headspace provided for volatiles analysis
2	Incorrect container received
3	Deviation from method
4	Holding time exceeded before sample received
5	Samples exceeded holding time before presevation was performed
§	Sampled on date not provided
♦	Sample holding time exceeded in laboratory
@	Sample holding time exceeded due to sampled on date
&	Sample Holding Time exceeded - Late arrival of instructions.

Asbestos

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than : - Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

Appendix 18

Environmental Risk Assessment Report

ENVIRONMENTAL RISK ASSESSMENT REPORT FOR A PROPOSED WASTE SOILS RECOVERY FACILITY AND ECO-PARK AT PRETTY BUSH, KILCOOLE, CO. WICKLOW

JULY 2016

Wicklow County Council
Comhairle Contae Chill Mhantáin

FEHILY TIMONEY & COMPANY

ENVIRONMENTAL RISK ASSESSMENT REPORT FOR A PROPOSED WASTE SOILS RECOVERY FACILITY AND ECO-PARK AT PRETTY BUSH, KILCOOLE, CO. WICKLOW

User is Responsible for Checking the Revision Status of This Document

Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Issue to Client	SG/DM/MG	DFM	DFM	12.07.2016

Client: Wicklow County Council

Keywords: Pretty Bush, inert dredge spoil, placement, groundwater, impacts

Abstract: This Environmental Risk Assessment (ERA) has been prepared to identify, what, if any, impacts may result to the hydrogeological regime at the Pretty Bush site as a result of the proposed placement of inert dredge spoil material there. This ERA supports the EIS and waste licence application being prepared to authorise the placement of this material at the site.

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1 INTRODUCTION

1.1 Background Information

The development of a waste soils recovery facility and Eco-Park at a Wicklow County Council (WCC) owned site at Pretty Bush, Kilcoole, Co. Wicklow has been proposed.

It is proposed to utilise this site for the deposition of up to 200,000 tonnes of dredge spoil material, mainly silt, clay and gravel, arising from the flood defence works being carried on the River Dargle in Greystones.

The flood defence works were authorised by An Bord Pleanála in 2008 and, as part of these works, it was identified that material not reused in the works would be "*removed off-site to suitably licensed disposal facility*". The proposed development satisfies this requirement as it will be required to hold a waste soils recovery facility licence from the EPA that approves the deposition of dredge spoil waste at the site.

Upon completion of the placement of riverbed spoil material, the site will be developed into an Eco-Park that will provide long term environmental and social benefits and recreational amenity for the local community.

The duration of the clearance and placement works is expected to be between 8-15 months, while the development of the Eco-park will occur in stages thereafter in line with appropriate planting seasons.

The location and an aerial view of the site in shown in Figure 1.1.

1.2 Requirement for an ERA

Pre-application consultation with the EPA in relation to the waste licence application for the proposed development identified that carrying out a suitable Environmental Risk Assessment (ERA) for the site which relates specifically to any potential groundwater impacts that may arise from the proposed development, would be an appropriate means of assessing potential impacts on groundwater.

Fehily Timoney and Company (FTC) has carried out this ERA in accordance with the EPA's recommendation and the contents in this report present the findings of the ERA.

1.3 Guidance

This report has been prepared based on the guidance and information provided in the following documents:

- EPA 2003, *Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report*
- Environmental Agency (UK) 2004, *Model Procedures for the Management of Land Contamination: Contaminated Land Report 11*
- EPA 2007, *Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites*
- EPA 2011, *Guidance on the Authorisation of Discharges to Groundwater*
- EPA 2013, *Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites*

Figure 1.1: Location and aerial view of the site

2 ENVIRONMENTAL SITE SETTING

The site is located in the townlands of Priestsnewtown and Kilquade, approximately 1 km north of Kilcoole village and 1 km south of Delgany village. Access is on the L1042 local Kilquade road, approximately 100 m east of the junction with the R761 Kilncarrig (Delgany – Kilcoole) regional road. Greystones and Bray towns are located approximately 3 km and 8 km north of the site, respectively.

The site is known locally as “The Rocks” and is owned by WCC, who purchased the land in 1998. Currently, a portion of the site is utilised as a mini depot by WCC for road maintenance.

The site covers an area of 5.6 ha. It is heavily overgrown with vegetation (mainly gorse, trees and bracken) and is undulating in nature. The land use in the surrounding area is shown in Figure 2.1. Pastures and discontinuous urban fabric represent the main land use types in the immediate surrounds of the site.

The site is not located within a Special Protection Area (SPA), a Special Area of Conservation (SAC), a Natural Heritage Area (NHA) or a proposed Natural Heritage Area (pNHA). However, a number of designated areas are located nearby. The designated areas within 10 km of the site are presented in Figure 2.2.

The site contains 2 no. small streams which run from north-south along the eastern boundary of the site and from north east-south west across the site. Currently the full extent of the site drains towards these streams, generally from the north-west to the south-east.

The southern end of the site is approximately 500m from the Kilcoole Stream. The Kilcoole Stream rises at an elevation of 120 m OD in the town of Kilpedder to the west of the site. It flows in a south-easterly direction and enters the ocean at St. Georges Channel to the east of Kilcoole. The full area of the site drains into the Kilcoole Stream downstream of site and an area of 7.57km^2 upstream drains into this waterbody.

Directly bordering the site to the north and west are a number of residential dwellings, a distribution building owned by Eir and the local L1042 road, while the site is bordered to the east, south and south west by the Kilncarrig Road, agricultural fields and a number of individual dwellings. The Farrankelly Close residential development is located directly opposite (north) from the main site access. Total populations and population densities of settlement areas surrounding the site are presented in Figure 2.3.

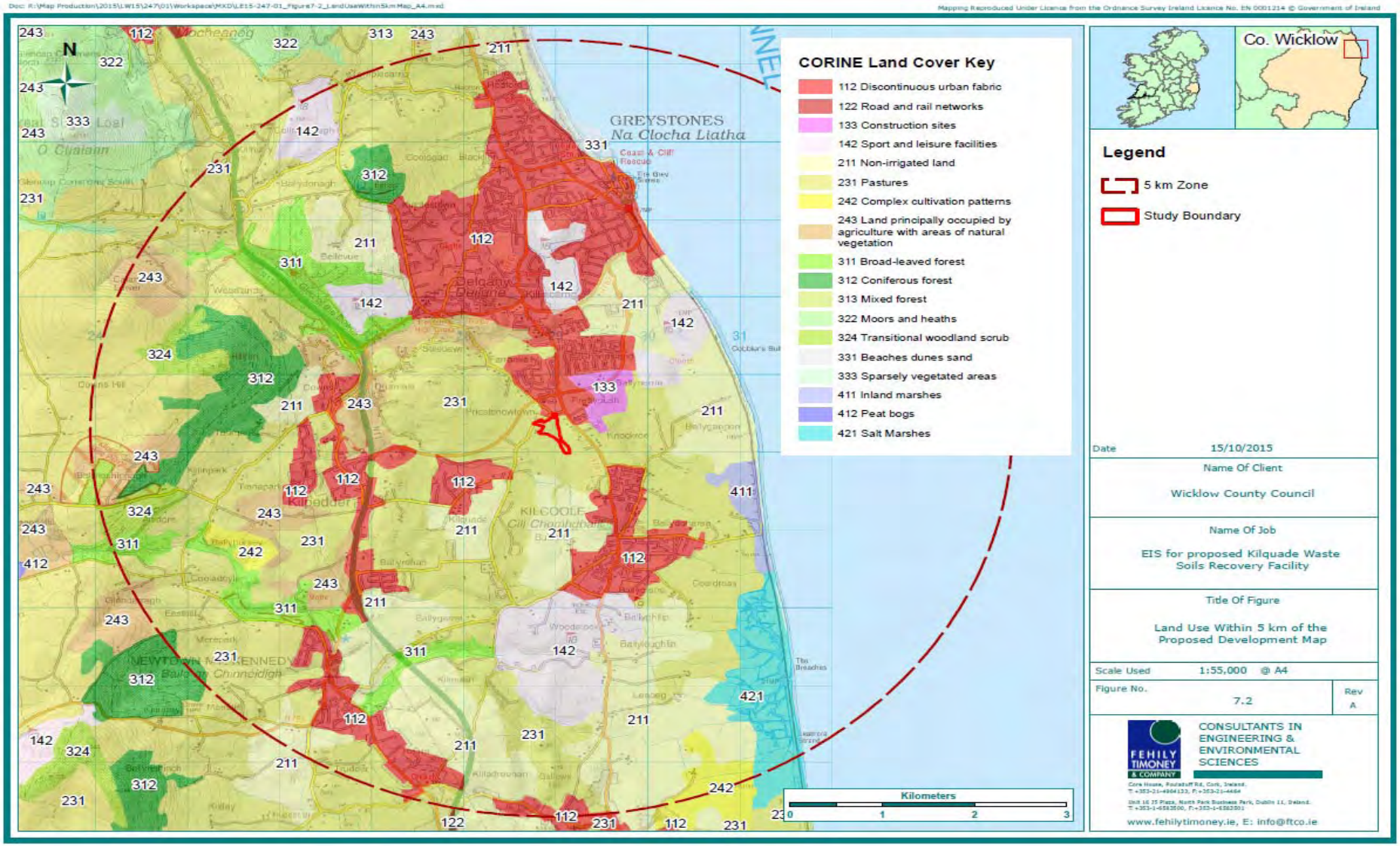


Figure 2.1: Land use within 5 km of the site

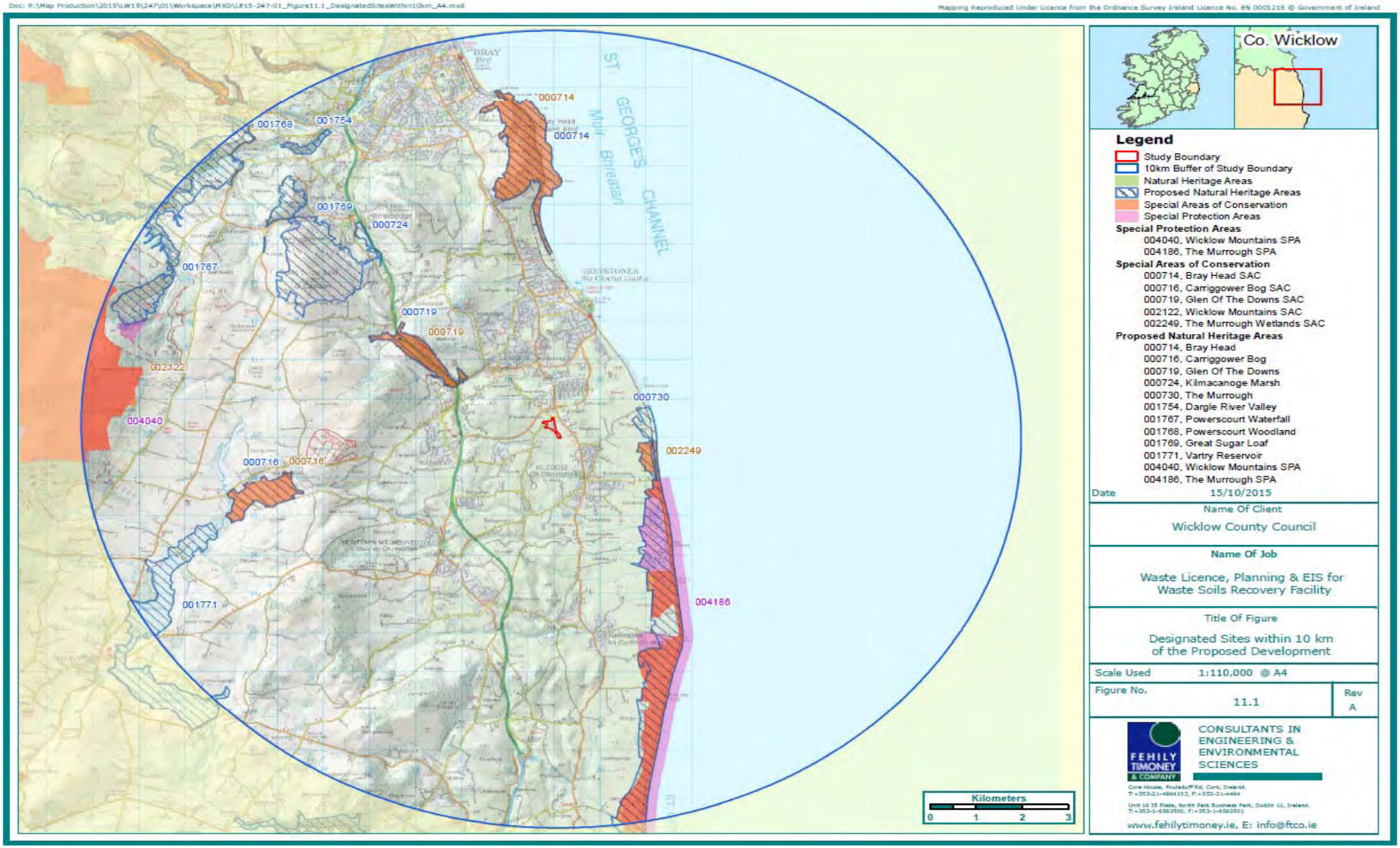


Figure 2.2: Designated areas within 10 km of the site

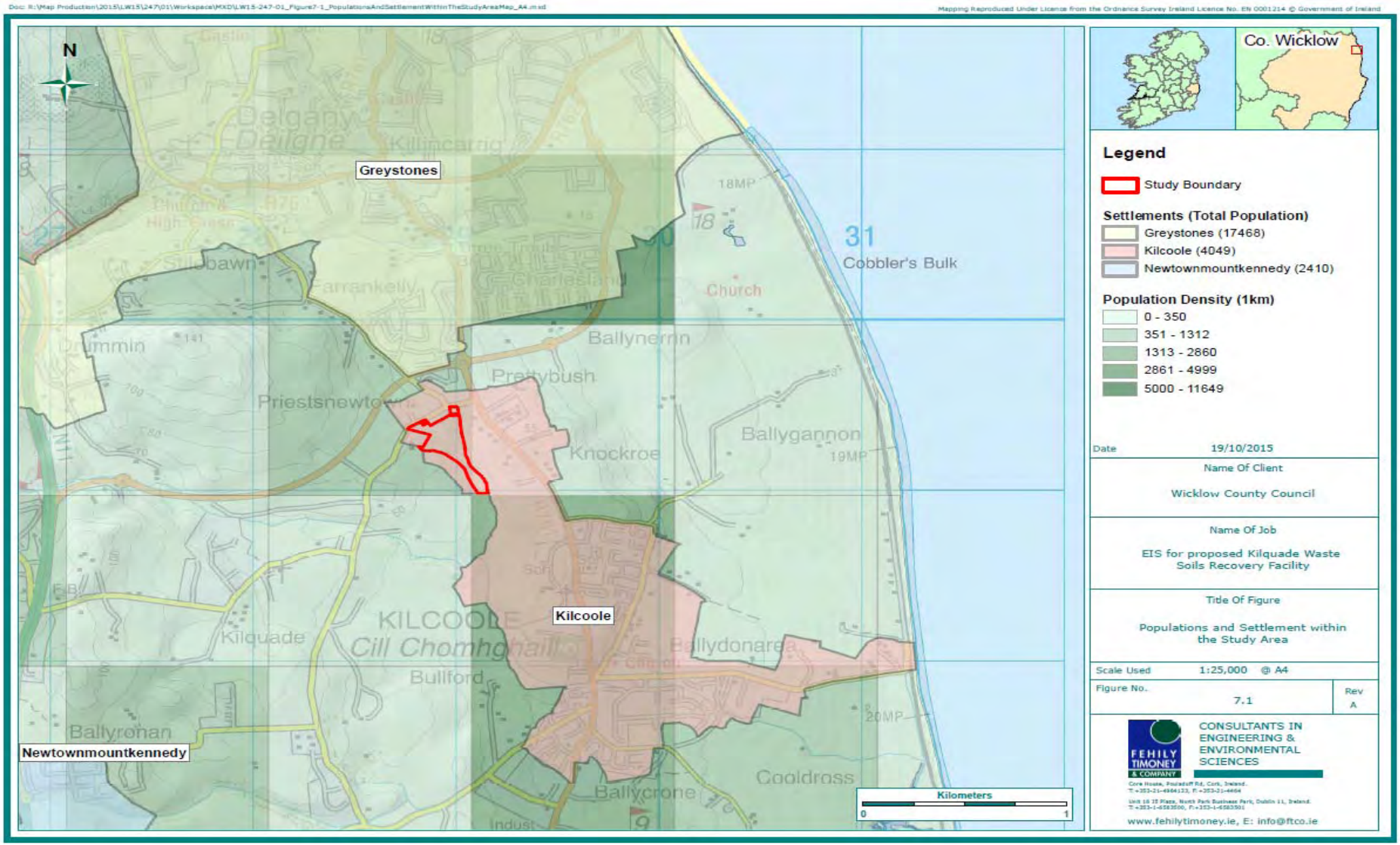


Figure 2.3: Population details of settlement areas nearby the site

2.1 Geology

2.1.1 Bedrock Geology

The Geological Survey of Ireland (GSI) publication 'Geology of Kildare-Wicklow' is the reference source for the description of the bedrock geology of the region. The GSI 1:100,000 scale bedrock geology map (Sheet 16) shows that the Cambrian Bray Head Formation underlies the site. The bedrock geology of the site and surrounding area is shown in Figure 2.4.

The Bray Head Formation covers the majority of the Wicklow area and comprises greywacke sandstones and siltstones interbedded with green, purple, red and grey slates and massive quartzites. Bedrock at the site is close to the surface and exposed in parts.

There are no major faults or folds in the immediate area surrounding the site.

2.1.2 Overburden Geology

The main soil associations within this part of County Wicklow are Acid Brown Earths (75%) with associated Gleys (15%) and Brown Podzolics (10%).

The main Quaternary sediments identified in the area are glacial till deposits derived from the underlying sandstone and shale which is present in the area. Additionally, limestone sands and gravels underlie the area to the southwest and southeast of the site.

The site itself is underlain by shallow bedrock, with little or no Quaternary overburden, i.e. limited soils cover and exposed rock in places. The Quaternary geology of the site and surrounding area is shown in Figure 2.5.

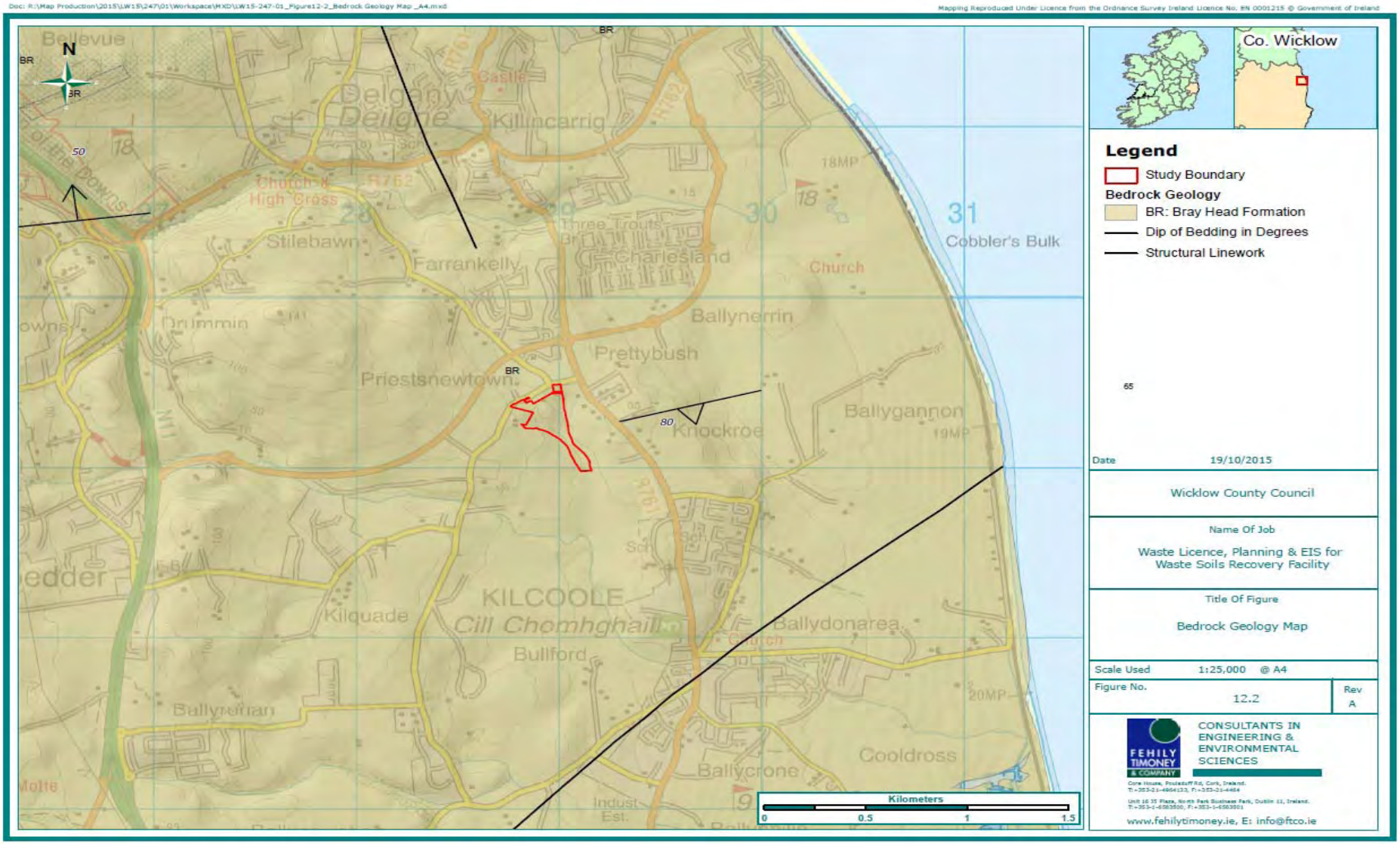


Figure 2.4: Bedrock geology of the site and surrounding area

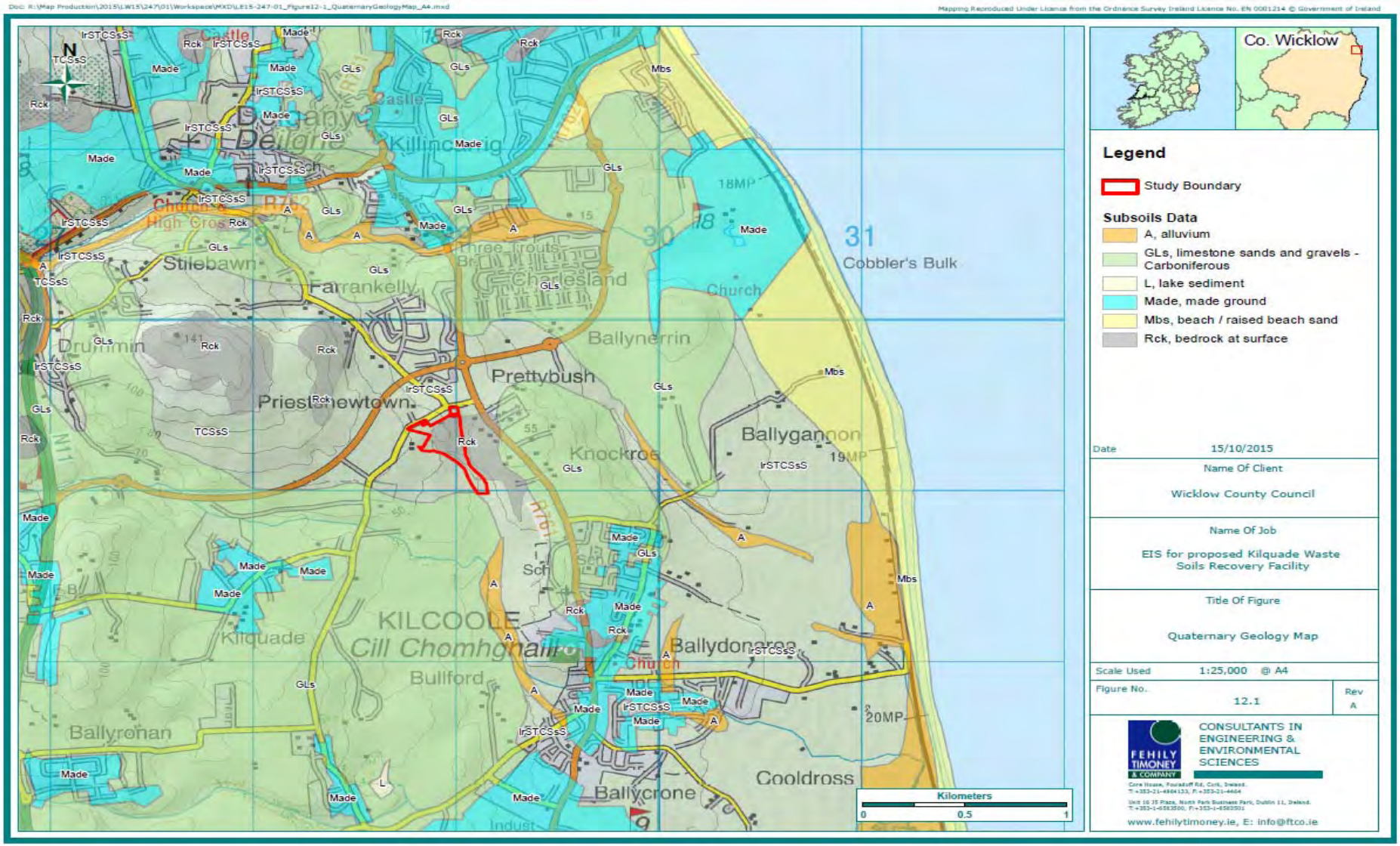


Figure 2.5: Quaternary geology of the site and surrounding area

2.2 Hydrogeology

The available GSI information for the region indicates that the bedrock underlying the site is classified as a 'Poor Aquifer (Pl)', with bedrock which is 'generally unproductive except locally'. The aquifer types in the region surrounding the site are shown in Figure 2.6.

Groundwater within the aquifer occurs mainly within fracture zones which may occur within the rocks. Well specific capacities are generally around 50 m^3/day according to the available GSI information, with groundwater abstracted mainly by domestic properties and farms.

The GSI lists four wells within 1km of the site boundary and a total of 26 wells within 2km, as shown in Figure 2.6. The wells in this area are mostly constructed to depths of between 12m and 48m according to the data available on the GSI website. It is likely that other properties in the area are also served by groundwater wells for which there is no publically available information.

Information on groundwater vulnerability at the site and in its surrounding area is provided in Section 3.2.5.

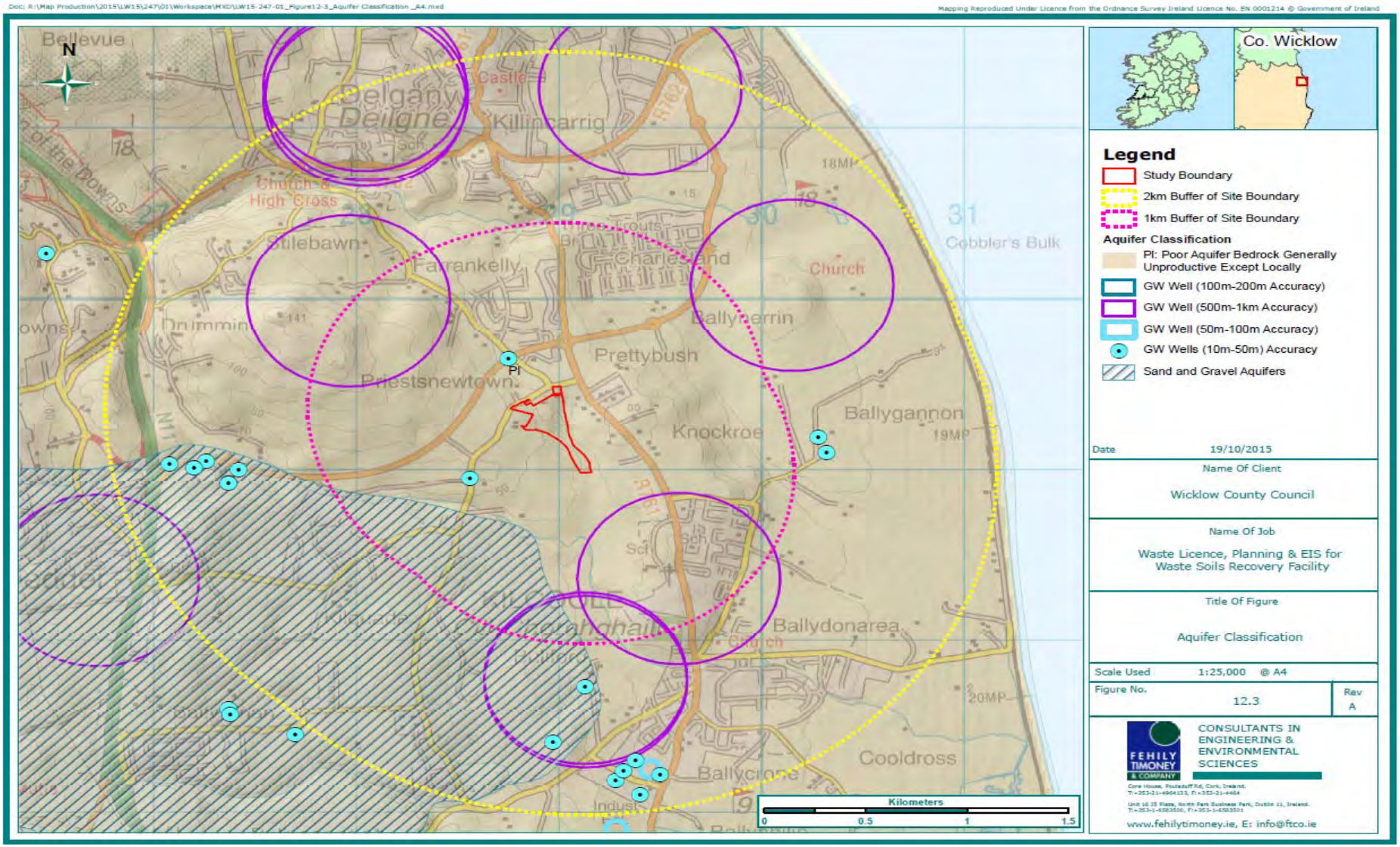


Figure 2.6: Aquifer types and groundwater wells in the surrounding area of the site

2.3 Surface Water Features

The site contains 2 no. small streams which run from north-south along the eastern boundary of the site and from north east-south west across the site. Currently the full extent of the site drains towards these streams, generally from the north-west to the south-east.

The site is located within the catchment of the Kilcoole Stream. The southern end of the site is approximately 500m from this stream. The Kilcoole Stream rises at an elevation of 120 m OD in the town of Kilpedder to the west of the site. It flows in a south-easterly direction and enters the ocean at St. Georges Channel to the east of Kilcoole. The full area of the site drains into the Kilcoole Stream downstream of site and an area of 7.57km^2 upstream also drains into this waterbody.

The surface water features and the surface waterbody catchments in the surrounding area of the site are shown in Figure 2.7 and Figure 2.8, respectively.

Chemical water quality monitoring of both the streams within the site boundary and the Kilcoole Stream has been carried out in recent years. Results gathered from this monitoring have indicated a generally good standard of surface water quality.

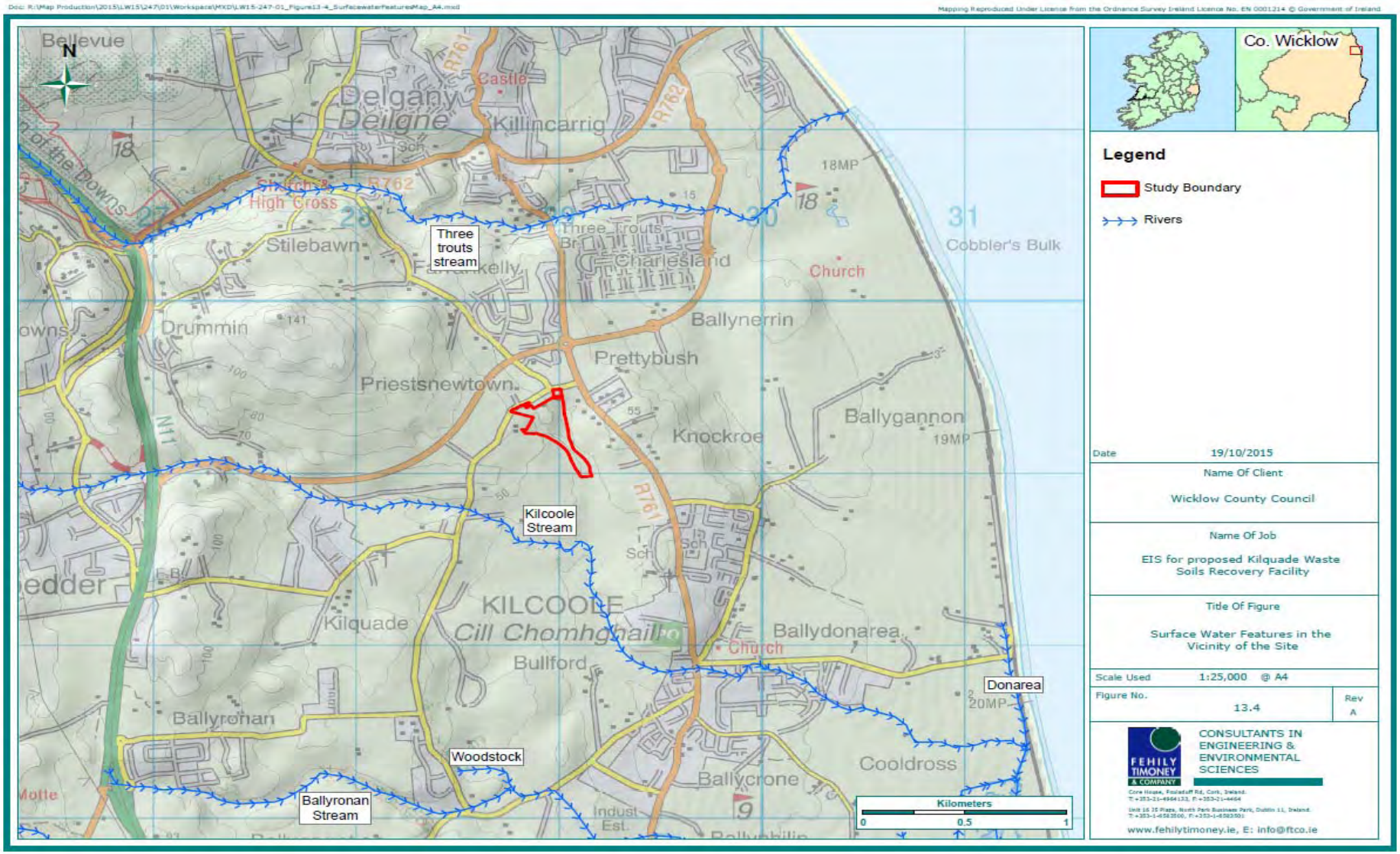


Figure 2.7: Surface water features in the surrounding area of the site

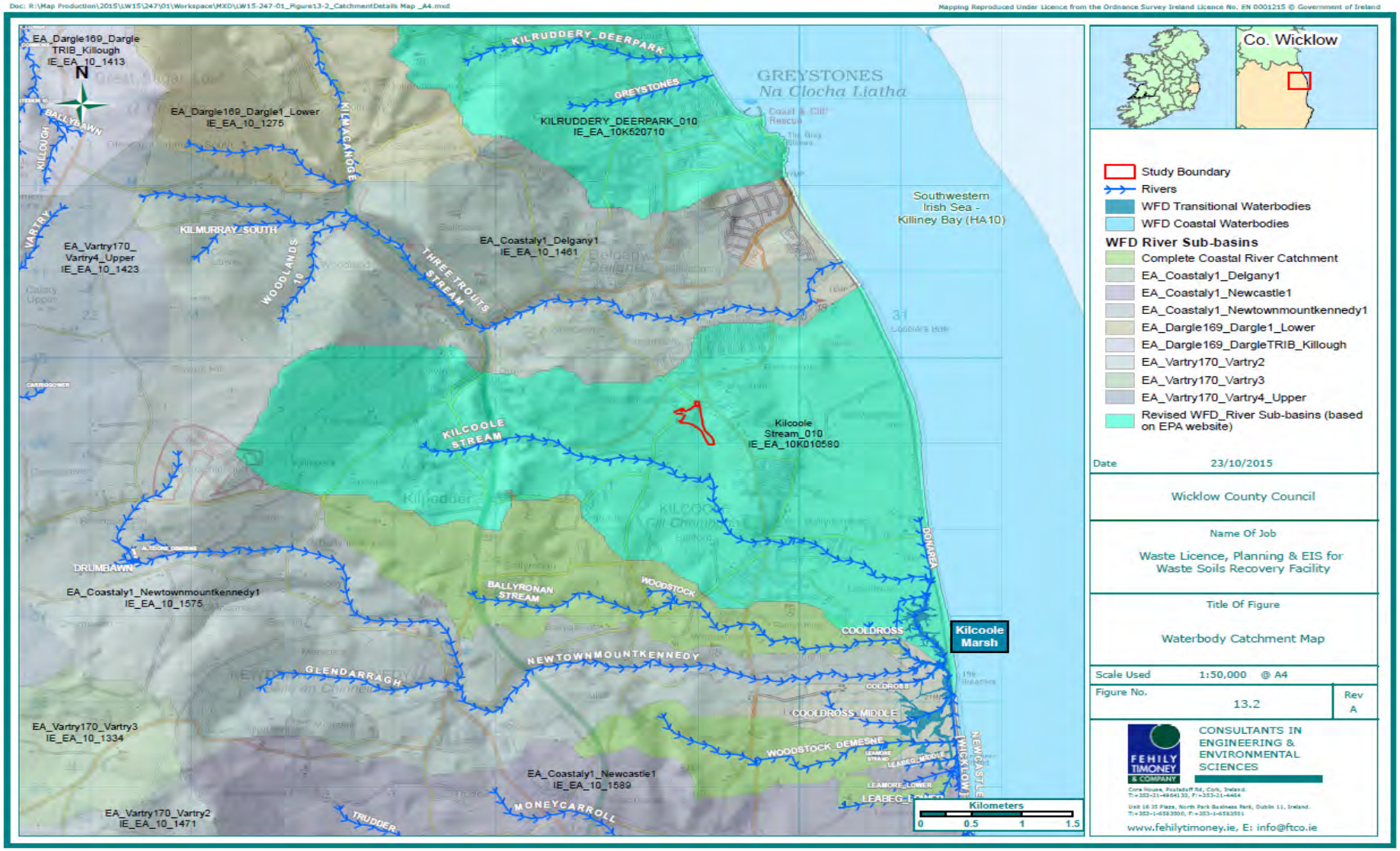


Figure 2.8: Surface waterbody catchments in the surrounding area of the site

3 RISK ASSESSMENT

Risk assessment considers the likelihood of occurrence and the consequence of occurrence of an event (Royal Society, 1992[1]). ERA is based on the development of a Conceptual Site Model (CSM) which is used to determine the potential exposure of a vulnerable receptor to a contaminant. The CSM is used as the basis for the risk assessment. It is used to identify all possible "sources", "pathways" and "receptors" as well as the processes that are likely to occur along each of the source-pathway-receptor (S-P-R) linkages and uncertainties.

The S-P-R assessment methodology, or variants thereof, and the development of a CSM are discussed in the guidance documents listed in Section 1.3 which were reviewed in the preparation of this ERA.

The assessment of a discharge to groundwater, which this ERA primarily focusses on, is risk-based and receptor focused. As such, pollution does not occur unless a pollutant causes harm to human health, the quality of aquatic ecosystems, or terrestrial ecosystems which are directly depending on aquatic ecosystems. Accordingly, this assessment involves a determination of the 'risk of impact' to receptors.

Figure 3.1: S-P-R Risk Factors (EPA, 2011)

The following sections assess the hazard **source**, the likely **pathways** and the **receptors** for the proposed works.

3.1 Source

For the purpose of this ERA, the 200,000 tonnes of dredge spoil material that is proposed to be deposited at the site presents the primary potential source of pollution. This material comprises clay, silt, sand, gravel and stone.

3.1.1 Material Analysis

Analysis has been undertaken on the dredge spoil material proposed for acceptance in order to verify its nature. Three separate periods of sampling work were undertaken by Gavin and Doherty Geosolutions in February 2015, October 2015 and April 2016.

These samples were compared with Waste Acceptance Criteria (WAC) limit values, which classify various wastes as suitable for acceptance at different types of landfill facilities based on their composition. These criteria are laid down in Council Decision 2003/33/EC and the limit values with which the material is compared are those classified as "inert waste". Limit values were examined for comparison only so as to substantiate the inert nature of the material.

The results of the testing undertaken on the dredge spoil material are summarised in Table 3.1, Table 3.2 and Table 3.3, and are compared with the Inert WAC limit values identified for comparison.

[1] Royal Society 1992, Risk: Analysis, Perception and Management. The Royal Society, London (ISBN 0-85403-467-6).

Table 3.1: Summary of Soil/Eluate Test Results for Incoming Material (Test 1: 23/02/15)

Parameter	Units	Incoming Material Samples										Landfill Waste Acceptance Criteria (WAC) Limits for Inert Wastes		
		TP1 1.1	TP1 3.5	TP2 0.9	TP2 1.2	TP3 2.5	TP6 0.95	TP6 3.3	TP7 2	TP8 2.05	TP9 2.8	Inert	Stable	Hazardous
Solid Waste														
TOC	%	0.82	0.46	0.47	0.46	0.28	1.34	0.6	3.19	0.2	0.2	3	5	6
Sum of BTEX	mg/kg	0.027	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	6	-	-
Sum of 7 PCBs	mg/kg	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	1	-	-
Mineral oil	mg/kg	<45	<45	<45	<45	<45	<45	<45	<45	<45	<45	500	-	-
PAH sum of 6	mg/kg	0.39	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	14.39	<0.22	<0.22	-	-	-
PAH sum of 17	mg/kg	1.03	<0.64	<0.64	<0.64	<0.64	<0.64	<0.64	34.77	<0.64	<0.64	100	-	-
10:1 Eluate														
Arsenic	mg/kg	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.5	2	25
Barium	mg/kg	0.11	0.04	0.07	0.07	0.05	0.04	0.06	0.21	<0.03	<0.03	20	100	300
Cadmium	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.04	1	5
Chromium	mg/kg	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.5	10	70
Copper	mg/kg	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	2	50	100
Mercury	mg/kg	0.0021	0.0011	0.0012	0.0013	0.0006	0.0025	0.0057	0.0028	0.0007	0.0018	0.01	0.2	2
Molybdenum	mg/kg	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	<0.02	<0.02	0.5	10	30
Nickel	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	0.4	10	40
Lead	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	10	50
Antimony	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	0.7	5
Selenium	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.1	0.5	7
Zinc	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	4	50	200
Chloride	mg/kg	5	5	<3	<3	<3	7	<3	21	5.6	10.3	800	15000	25000
Fluoride	mg/kg	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	10	150	500
Sulphate as SO_4	mg/kg	32.9	13.8	26.6	24.2	30.6	77.9	9.9	37.7	5.6	10.3	1000	20000	50000
Total Dissolved Solids	mg/kg	1531	920	940	470	840	1810	1021	1481	1631	830	4000	60000	10000
Phenol	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1	-	-
Dissolved Organic Carbon	mg/kg	60	60	40	50	40	40	50	100	30	<20	500	800	1000

Table 3.2: Summary of Soil/Eluate Test Results for Incoming Material (Test 2: 21/10/15)

Parameter	Units	Incoming Material Samples											Landfill Waste Acceptance Criteria (WAC) Limits for Inert Wastes		
		1	2	3	4	5	6	7	8	9	10	11	Inert	Stable	Hazardous
Solid Waste															
TOC	%	0.2	0.16	0.12	0.14	0.22	0.18	0.16	0.2	0.14	0.05	0.17	3	5	6
Sum of BTEX	mg/kg	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	6	-	-
Sum of 7 PCBs	mg/kg	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	1	-	-
Mineral oil	mg/kg	<45	<45	<45	<45	<45	<45	<45	<45	<45	<45	<45	500	-	-
PAH sum of 6	mg/kg	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22	-	-	-
PAH sum of 17	mg/kg	<0.64	<0.64	<0.64	<0.64	<0.64	<0.64	<0.64	<0.64	<0.64	<0.64	<0.64	100	-	-
10:1 Eluate															
Arsenic	mg/kg	0.054	<0.025	0.033	<0.025	<0.025	<0.025	<0.025	<0.025	0.032	<0.025	0.035	0.5	2	25
Barium	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	20	100	300
Cadmium	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.04	1	5
Chromium	mg/kg	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.5	10	70
Copper	mg/kg	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	2	50	100
Mercury	mg/kg	0.0049	0.0049	0.0043	0.0046	0.0049	0.0063	0.0045	0.0001	0.0003	0.0003	0.0002	0.01	0.2	2
Molybdenum	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.5	10	30
Nickel	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.4	10	40
Lead	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	10	50
Antimony	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	0.7	5
Selenium	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.1	0.5	7
Zinc	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	4	50	200
Chloride	mg/kg	10	<3	<3	<3	<3	4	<3	<3	<3	<3	<3	800	15000	25000
Fluoride	mg/kg	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	10	150	500
Sulphate as SO_4	mg/kg	40.4	3.4	23.7	17.1	15.6	14.7	15.1	17.2	35	19.6	18.5	1000	20000	50000
Total Dissolved Solids	mg/kg	120	800	720	620	720	1040	660	520	<100	540	860	4000	60000	10000
Phenol	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1	-	-
Dissolved Organic Carbon	mg/kg	30	30	30	30	30	30	30	40	30	30	30	500	800	1000

Table 3.3: Summary of Soil/Eluate Test Results for Incoming Material (Test 3: 13/04/16)

Parameter	Units	Incoming Material Samples					Landfill Waste Acceptance Criteria (WAC) Limits for Inert Wastes		
		Sample 1	Sample 3	Sample 5	Sample 7	Sample 9	Inert	Stable	Hazardous
Solid Waste									
TOC	%	0.15	0.16	0.22	0.19	0.17	3	5	6
Sum of BTEX	mg/kg	<0.025	<0.025	<0.025	<0.025	<0.025	6	-	-
Sum of 7 PCBs	mg/kg	<0.035	<0.035	<0.035	<0.035	<0.035	1	-	-
Mineral oil	mg/kg	<45	<45	<45	<45	<45	500	-	-
PAH sum of 6	mg/kg	<0.22	<0.22	<0.22	<0.22	<0.22	-	-	-
PAH sum of 17	mg/kg	<0.64	<0.64	<0.64	<0.64	<0.64	100	-	-
10:1 Eluate									
Arsenic	mg/kg	0.063	<0.025	0.037	<0.025	0.044	0.5	2	25
Barium	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	20	100	300
Cadmium	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.04	1	5
Chromium	mg/kg	<0.015	<0.015	<0.015	<0.015	<0.015	0.5	10	70
Copper	mg/kg	<0.07	<0.07	<0.07	<0.07	<0.07	2	50	100
Mercury	mg/kg	0.0004	0.0004	0.0003	0.0006	0.0004	0.01	0.2	2
Molybdenum	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.5	10	30
Nickel	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.4	10	40
Lead	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	10	50
Antimony	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	0.7	5
Selenium	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	0.1	0.5	7
Zinc	mg/kg	0.04	0.04	0.03	<0.03	<0.03	4	50	200
Chloride	mg/kg	64	74	66	66	85	800	15000	25000
Fluoride	mg/kg	<3	<3	<3	<3	<3	10	150	500
Sulphate as SO_4	mg/kg	133.2	141.3	128.5	127.9	151.3	1000	20000	50000
Total Dissolved Solids	mg/kg	780	810	710	1040	840	4000	60000	10000
Phenol	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	1	-	-
Dissolved Organic Carbon	mg/kg	30	30	30	20	20	500	800	1000

The results presented in Table 3.1, Table 3.2 and Table 3.3 indicate that the material proposed to be deposited at the site is inert. The likelihood that this material may result in contamination of groundwater at the site is considered to be low.

It should be noted that a single sample of the dredge spoil material which was sampled in February 2015 slightly exceeded the comparable WAC inert criteria limit for Total Organic Carbon (TOC). However, this result is consistent with a similar exceedance within an in-situ soil sample analysed from the Pretty Bush site and this exceedance is not considered significant in the context of the development. Furthermore, no WAC inert criteria limits were exceeded for any of the samples obtained from the more recent sampling of dredge spoil material in October 2015 and April 2016.

Specific waste acceptance criteria will be applied for the imported material. Prior to placement of the material at the site, a letter of suitability, as to the nature and suitability of the material for placement, shall be provided by a suitable person for the first 5,000 tonnes of material and a further letter of suitability shall be provided for each subsequent 5,000 tonnes of material.

A weekly random waste characterisation of all imported material will also be carried out. Information to be identified will include the source, origin and physical appearance of the waste.

The above measures will help to ensure that any potential subsurface contamination from the placement of the dredge spoil material is prevented.

3.1.2 Other Potential Sources

While the the 200,000 tonnes of dredge spoil material proposed to be deposited at the site presents the primary potential source of pollution, potential contamination of the exposed bedrock/aquifer may arise from other sources associated with the planned works.

Construction Plant will be accessing the site during the proposed works, posing a potential direct contamination risk to the exposed bedrock/aquifer through potential for fuel spillages. To mitigate against this risk, refuelling of machinery will only occur offsite or in specially designated areas such as site compounds, using designated refueling bowsers.

Any other diesel, fuel or hydraulic oils stored on site will be stored in bunded storage tanks – the bund area will have a volume of at least 110 % of the volume of such materials stored.

All personnel working on site will also be trained in pollution incident control response. Emergency Silt Control and Spillage Response Procedures will be kept on site to inform personnel in the event of a pollution incident.

3.2 Pathway

A pathway is a mechanism or route by which a contaminant comes into contact with, or otherwise affects, a receptor. Groundwater migration is considered to be the main pathway associated with the placement of the dredge spoil material at the site. This pathway and the potential pathway linkages associated with it at the site are summarised below.

3.2.1 Groundwater Migration

As previously noted, the material to be deposited at the site is inert. As a result, contamination of groundwater from the placement of this material represents a highly unlikely event.

Nonetheless, a potential groundwater migration pathway is present at the site and has been investigated for this ERA. This pathway is as follows.

The groundwater would percolate vertically downwards into the substrata. As the sub-soil thickness across most of the site is not extensive or lacking in places, the groundwater would undergo limited, if any, attenuation as it passed through the overburden deposits, which are composed mainly of glacial till. It would be diluted upon contact with the water table and would migrate laterally in the direction of groundwater flow.

Groundwater migration along this pathway would continue until the groundwater reached the streams onsite which runs from north-south along the eastern boundary of the site and north west - south east on the western side of the site. At this point, it is likely that some of the slightly diluted and attenuated groundwater would discharge to this stream, while the remainder would follow the local groundwater pathways along it.

3.2.2 Groundwater Flow Velocity

The rate of movement and dilution of groundwater at the site is dictated by the nature and permeability of the underlying aquifer. As previously described, the site is underlain by predominantly glacial till which is generally of moderate permeability. The flow gradient is approximately 1 in 17 or 0.058, indicating that the rate of groundwater flow through the bedrock is relatively quick.

3.2.3 Groundwater Flow Direction

The groundwater flow direction at the site is from west to east, towards the stream which runs from north-south along the eastern boundary of the site.

Under EPA Guidance, groundwater risk pathways are assessed according to two main criteria:

- Aquifer classification
- Groundwater vulnerability

3.2.4 Aquifer Classification

From examining the available GSI information, the underlying bedrock aquifer is classified as a 'Poor Aquifer (Pl)', with bedrock which is 'generally unproductive except locally' (as shown in Figure 2.6.).

3.2.5 Groundwater Vulnerability

Groundwater vulnerability, as defined by the GSI, is the term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. The factors used in assessing groundwater vulnerability include subsoil type and thickness and recharge type. The GSI procedure whereby groundwater protection is assessed is outlined in the EPA-GSI publication 'Groundwater Protection Schemes'. The procedure proposes a matrix, which relates vulnerability, source and resource such that a particular site is given a Response ("R") to specific activities.

The GSI distribution of vulnerability for the area is predominantly 'Extreme' due to shallow bedrock with a small area of 'High' vulnerability at the southern end of the site, as shown in Figure 3.2.

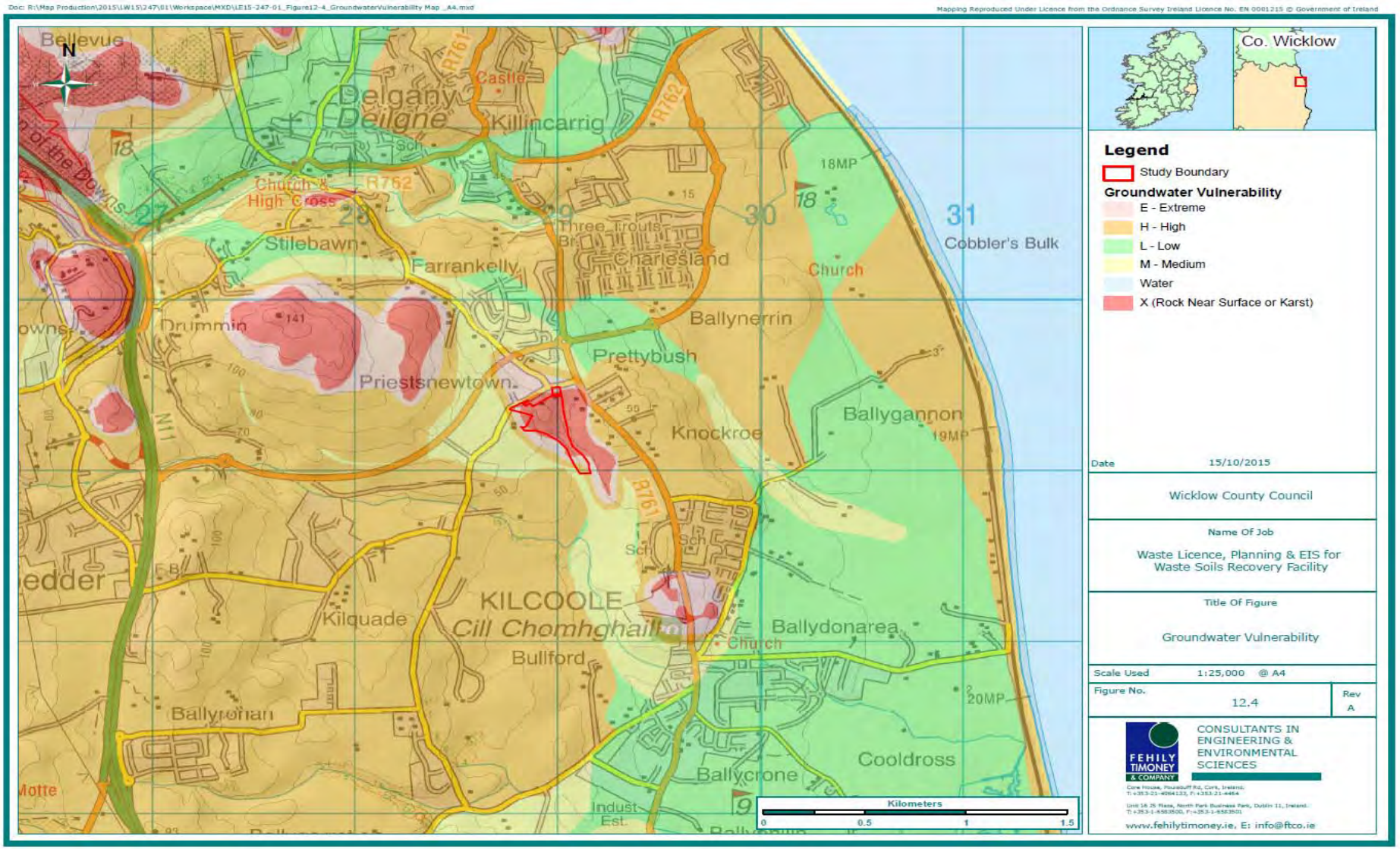


Figure 3.2: Groundwater vulnerability of the site and surrounding area

The assessed vulnerability for the majority of the site is shown in Table 3.4. The table illustrates the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted based on the findings of ground investigations.

Table 3.4: GSI Guidelines – Aquifer Vulnerability Mapping

Vulnerability rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (Sand / gravel)	Moderate Permeability (e.g. Sandy soil)	Low Permeability (e.g. Clayey subsoil, clay.)
Extreme (E)	0 - 3 m	0 - 3 m	0 - 3 m
High (H)	>3 m	3 -10 m	3 - 5 m
Moderate (M)	N/A	>10 m	5 - 10 m
Low (L)	N/A	N/A	>10 m

Notes: N/A = not applicable
Precise permeability values not available
Highlighted area reflects site conditions

Existing information regarding the site indicates that the overburden deposits of mainly glacial till have generally a moderate permeability and may therefore act as a confining layer (where present), preventing the free movement of surface water to the underlying aquifer within the bedrock. The thickness of the overburden layer across the site is considered to be mostly less than 1 m. Therefore, a vulnerability rating of 'High' to 'Extreme' can be applied to the aquifer below the site. This suggests that any potential contamination would encounter limited attenuation prior to reaching bedrock.

3.3 Receptor

Groundwater is considered a receptor under the EPA Guidance Document (2011) when it is being used for either public or private water supply. This section provides an overview of local groundwater abstractions, groundwater monitoring and groundwater quality. Additionally, an overview of the surface water quality of the small stream which flows along the eastern boundary of the site is provided, as this stream also constitutes a receptor from potential groundwater contamination at the site.

3.3.1 Groundwater Extraction

The GSI lists four wells within 1km of the site boundary and a total of 26 wells within 2km, as shown in Figure 2.6. The wells in this area are mostly constructed to depths of between 12m and 48m according to the data available on the GSI website. While there are a large number of wells surrounding the site, it is understood that the vast majority of homes and businesses in the area use mains water supply and do not rely on groundwater wells.

The majority of the wells shown in Figure 2.6 are not located directly downgradient of the site within its zone of influence. The groundwater flow direction from west to east suggests that just two wells, located to the east of the site, would be at risk. However, these wells are located at a distance of greater than 1km from the site. It is therefore considered unlikely that they would be affected by potential subsurface contamination, as any contaminated groundwater would likely have been significantly diluted and attenuated by the time it reaches these wells.

The small stream which runs from north-south along the eastern boundary of the site is the main surface water body at risk from groundwater discharges. Groundwater from the site flows in a west to east direction towards this stream. Surface water bodies outside the immediate vicinity of the site are unlikely to be affected by groundwater discharges unless they are connected by an adjoining river or stream. For example, if significant concentrations of pollutants entered into the stream along the eastern boundary of the site, they could potentially be carried into the Kilcoole Stream. However, this scenario is considered to be unlikely.

The site is not located within a groundwater dependent ecosystem and no such ecosystems are located within its immediate surrounds.

3.3.2 Groundwater Monitoring

The baseline groundwater quality was established for the site by means of a groundwater monitoring and sampling regime. Three groundwater wells were monitored as part of this regime. The locations of these wells are shown in Figure 3.3.

Groundwater measurements at the three well were undertaken by FTC using a dipmeter approximately one week after their installation in 2015. These measurements are presented in Table 3.5.

Table 3.5: Groundwater well readings

Borehole	GPS Coordinates		Ground Level (mAOD)	Depth to Groundwater (mBGL)	Groundwater Level (mAOD)
	X	Y			
RC01	328986.5	209453.5	48.55	6.16m (bedrock) 6.11m (overburden)	42.39mOD (bedrock) 42.44mOD (overburden)
RC02	328846.3	209365.9	52.274	1.01m (bedrock)	51.264mOD (bedrock)
RC03	329082.9	209053.0	43.592	2.26m (bedrock)	41.332mOD (bedrock)

Groundwater quality from both the bedrock (GW1D) and the overburden (GW1S) was monitored at the borehole RC01.

Figure 3.3: Baseline groundwater well monitoring locations

3.3.3 Review of Existing Groundwater Quality

Approximately one week after their installation, the groundwater wells were purged and sampled by FTC. Subsequent to recording the water levels, in-situ tests were undertaken by FTC prior to sampling which included pH, temperature, conductivity and dissolved oxygen. The results of these in-situ tests are presented in Table 3.6 with a comparison with relevant Interim Guidance Values (IGVs) as published by the EPA (2003) in order to provide a baseline groundwater quality for the site.

Table 3.6: In-situ Groundwater Analysis

Parameter	Units	GW2	GW3	GW1D (bedrock)	GW1S (overburden)	IGV
pH	Units	7.9	6.8	7.8	6.5	6.5-9.5
Temperature	°C	10.8	10.4	10.5	11.7	<25°C
Conductivity		450	359	477	496	<1000
Dissolved Oxygen	mg/l	4.82	8.51	9.24	2.97	No abnormal change
Appearance/ Odour	µS/cm	Brown, turbid, no odour	Brown/grey, turbid, no odour	Light brown, turbid	Brown, turbid, no odour, very slight oily sheen	No abnormal change

Groundwater samples were also recovered by FTC after purging the wells. A summary of results is presented in Table 3.7 with a comparison with relevant IGVs as published by the EPA (2003).

Table 3.7: Groundwater Analysis Results 2015

Parameter	Units	GW2	GW3	GW1D (bedrock)	GW1S (overburden)	IGV
Coliforms, Total	CFU/100ml	**8160**	**13000**	**>242000**	**>242000**	0
Coliforms, Faecal	CFU/100ml	**47**	**>100**	**>100**	**68**	0
Suspended solids, Total	mg/l	236	40400	1260	381	-
Alkalinity, Total as CaCO3	mg/l	150	600	160	225	No abnormal change
BOD, filtered	mg/l	<1	<1	<1	<1	-
Organic Carbon, Total	mg/l	<3	<3	<3	20.3	No abnormal change
Ammoniacal Nitrogen as N	mg/l	<0.2	0.644	<0.2	0.713	-
Fluoride	mg/l	<0.5	<0.5	<0.5	<0.5	1.0
COD, unfiltered	mg/l	49.1	230	51.2	180	-
Conductivity @ 20°C	mS/cm	0.396	0.437	0.388	0.424	1.0
Silicon	mg/l	5.62	5.54	4.11	3.47	No abnormal change
Aluminium	µg/l	<2.9	11	5.16	72.6	200
Antimony	µg/l	<0.16	0.565	<0.16	<0.16	-

Parameter	Units	GW2	GW3	GW1D (bedrock)	GW1S (overburden)	IGV
Arsenic	µg/l	<0.12	0.988	1.91	2.53	10
Barium	µg/l	1.91	5.39	13	54	100
Beryllium	µg/l	<0.07	<0.07	<0.07	<0.07	-
Boron	µg/l	9.65	10.4	16.2	63.1	100
Cadmium	µg/l	<0.1	<0.1	<0.1	0.116	5
Chromium	µg/l	1.3	1.43	1.38	3.45	30
Cobalt	µg/l	<0.06	1.29	1.21	6.84	-
Copper	µg/l	<0.85	1.35	0.903	2.4	30
Lead	µg/l	<0.02	0.035	<0.02	0.156	10
Manganese	µg/l	0.607	**1480**	**926**	**8500**	50
Molybdenum	µg/l	<0.24	3.25	1.48	1.02	-
Nickel	µg/l	0.506	3.28	1.65	4.54	20
Phosphorous	µg/l	<6.3	<6.3	<6.3	1.09	-
Selenium	µg/l	<0.39	1.2	0.68	1.09	-
Tellerium	µg/l	<2	<2	<2	<2	-
Thallium	µg/l	<0.96	<0.96	<0.96	<0.96	-
Tin	µg/l	3.68	4.28	2.17	4.17	-
Uranium	µg/l	<1.5	<1.5	3.18	<1.5	9
Titanium	µg/l	<1.5	<1.5	<1.5	<1.5	-
Vanadium	µg/l	0.413	0.54	0.718	1.1	-
Zinc	µg/l	2.21	0.67	1.29	2.28	100
Mercury	µg/l	<0.01	<0.01	<0.01	<0.01	1
Sulphate	mg/l	32.8	16.4	26.7	32.6	200
Chloride	mg/l	26.4	**30.2**	**41.1**	29.2	30
Nitrate	mg/l	<0.0152	<0.0152	0.0167	<0.0152	0.1
Phosphate (ortho) as PO4	mg/l	<0.05	<0.05	0.053	<0.05	0.03
Total Oxidised Nitrogen as N	mg/l	6.46	8.68	1.7	0.341	No abnormal change
Cyanide, Total	mg/l	<0.05	<0.05	<0.05	<0.05	0.01
Calcium	mg/l	42.9	53	54	57.4	200
Sodium	mg/l	23.1	16.7	20.9	21.6	150
Magnesium	mg/l	13.6	13.2	9.49	5.64	50
Potassium	mg/l	1.24	3.47	2.3	**6.04**	5
Iron	mg/l	<0.019	<0.019	<0.019	**0.493**	0.2
pH	Units	8.02	7.82	7.82	7.31	6.5-9.5
Phenol	mg/l	<0.002	<0.002	<0.002	<0.002	0.0005
Cresols	mg/l	<0.006	<0.006	0.01	<0.006	-
Xylenols	mg/l	<0.008	<0.008	<0.008	<0.008	-
Phenols	mg/l	<0.016	<0.016	<0.016	<0.016	0.0005
Silver	µg/l	<1.5	<1.5	<1.5	<1.5	-

With the exception of exceedances in coliforms, manganese, chloride, potassium and iron, the remaining values are below the IGVs set by the EPA. It is likely that the exceedances of manganese, chloride, potassium and iron reflect the chemical composition of the bedrock and groundwater in this area and these levels would not be considered unusual. The bacteriological exceedances (coliforms) may reflect contamination of the groundwater caused by nearby septic tanks or agricultural activities.

3.3.4 Surface Water Quality

The surface water features and the surface waterbody catchments in the surrounding area of the site are shown in Figure 2.7 and Figure 2.8, respectively.

Baseline surface water quality monitoring of the 2 no. streams which drains the site was carried out in 2015. These streams converge and subsequently discharge into the Kilcoole stream to the south of the site.

Monitoring of two surface water monitoring points, namely SW1 and SW2, was carried out in September 2015. The locations of these monitoring points are shown in Figure 3.4.

Figure 3.4: Baseline surface water monitoring locations

Results of the monitoring carried are presented in Table 3.8. The streams where the monitoring took place are not classified as salmonid waters and water is not abstracted for drinking water supply. However, the European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293 of 1988) and the European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations 1989 (S.I. No. 294 of 1989) are used as standards for surface water quality. These standards, if applicable, are also presented in Table 3.8 so that a comparison can be made with the surface water quality monitoring results obtained.

Table 3.8: Surface Water Analysis Results 2015 and Standard Values

Parameter	Unit	SW1 result	SW2 result	Surface Water Regulations[1]			Salmonid Regulations[2]
				A1*	A2**	A3***	
Total Suspended Solids	mg/l	2.5	<2	50	-	-	≤25
Total Alkalinity as CaCO3	mg/l	119	219	-	-	-	-
BOD	mg/l	<1	<1	5	5	7	≤5
Total Organic Carbon	mg/l	6.06	5.24	-	-	-	-
Ammoniacal Nitrogen as N	mg/l	<0.2	<0.2	0.16	1.17	3.11	0.77
COD	mg/l	10.9	12	-	-	40	-
Conductivity @20C	µS/cm	0.304	0.467	1000	1000	1000	-
Cadmium	µg/l	<0.1	<0.1	5	5	5	-
Chromium	µg/l	1.33	3.08	5	5	5	-
Copper	µg/l	1.11	0.878	50	100	1000	50
Lead	µg/l	0.053	0.431	5	5	5	-
Manganese	µg/l	0.147	0.832	5	300	1000	-
Zinc	µg/l	4.63	1.36	3000	5000	5000	≤30
Mercury	µg/l	<0.01	<0.01	1	1	1	-
Sulphate	mg/l	16.8	17.6	200	200	200	-
Chloride	mg/l	27.7	34.3	250	250	250	-
Ortho-Phosphate as PO4	mg/l	0.109	0.0087	0.5	0.5	0.7	-
TON as N	mg/l	19.6	1.8	50	50	50	-
Phosphorous	µg/l	29.3	20.3	500	700	700	-
Calcium	mg/l	36.4	87.2	-	-	-	-
Sodium	mg/l	18.9	27.1	-	-	-	-
Magnesium	mg/l	8.16	7.63	-	-	-	-
Potassium	mg/l	4.09	4.21	-	-	-	-
Iron	mg/l	<0.019	<0.019	0.2	2	2	-
pH	pH units	7.92	8.17	5.5-8.5	5.5-9.0	5.5-9.0	≥6 and ≤9

Notes:
[1] S.I. No. 294/1989: European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989.
[2] S.I. No. 293/1988: European Communities (Quality of Salmonid Waters) Regulations, 1988.
* Category A1: Simple physical treatment and disinfection, e.g. rapid filtration and disinfection.
** Category A2: Normal physical treatment, chemical treatment and disinfection, e.g. prechlorination, coagulation, flocculation.
*** Category A3: Intensive physical and chemical treatment, extended treatment and disinfection, e.g. chlorination to break-point, coagulation, flocculation, decantation, filtration, adsorption (activated carbon), disinfection (ozone, final chlorination).

It is evident from the results presented in Table 3.8 that the surface water quality of the streams which drain the site is good. Neither surface water regulation nor salmonid regulation standards were exceeded for any of the surface water parameters which were analysed.

3.4 SPR Linkages – Risk Screening Overview

In accordance with EPA Guidance, SPR linkages are determined by identifying the "source", "pathways" and "receptors".

The "source" of potential groundwater contamination is the 200,000 tonnes of dredge spoil material that is proposed to be deposited at the site. It is considered highly unlikely that this material will result in groundwater contamination at the site due to its inert composition.

The "pathway" is the underlying geology of the site, including both the overburden layer and the underlying bedrock aquifer.

The risk to groundwater dependent "receptors" is considered to be low. Should the unlikely occurrence of subsurface contamination from the placement of the dredge spoil material at the site arise, the majority of the wells located nearby the site will not be affected as they are located outside of the site's zone of influence. The two wells located to the east of the site may be somewhat at risk. However, this risk is considered to be low due to the considerable distance they are located from the site. The 2 no. small stream within the site boundary may be affected from subsurface contamination. Should the contamination event be significant enough, the Kilcoole Stream could also be at risk. No habitats within the immediate vicinity of the site are dependent on groundwater.

4 ASSESSMENT OF POTENTIAL GROUNDWATER IMPACTS

4.1 Potential Impacts on Receptors

The inert nature of the material to be deposited at the site indicates that it is highly unlikely that any subsurface contamination will arise. Nearby groundwater dependent receptors are therefore unlikely to be adversely affected by this project. However, in the unlikely case that subsurface contamination does arise, the following groundwater dependent receptors may be affected.

The groundwater dependent wells located nearby the site may be somewhat at risk. However, this risk is considered to be low. The majority of these wells are not located directly downgradient of the site within its zone of influence. The small number of wells that are located within this zone are located at a distance of greater than 1km from the site, meaning that it is unlikely that they would be affected by potential subsurface contamination at the site.

The 2 no. small streams which run from north-south along the eastern boundary of the site and north east-south west across the site may also be affected. Baseline monitoring of these streams has indicated a good surface water quality. The streams will be monitored before, during and after the placement of the dredge spoil material to ensure that no adverse impacts have arisen from the placement of this material.

No groundwater dependent ecosystems would be at risk from potential subsurface contamination at the site, as no such ecosystems are located at the site's location or within its immediate surrounds nearby.

4.2 Groundwater Quality

A summary of baseline groundwater monitoring results for the site are presented in Section **Error! Reference source not found.** of this report.

Recorded concentrations for most parameters during the baseline monitoring fell below EPA IGV Standards and limit values for Drinking Water Regulations (S.I. No. 278 of 2007), which were used for comparison purposes. As discussed in Section 3, there are some exceptions to this.

It is likely that the exceedances of manganese, chloride, potassium and iron reflect the chemical composition of the bedrock and groundwater in this area and these levels would not be considered unusual. The bacteriological exceedances (coliforms) may reflect contamination of the groundwater caused by nearby septic tanks or agricultural activities.

In order to protect the hydrogeology of the area, the existing groundwater wells will be monitored for water level and water quality before, during and after the placement of the dredge spoil material. Results obtained will be compared with the baseline water level and water quality results already collected to ensure that the placement works have had no impact on the hydrogeology of the area.

In the unlikely event of subsurface contamination arising from the placement of the dredge spoil material at the site, the above groundwater monitoring programme will identify this contamination immediately and therefore allow for a rapid remediation response to be put in place, if required.

5 MITIGATION STRATEGY

The nature of the dredge spoil material to be deposited at the site is inert. Nonetheless, measures have been proposed for implementation so as to ensure that the likelihood of any potential impacts occurring is minimal. These measures have been outlined in full in Section 3.1.1. They include the application of specific waste acceptance criteria and the completion of a weekly random waste characterization on all imported material.

The proposed measures will help to ensure that any potential subsurface contamination from the placement of the dredge spoil material is prevented.

6 SUMMARY & CONCLUSION

The inert nature of the 200,000 tonnes of dredge spoil material that is proposed to be deposited indicates that it is highly unlikely that any subsurface contamination will arise at the site from the placement works.

Nonetheless, this ERA has analysed the main S-P-R linkages so as to present the potential receptors which may be at risk should contamination occur.

The location of the nearby groundwater wells with respect to the site indicates that they are at a low risk. No groundwater dependent habitats are located within the immediate vicinity of the site.

Measures will be taken to reduce the likelihood of any subsurface contamination occurring from the placement works. These include the application of specific waste criteria and a random weekly characterisation for the imported material.

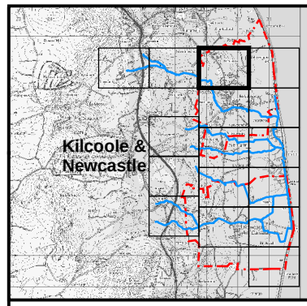
Groundwater and surface water monitoring will take place before, during and after the placement of the dredge spoil material to ensure that no adverse impacts have arisen from the placement of this material. Monitoring results will be compared with those obtained from the baseline monitoring carried out in 2015 so that any potential worsening of water quality may be identified immediately and remedial action put in place, if required.

While the possibility of subsurface contamination occurring at the site from the placement works cannot be ruled out completely, the risk of such an event occurring is minimal. Should this highly unlikely event occur, this ERA has indicated that any potential impacts are unlikely to be severe.

Appendix 19

CFRAMS Mapping

Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
1007M00326	34.34	N/A	34.44	N/A	34.57	N/A
1007M00301	33.23	N/A	33.30	N/A	33.41	N/A
1007M00292E	31.28	N/A	31.32	N/A	31.35	N/A



The viewer of this map should refer to the Disclaimer, Guidance Notes and Conditions of Use that accompany this map. This draft map is for consultation purposes only, and should not be used for any other purpose.

Legend

- 10% Fluvial AEP Event
- 1% Fluvial AEP Event
- 0.1% Fluvial AEP Event
- Modelled River Centreline
- AFA Extents
- Node Point
- Node ID Node Label

DRAFT

REV:	NOTE:	DATE:

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Map: Kilcoole & Newcastle Fluvial Flood Extents

Map Type:	EXTENT		
Source:	FLUVIAL		
Map Area:	HPW		
Scenario:	CURRENT		
Drawn By :	C.C.	**Date :**	9th February 2015
Checked By :	D.I.	**Date :**	9th February 2015
Approved By :	G.G.	**Date :**	9th February 2015

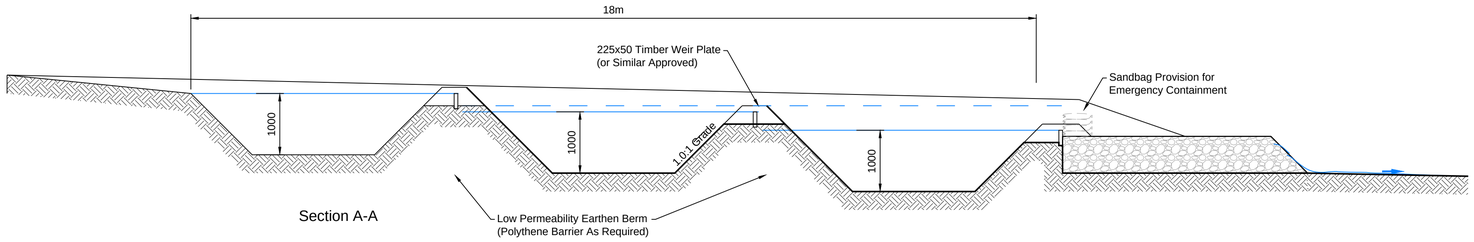
Drawing No. : E10KIL_EXFCD_C0_SH06

Map Series : Page 6 of 16

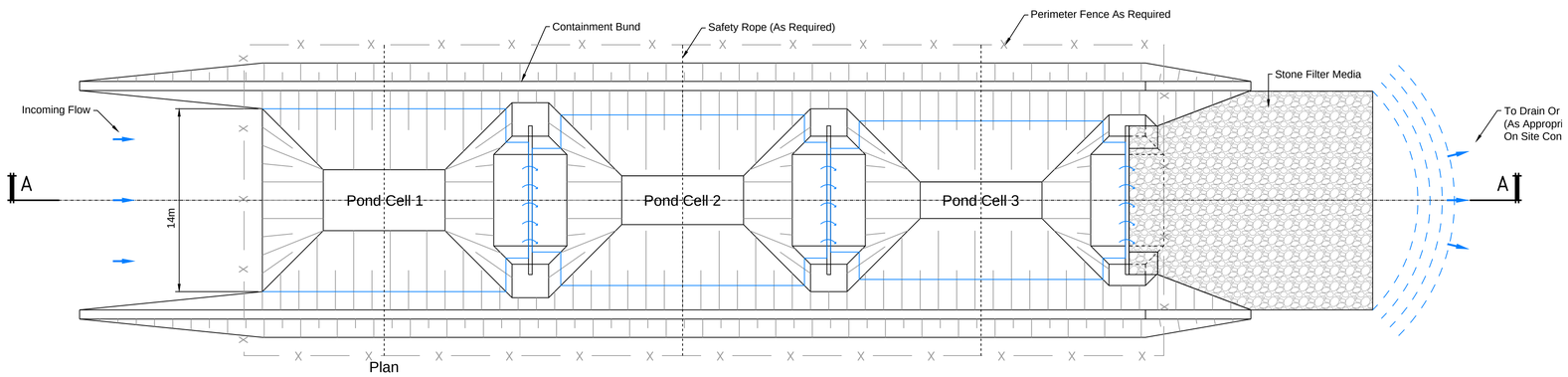
Drawing Scale : 1:5,000 @ A3

Appendix 20

Drainage Detail



Section A-A



Plan

DRAFT 1

PLAN DETAIL - MULTISTAGE STILLING POND

Scale 1:50

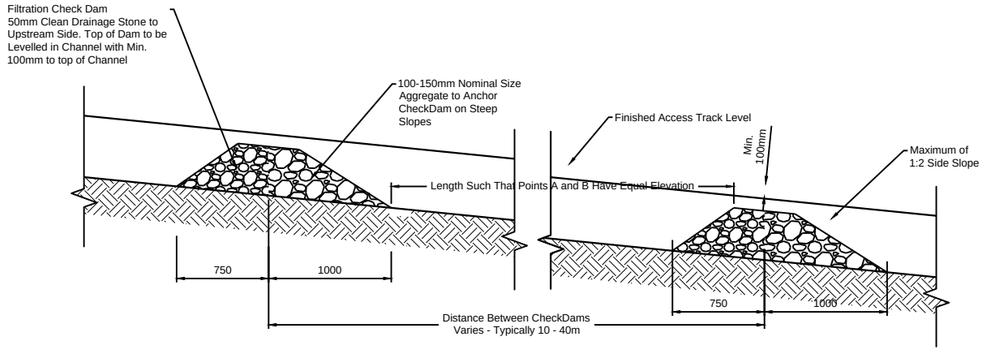
0m 0m 1m 1m 2m 2m 3m 3m 4m

Scale 1:50

SCALE - VERTICAL

SCALE HORIZ.

ORIGINAL DRAWING SIZE A1 - (841 x 594)



DRAINAGE CHANNEL CHECK DAM DETAIL
REQUIRED WHERE SLOPE >6%

Scale 1:50

SILT TRAP IN DRAINAGE DITCH

Scale 1:20

0m 1m 1m 1m 1m 1m 2m 2m 2m 2m 3m

Scale 1:50

NOTES:

1. Check Dams to be embedded into the side walls and invert of the drainage ditch excavation by at least 100mm.
2. Where downslope conditions are suitable i.e. area of dry vegetated ground with a continuous slope away from the road, breakout Outfalls may be used for road drainage.
3. Silt traps to be installed in road drainage ditches.

Rev.	Drawn	Chk'd	App'd	Rev Origin	Description
A	GW	RDW	DM	Cork TBA	ISSUE FOR APPROVAL

Revision History: A — PLANNING

Name of Client

WICKLOW COUNTY COUNCIL

Name of Job

PRETTY BUSH WASTE SOILS RECOVERY FACILITY & ECO PARK

Title of Drawing

CHECK DAM AND SILT TRAP DETAIL

Scales Used
1:50, 1:20

This Drawing was printed to A3-

Dwg. No.
LW15-247-01-0501-002

Rev.
A

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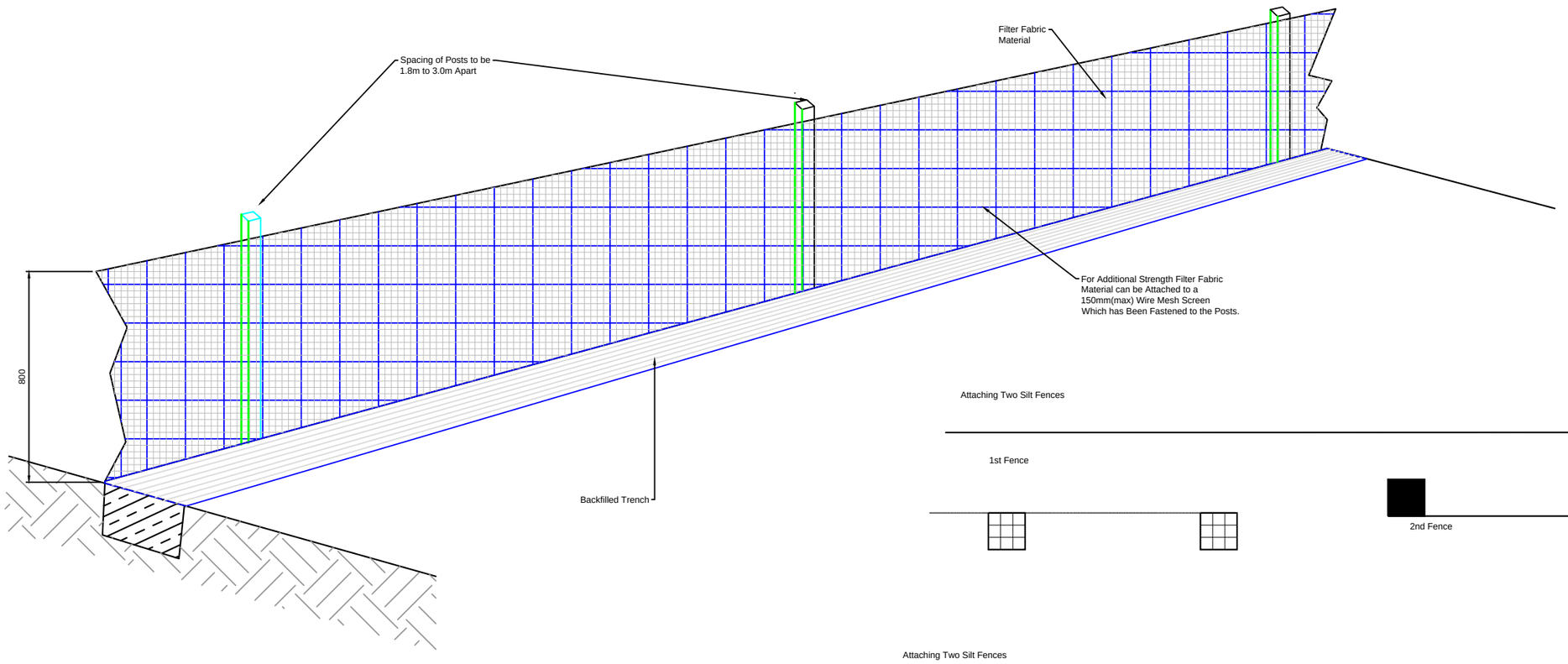
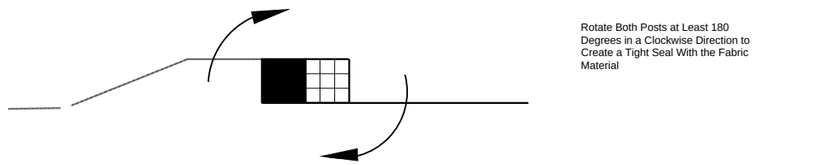
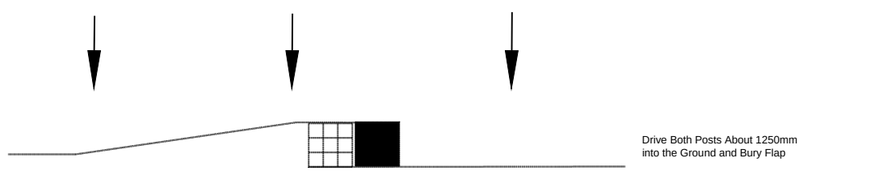


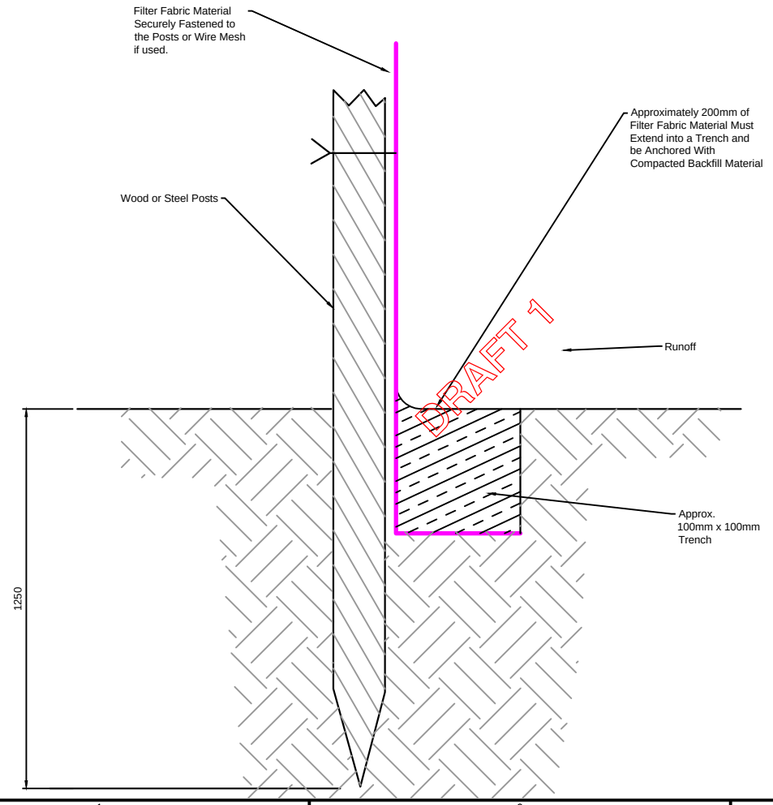
Attaching Two Silt Fences

Attaching Two Silt Fences



Direction of Runoff Waters





Rev.	Drawn	Chk'd	Appd	Rev Origin	Description
A	GW	RDW	DM	Cork	
				TBA	

Revision History: A — PLANNING

Name of Client

WICKLOW COUNTY COUNCIL

Name of Job

PRETTY BUSH WASTE SOILS
RECOVERY FACILITY & ECO PARK

Title of Drawing

DETAIL OF SILT FENCING

Scales Used N/A

This Drawing was printed to A3.

Dwg. No. LW15-247-01-0501-003

Rev. A

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Appendix 21

Archaeological Assessment

Receiving Environment

General Archaeological and Historical Background

County Wicklow occupies an area of 2,017 square km. It is the 17th largest county in Ireland as well as being the 17th largest by population. The Wicklow Mountain range is the largest continuous upland region in the country and the mountainous area is mainly formed by granite, with a marginal zone of micraschist.

During the Mesolithic period (*c*. 7000–4000 BC) people existed as hunters/gatherers, living on the coastline, along rivers and lakesides. They used flint and other stones to manufacture sharp tools, and locating scatters of discarded stone tools and debris from their manufacture can sometimes identify settlements. Their impact on the landscape was minimal, and the limited amount of evidence includes the remains of timber houses and primitive stone tools. The earliest evidence of settlement in County Wicklow dates to this period and is represented by Late Mesolithic material found mainly along a coastal strip, with the exception of one flint assemblage found approximately 4 km inland. These find locations are consistent with the estuarine conditions favoured by Mesolithic settlers. One cave site found in 1932 at Dunbur Head, south of Wicklow town, was noted to have a heavy concentration of broken flint (Archaeological Survey of Ireland 1997, 1). It is possible that they represent the remains of at least one Mesolithic settler family (Gurrin 2006, 7). Later fieldwork by G.F. Mitchell found a number of sites with evidence of flint working, as well as a large deposit of flint debris including scrapers and blades at the southern end of Brittas Bay.

The population became more settled during the Neolithic period (*c*. 4000-2400 BC) with a subsistence economy based on crop growing and stock-raising. This period also saw changes in burial practices, and a tradition of burying the dead collectively and carrying out of cremations emerged. The tombs are generally divided into four distinct groups, identified on the basis of their architecture, distribution, date range and associated architecture: portal tombs, passage tombs, wedge tombs and court tombs, the latter of which have not been recorded from within County Wicklow (Archaeological Survey of Ireland 1997, 3). Of the 16 megalithic tombs recorded in *The Archaeological Inventory of County Wicklow*, nine are concentrated to the west of the county, in areas south of Rathdrum and in the east along the coast at Brittas.

Palaeobotanical research and sampling in County Wicklow has shown a forest cover of pine and elm, land clearance and peaks in grass pollen, as well as large areas of upland used for grazing during the Neolithic. Pre-tomb habitation floors from an excavated passage tomb at Baltinglass Hill yielded flint scrapers and a quantity of wheat grain. A saddle quern uncovered there shows evidence of cereal cultivation. These Neolithic peoples were the first to clear large tracts of land for arable use and impose structures on the Wicklow landscape, signifying community enterprise, shared burial customs and religious architecture.

The Bronze Age (*c*. 2400-600 BC) is characterised by the introduction of metalworking technology to Ireland and coincides with many changes in the archaeological record, both in terms of material culture as well as the nature of the sites and monuments themselves. Though this activity has markedly different characteristics to that of the preceding Neolithic period, including new structural forms and new artefacts, it also reflects a degree of continuity. During this period knowledge of metalworking was acquired resulting in changes in material culture such as the introduction of metal tools and artefacts as well as the introduction of a highly decorated pottery called Beaker pottery. In addition to changes in material culture, there were changes in burial rite from communal megalithic tombs to single burial in cists. Bronze Age monuments from County Wicklow include standing stones, stone circles, rock art, cist and pit burials, cairns and barrows.

Finds of casting moulds, bronze socketed weapons and the exploitation of gold ores in the Avoca area appear at this time. The Bronze Age shows an overall period of expansion in the county, with evidence for settlement spreading along river valleys and into the lowlands of Wicklow.

There are two ring-ditches (RMP WI013-077 and RMP WI013-105) within the 1 km study area, and both were excavated as part of archaeological works carried out for the Greystones Southern Access Route. A cremation pit (RMP WI013-113) and two structures (RMP WI013-114 and RMP WI013-115) were also excavated in association with the ring-ditch (RMP WI013-077) recorded in Charlesland townland, approximately 300 m north east of the proposed development area.

Ring-ditches are circular or near circular features usually measuring less than 10 m in diameter and which are frequently recorded through the use of aerial photography. The function of these monuments is unclear as they may be the remains of ploughed out barrows, round houses or modern features and, as such, may date to any period from prehistory onwards.

The remains of an isolated Bronze Age urn burial (RMP WI013-112) were excavated in Charlesland townland in 2004. An unclassified barrow (RMP WI013-101) measuring approximately 13 m in diameter was excavated in 2004 as part of the Greystones Southern Access Route. Barrows are artificial mounds of earth or earth and stone and were usually constructed to contain or conceal burials. They are part of the Bronze Age/Iron Age burial tradition (c. 2400 BC - AD 400).

There are six *fulachta fiadh* within the 1 km study area (RMP WI013-006001, RMP WI013-079, RMP RMP WI013-099, RMP WI013-100, WI013-109 and RMP WI013-110), with four being located to the north east of the proposed development area and two to the south west.

Fulachta fiadh are one of the most numerous monument types in Ireland, with over 4,500 recorded examples (Waddell 2005, 174). Their name derives from Geoffrey Keating's 17th century manuscript *Foras Feasa ar Eirinn*, and as a complete term it does not appear in any early manuscripts. They are generally interpreted as being used for cooking, while alternative theories include bathing, dyeing, tanning and micro-brewing.

Five habitation sites are recorded within the 1 km study area, with four of the sites (RMP WI013-075, RMP WI013-076, RMP WI013-078 and RMP WI013-080) located to the north east of the development area in Charlesland townland, and RMP WI013-073 located to the north in Farrankelly townland. All sites were revealed and excavated during works either associated with the Greystones Southern Access Route or the Charlesland Residential Development.

Five sites are recorded as "*excavations*" within the 1 km study area on the National Monuments Service on-line database (www.archaeology.ie). Three of these sites (RMP WI013-006002, RMP WI013-097 and RMP WI013-111) are located in Charlesland townland, north east of the proposed development area. RMP WI013-103 is located west of the development area in Priestsnewtown townland and RMP WI013-104 is recorded to the north in Farrankelly townland. RMP WI013-103 and RMP WI013-104 were revealed and excavated as part of works associated with the Greystones Southern Access Route, while RMP WI013-006002, RMP WI013-097 and RMP WI013-111 were associated with the Charlesland Residential Development.

Excavation of RMP WI013-006002 revealed a palisade trench located to the south and east of a large burnt mound (RMP WI013-006001). The trench produced a date of 1400-1120 calibrated BC. Excavation of RMP WI013-097 produced evidence for a series of pits, post-holes, stake-holes, hearths, troughs and burnt spreads. A series of Medieval pits containing Leinster Cooking Ware pottery were excavated as part of RMP WI013-111. (Leinster Cooking Ware is the most common Medieval pottery type found in Leinster and dates broadly from the mid-12th to the 14th centuries). RMP WI013-103 consisted of six pits and 12 post-holes, some of which contained burnt stone, charcoal and cremated bone. The excavator suggested that these remains may be part of a more substantial structure, which may have extended beyond the limit of the excavation area (www.excavations.ie). Excavation of RMP WI013-104 revealed 12 pits dispersed over an area measuring 160 m x 40 m. This is the closest known site to the proposed development area and is centered on a point 220 m to the north.

Excavation of a corn-drying kiln (RMP WI013-102) in Priestsnewtown townland revealed a series of pits, stake-holes and a roughly key-hole shaped area filled with baked clay. These structures were until recently considered to date from the Medieval period (5th -16th centuries AD) onwards, but a number of recent excavations have demonstrated that corn-drying kilns may date from the Bronze Age (www.excavations.ie).

During the Iron Age (*c*. 600 BC-400 AD) new influences came into Ireland which gradually introduced the knowledge and use of iron, although for several centuries bronze continued to be widely used. The Iron Age in Ireland however is problematic for archaeologists as few artefacts dating exclusively to this period have been found, and without extensive excavation it cannot be determined whether several monument types, such as ring-barrows or standing stones, date to the Bronze Age or Iron Age. Most knowledge for this period stems from Irish folklore, the epic poems and legends of warrior kings and queens that are traditionally believed to be Celtic in origin.

The 6th century witnessed a flourishing in the monastic way of life, notably in County Wicklow with the founding of Glendalough by St. Kevin. A century of Viking raids from the mid-9th century onwards caused havoc to the monastic institutions as well as the indigenous dynasties, although they both survived and ultimately integrated with these peoples.

The Early Medieval period (*c*. 400-1169 AD) is depicted in the surviving sources as entirely rural, characterised by the basic territorial unit known as *túath.* Walsh (2000, 30) estimates that there were at least 100, and perhaps as many as 150, kings in Ireland at any given time during this period, each ruling over his own *túath.*

The new religious culture brought changes in settlement and agricultural patterns. The ringforts and associated field patterns of the Early Medieval period indicate a life largely based on grazing. During this turbulent period roughly circular defensive enclosures known as ringforts were constructed to protect farmsteads. They were enclosed by an earthen bank and exterior ditch, and ranged from approximately 25 m to 50 m in diameter. The smaller sized and single banked type (univallate) was more than likely home to the lower ranks of society, while larger examples with more than one bank (bivallate/trivallate) housed the more powerful kings and lords. They are regarded as defended family homesteads and the extant dating evidence suggests they were primarily built between the 7th and 9th centuries AD (Stout 1997, 22-31). The ringfort is considered to be the most common indicator of settlement during the Early Medieval period. The most recent detailed study (*ibid*., 53) has suggested that there is an approximate total of 45,119 potential ringforts or enclosure sites throughout Ireland. Over 200 ringforts appear in County Wicklow (Archaeological Survey of Ireland 1997).

Enclosure sites belong to a classification of monument whose precise nature is unclear. Often they may represent ringforts, which have either been damaged to a point where they cannot be positively recognised, or are smaller or more irregular in plan than the accepted range for a ringfort. An Early Medieval date is generally likely for this site type, though not a certainty.

There are six enclosures recorded within the 1 km study area (RMP WI013-007001, RMP WI013-007002, RMP WI013-018, RMP WI013-019, RMP WI013-020 and RMP WI013-020001). RMP WI013-007001 and RMP WI013-007002 were located beside each other in Charlesland townland, and were originally recorded through aerial photography (www.archaeology.ie). Excavation in 2004 revealed a 5th - 6th century penannular enclosure (RMP WI013-007001) measuring 26 m in diameter, which was partially truncated by a larger 13th -14th century enclosure (RMP WI013-007002) measuring approximately 42 m in diameter.

Enclosures RMP WI013-018, RMP WI013-019, RMP WI013-020 and RMP WI013-020001 are located in Priestsnewtown townland, to the west of the proposed development area. These sites are recorded through aerial photography and do not exist above-ground.

The Early Medieval period is also characterised by the foundation of a large number of ecclesiastical sites throughout Ireland in the centuries following the introduction of Christianity in the 5th century. The early churches tended to be constructed of wood or post-and-wattle. Between the late 8th and 10th centuries mortared stone churches gradually replaced the earlier structures. Many of the sites, some of which were monastic foundations, were probably originally defined by an enclosing wall or bank similar to that found at coeval secular sites. This enclosing feature was probably built more to define the sacred character of the area of the church than as a defence against aggression. An inner and outer enclosure can be seen at some of the more important sites; the inner enclosure surrounding the sacred area of church and burial ground and the outer enclosure providing a boundary around living quarters and craft areas. Where remains of an enclosure survive it is often the only evidence that the site was an early Christian foundation.

A church (RMP WI013-021), a font (RMP WI013-021001), a graveyard (RMP WI013-021002) and a bullaun stone (RMP WI013-021003) are recorded in Kilquade townland, approximately 1 km south west of the proposed development area. The church is situated in gently undulating terrain, and is traditionally the site of an early foundation on which now stands a 19th century church. There are no pre-19th century headstones in the graveyard.

A bullaun stone (RMP WI013-062001) is also recorded in Kilcoole townland, although it is noted (www.archaeology.ie) that this is merely the present location of this religious architectural feature.

The commencement of Viking raids at the end of the 8th century and their subsequent settlement during the following two centuries marked the first ever foreign invasion of Ireland. Viking settlement

evidence is scarce and has been found in Dublin and Waterford, however excavations there have revealed extensive remains of the Viking towns. Outside these towns understanding of Viking settlement is largely drawn from documentary and place-name evidence. In addition to Dublin and Waterford, documentary sources provide evidence for the Viking foundation of the coastal towns of Limerick, Wexford and Cork (Edwards 2006, 179). Other indirect evidence which suggest Viking settlement, or at least a Norse influence in Ireland, is represented by upwards of 120 Viking-age coin hoards, possible votive offerings of Viking style objects and the assimilation of Scandinavian art styles into Irish design. Whilst the initial Viking raids would have been traumatic, the wealth and urban expansion brought into the country as a result of Viking trading would have eventually benefited the Gaelic Irish and the cultural assimilation in some parts would have been significant.

The arrival of Anglo-Normans in Ireland towards the end of the 12th century caused great changes during the following century. Large numbers of colonists arrived from England and Wales and established towns and villages. They brought with them new methods of agriculture which facilitated an intensification of production. Surplus foods were exported to markets all along Atlantic Europe which created great wealth and economic growth. Results of this wealth can be seen in the landscape in the form of stone castles, churches and monasteries.

The political structure of the Anglo-Normans centered itself around the establishment of shires, manors, castles, villages and churches. In the initial decades after the Anglo-Norman invasion a distinctive type of earth and timber fortification was constructed- the motte and bailey. Mottes were raised mounds of earth topped with a wooden or stone tower while the bailey was an enclosure, surrounded by an earthen ditch with a timber palisade, used to house ancillary structures, horses and livestock. There are four motte and baileys and 42 mottes recorded in County Wicklow (www.archaeology.ie).

In certain areas of Ireland however Anglo-Norman settlers constructed square or rectangular enclosures, now termed moated sites. Their main defensive feature was a wide, often water-filled, fosse with an internal bank. As in the case of ringforts, these enclosures protected a house and outbuildings usually built of wood. They appear to have been constructed in the latter part of the 13th century, although little precise information is available. There are 23 moated sites recorded in County Wicklow (www.archaeology.ie).

More substantial stone castles followed the motte and bailey and moated sites in the 13th and 14th centuries. Tower houses are regarded as a late type of castle and were erected from the 14th to early 17th centuries. Their primary function was defensive, with narrow windows and a tower often surrounded by a high stone wall (bawn). An Act of Parliament of 1429 gave a subsidy of £10 to "*liege*" men to build castles of a minimum size of 20 ft in length, 16 ft in breadth and 40 ft in height (6 m x 5 m x 12 m). By 1449 so many of these £10 castles had been built that a limit had to be placed on the grants. The later tower houses were often smaller, with less bulky walls and no vaulting. There are 13 tower houses recorded in County Wicklow (www.archaeology.ie).

The 14th century throughout north west Europe is generally regarded as having been a time of crisis, and Ireland was no exception. Although the Irish economy had been growing in the late 13th century, it was not growing quickly enough to support the rapidly expanding population, especially when Edward I was using the trade of Irish goods to finance his campaigns in Scotland and Wales. When the Great European Famine of 1315-17 AD arrived in Ireland, brought about by lengthy periods of severe weather and climate change, its effects were exacerbated by the Bruce Invasion of 1315-18 AD. Manorial records which date to the early 14th century show that there was a noticeable decline in agricultural production. This economic instability and decline was further worsened with the onset of the Bubonic Plague in 1348 AD.

Before the Tudors came to the throne the kings of England were also the kings of western France and so, during the 14th and 15th centuries, the various lords who ruled in Ireland were largely left to themselves. The Tudor conquest however brought a much greater interest in the affairs of Ireland. They wanted to put a stop to the raids of the Gaelic Irish on the areas under English rule. To do this, they ruthlessly put down any rebellions and even quashed inter-tribal feuds. English settlers were then brought in to settle their lands. The first of these plantations occurred in the mid-16th century in what is now Laois and Offaly. After the Desmond rising in Munster in 1585 AD came another plantation, and parts of south western Tipperary were planted at that time.

From 1593 AD until 1603 AD there was a countrywide war between the Gaelic Irish, who were supported by the French, and the Elizabethan English. The Irish were finally defeated and with the

"*Flight of the Earls*" from Rathmullan, County Donegal in 1607, Ulster, which had previously been independent of English rule, was planted.

Expansion in the agricultural sector following a period of economic growth in Ireland from the mid-1730s led to rising prices and growth in trade. This increase in agricultural productivity resulted in growth in related industrial development throughout the country.

Nineteenth century Wicklow suffered as a result of overpopulation and poverty and the people were devastated by the Great Famine. The 1841 census recorded the population of the county as 126,143, and with a large increase in population marginal lands were increasingly brought in to production. The effects of the Great Famine and emigration resulted in a dramatic decrease in the population of the county, with the 1891 census recording a population of 62,136- i.e. less than half the level of the pre-Famine enumeration (Gurrin 2006, 72). The proportional fall in numbers in upland areas was even greater as marginal land was abandoned in favour of urbanised centres.

Improvements in transport opened the county to tourism, and in particular the availability of cheap railway travel made day trips to Wicklow from Dublin feasible and relatively inexpensive. Although the railway did not venture in to the uplands, rail transport had reached Rathdrum by 1861 and to the west, a branch-line from Sallins, on the Great Southern and Western Railway's Dublin-Cork line, to Baltinglass had been constructed by 1885.

The proposed development area is located in Priestsnewtown townland, which is in the barony of Newcastle and parish of Kilcoole. Lewis (1837, Vol. II, 70) records the village of Kilcoole as containing:

"*76 houses, of which a few are well built and roofed with slate, but the greater number are small thatched dwellings… The soil varies greatly, and though in some parts rough and stony, is well adapted for tillage, and produces good crops, and some of the earliest potatoes brought into the market of Dublin are raised here. Towards the sea are large tracts of bog, affording excellent fuel*" (*ibid*.).

Summary of Previous Fieldwork in the Study Area

Reference to Summary Accounts of Archaeological Excavations in Ireland (www.excavations.ie) has shown that six fieldwork projects have been carried out in Priestsnewtown townland, the location of the proposed development. All fieldwork was carried out in 2004 and was directly associated with construction of the Greystones Southern Access Route.

Excavation Licence Number 04E0128 revealed a number of archaeological sites, consisting of pits, a charcoal-enriched clay spread, post-holes, oxidised clay, a burnt mound (Site 19, RMP WI013-106) which was preserved *in situ* and burnt stone (Site 20, RMP WI013-107) which was also preserved *in situ*.

Excavation Licence Number 04E0267 revealed two spreads of heat shattered sandstone fragments. Both features were interpreted as possible *fulachta fiadh*. Site 1 (RMP WI013-099) measured approximately 6 m x 3 m while Site 2 (RMP WI013-100) measured approximately 6 m x 3.5m. Site 1 was undisturbed by construction work and was fully preserved *in situ*, while a pipe trench partially truncated Site 2.

Excavation Licence Number 04E0401 revealed an annular ditch approximately 13 m in diameter, enclosing 22 post-holes and three cremation pits. A series of pits, post-holes, a cremation and a number of linear ditches were also excavated outside the area of the ditch. This site is recorded as RMP WI013-101.

Excavation Licence Number 04E0402 revealed three deposits, seven stake-holes, two cultivation furrows and an area of oxidised clay. The overall site measured 35 m north/south x 12 m east/west and is interpreted as representing the remains of a corn-drying kiln. This site is recorded as RMP WI013-102.

Excavation Licence Number 04E0403 consisted of a concentrated group of 12 prehistoric post-holes and six pits, with the overall site measuring 10.5 m x 8 m. This site is recorded as RMP WI013-103.

Excavation Licence Number 04E0467 revealed a prehistoric ring-ditch and a hearth. The site consisted of the southern half of a ring-ditch (the other half, lying to the north, was outside the construction corridor) measuring approximately 12 m in diameter. The hearth had a surviving length of 0.8 m x 0.55 m wide x 0.12 m deep. This site is recorded as RMP WI013-105.

Topographical Files of the National Museum of Ireland

Information on artefact finds and excavations from County Wicklow is recorded by the National Museum of Ireland. Location information relating to such finds is important in establishing prehistoric and historic activity in the study area. There are no entries recorded in the Topographical Files for Priestsnewtown townland, the location of the proposed development.

Cartographic Analysis

Ordnance Survey Map First Edition 1:10,560 1839 (figure 15-6)
A townland boundary is recorded along the eastern side of the proposed development area, and a small part of the northern area of land take. Research suggests that:

"*hoards and single finds of Bronze Age weapons, shields, horns, cauldrons and gold personal objects can all be shown to occur on boundaries*" (Kelly 2006, 28).

The development area is recorded as enclosed with relatively small fields on the First Edition map. Five roofed structures in two separate holdings and an associated access track are recorded immediately west of the western boundary on the First Edition map. These structures are not recorded on later editions of the Ordnance Survey maps. A roofed structure is also recorded immediately north of the northern boundary on the First Edition map, and again this structure is not recorded on later editions of the Ordnance Survey maps. A possible small quarry is recorded in the north west corner of the proposed area of land take.

There are no archaeological, architectural or cultural heritage features recorded on the First Edition 1:10,560 map within the area of proposed land take.

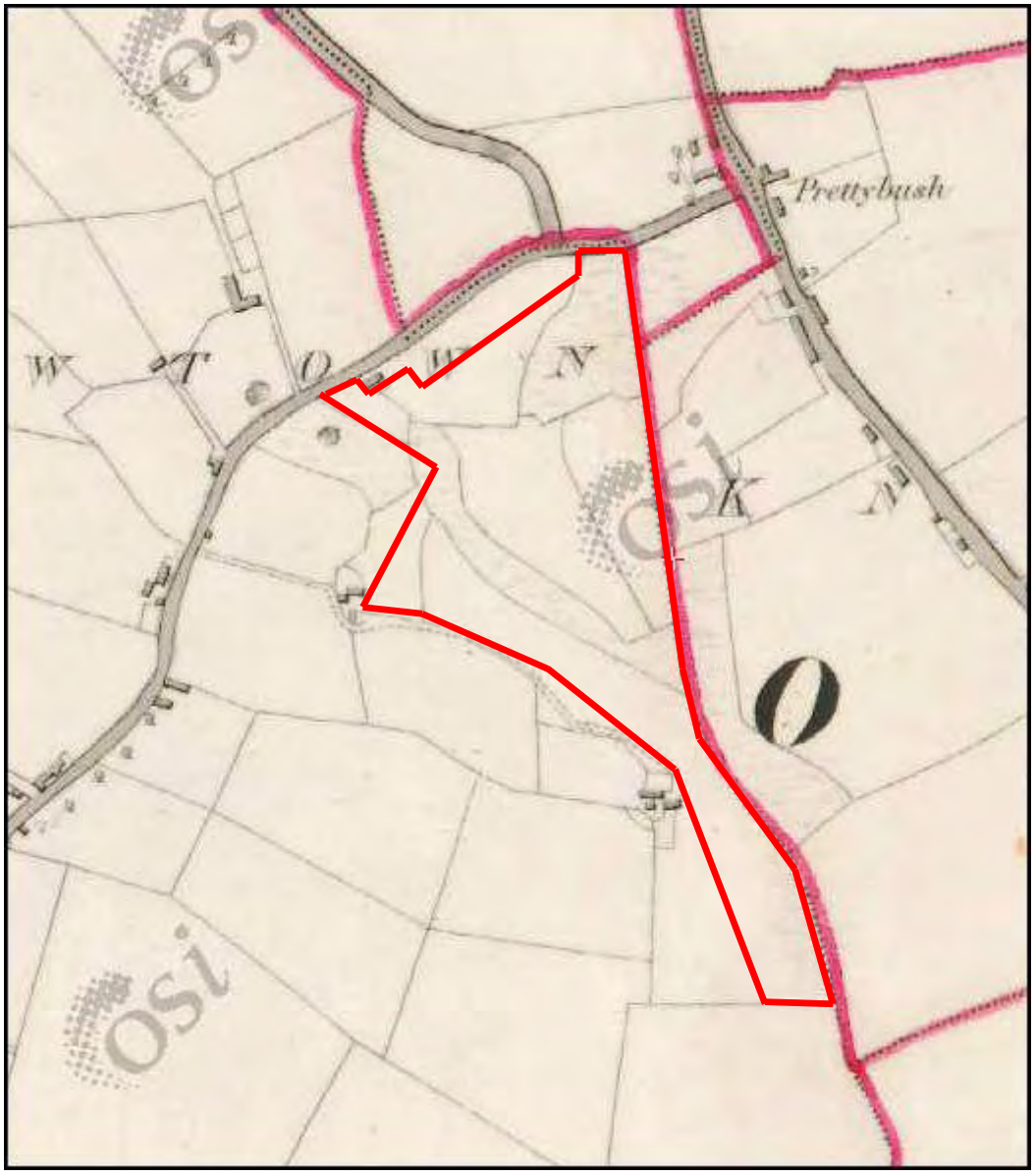

Figure 15-6: First Edition Ordnance Survey map 1:10,560 (1839) showing proposed development area

Ordnance Survey Map Third Edition 1:10,560 1911 (figure 15-7)
The Third Edition Ordnance Survey map records the proposed development area as furze.

There are no archaeological, architectural or cultural heritage features recorded on the Third Edition 1:10,560 map within the area of proposed land take.

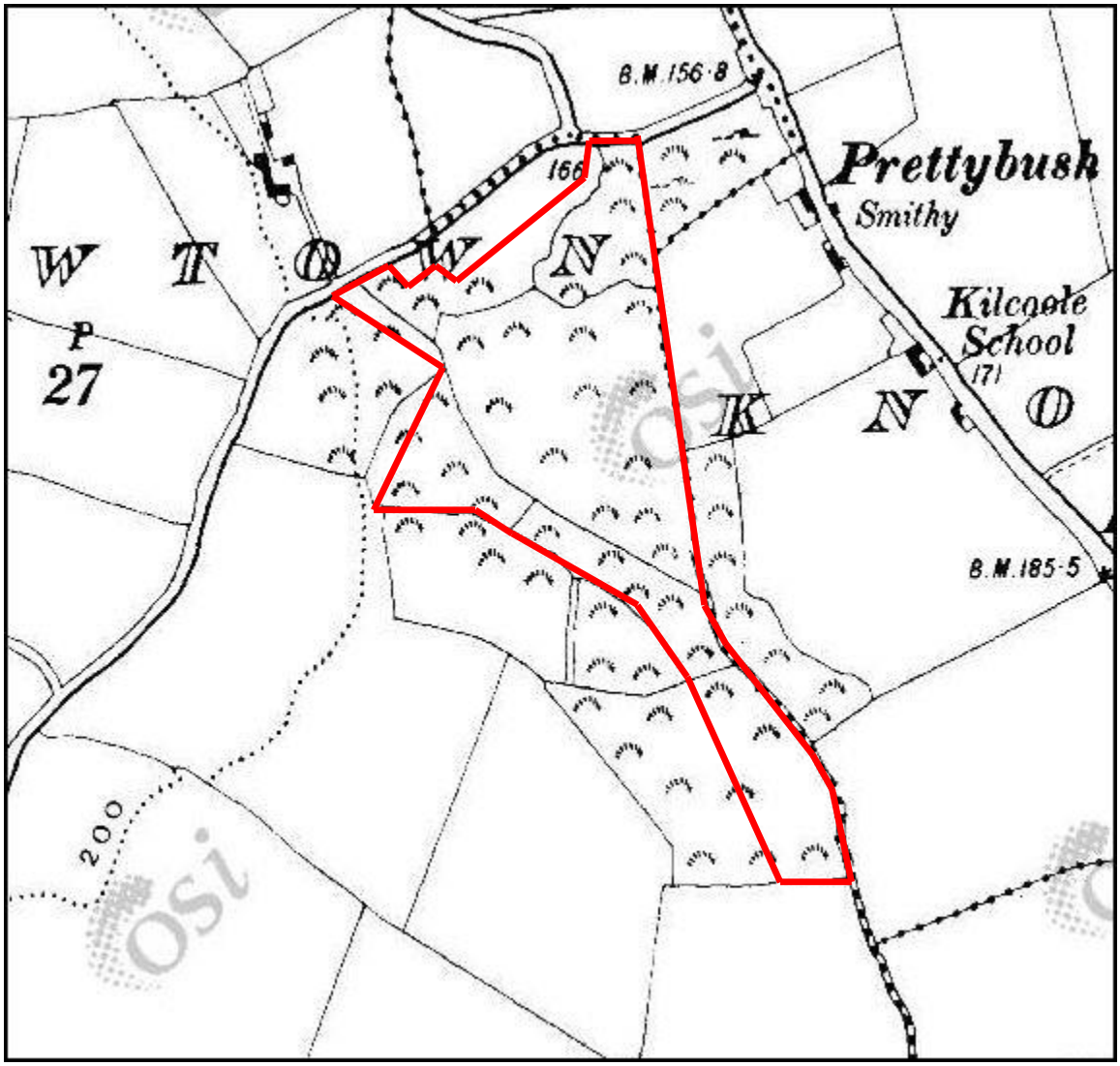

Figure 15-7: Third Edition Ordnance Survey map 1:10,560 (1911) showing proposed development area

Ordnance Survey Map First Edition 1:2,500 1907-1909 (figure 15-8)
There are no differences recorded within the proposed development area between the Third Edition 1:10,560 OS map and the First Edition 1:2,500 OS map.

There are no archaeological, architectural or cultural heritage features recorded on the First Edition 1:2,500 map within the area of proposed land take.

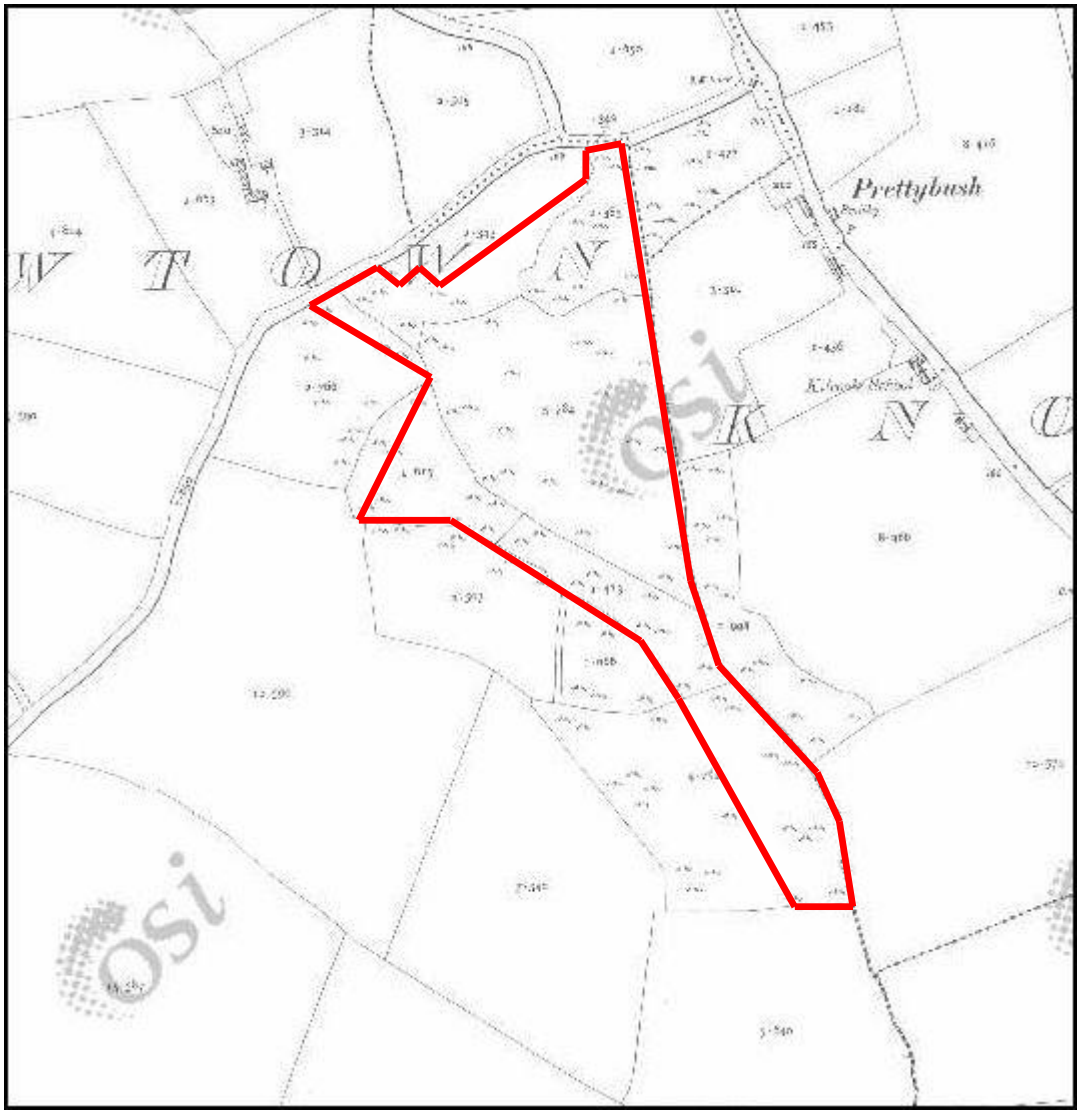

Figure 15-8: First Edition Ordnance Survey map 1:2,500 (1907-1909) showing proposed development area

Aerial Photography

Aerial photographs held by Ordnance Survey Ireland (www.maps.osi.ie) were consulted to look for the presence of previously unrecorded archaeological or architectural remains within the proposed development area.

The 2000 and 2005 photographs record a similar landscape to that which was noted during the walkover survey (see **Field Inspection Results** below), with the development area recorded as being heavily overgrown within all areas of proposed land take, with the exception of a small section in the north east corner.

More recent aerial photography (www.bing.com/maps) also records the proposed development area as being very overgrown.

There was no evidence of any archaeological, architectural or cultural heritage features recorded on aerial photographs within the proposed development area.

County Development Plan

Wicklow County Development Plan 2010-2016

It is an Objective (AR1) of Wicklow County Council that:

"*No development in the vicinity of a feature included in the Record of Monuments & Places (RMP) will be permitted where it seriously detracts from the setting of the feature or which is seriously injurious to its cultural or educational value*" (Wicklow County Council 2010, 236).

It is also an Objective (AR3) of Wicklow County Council to ensure that:

"*Provision is made through the development control process for the protection of previously unknown archaeological sites and features where they are discovered during development works*" (*ibid*.).

Schedule 16.1 of the Wicklow County Development Plan (2010, Volume 2, 22) contains a list of *Areas of Archaeological Potential & Significance*. There are no Areas of Archaeological Potential and Significance within the proposed development area or the 1 km study area.

Schedule 16.2 of the Wicklow County Development Plan (*ibid*.) contains a list of *Major Sites of Archaeological Importance in Wicklow in State Ownership or Guardianship*. There are no Major Sites of Archaeological Importance within the proposed development area or the 1 km study area.

The proposed development area is located outside the boundary of the Adopted Greystones-Delgany and Kilcoole Local Area Plan 2013-2019 (www.wicklow.ie).

There are no RMP sites within the proposed development area. There are 35 RMP sites within the 1 km study area.

It is an Objective (RPS4) of Wicklow County Council to:

"*strongly resist the demolition of protected structures, unless it can be demonstrated that exceptional circumstances exist. In cases where demolition or partial demolition is permitted or where permission is given for the removal of feature(s), the proper recording of the building /feature will be required before any changes are made*" (Wicklow County Council 2010, 237/238).

Appendix 4 Volume 2 of the Wicklow County Development Plan (2010) contains the *Record of Protected Structures* for the county. There are no Protected Structures within the proposed development area. There are six Protected Structures within the 1 km study area.

Table 16.1 of the Wicklow County Development Plan (2010, 239) contains the list of *Architectural Conservation Areas* for the county. There are no Architectural Conservation Areas within the proposed development area or the 1 km study area.

National Inventory of Architectural Heritage

There are no entries recorded on the NIAH building survey (www.buildingsofireland.ie) within the proposed development area. There are three entries recorded on the building survey within the 1 km study area. There are no entries recorded on the NIAH garden survey within the proposed development area. There are five entries recorded on the garden survey partially within the 1 km study area.

Field Inspection Results

The field inspection sought to assess the site, its previous and current land use, the topography and any additional environmental information relevant to the report. The site visit took place on 25th September 2015 and weather at the time of the site visit was dry, bright and cold.

The north east corner of the proposed development area (Plate 15-1) was shown to be a levelled, possibly scarped, compact surface with a spoil heap at its southern end. The remainder of the site was shown to be very overgrown with tall bushes and trees. A roughly north west/south east generally overgrown informal path extends the full length of the site, with all other areas of land take being inaccessible (Plates 15-2 – 15-6). The site is slightly elevated at its northern end, although with poor visibility in all directions from that area, and as it extends southwards it becomes generally steep-sided. The site was mainly dry, but it was occasionally slightly wet underfoot in the middle and at the southern end. Views were poor from all areas of proposed land take.

No archaeological, architectural or cultural heritage features were revealed within any areas of proposed land take as a result of carrying out the walkover survey.

Plate 15-1: North east corner of proposed development area, looking south

Plate 15-2: Northern end of proposed development area, looking north

Plate 15-3: Northern end of proposed development area, looking east

Plate 15-4: Middle of proposed development area, looking north west

Plate 15-5: Overgrown path at southern end of proposed development area, looking north west

Plate 15-6: Southern end of proposed development area, looking north west

Planning Policy Context

Archaeological Resource

The *National Monuments Act, 1930 to 2004* and relevant provisions of the *National Cultural Institutions Act, 1997* are the primary means of ensuring the satisfactory protection of archaeological remains, which includes all man-made structures of whatever form or date except buildings habitually used for ecclesiastical purposes.

A number of mechanisms under the National Monuments Act are applied to secure the protection of archaeological monuments. These include the Record of Monuments and Places, the Register of Historic Monuments, the placing of Preservation Orders and Temporary Preservation Orders on endangered sites and National Monuments in the Ownership or Guardianship of the Minister for Arts, Heritage and the Gaeltacht or a Local Authority.

The Minister may acquire National Monuments by agreement or by compulsory order. The State or the Local Authority may assume Guardianship of any National Monument (other than dwellings). The owners of National Monuments (other than dwellings) may also appoint the Minister or the Local Authority as Guardian of that monument if the State or Local Authority agrees. Once the site is in ownership or Guardianship of the State, it may not be interfered with without the written consent of the Minister.

Section 5 of the 1987 Act requires the Minister to establish and maintain a Register of Historic Monuments. Historic monuments and archaeological areas present on the Register are afforded statutory protection under the 1987 Act. Any interference with sites recorded on the Register is illegal without the permission of the Minister. Two months notice in writing is required prior to any work being undertaken on or in the vicinity of a Registered Monument. The Register also includes sites under Preservation Orders and Temporary Preservation Orders. All Registered Monuments are included in the Record of Monuments and Places.

Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a

Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister.

Section 12(1) of the 1994 Act requires the Minister for Arts, Heritage, Gaeltacht and the Islands to establish and maintain a Record of Monuments and Places where the Minister believes that such monuments exist. The Record comprises a list of monuments and relevant places and a map/s showing each monument and relevant place in respect of each county in the State. All sites recorded on the Record of Monuments and Places receive statutory protection under the National Monuments Act 1994.

Section 12(3) of the 1994 Act provides that:

"*where the owner or occupier (other than the Minister for Arts, Heritage, Gaeltacht and the Islands) of a monument or place included in the Record, or any other person, proposes to carry out, or to cause or permit the carrying out of, any work at or in relation to such a monument or place, he or she shall give notice in writing to the Minister of Arts, Heritage, Gaeltacht and the Islands to carry out work and shall not, except in the case of urgent necessity and with the consent of the Minister, commence the work until two months after the giving of notice*".

Architectural and Built Heritage Resource

The main laws protecting the built heritage are the *Architectural Heritage (National Inventory) and Historic Monuments (Miscellaneous Provisions) Act, 1999* and the *Planning and Development Act, 2000* (Amended 2010). The Architectural Heritage and Historic Monuments Act requires the Minister to establish a survey to identify, record and assess the architectural heritage of the country. The National Inventory of Architectural Heritage (NIAH) records all built heritage structures within specific counties in Ireland. As inclusion in the Inventory does not provide statutory protection, the document is used to advise Local Authorities on compilation of a Record of Protected Structures (RPS) as required by the Planning and Development Act, 2000.
The Planning and Development Act, 2000 requires Local Authorities to establish a Record of Protected Structures to be included in the County Development Plan (CDP). This Plan includes objectives designed to protect the archaeological, architectural and cultural heritage resource during the planning process. Buildings recorded in the RPS can include Recorded Monuments, structures listed in the NIAH, or buildings deemed to be of architectural, archaeological or artistic importance by the Minister. Sites, areas or structures of archaeological, architectural or artistic interest listed in the RPS receive statutory protection from injury or demolition under the Planning and Development Act, 2000. Damage to or demolition of a site registered on the RPS is an offence. The RPS list is not always comprehensive in every county.

The Local Authority has the power to order conservation and restoration works to be undertaken by the owner of a Protected Structure if it considers the building in need of repair. An owner or developer must make a written request to the Local Authority to carry out any works on a Protected Structure and its environs, which will be reviewed within 12 weeks of application. Failure to do so may result in prosecution.

Wicklow County Development Plan 2010 – 2016

Wicklow County Council has written Objectives on the preservation of archaeological, architectural and cultural heritage remains in advance of permitted development. These relate to archaeological monuments and objects, vernacular structures and industrial heritage features amongst others.

Impact Assessment and the Archaeological Resource

Potential Impacts on Archaeological Remains

Impacts can be identified from detailed information about a project, the nature of the area affected and the range of archaeological resources potentially affected. Development sites can affect the archaeological resource of a given landscape in a number of ways.

- Permanent and temporary land-take, associated structures, landscape mounding, and their construction may result in damage to or loss of archaeological remains and deposits, or physical loss to the setting of historic monuments and to the physical coherence of the landscape;
- Archaeological sites can be affected adversely in a number of ways: disturbance by excavation, topsoil stripping and the passage of heavy machinery; disturbance by vehicles working in unsuitable conditions; or burial of sites, limiting accessibility for future archaeological investigation;
- Hydrological changes in groundwater or surface water levels can result from construction activities such as de-watering and spoil disposal, or longer-term changes in drainage patterns. These may desiccate archaeological remains and associated deposits;
- Visual impacts on the historic landscape sometimes arise from construction traffic and facilities, built earthworks and structures, landscape mounding and planting, noise, fences and associated works. These features can impinge directly on historic monuments and historic landscape elements as well as their visual amenity value;
- Landscape measures such as tree planting can damage sub-surface archaeological features, due to topsoil stripping and through the root action of trees and shrubs as they grow;
- Ground consolidation by construction activities or the weight of permanent embankments can cause damage to buried archaeological remains, especially in colluvium or peat deposits;
- Disruption due to construction also offers in general the potential for adversely affecting archaeological remains. This can include machinery, site offices, service trenches etc;
- Although not widely appreciated, positive impacts can accrue from permitted developments. These can include positive resource management policies, improved maintenance and access to archaeological monuments and the increased level of knowledge of a site or historic landscape as a result of archaeological assessment and fieldwork.

Predicted Impacts

There is no standard scale against which the severity of impacts on the archaeological and historic landscape may be judged. The severity of a given level of land-take or visual intrusion varies with the type of monument, site or landscape feature and its existing environment. Severity of impact can be judged taking the following into account:

- The proportion of the feature affected and how far physical characteristics fundamental to the understanding of the feature would be lost;
- Consideration of the type, date, survival/condition, fragility/vulnerability, rarity, potential and amenity value of the feature affected;
- Assessment of the levels of noise, visual and hydrological impacts, either in general or site specific terms, as may be provided by other specialists.

Impacts are defined as:

"the degree of change in an environment resulting from a development" (Environmental Protection Agency 2002, 30).

Table 15-6: Significance of Impacts

Level of Impact	*Significance Criteria*
Profound	An impact which obliterates sensitive characteristics
Significant	An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
Moderate	An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends
Slight	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities
Imperceptible	An impact capable of measurement but without noticeable consequences

Mitigation Measures and the Archaeological Resource

Mitigation is defined as features of the design or other measures of the proposed development that can be adopted to avoid, prevent, reduce or offset negative impacts.

The best opportunities for avoiding damage to archaeological remains or intrusion on their setting and amenity arise when the site options for the development are being considered. Damage to the archaeological resource immediately adjacent to developments may be prevented by the selection of appropriate construction methods. Reducing adverse impacts can be achieved by good design, for example by screening historic buildings or upstanding archaeological monuments or by burying archaeological sites undisturbed rather than destroying them. Offsetting adverse impacts is probably best illustrated by the full investigation and recording of archaeological sites that cannot be preserved *in situ*.

Definition of Mitigation Strategies

The ideal mitigation for all archaeological sites is preservation *in situ*. This however is not always a practical solution, and a series of recommendations are therefore offered to provide ameliorative measures where avoidance and preservation *in situ* are not possible.

Preservation in situ refers to the actual physical preservation of archaeological sites and monuments, including deposits, features and structures.

Archaeological excavation involves the scientific removal and recording of all archaeological features, deposits and objects to the level of geological strata or the base level of a given development. Full archaeological excavation is recommended where initial investigation has uncovered evidence of archaeologically significant material and where avoidance of the site is not possible.

Archaeological test trenching is defined as:

"that form of excavation where the purpose is to establish the nature and extent of archaeological deposits and features present in a location which it is proposed to develop (though not normally to fully investigate those deposits or features) and allow an assessment to be made of the archaeological impact of the proposed development" (DAHGI 1999, 27).

Archaeological monitoring:

"involves an archaeologist being present in the course of the carrying out of development works (which may include conservation works), so as to identify and protect archaeological deposits, features or objects which may be uncovered or otherwise affected by the works" (*ibid*., 28).