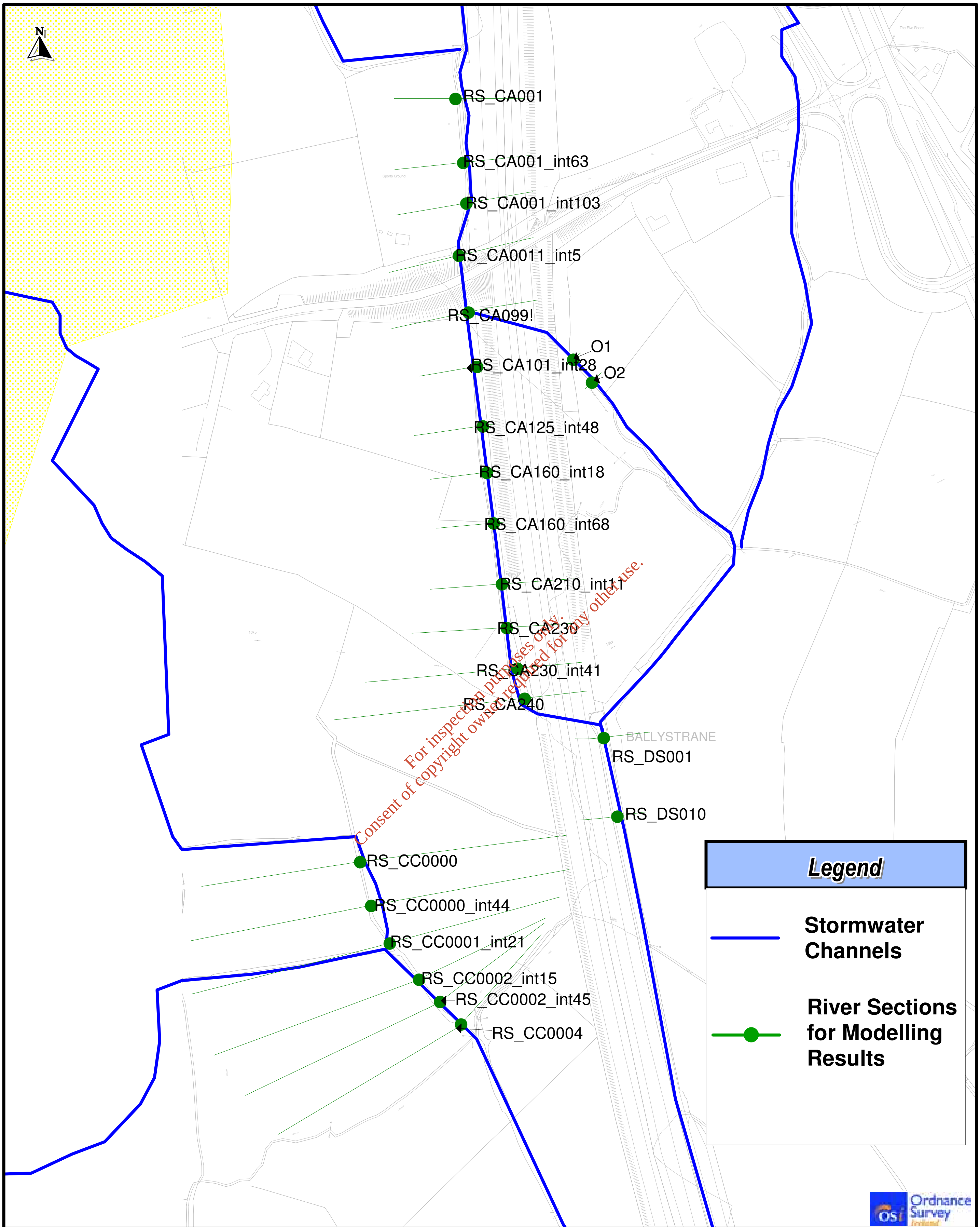
APPENDIX D

Modelling results



Project	*Fingall Landfill*
Figure	D1
Title	**Locations for Modelling Results**

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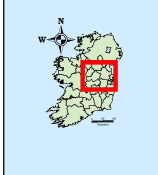

Issue Details

Drawn: WS		Project No.	MDR0303
Checked: CW		File Ref.	
Approved: GG		MDR0303MI0154	
Scale: N/A		Drawing No.	Rev.
Date: 20.04.2006		MI0154	F01

Notes
1. This drawing is the property of RPS-MCOS Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Malin Head.
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RUN	30 Year_EXISTING_ClimateChange10%				30 Year_SCENARIO1_ClimateChange10%				Differences			
Object	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time (mins)	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)
O1	09:05	0.688	31.23	0.90	09:00	0.698	31.23	0.90	5	-0.0095	-0.0021	-0.004
O2	09:05	0.688	30.92	1.16	09:00	0.698	30.93	1.17	5	-0.0094	-0.0018	-0.005
RS_CA001	09:00	2.978	34.34	1.02	09:00	3.057	34.35	1.02	0	-0.0791	-0.0039	-0.009
RS_CA0011_int5	09:05	2.974	33.30	0.27	09:00	3.056	32.87	0.47	5	-0.0828	0.4301	-0.204
RS_CA001_int103	09:00	2.975	33.30	1.29	09:00	3.057	33.04	1.70	0	-0.0813	0.2625	-0.410
RS_CA001_int63	09:00	2.977	33.55	1.71	09:00	3.057	33.55	1.77	0	-0.0797	0.0020	-0.057
RS_CA099!	09:05	2.974	32.45	0.30	09:00	3.056	32.47	0.31	5	-0.0828	-0.0131	-0.004
RS_CA101_int28	09:05	2.286	32.33	0.83	09:00	2.358	32.34	0.84	5	-0.0726	-0.0111	-0.011
RS_CA125_int48	09:05	2.286	32.16	0.90	09:00	2.358	32.17	0.91	5	-0.0723	-0.0079	-0.015
RS_CA160_int18	09:05	2.286	31.37	2.02	09:05	2.360	31.37	2.04	0	-0.0740	-0.0055	-0.021
RS_CA160_int68	09:05	2.286	30.19	2.16	09:00	2.359	30.20	2.17	5	-0.0733	-0.0074	-0.017
RS_CA210_int11	09:05	2.285	29.32	1.70	09:00	2.358	29.32	1.72	5	-0.0728	-0.0066	-0.018
RS_CA230	09:05	2.285	28.76	1.22	09:00	2.358	28.77	1.23	5	-0.0724	-0.0044	-0.011
RS_CA230_int41	09:05	2.285	28.24	1.47	09:05	2.358	28.25	1.47	0	-0.0726	-0.0080	-0.005
RS_CA240	09:05	2.284	28.00	1.05	09:05	2.358	28.01	1.05	0	-0.0745	-0.0108	0.001
RS_CC0000	05:00	2.445	26.87	0.29	05:00	2.445	26.87	0.29	0	0.0000	0.0000	0.000
RS_CC0000_int44	05:00	2.432	26.67	1.00	05:00	2.432	26.67	0.99	0	-0.0001	0.0000	0.013
RS_CC0001_int21	05:05	2.435	26.36	1.71	05:05	2.435	26.36	2.02	0	0.0000	0.0001	-0.309
RS_CC0002_int15	05:05	3.361	26.21	1.17	04:05	3.361	26.21	1.17	60	0.0004	0.0001	0.001
RS_CC0002_int45	05:10	3.362	26.03	1.56	04:10	3.360	26.03	1.56	60	0.0016	0.0001	-0.001
RS_CC0004	05:10	3.362	25.85	1.36	04:10	3.360	25.85	1.36	60	0.0014	0.0002	0.000
RS_DS001	09:05	2.284	27.07	0.87	09:05	2.358	27.08	0.88	0	-0.0745	-0.0092	-0.014
RS_DS010	09:10	2.284	26.45	1.54	09:05	2.358	26.45	1.56	5	-0.0746	-0.0071	-0.018

RUN	50 Year_EXISTING_ClimateChange10%				50 Year_SCENARIO1_ClimateChange10%				Differences			
Object	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time (mins)	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)
O1	09:05	0.716	31.23	0.91	09:00	0.735	31.24	0.92	5	-0.0194	-0.0043	-0.008
O2	09:05	0.716	30.93	1.18	09:00	0.735	30.93	1.19	5	-0.0194	-0.0037	-0.011
RS_CA001	09:00	3.231	34.35	1.04	09:00	3.416	34.36	1.06	0	-0.1852	-0.0084	-0.018
RS_CA0011_int5	09:05	3.226	33.36	0.27	09:00	3.415	32.93	0.49	5	-0.1894	0.4379	-0.216
RS_CA001_int103	09:00	3.228	33.36	1.29	09:00	3.416	33.07	1.73	0	-0.1881	0.2906	-0.437
RS_CA001_int63	09:00	3.230	33.57	1.72	09:00	3.416	33.58	1.81	0	-0.1863	-0.0023	-0.087
RS_CA099!	09:05	3.226	32.49	0.31	09:00	3.415	32.52	0.32	5	-0.1894	-0.0281	-0.008
RS_CA101_int28	09:05	2.510	32.36	0.86	09:00	2.680	32.38	0.89	5	-0.1695	-0.0234	-0.023
RS_CA125_int48	09:05	2.510	32.18	0.94	09:00	2.679	32.20	0.97	5	-0.1691	-0.0182	-0.030
RS_CA160_int18	09:05	2.510	31.39	2.09	09:00	2.679	31.40	2.12	5	-0.1692	-0.0131	-0.023
RS_CA160_int68	09:10	2.515	30.22	2.22	09:00	2.679	30.23	2.26	10	-0.1642	-0.0152	-0.042
RS_CA210_int11	09:05	2.509	29.34	1.76	09:00	2.679	29.35	1.80	5	-0.1693	-0.0153	-0.041
RS_CA230	09:05	2.509	28.78	1.26	09:00	2.678	28.79	1.29	5	-0.1692	-0.0098	-0.030
RS_CA230_int41	09:05	2.509	28.27	1.49	09:05	2.679	28.28	1.53	0	-0.1698	-0.0101	-0.046
RS_CA240	09:10	2.509	28.03	1.05	09:05	2.679	28.06	1.05	5	-0.1706	-0.0239	-0.001
RS_CC0000	05:00	2.748	26.88	0.30	05:00	2.748	26.88	0.30	0	0.0000	0.0000	0.000
RS_CC0000_int44	05:05	2.733	26.68	1.03	05:00	2.733	26.68	0.98	5	0.0001	0.0001	0.055
RS_CC0001_int21	05:05	2.738	26.37	1.76	05:05	2.735	26.37	2.07	0	0.0022	-0.0028	-0.316
RS_CC0002_int15	05:10	3.691	26.22	1.16	04:05	3.785	26.23	1.16	65	-0.0945	-0.0034	-0.002
RS_CC0002_int45	05:10	3.691	26.06	1.56	04:10	3.782	26.07	1.56	60	-0.0914	-0.0080	0.000
RS_CC0004	05:10	3.691	25.88	1.38	04:10	3.783	25.89	1.39	60	-0.0920	-0.0097	-0.007
RS_DS001	09:10	2.509	27.10	0.90	09:05	2.679	27.12	0.92	5	-0.1706	-0.0202	-0.023
RS_DS010	09:10	2.509	26.47	1.60	09:05	2.680	26.49	1.63	5	-0.1705	-0.0161	-0.035

RUN	100 Year_EXISTING_ClimateChange10%				100 Year_SCENARIO1_ClimateChange10%				Differences			
Object	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time (mins)	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)
O1	09:05	0.768	31.25	0.93	09:00	0.778	31.25	0.93	5	-0.0100	-0.0021	-0.004
O2	09:05	0.768	30.94	1.21	09:00	0.778	30.94	1.21	5	-0.0101	-0.0019	-0.005
RS_CA001	09:00	3.761	34.38	1.09	09:00	3.867	34.38	1.10	0	-0.1061	-0.0048	-0.009
RS_CA0011_int5	09:05	3.753	33.50	0.27	09:00	3.866	33.00	0.50	5	-0.1134	0.5009	-0.229
RS_CA001_int103	09:00	3.756	33.50	1.29	09:00	3.867	33.12	1.75	0	-0.1106	0.3772	-0.459
RS_CA001_int63	09:00	3.759	33.63	1.73	09:00	3.867	33.61	1.85	0	-0.1076	0.0141	-0.118
RS_CA099!	09:05	3.753	32.57	0.34	09:00	3.866	32.58	0.34	5	-0.1134	-0.0155	-0.005
RS_CA101_int28	09:05	2.985	32.42	0.92	09:00	3.088	32.44	0.94	5	-0.1033	-0.0133	-0.013
RS_CA125_int48	09:05	2.984	32.23	1.02	09:00	3.088	32.24	1.04	5	-0.1032	-0.0102	-0.017
RS_CA160_int18	09:05	2.984	31.42	2.19	09:00	3.087	31.43	2.22	5	-0.1032	-0.0072	-0.025
RS_CA160_int68	09:05	2.984	30.26	2.32	09:00	3.087	30.27	2.35	5	-0.1032	-0.0088	-0.024
RS_CA210_int11	09:10	2.984	29.38	1.87	09:00	3.087	29.39	1.88	10	-0.1033	-0.0087	-0.019
RS_CA230	09:10	2.984	28.80	1.34	09:00	3.087	28.81	1.35	10	-0.1028	-0.0055	-0.014
RS_CA230_int41	09:10	2.984	28.30	1.55	09:00	3.087	28.31	1.55	10	-0.1024	-0.0112	0.000
RS_CA240	09:10	2.984	28.10	1.05	09:05	3.088	28.11	1.05	5	-0.1031	-0.0060	0.000
RS_CC0000	05:00	3.128	26.89	0.31	05:00	3.128	26.89	0.31	0	0.0000	0.0000	0.000
RS_CC0000_int44	05:00	3.112	26.69	0.98	05:00	3.112	26.69	0.98	0	-0.0001	0.0000	0.000
RS_CC0001_int21	05:05	3.115	26.39	1.75	05:05	3.112	26.39	2.11	0	0.0028	-0.0004	-0.357
RS_CC0002_int15	05:05	4.301	26.25	1.17	04:05	4.317	26.25	1.18	60	-0.0155	-0.0007	-0.011
RS_CC0002_int45	05:10	4.296	26.11	1.56	04:10	4.311	26.11	1.56	60	-0.0147	-0.0010	0.000
RS_CC0004	05:10	4.297	25.94	1.43	04:10	4.312	25.94	1.43	60	-0.0156	-0.0013	-0.002
RS_DS001	09:10	2.984	27.16	0.96	09:05	3.029	27.16	0.97	5	-0.0448	-0.0050	-0.005
RS_DS010	09:10	2.985	26.51	1.69	09:05	3.029	26.52	1.69	5	-0.0449	-0.0042	-0.008

RUN	200 Year_EXISTING_ClimateChange10%				200 Year_SCENARIO1_ClimateChange10%				Differences			
Object	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time (mins)	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)
O1	09:10	0.811	31.25	0.94	09:00	0.818	31.26	0.95	10	-0.0075	-0.0016	-0.003
O2	09:10	0.811	30.95	1.23	09:00	0.818	30.95	1.23	10	-0.0074	-0.0014	-0.003
RS_CA001	09:00	4.272	34.40	1.13	09:00	4.351	34.40	1.14	0	-0.0789	-0.0032	-0.006
RS_CA0011_int5	09:05	4.258	33.62	0.27	09:00	4.349	33.07	0.52	5	-0.0915	0.5504	-0.241
RS_CA001_int103	09:00	4.266	33.62	1.30	09:00	4.350	33.17	1.77	0	-0.0845	0.4523	-0.474
RS_CA001_int63	09:00	4.270	33.69	1.73	09:00	4.351	33.64	1.91	0	-0.0806	0.0421	-0.174
RS_CA099!	09:05	4.258	32.64	0.36	09:00	4.349	32.65	0.36	5	-0.0916	-0.0121	-0.003
RS_CA101_int28	09:10	3.448	32.48	0.98	09:00	3.531	32.49	0.99	10	-0.0830	-0.0104	-0.010
RS_CA125_int48	09:10	3.450	32.28	1.09	09:00	3.530	32.29	1.11	10	-0.0797	-0.0081	-0.014
RS_CA160_int18	09:20	3.447	31.45	2.32	08:50	3.559	31.46	2.34	30	-0.1114	-0.0043	-0.026
RS_CA160_int68	09:20	3.437	30.30	2.42	09:05	3.549	30.31	2.43	15	-0.1117	-0.0090	-0.015
RS_CA210_int11	09:10	3.444	29.42	1.94	09:00	3.530	29.42	1.96	10	-0.0860	-0.0072	-0.014
RS_CA230	09:10	3.446	28.83	1.40	09:00	3.531	28.83	1.41	10	-0.0856	-0.0041	-0.011
RS_CA230_int41	09:10	3.446	28.35	1.55	09:00	3.531	28.35	1.57	10	-0.0851	-0.0045	-0.022
RS_CA240	09:10	3.447	28.12	1.05	09:00	3.529	28.12	1.05	10	-0.0829	-0.0023	-0.001
RS_CC0000	05:00	3.574	26.90	0.32	05:00	3.574	26.90	0.32	0	0.0006	0.0000	0.000
RS_CC0000_int44	05:00	3.557	26.70	1.05	05:00	3.556	26.70	1.05	0	0.0012	0.0000	0.000
RS_CC0001_int21	05:05	3.559	26.40	1.75	05:05	3.555	26.40	2.13	0	0.0040	0.0039	-0.382
RS_CC0002_int15	05:05	4.920	26.27	1.16	04:05	4.766	26.27	1.17	60	0.1536	0.0045	-0.004
RS_CC0002_int45	05:10	4.909	26.15	1.56	04:10	4.761	26.14	1.56	60	0.1489	0.0077	-0.001
RS_CC0004	05:10	4.909	25.99	1.49	04:10	4.756	25.98	1.47	60	0.1528	0.0124	0.013
RS_DS001	09:10	3.122	27.17	0.98	09:00	3.139	27.17	0.98	10	-0.0174	-0.0019	-0.002
RS_DS010	09:10	3.122	26.53	1.71	09:05	3.139	26.53	1.71	5	-0.0173	-0.0016	-0.003

RUN	30 Year_EXISTING_ClimateChange10%				30 Year_SCENARIO2_ClimateChange10%				Differences			
Object	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time (mins)	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)
O1	09:05	0.688	31.23	0.90	09:00	0.698	31.23	0.90	5	-0.0094	-0.0021	-0.004
O2	09:05	0.688	30.92	1.16	09:00	0.698	30.93	1.17	5	-0.0094	-0.0018	-0.006
RS_CA001	09:00	2.978	34.34	1.02	09:00	3.057	34.35	1.03	0	-0.0791	-0.0039	-0.009
RS_CA0011_int5	09:05	2.974	33.30	0.27	09:00	3.056	32.87	0.47	5	-0.0828	0.4301	-0.204
RS_CA001_int103	09:00	2.975	33.30	1.29	09:00	3.057	33.04	1.70	0	-0.0814	0.2625	-0.410
RS_CA001_int63	09:00	2.977	33.55	1.71	09:00	3.057	33.55	1.77	0	-0.0798	0.0020	-0.057
RS_CA099!	09:05	2.974	32.45	0.30	09:00	3.056	32.47	0.31	5	-0.0828	-0.0129	-0.004
RS_CA101_int28	09:05	2.286	32.33	0.83	09:00	2.358	32.34	0.84	5	-0.0729	-0.0110	-0.011
RS_CA125_int48	09:05	2.286	32.16	0.90	09:00	2.358	32.17	0.91	5	-0.0721	-0.0079	-0.016
RS_CA160_int18	09:05	2.286	31.37	2.02	08:45	2.361	31.37	2.04	20	-0.0756	-0.0066	-0.023
RS_CA160_int68	09:05	2.286	30.19	2.16	09:00	2.357	30.20	2.18	5	-0.0709	-0.0075	-0.019
RS_CA210_int11	09:05	2.285	29.32	1.70	09:05	2.358	29.32	1.72	0	-0.0726	-0.0067	-0.018
RS_CA230	09:05	2.285	28.76	1.22	09:05	2.357	28.77	1.23	0	-0.0720	-0.0043	-0.011
RS_CA230_int41	09:05	2.285	28.24	1.47	09:00	2.357	28.25	1.47	5	-0.0721	-0.0080	-0.005
RS_CA240	09:05	2.284	28.00	1.05	09:05	2.357	28.01	1.05	0	-0.0732	-0.0106	0.001
RS_CC0000	05:00	2.445	26.87	0.29	05:00	2.445	26.87	0.29	0	0.0000	0.0000	0.000
RS_CC0000_int44	05:00	2.432	26.67	1.00	05:00	2.433	26.67	0.99	0	-0.0001	0.0000	0.013
RS_CC0001_int21	05:05	2.435	26.36	1.71	05:05	2.435	26.36	2.02	0	0.0002	0.0001	-0.311
RS_CC0002_int15	05:05	3.361	26.21	1.17	04:05	3.361	26.21	1.17	60	0.0002	0.0001	0.001
RS_CC0002_int45	05:10	3.362	26.03	1.56	04:10	3.360	26.03	1.56	60	0.0015	0.0001	-0.001
RS_CC0004	05:10	3.362	25.85	1.36	04:10	3.360	25.85	1.36	60	0.0015	0.0002	0.000
RS_DS001	09:05	2.284	27.07	0.87	09:05	2.357	27.08	0.88	0	-0.0732	-0.0091	-0.014
RS_DS010	09:10	2.284	26.45	1.54	09:05	2.357	26.45	1.56	5	-0.0737	-0.0070	-0.018

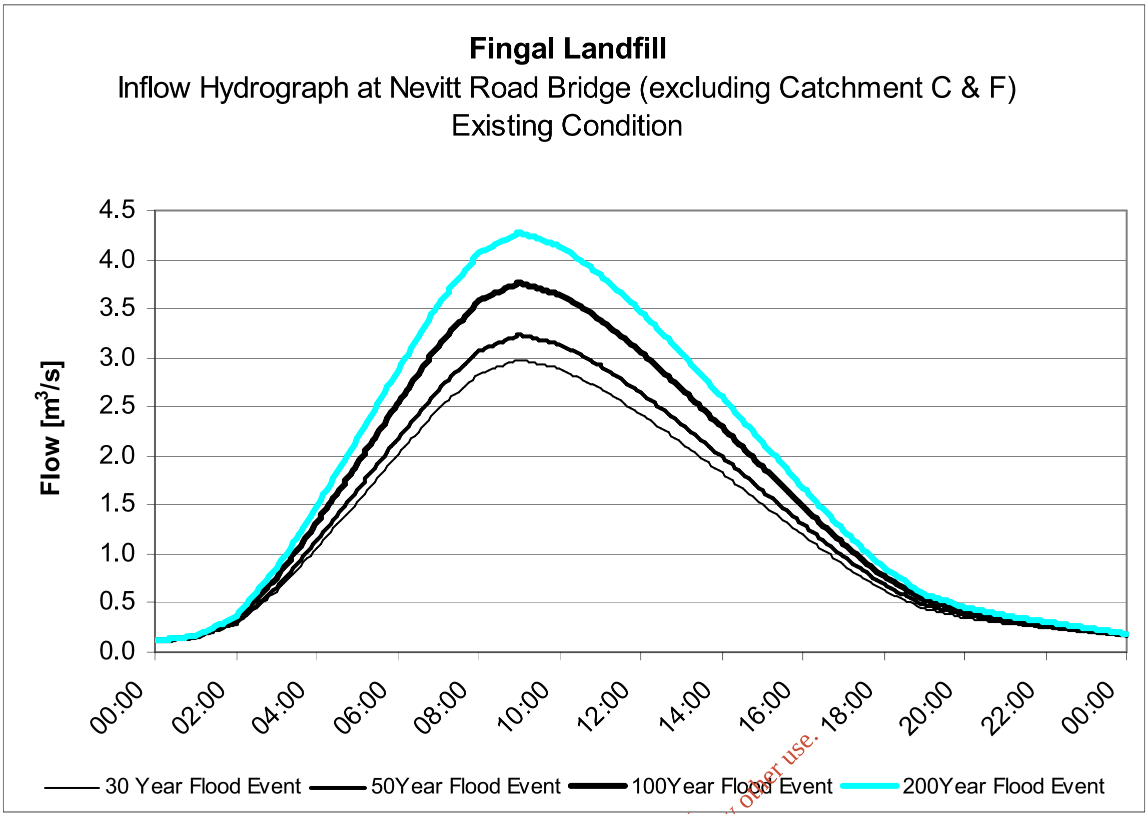
RUN	50 Year_EXISTING_ClimateChange10%				50 Year_SCENARIO2_ClimateChange10%				Differences			
Object	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time (mins)	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)
O1	09:05	0.716	31.23	0.91	09:00	0.735	31.24	0.92	5	-0.0194	-0.0043	-0.008
O2	09:05	0.716	30.93	1.18	09:00	0.735	30.93	1.19	5	-0.0194	-0.0037	-0.011
RS_CA001	09:00	3.231	34.35	1.04	09:00	3.416	34.36	1.06	0	-0.1852	-0.0085	-0.018
RS_CA0011_int5	09:05	3.226	33.36	0.27	09:00	3.415	32.93	0.49	5	-0.1895	0.4379	-0.216
RS_CA001_int103	09:00	3.228	33.36	1.29	09:00	3.416	33.07	1.73	0	-0.1881	0.2906	-0.437
RS_CA001_int63	09:00	3.230	33.57	1.72	09:00	3.416	33.58	1.81	0	-0.1864	-0.0023	-0.087
RS_CA099!	09:05	3.226	32.49	0.31	09:00	3.415	32.52	0.32	5	-0.1895	-0.0281	-0.008
RS_CA101_int28	09:05	2.510	32.36	0.86	09:00	2.680	32.38	0.89	5	-0.1694	-0.0234	-0.023
RS_CA125_int48	09:05	2.510	32.18	0.94	09:00	2.679	32.20	0.97	5	-0.1691	-0.0182	-0.030
RS_CA160_int18	09:05	2.510	31.39	2.09	09:00	2.679	31.40	2.12	5	-0.1692	-0.0131	-0.023
RS_CA160_int68	09:10	2.515	30.22	2.22	09:00	2.679	30.23	2.26	10	-0.1642	-0.0152	-0.042
RS_CA210_int11	09:05	2.509	29.34	1.76	09:00	2.679	29.35	1.80	5	-0.1694	-0.0153	-0.041
RS_CA230	09:05	2.509	28.78	1.26	09:00	2.678	28.79	1.29	5	-0.1693	-0.0098	-0.030
RS_CA230_int41	09:05	2.509	28.27	1.49	09:05	2.679	28.28	1.53	0	-0.1698	-0.0100	-0.046
RS_CA240	09:10	2.509	28.03	1.05	09:05	2.679	28.06	1.05	5	-0.1705	-0.0239	-0.001
RS_CC0000	05:00	2.748	26.88	0.30	05:00	2.748	26.88	0.30	0	0.0000	0.0000	0.000
RS_CC0000_int44	05:05	2.733	26.68	1.03	05:00	2.733	26.68	0.98	5	0.0005	0.0001	0.055
RS_CC0001_int21	05:05	2.738	26.37	1.76	05:05	2.736	26.37	2.08	0	0.0018	-0.0029	-0.317
RS_CC0002_int15	05:10	3.691	26.22	1.16	04:05	3.785	26.23	1.16	65	-0.0945	-0.0034	-0.002
RS_CC0002_int45	05:10	3.691	26.06	1.56	04:10	3.782	26.07	1.56	60	-0.0916	-0.0080	0.000
RS_CC0004	05:10	3.691	25.88	1.38	04:10	3.783	25.89	1.39	60	-0.0922	-0.0097	-0.007
RS_DS001	09:10	2.509	27.10	0.90	09:05	2.679	27.12	0.92	5	-0.1705	-0.0200	-0.023
RS_DS010	09:10	2.509	26.47	1.60	09:05	2.680	26.49	1.63	5	-0.1705	-0.0161	-0.035

RUN	100 Year_EXISTING_ClimateChange10%				100 Year_SCENARIO2_ClimateChange10%				Differences			
Object	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time (mins)	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)
O1	09:05	0.768	31.25	0.93	09:00	0.778	31.25	0.93	5	-0.0100	-0.0021	-0.004
O2	09:05	0.768	30.94	1.21	09:00	0.778	30.94	1.21	5	-0.0100	-0.0019	-0.005
RS_CA001	09:00	3.761	34.38	1.09	09:00	3.867	34.38	1.10	0	-0.1061	-0.0048	-0.009
RS_CA0011_int5	09:05	3.753	33.50	0.27	09:00	3.866	33.00	0.50	5	-0.1132	0.5009	-0.229
RS_CA001_int103	09:00	3.756	33.50	1.29	09:00	3.867	33.12	1.75	0	-0.1106	0.3772	-0.459
RS_CA001_int63	09:00	3.759	33.63	1.73	09:00	3.867	33.61	1.85	0	-0.1077	0.0141	-0.118
RS_CA099!	09:05	3.753	32.57	0.34	09:00	3.866	32.58	0.34	5	-0.1133	-0.0155	-0.005
RS_CA101_int28	09:05	2.985	32.42	0.92	09:00	3.088	32.44	0.94	5	-0.1031	-0.0133	-0.013
RS_CA125_int48	09:05	2.984	32.23	1.02	09:00	3.088	32.24	1.04	5	-0.1031	-0.0102	-0.017
RS_CA160_int18	09:05	2.984	31.42	2.19	09:00	3.087	31.43	2.22	5	-0.1032	-0.0072	-0.025
RS_CA160_int68	09:05	2.984	30.26	2.32	09:00	3.087	30.27	2.35	5	-0.1032	-0.0088	-0.024
RS_CA210_int11	09:10	2.984	29.38	1.87	09:00	3.087	29.39	1.88	10	-0.1033	-0.0087	-0.019
RS_CA230	09:10	2.984	28.80	1.34	09:00	3.087	28.81	1.35	10	-0.1028	-0.0054	-0.014
RS_CA230_int41	09:10	2.984	28.30	1.55	09:05	3.086	28.31	1.55	5	-0.1023	-0.0112	0.000
RS_CA240	09:10	2.984	28.10	1.05	09:05	3.087	28.11	1.05	5	-0.1030	-0.0060	0.000
RS_CC0000	05:00	3.128	26.89	0.31	05:00	3.128	26.89	0.31	0	0.0000	0.0000	0.000
RS_CC0000_int44	05:00	3.112	26.69	0.98	05:00	3.112	26.69	0.98	0	0.0000	0.0000	0.000
RS_CC0001_int21	05:05	3.115	26.39	1.75	05:05	3.112	26.39	2.11	0	0.0026	-0.0004	-0.357
RS_CC0002_int15	05:05	4.301	26.25	1.17	04:05	4.317	26.25	1.18	60	-0.0155	-0.0007	-0.011
RS_CC0002_int45	05:10	4.296	26.11	1.56	04:10	4.311	26.11	1.56	60	-0.0147	-0.0010	0.000
RS_CC0004	05:10	4.297	25.94	1.43	04:10	4.312	25.94	1.43	60	-0.0156	-0.0013	-0.002
RS_DS001	09:10	2.984	27.16	0.96	09:05	3.029	27.16	0.97	5	-0.0448	-0.0050	-0.005
RS_DS010	09:10	2.985	26.51	1.69	09:05	3.029	26.52	1.69	5	-0.0449	-0.0042	-0.008

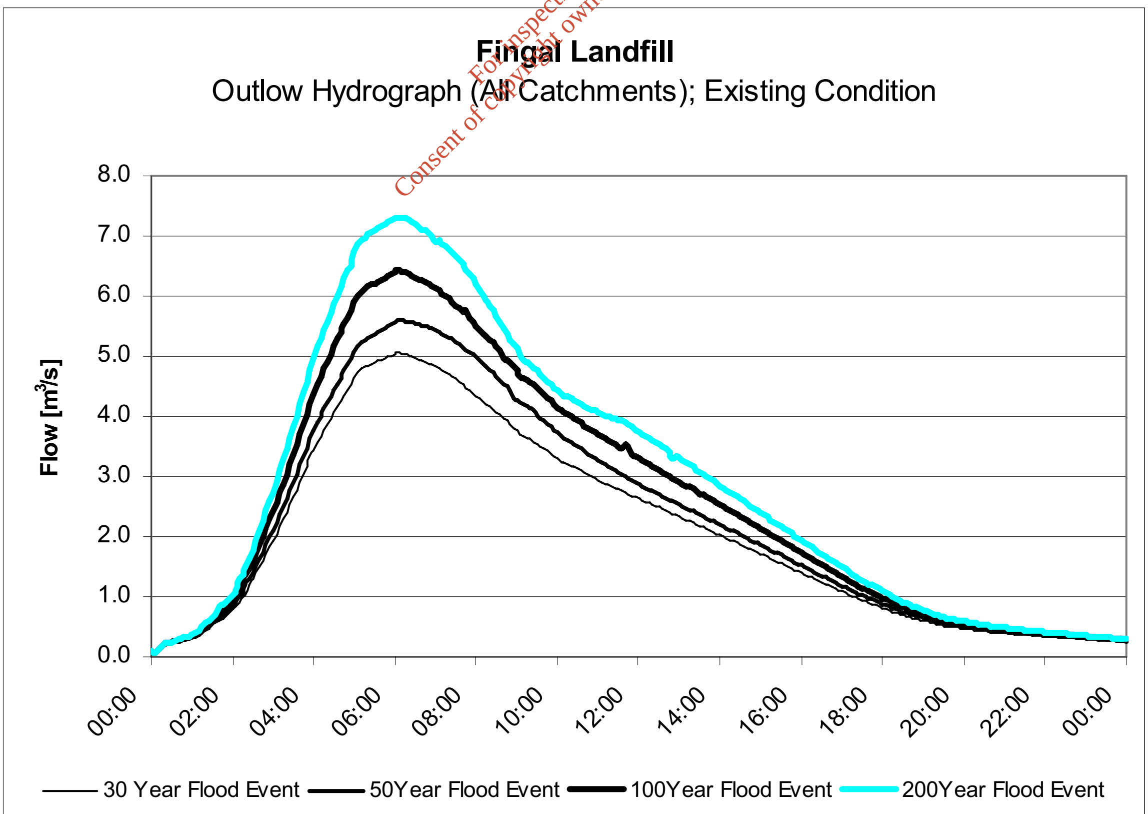
RUN	200 Year_EXISTING_ClimateChange10%				200 Year_SCENARIO2_ClimateChange10%				Differences			
Object	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)	Max Flow Time (mins)	Max Flow (m^3/s)	Max Stage (m AD)	Max Velocity (m/s)
O1	09:10	0.811	31.25	0.94	09:00	0.818	31.26	0.95	10	-0.0075	-0.0016	-0.003
O2	09:10	0.811	30.95	1.23	09:00	0.818	30.95	1.23	10	-0.0074	-0.0014	-0.003
RS_CA001	09:00	4.272	34.40	1.13	09:00	4.351	34.40	1.14	0	-0.0789	-0.0032	-0.006
RS_CA0011_int5	09:05	4.258	33.62	0.27	09:00	4.349	33.07	0.52	5	-0.0915	0.5504	-0.241
RS_CA001_int103	09:00	4.266	33.62	1.30	09:00	4.350	33.17	1.77	0	-0.0845	0.4523	-0.473
RS_CA001_int63	09:00	4.270	33.69	1.73	09:00	4.350	33.64	1.91	0	-0.0805	0.0421	-0.173
RS_CA099!	09:05	4.258	32.64	0.36	09:00	4.349	32.65	0.36	5	-0.0916	-0.0121	-0.003
RS_CA101_int28	09:10	3.448	32.48	0.98	09:00	3.530	32.49	0.99	10	-0.0821	-0.0105	-0.010
RS_CA125_int48	09:10	3.450	32.28	1.09	09:00	3.529	32.29	1.11	10	-0.0786	-0.0081	-0.013
RS_CA160_int18	09:20	3.447	31.45	2.32	08:45	3.551	31.46	2.34	35	-0.1036	-0.0052	-0.026
RS_CA160_int68	09:20	3.437	30.30	2.42	08:45	3.542	30.31	2.43	35	-0.1046	-0.0084	-0.013
RS_CA210_int11	09:10	3.444	29.42	1.94	09:00	3.529	29.42	1.96	10	-0.0848	-0.0072	-0.012
RS_CA230	09:10	3.446	28.83	1.40	09:00	3.527	28.83	1.41	10	-0.0816	-0.0041	-0.011
RS_CA230_int41	09:10	3.446	28.35	1.55	09:00	3.528	28.35	1.55	10	-0.0822	-0.0044	0.000
RS_CA240	09:10	3.447	28.12	1.05	09:00	3.529	28.12	1.05	10	-0.0822	-0.0023	-0.001
RS_CC0000	05:00	3.574	26.90	0.32	05:00	3.574	26.90	0.32	0	0.0006	0.0000	0.000
RS_CC0000_int44	05:00	3.557	26.70	1.05	05:00	3.556	26.70	1.03	0	0.0015	0.0000	0.019
RS_CC0001_int21	05:05	3.559	26.40	1.75	05:05	3.555	26.40	2.13	0	0.0037	0.0039	-0.382
RS_CC0002_int15	05:05	4.920	26.27	1.16	04:05	4.766	26.27	1.17	60	0.1536	0.0045	-0.004
RS_CC0002_int45	05:10	4.909	26.15	1.56	04:10	4.761	26.14	1.56	60	0.1489	0.0077	-0.001
RS_CC0004	05:10	4.909	25.99	1.49	04:10	4.756	25.98	1.47	60	0.1528	0.0124	0.013
RS_DS001	09:10	3.122	27.17	0.98	09:00	3.139	27.17	0.98	10	-0.0175	-0.0019	-0.002
RS_DS010	09:10	3.122	26.53	1.71	09:05	3.139	26.53	1.71	5	-0.0174	-0.0016	-0.003

APPENDIX E

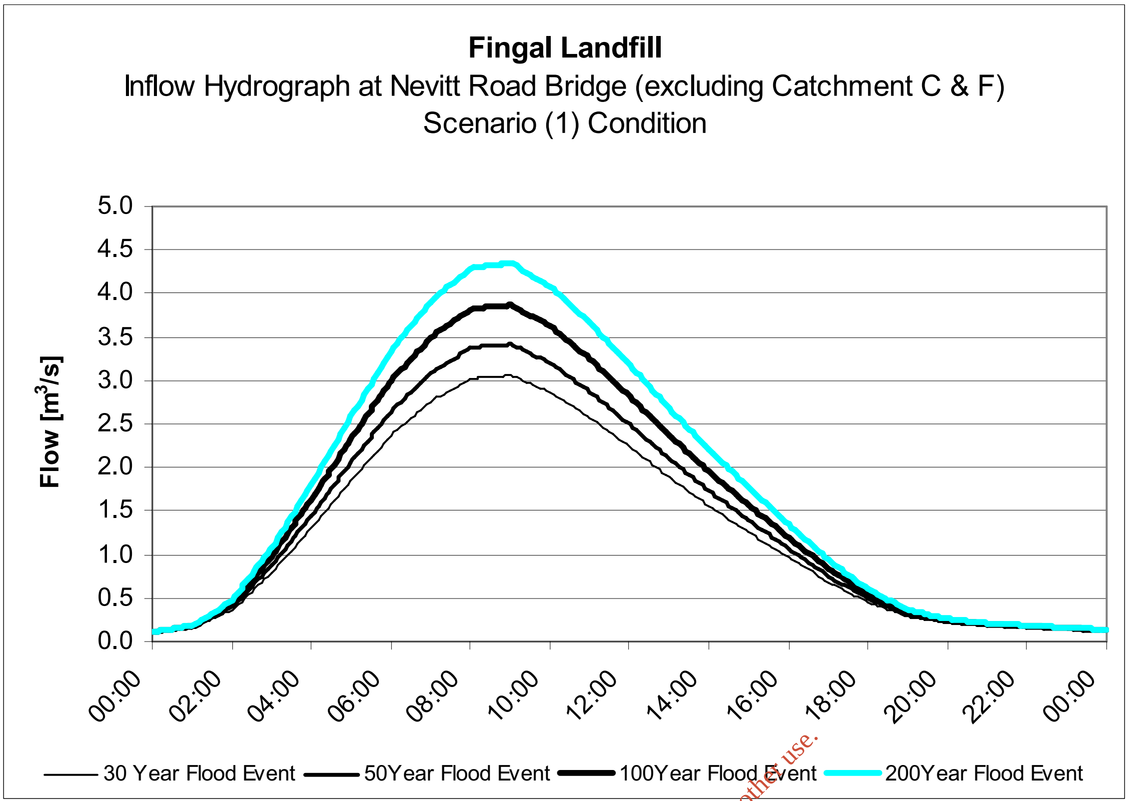
Inflow and outflow hydrographs



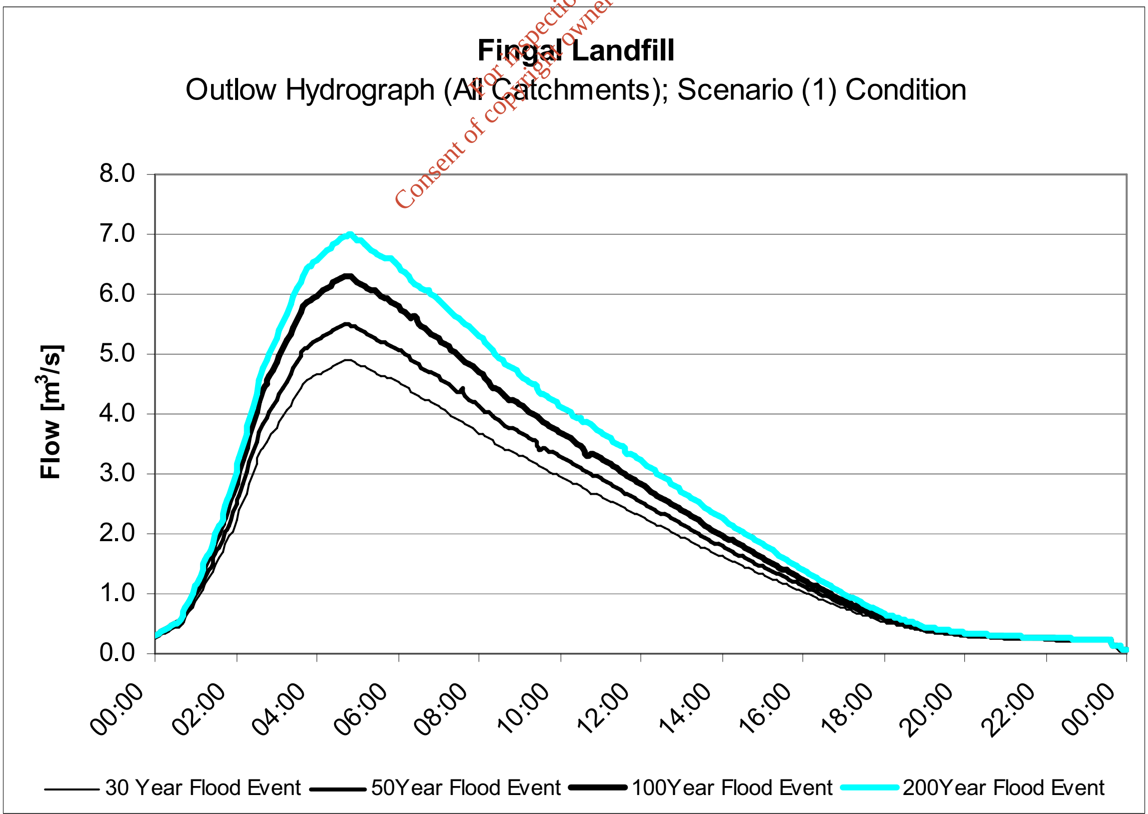
Inflow Hydrographs at RS_CA001 for varying return intervals; Existing condition



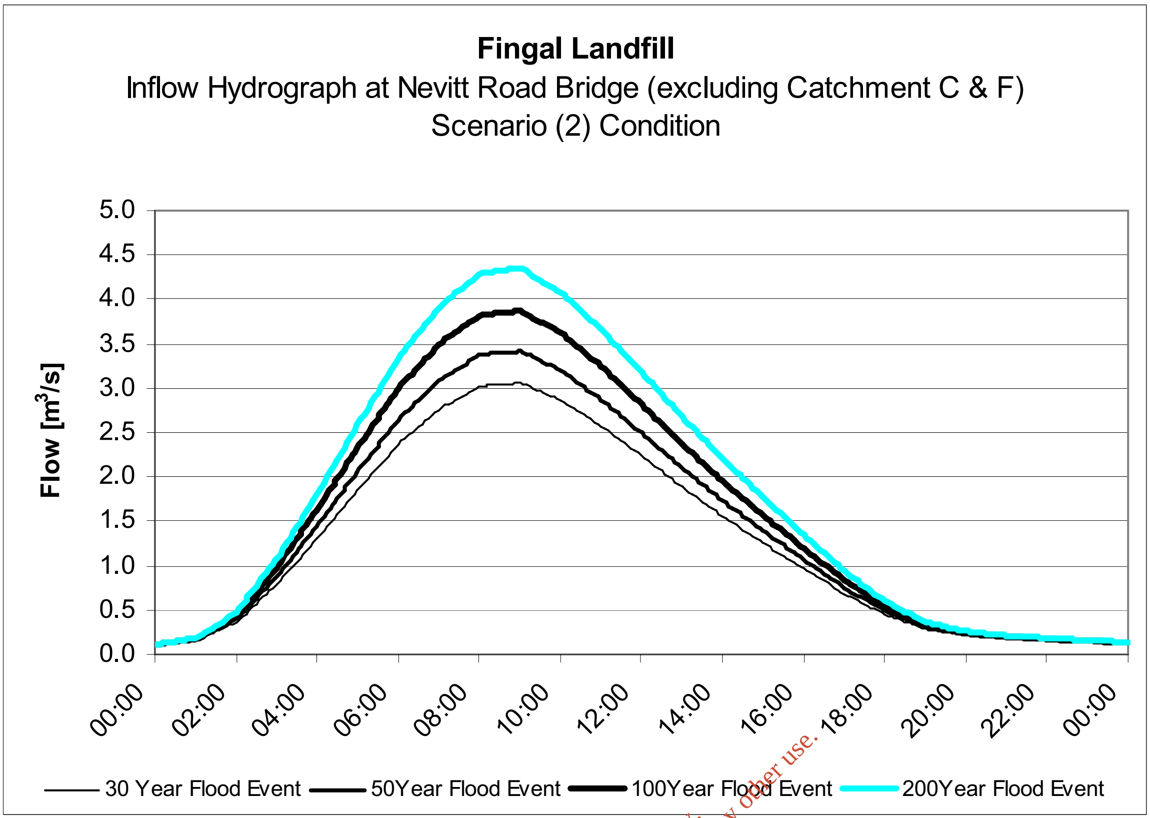
Outflow Hydrographs at RS_CC0004 for varying return intervals; Existing condition



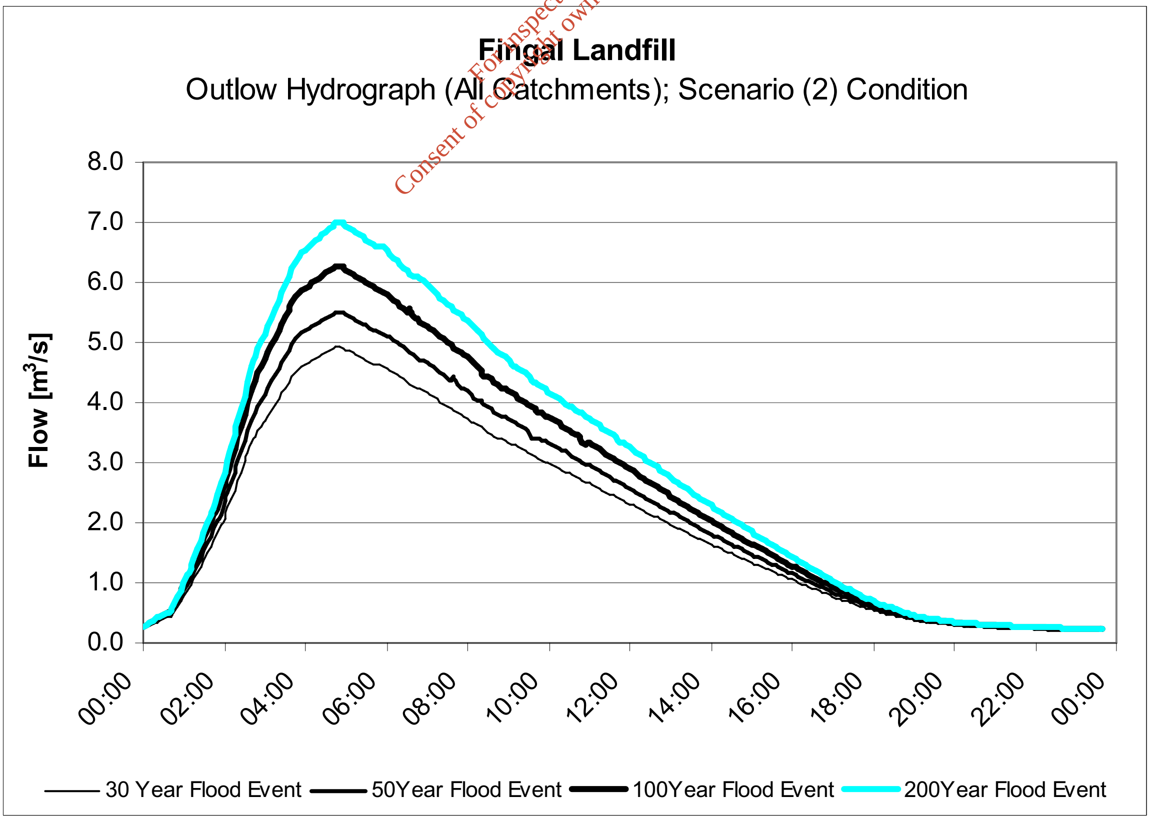
Inflow Hydrographs at RS_CA001 for varying return intervals; Scenario (1)



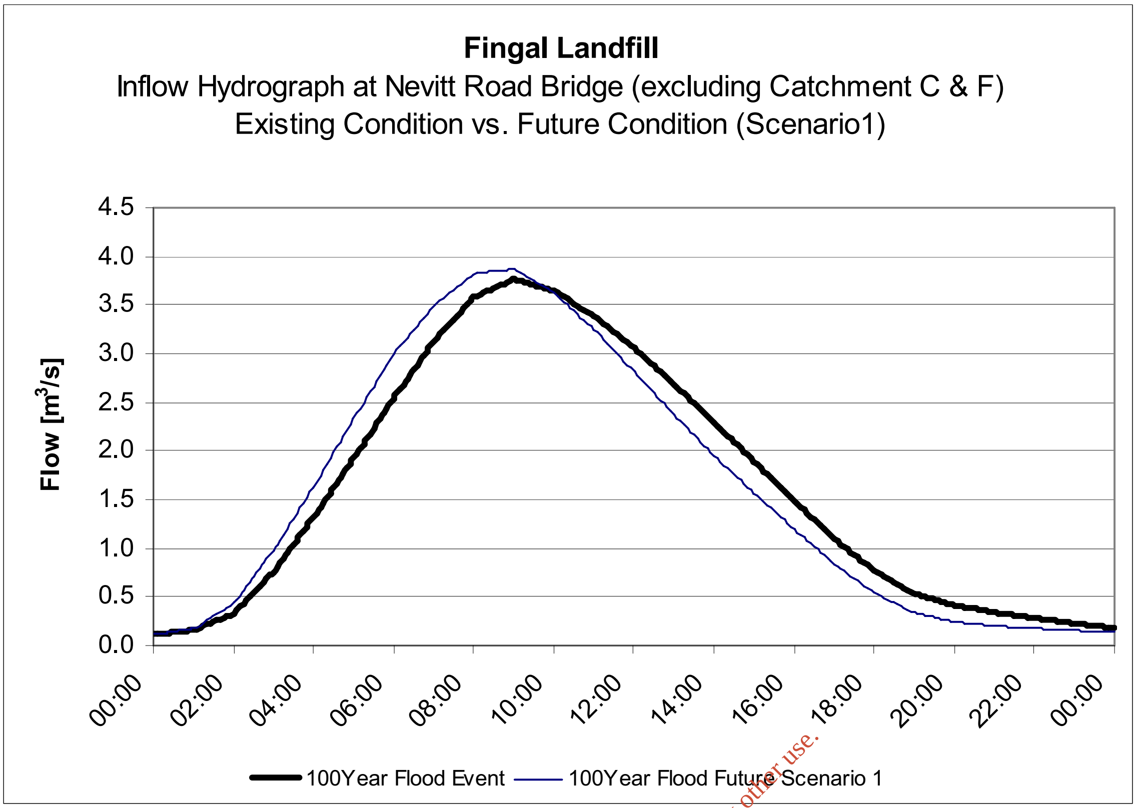
Outflow Hydrographs at RS_CC0004 for varying return intervals; Scenario (1)



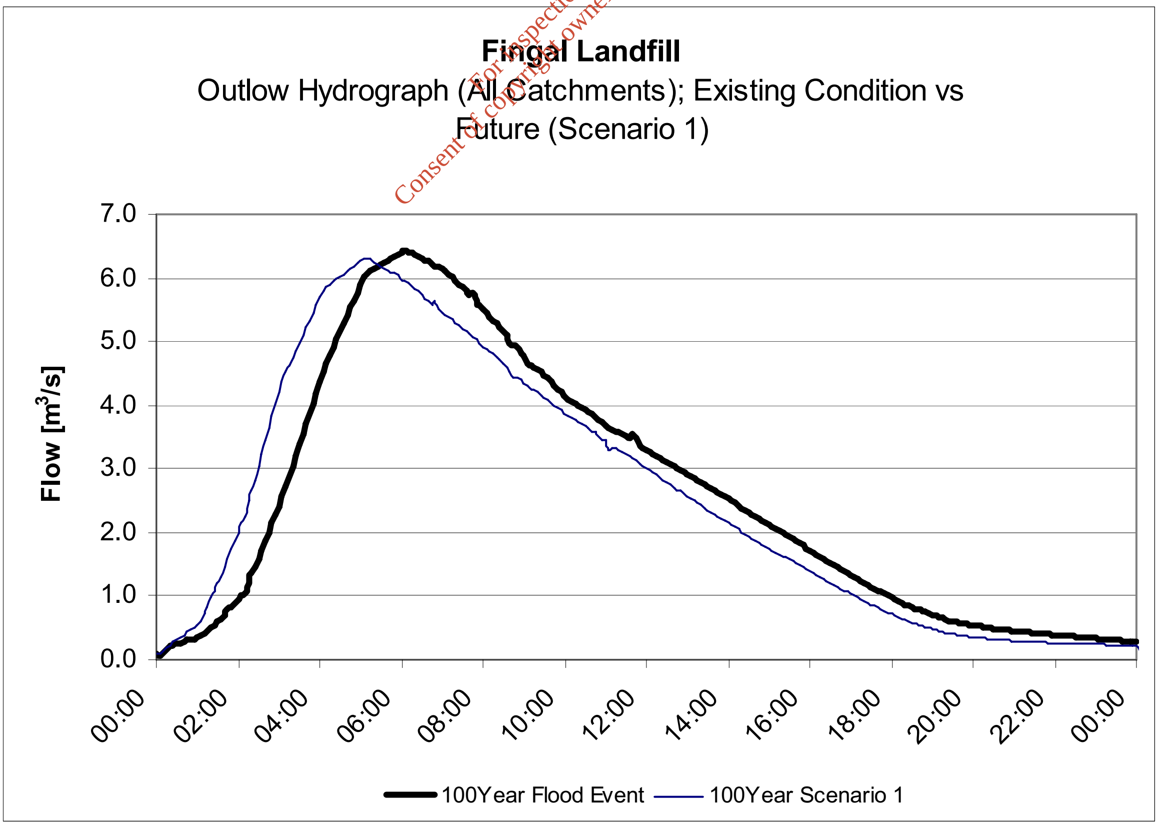
Inflow Hydrographs at RS_CA001 for varying return intervals; Scenario (2)



Outflow Hydrographs at RS_CC0004 for varying return intervals; Scenario (2)



Inflow Hydrographs at RS_CA001 100 Flood; Existing vs. Future (Scenario1)



Outflow Hydrograph 100 Year Flood; Existing vs. Future (Scenario1)

APPENDIX D

AQUATIC ECOLOGY

CONSERVATION SERVICES

FINGAL LANDFILL EIS

AQUATIC ECOLOGY REPORT

Final

27th March 2006

Conservation Services, Tullaha, Glenflesk, Killarney, Co. Kerry
Tel/Fax 064 30130 e-mail conserv@eircom.net

CONTENTS

APPENDIX 1	HABITAT ASSESSMENT AT INVERTEBRATE SAMPLING SITES
APPENDIX 2	FISH SURVEY DATA
APPENDIX 3	SUBMISSIONS
APPENDIX 4	PHOTOGRAPHS

1 INTRODUCTION

Fingal County Council have appointed RPS Consulting Engineers, to undertake the preparation of an Environmental Impact Statement for the proposed new Fingal landfill facility in north County Dublin. As part of the Environmental Impact Statement, Conservation Services, Ecological & Environmental Consultants have been commissioned by RPS Consulting Engineers to carry out a baseline aquatic survey of the potentially affected sections of the Corduff River in the catchment of which the proposed Fingal landfill is located.

The objectives of the survey are:

- To assess the present water quality and general ecological condition of the Corduff River and its tributaries on the proposed landfill site, immediately upstream and downstream of the proposed landfill site.

- To assess the present status of salmonid fish stocks and the quality of salmonid habitat in the Corduff system on and downstream of the proposed landfill.

- To assess the importance of the Corduff River from an ecological and fishery view point.

- To provide baseline data on the biological condition of the Corduff River against which any future changes can be assessed.

- To assess the potential environmental impacts of the proposed landfill on the ecology of the Corduff River.

It should be noted that the present assessment deals exclusively with potential direct impacts on the freshwater aquatic environment from the proposed Fingal landfill. Assessment of potential impacts from the treatment and disposal of leachate generated at the Fingal Landfill at other existing or proposed licensed facilities does not form part of the present assessment.

The following bodies were invited to submit information and/or comments for this report:

i. Eastern Regional Fisheries Board
ii. Central Fisheries Board
iii. Department of the Environment, Heritage & Local Government
iv. Marine Institute
v. EPA, Office of Environmental Enforcement

It should be noted however that except where otherwise stated, the findings and conclusions of the report are those of Conservation Services.

The main legal constraints on the proposed development in relation to aquatic flora, fauna, habitats and fisheries are:

The Local Government (Water Pollution) Act, 1977 (and associated regulations)	Prohibits the entry of unlicensed polluting matter into waters
The Fisheries (Consolidation) Act, 1959 as amended by the Fisheries (Amendment) Act, 1962	Prohibits: 1. The entry of deleterious matter into waters. (Deleterious matter is defined as any substance that is liable to injure fish, their spawning grounds or their food, or to injure fish in their value as human food.) 2. Obstructing the passage of salmon, trout or eels or their smolts and fry 3. Injury or disturbance of the spawn or fry of salmon, trout or eels or to their spawning or nursery areas
Fisheries (Amendment) Act 1999	Requires the regional fisheries board to have regard for the need for the conservation of fish and other species

	of fauna & flora habitat and biodiversity of inland fisheries and ecosystems.
The Freshwater Fish Directive 78/659/EEC as transposed into Irish law under E.C. (Quality of Salmonid Waters) Regulations 1988 (S.I. No. 293 of 1988)	Lays down standards for the quality of designated waters and requirements for monitoring.
The Wildlife Act 1976	Prohibits damage to protected species which includes certain freshwater aquatic species.
Water Framework Directive (2000/60/EC)	The Water Framework Directive requires the maintenance of good ecological quality in all surface waters, which in the Irish context is generally taken to mean achieving salmonid water quality standards regardless of whether the watercourse is designated under the Salmonid Regulations.

2 METHODOLOGY

2.1 HABITAT ASSESSMENT

Habitat quality for in-stream invertebrate and plant communities, and for fish, and riparian birds and mammals, is primarily a function of 'naturalness' and diversity. The more diverse the stream habitat in terms of substrate, flow rate, depth, riparian vegetation, light conditions etc., the richer the biological community is likely to be, and the more suitable it is likely to be for salmonid fish (trout and salmon). Habitat assessment was carried out at each of the biological sampling sites. Biological sampling sites were assessed in terms of:

- Stream width and depth
- Substrate type, listing substrate fractions in order of dominance, i.e. large rocks, cobble, gravel, sand, mud etc.
- Flow type, listing percentage of riffle, glide and pool in the sampling area
- Dominant bankside vegetation, listing the main species overhanging the stream
- Estimated degree of shade of the sampling site by bankside vegetation.
- Rating of the site as habitat for salmonid adult, nursery and spawning on a scale of None/ Poor/ Fair/ Good/ Very Good/ Excellent broadly based on a qualitative procedure described by Kennedy (1984). This rating assesses the physical suitability of the habitat; the presence/absence/density of salmonids at the site will also depend on present and historical water quality and accessibility of the site to fish.

A rating of "none" indicates that the ecologist carrying out the assessment regards it as impossible that the stream could support salmonid fish in the relevant life stage.

A rating of "None - Poor" indicates that it is regarded as possible but extremely unlikely that the stream could support salmonid fish in the relevant life stage.

A general assessment of salmonid habitat quality was carried out from the upstream boundary of the proposed landfill to the tidal limit. This assessment consisted of walking/wading the stream/river channel. Salmonid habitat quality was assessed, taking into account width, depth, type of flow (riffle/glide/pool), bottom material, bankside vegetation, etc. Based on these observations, the value of each stream section for spawning, as a nursery area for juveniles, and as an area for adult salmonids, was estimated.

Specifically the principal in-stream physical habitat variables that determine suitability for juvenile salmon and brown trout are water depth, water velocity, streambed substratum, and cover (Heggenes 1990). Mills (1989) suggests favourable locations for spawning are likely to occur where the gradient of a river is 3% or less. Preferred current velocity for spawning is within the range 25–90 cm s^{-1}, with a water depth in the range 17–76 cm (Hendry & Cragg-Hine 1997). Typical spawning sites are the transitional areas between pool and riffle where flow is accelerating and depth decreasing, where gravel of suitable coarseness is present and interstices are kept clean by up-welling flow (Peterson 1978, Bjorn & Reiser 1991). However, the ranges of hydrological conditions and grain-size composition in spawning gravels quoted in the literature vary considerably (Jones 1959; Ottaway *et al.* 1981; Beland *et al*. 1982; Bjorn & Reiser 1991; Kondolf & Wolman 1993). Salmonid fry and parr occupy shallow, fast-flowing water with a moderately coarse substrate with cover (Symons & Heland 1978, Baglinière & Champigneulle 1986). Deep or slow-moving water, particularly when associated with a sand or silt substrate, does not support resident juvenile salmonids (Wankowski & Thorpe 1979, Baglinière & Champigneulle 1986). Suitable cover for juveniles includes areas of deep water, surface turbulence, loose substrate, large rocks and other submerged obstructions, undercut banks, overhanging vegetation, woody debris lodged in the channel, and aquatic vegetation (Heggenes 1990; Bjorn & Reiser 1991; Haury et al. 1995).

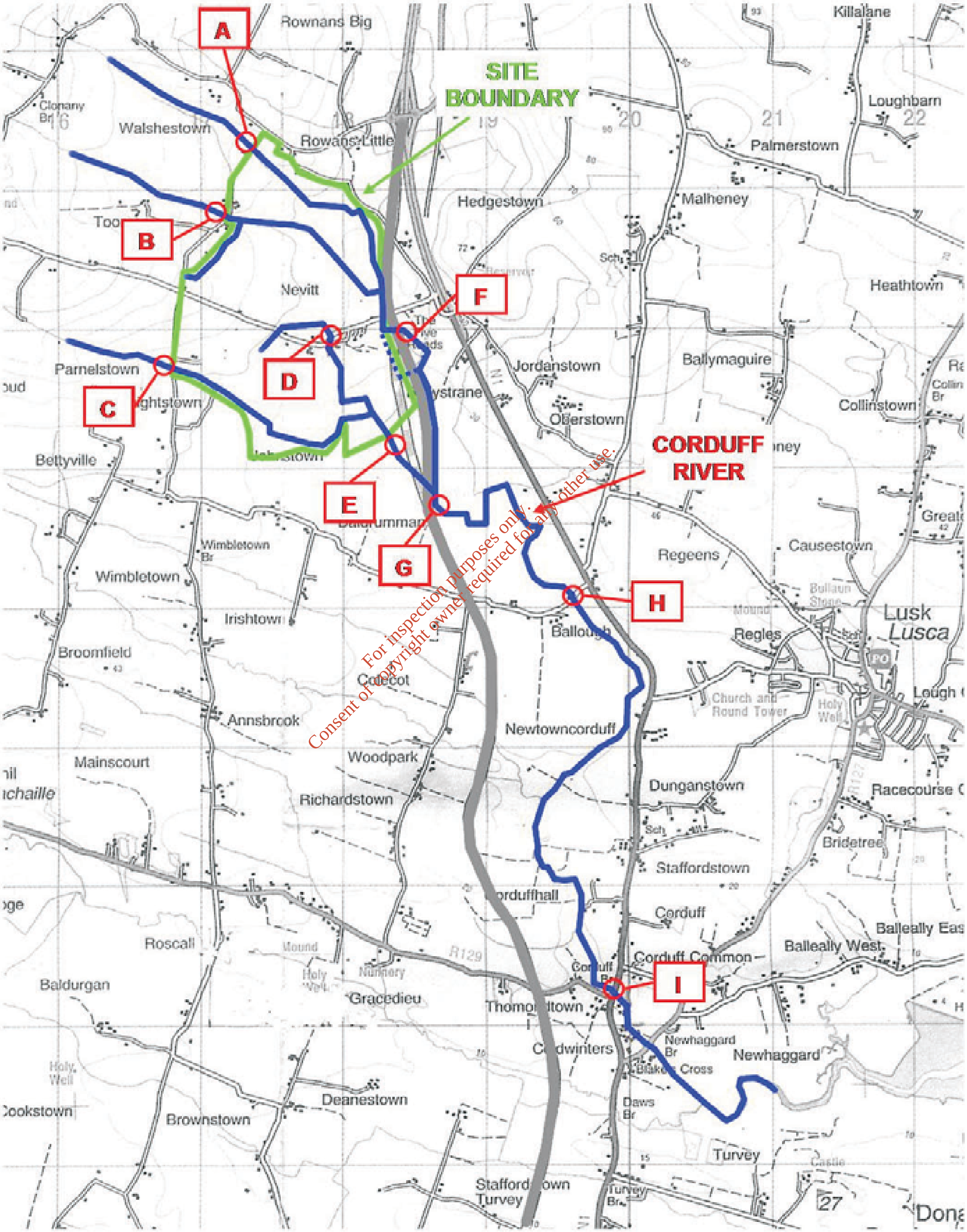
Locations for identification of habitat sections were recorded as Irish Grid References using a Garmin GPS 38. To illustrate the habitat quality photographs were taken a Olympus µ300 digital camera. Habitat assessment of watercourses within the proposed landfill site was carried out in February 2004; habitat assessment downstream of the proposed landfill site was carried out in April 2005.

2.2 INVERTEBRATE SAMPLING AND WATER QUALITY ASSESSMENT

Nine sites were selected for invertebrate sampling (Map 1):

MAP 1 LOCATION OF INVERTEBRATE ASSESSMENT SITES

Locations shown are approximate; for exact locations, see Grid References in text



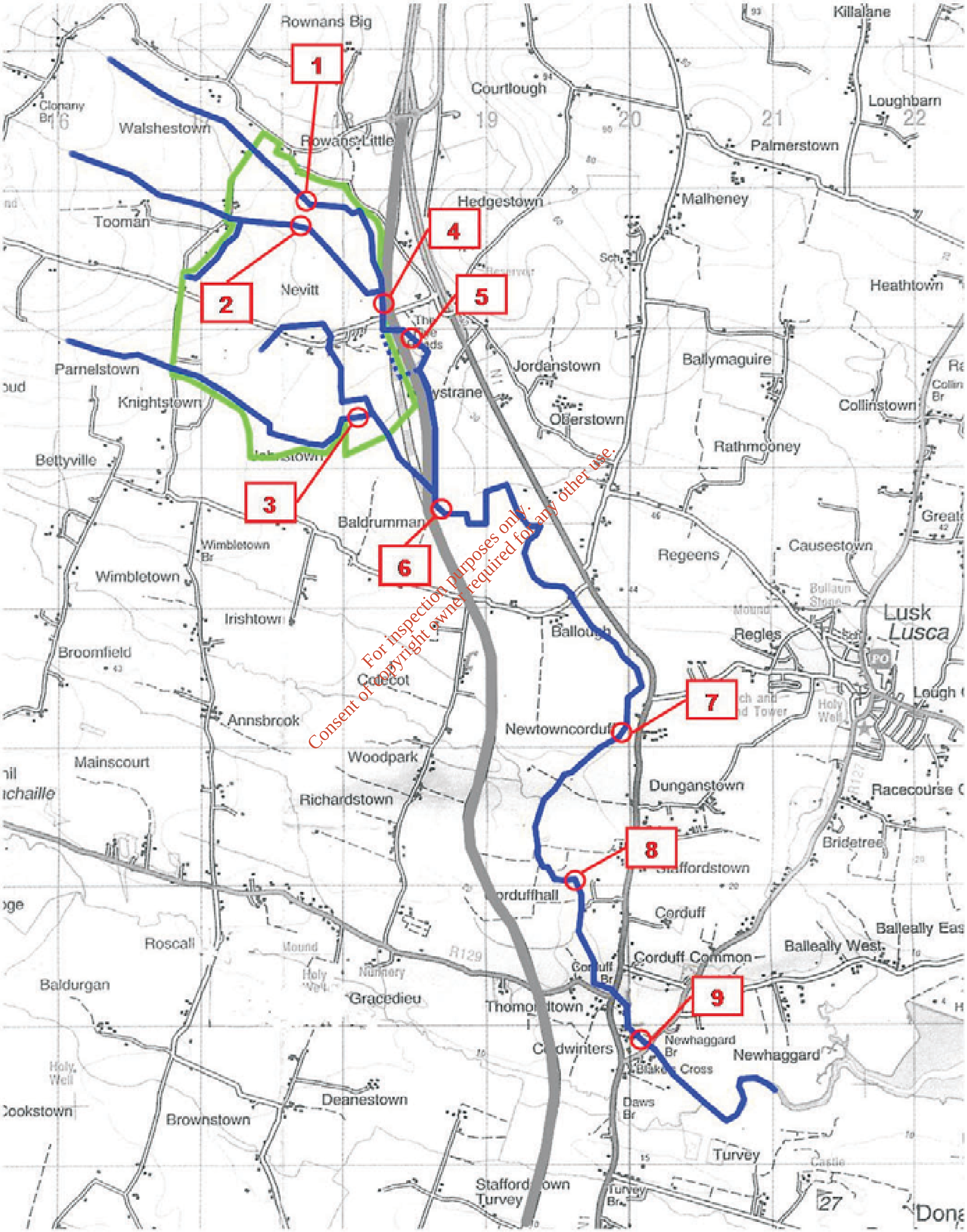
SITE	LOCATION	GRID REFERENCE
A	Stream 1 at upstream perimeter of proposed landfill site.	O1738 5829
B	Stream 2 at upstream perimeter of proposed landfill site.	O1721 5786
C	Stream 4 at upstream perimeter of proposed landfill site.	O1680 5673
D	Stream 3 within proposed landfill site	O1787 5690
E	At downstream perimeter of proposed landfill site below confluence of Streams 3 & 4.	O1830 5631
F	At downstream perimeter of proposed landfill site below confluence of Streams 1 & 2.	O1828 5712
G	c.700m downstream of the proposed landfill site. Just below confluence of all of the streams which flow from the proposed landfill site.	O1868 5568
H	Bridge at Ballough c. 2.5km downstream of proposed landfill site	O1962 5511
I	Corduff Bridge c. 6.5km downstream of proposed landfill site	O1992 5223

Sampling was carried out on 26 April 2005. Site locations were identified and recorded as Irish grid references using a Garmin GPS 38. A five-minute kick and stone wash sample was taken at each of the 9 sites (ISO 7828:1985). Each sample was retained in a large plastic bag at the sampling site. Sample processing and preservation was carried out under laboratory conditions within 24 hours of sampling. Mud was removed from each sample by sieving under running water through a 500µm sieve. Sieved samples were then live sorted for 30 minutes in a white plastic sorting tray under a bench lamp (ISO 5667-3:1994) and if necessary using a magnifying lens. Macroinvertebrates were stored in 70% alcohol. Preserved invertebrates were identified to the level required for the EPA Q-rating method (McGarrigle *et al,* 2002) using high-power and low-power binocular microscopes when necessary. The preserved samples were archived for future examination or verification. Based on the relative abundance of indicator species, a biotic index (Q-rating) was determined for each site in accordance with the biological assessment procedure used by the Environmental Protection Agency (Statutory Instruments No. 258 of 1998) and more detailed unpublished methodology (McGarrigle, Clabby and Lucey pers. comm.).

2.3 ASSESSMENT OF FISH STOCK

Nine sites were selected for fish assessment (Map 3):

MAP 3 LOCATION OF FISH ASSESSMENT SITES
Locations shown are approximate; for exact locations, see Grid References in text



SITE	LOCATION	GRID REFERENCE
1	On Stream 1 within proposed landfill area	O1750 5815 to O1773 5792
2	On Stream 2 within proposed landfill area	O1758 5775 to O1769 5773
3	On Stream 4 within proposed landfill area	O1829 5630 to O1831 5629
4	Within landfill area, downstream of the confluence of streams 1 & 2 and upstream of the culvert under the Nevitt slip road from the M1.	O1828 5721 to O1827 5709
5	Immediately downstream of proposed landfill site and downstream of M1	O1838 5698 to O1846 5687
6	c.700m downstream of the proposed landfill site. Just below confluence of all of the streams which flow from the proposed landfill site.	O1865 5570 to O1878 5564
7	c. 4km downstream of proposed landfill site.	O2001 5429 to O1995 5409
8	c. 5.5km downstream of proposed landfill site.	O1956 5305 to O1965 5302
9	Between Newhaggard Bridge and Corduff Bridge, c. 6.5km downstream of proposed landfill site.	O1998 5202 to O2014 5185

Site locations were identified and recorded as Irish grid references using a Garmin eTrex GPS. Timed electrofishing was carried out at each site to provide a Catch Per Unit Effort (CPUE) index of the fish population density and minimum density estimate. Fish were captured using a Safari Research Surveyor pulsed direct current backpack electrofisher. Fish captured were held in the river in a perforated bin. Prior to handling, fish were anaesthetised in a benzocaine solution to reduce handling stress. Fish were then identified, and fork length of salmonids was measured to the nearest mm. Salmonid age was determined by length frequency distribution combined with scale reading using a high power binocular microscope. Salmonids were classified according to age as fish spawned last winter (0+), 1 year old (1+), 2 years old (2+), etc. Where fish scales show the more rapid growth rate which suggests sea or estuarine growth, age is shown with freshwater growth followed by sea growth. For example, 2.+ indicates two winters in fresh water followed by a period at sea or in the estuary, but returning to freshwater in the same year, while 2.1+ indicates two winters in freshwater and one sea winter. The electrofishing was carried out 22nd – 24th June 2005.

2.4 GUIDELINES USED FOR CLASSIFICATION OF IMPORTANCE OF FRESHWATERS

Rating

A **Internationally Important**

Habitats designated as SACs for Annex II species under the EU Habitats Directive. Major Salmon river fisheries. Major salmonid lake fisheries.

B **Nationally or Regionally Important**

Other major salmonid waters and waters with major amenity fishery value. Commercially important coarse fisheries. Waters with important populations of species protected under the Wildlife Act and/or important populations of Annex II species under the EU Habitats Directive. Waters designated or proposed as Natural Heritage Areas by Dúchas.

C **High Value, locally important**

Small water bodies with known salmonid populations or with good potential salmonid habitat, or any population of species protected under the Wildlife Act and/or listed Annex II species under the EU Habitats Directive. Large water bodies with some fisheries value.

D Moderate value, locally important

Small water bodies with some coarse fisheries value or some potential salmonid habitat. Any stream with an unpolluted Q-value rating.

E Low value

Water bodies with no current fisheries value and no significant potential fisheries value. Habitat diversity low and degraded.

2.5 ASSESSMENT OF SIGNIFICANCE OF POTENTIAL IMPACTS

Impacts are defined on the basis of severity of impact on salmonid fish or any rare, protected, or commercially significant species and/or habitats. Assessment of the importance of a potential impact takes into account not only the ecological considerations in the immediate vicinity of the potential impact, but also geographical and wider catchment considerations

Because of their amenity, commercial and legal status, salmonid fish (trout and salmon) are given special consideration. If an aspect of a proposed development is judged likely to have a measurable negative effect on salmonid fish populations, it would be classified as a significant potential impact. The criteria for assessing the significance of impacts on flora, fauna and fisheries are as follows. (For details of water-body categories see section 2.4)

A Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MAJOR	SEVERE	SEVERE	SEVERE
Localised	MAJOR	MAJOR	SEVERE	SEVERE

B Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MAJOR	MAJOR	SEVERE	SEVERE
Localised	MODERATE	MODERATE	MAJOR	MAJOR

C Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MODERATE	MODERATE	MAJOR	MAJOR
Localised	MINOR	MODERATE	MODERATE	MODERATE

D Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MINOR	MINOR	MODERATE	MODERATE
Localised	NOT SIGNIFICANT	MINOR	MINOR	MINOR

E Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	NOT SIGNIFICANT	NOT SIGNIFICANT	MINOR	MINOR
Localised	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT

In line with the EPA guidelines (EPA 2002) the following terms are defined when quantifying duration;

Temporary: Up to 1 year,

Short-term: From 1 to 7 years

Medium-term: 7 to 15 years

Long-term: 15 – 60 years

Permanent: over 60 years.

For the purposes of this report 'localised' impacts on rivers are loosely defined as impacts measurable no more than 250 metres from the impact source. 'Extensive' impacts on rivers are defined as impacts measurable more than 250m from the impact source. Any impact on salmonid spawning habitat or nursery habitat where it is in short supply, would be regarded as an extensive impact as it is likely to have an impact on the salmonid population beyond the immediate vicinity of the impact source.

2.6 LIMITATIONS ENCOUNTERED

As 0+ fish are still very small in June, trout spawned last winter (0+) were probably under recorded.

3 EXISTING ENVIRONMENT

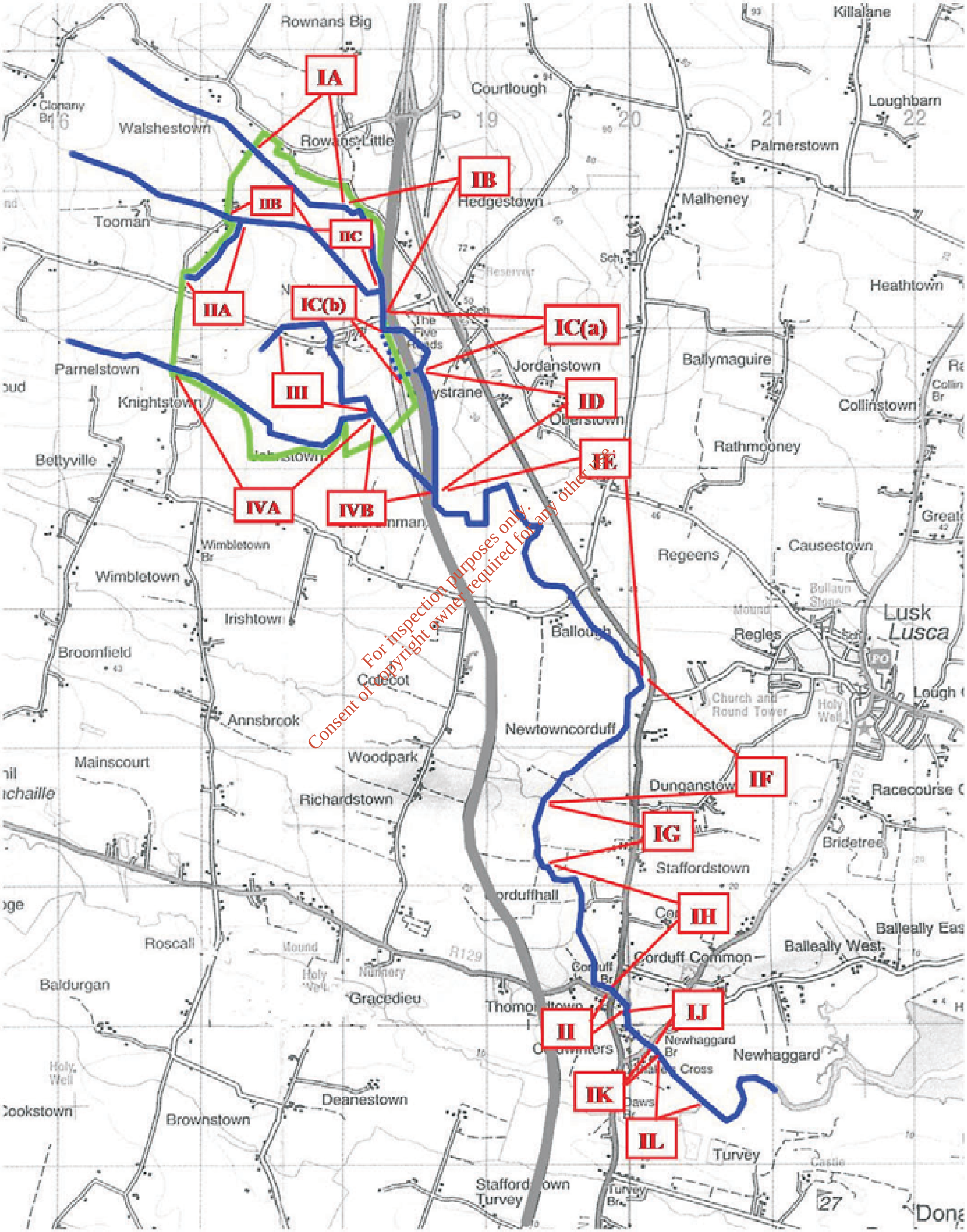
The proposed Fingal landfill site is drained by four small streams, all of which converge adjacent to the eastern boundary of the site to form a tributary of the Corduff (Ballough) River (EPA code 08/B/03), which flows for c.7km to its confluence with the Ballyboghill River c.2km upstream of Rogerstown Estuary.

3.1 HABITAT ASSESSMENT

Results of habitat assessment at invertebrate sampling sites are tabulated in Appendix 1. On the basis of the general habitat assessment the river/stream habitat on and downstream of the proposed landfill site is divided into 18 sections (see Map 2).

MAP 2 LOCATION OF HABITAT SECTIONS

Locations shown are approximate; for exact locations, see Grid References in text



3.1.1 HABITAT WITHIN PROPOSED LANDFILL SITE BOUNDARIES

3.1.1.1 Section I-A

Course	O 1730 5825 to O 1792 5789
Length	c.750m
Description	Swiftly flowing stream, predominantly riffle and cascade on substrate of bed rock, cobble and gravel with mud and sand. Width is 2-3 m and depth is generally 10–15cm but with some deeper pools. This section of stream flows through a 15–30ft deep gorge with dense woodland, predominantly of alder with some sycamore and beech. During prolonged periods of dry weather this stream reduces greatly and constitutes poor salmonid habitat.
Photo. No.	1 - 3
Salmonid Habitat Rating	Adult: Poor - Fair Nursery: Good Spawning: Fair

3.1.1.2 Section I-B

Course	O1792 5789 to 1828 5711 (culvert under slip road at flyover)
Length	1.2km
Description	Muddy glide and riffle over cobble and mud. Heavy shade from hedgerow and alders. At the bottom of this habitat section the stream is piped through two round pipe culverts under the approach road to the M1 flyover. At low water most or all of the stream flow enters a pipe under the M1 just downstream of this twin culvert (see photo. 9 beside red bucket). This pipe is likely to constitute a major obstacle to upstream fish movement. During high water a substantial proportion of the flow is carried by the artificial channel on the

	west side of the M1 (see habitat Section I-C(b) below).
Photo. No.	4-5
Salmonid Habitat Rating	Adult: Poor Nursery: Fair Spawning: Poor - Fair

3.1.1.3 Section I-C(b)

Course	O1828 5711 to 1835 5663 (motorway culvert)
Length	c.0.5km
Description	In high flow conditions much of the stream flow passes along this artificial boulder lined channel with substrates of cobble and mud (Photos. 6 & 7) and passes under the M1 through a four pipe culvert (photo. 8). These culverts are likely to constitute a major obstacle to upstream fish movement. During dry weather this channel is virtually dry (photos. 10 – 12).
Photo. No.	6 - 12
Salmonid Habitat Rating	Adult: None – Poor Nursery: Poor Spawning: None - Poor

3.1.1.4 Section II-A

Course	O1690 5740 to O1730 5778
Length	c.0.7 km
Description	The upper c.250m which is a very small stream is heavily shaded by hedgerow and with negligible salmonid habitat quality. The remaining length is mostly riffle over muddy cobble flowing through deciduous woodland in a steep sided gorge. The last c.150m of this section is culverted.

Photo. No.	13 & 14
Salmonid Habitat Rating	Adult: Poor – None Nursery: Fair Spawning: Fair

3.1.1.5 Section II-B

Course	O1730 5778 to O1760 5775
Length	c. 0.5km
Description	Mixture of muddy riffle and glide flowing through ash woodland.
Photo. No.	15 & 16
Salmonid Habitat Rating	Adult: Poor Nursery: Good Spawning: Fair

3.1.1.6 Section II-C

Course	O1760 5775 to O1829 5727
Length	c. 1 km
Description	Muddy glide with some riffle on muddy cobble and gravel, through linear woodland of ash and alder.
Photo. No.	17
Salmonid Habitat Rating	Adult: Poor Nursery: Fair – Good Spawning: Poor - Fair

3.1.1.7 SECTION III

Course	O1755 5700 to O 1821 5641

Length	c. 1.2km
Description	Small drain
Photo. No.	18
Salmonid Habitat Rating	Adult: None Nursery: None – Poor Spawning: None

3.1.1.8 SECTION IV-A

Course	O1680 5670 to O 1821 5641
Length	c. 1.8 km
Description	Small stream with mixture of muddy riffle and glide on cobble, gravel and mud. Mostly heavily shaded by hedgerow.
Photo. No.	19
Salmonid Habitat Rating	Adult: Poor Nursery: Fair – Good Spawning: Fair

3.1.2 HABITAT DOWNSTREAM OF PROPOSED LANDFILL SITE

3.1.2.1 SECTION IV-B

Course	O1829 5631 to O1856 5575
Length	c. 1km
Description	Very poor muddy glide in straight uniform muddy channel (Photos 20 & 21). At the lower end of this section the stream runs in an artificial channel c. 35 m long of wire mesh and rubble (Photos 22 & 23) before entering a twin culvert under the M1 (Photo. 24).
Photo. No.	20 - 24
Salmonid Habitat Rating	Adult: None – Poor Nursery: Poor – Fair Spawning: None - Poor

3.1.2.2 SECTION I-C(a)

Course	O1843 5663 to O1843 5663
Length	c.750m
Description	This section flows from the downstream end of the motorway pipe (Photo. 25) to the confluence with the high flow channel downstream of the 4 pipe culvert at O1843 5663 (Photos 28 & 29 at right hand side of picture). The pipes at both ends of the section are likely to constitute a major obstacle to upstream fish movement. The section consists of poor muddy riffle and shallow glide over substrates of mud and gravel with a little cobble (photos. 26 & 27). There is good bankside cover of alder and hawthorn.
Photo. No.	25 - 28

Salmonid Habitat Rating	Adult: Poor Nursery: Fair Adult: Fair

3.1.2.3 SECTION I-D

Course	O1843 5663 to O1864 5573
Length	c.1km
Description	Artificial straight channel boulder lined in its upper section (Photos. 30 & 31). Poor muddy gravel riffle and muddy glide. Well developed *Rorippa* in the lower and uppermost sections (Photos 29 & 32). No bankside trees or bushes. Joins stream from Sections III and IV at twin culvert (Photo. 33)
Photo. No.	29 - 33
Salmonid Habitat Rating	Adult: Poor Nursery: Fair Spawning: Fair

3.1.2.4 SECTION I-E

Course	O1864 5573 to O2005 5440
Length	c.2.5km
Description	Poor uniform excavated channel with uniform slow shallow muddy glide. Substrate of mud. Much of bankside devoid of tree/bush cover but some sections of hawthorn hedge.
Photo. No.	34 - 37
Salmonid Habitat Rating	Adult: Poor – Fair Nursery: Poor Spawning: None - Poor

3.1.2.5 SECTION I-F

Course	O2005 5440 to O1940 5357
Length	c.1km
Description	Good mixture of glide and riffle over muddy cobble with a few pools to 50cm deep. Sinuous stream with good cover of mature ash, willow and alder.
Photo. No.	38 - 41
Salmonid Habitat Rating	Adult: Fair – Good Nursery: Good Spawning: Fair

3.1.2.6 SECTION I-G

Course	O1940 5357 to O1940 5315
Length	c.750m
Description	Deep slow muddy glide backed up behind weir (Photo 43).
Photo. No.	42 & 43
Salmonid Habitat Rating	Adult: Fair – Good Nursery: Poor – Fair Spawning: None - Poor

3.1.2.7 SECTION I-H

Course	O1940 5315 to O1985 5230
Length	c.1.25km
Description	Mixture of muddy cobble riffle and deep muddy glide.
Photo. No.	44 - 47
Salmonid Habitat Rating	Adult: Fair – Good Nursery: Fair – Good Spawning: Fair

3.1.2.8 SECTION I-I

Course	O1985 5230 to O2002 5215
Length	c.100m
Description	Mostly pool and deep glide and with some muddy riffle.
Photo. No.	48 & 49
Salmonid Habitat Rating	Adult: Good Nursery: Fair Spawning: Poor

3.1.2.9 SECTION I-J

Course	O2002 5215 O2010 5185
Length	c.400m
Description	Mixture or muddy gravel riffle and shallow muddy glide. Part of southern bank is concreted.
Photo. No.	50 - 52
Salmonid Habitat Rating	Adult: Fair – Good Nursery: Fair – Good Spawning: Fair

3.1.2.10 SECTION I-K

Course	O2010 5185 to O2025 5180
Length	c.100m
Description	Muddy glide with few muddy gravel and cobble riffles.
Photo. No.	53 & 54
Salmonid Habitat Rating	Adult: Fair Nursery: Fair Spawning: Fair

3.1.2.11 SECTION I-L

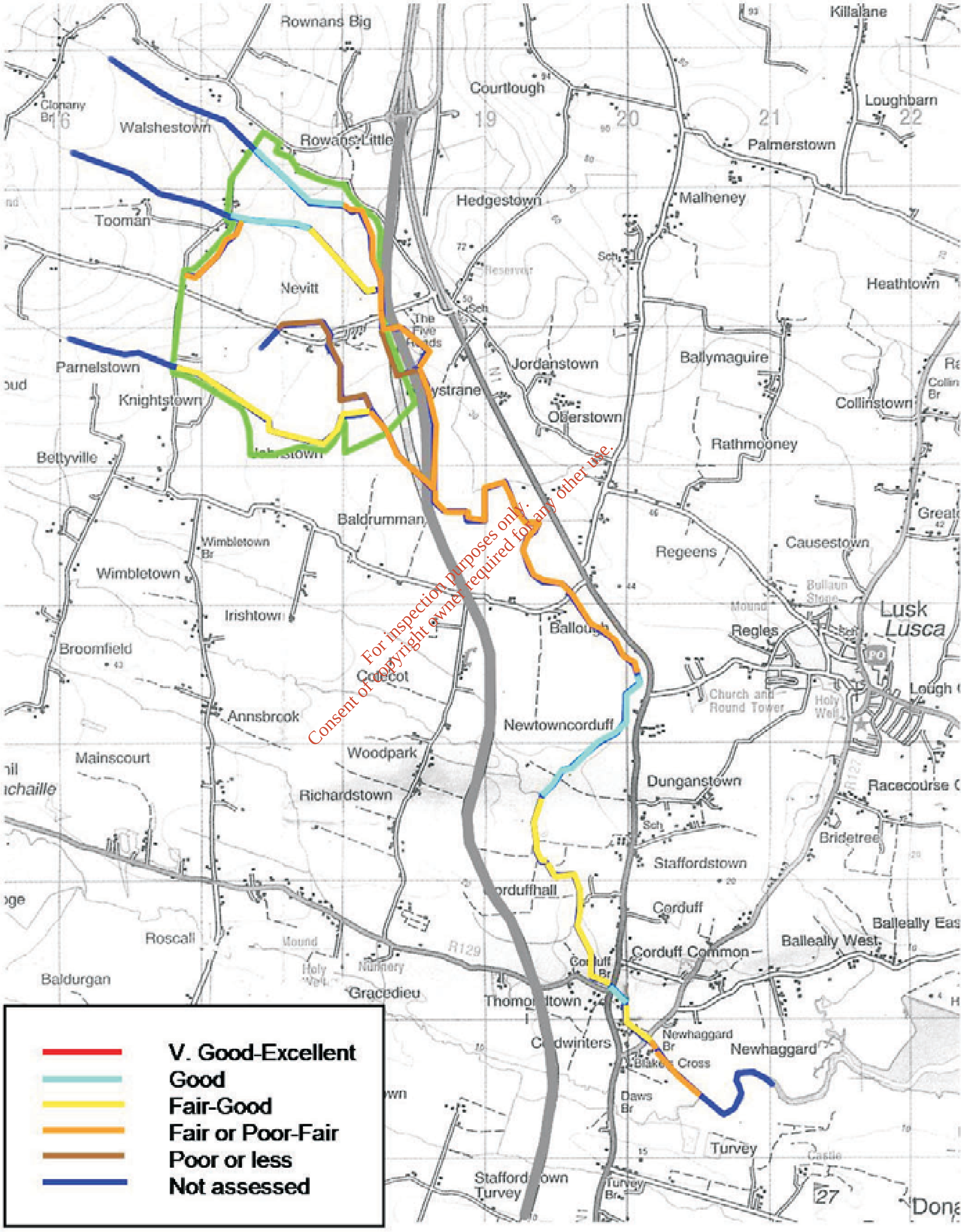
Course	O2025 5180 to O2050 5145
Length	c.500m
Description	Wide deep slow muddy glide.
Photo. No.	55 & 56
Salmonid Habitat Rating	Adult: Fair Nursery: None Spawning: None

3.1.3 SUMMARY OF SALMONID HABITAT QUALITY IN POTENTIALLY AFFECTED STREAMS/RIVERS

Salmonid Habitat Quality	On Proposed Landfill Site	Downstream of Proposed Landfill Site
Good	1.25 km	1.1 km
Fair – Good	2.8 km	2.4 km
Fair or Poor-Fair	1.9 km	5.85 km
Poor or less	2.2km	0 km

MAP 4 SUMMARY OF SALMONID HABITAT QUALITY

Locations shown are approximate; for exact locations, see Grid References in text



3.2 INVERTEBRATE ANALYSIS AND WATER QUALITY ASSESSMENT

3.2.1 CURRENT WATER QUALITY

Sampling site locations, including grid references, are given in report section 2.2. Site locations are shown on Map 1.

SITE A

The invertebrate community at this site, tabulated below merits a Q-rating of Q3 indicating moderately polluted conditions.

INDICATOR GROUP	TAXON	Number
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	None recorded	
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	c.160
	Baetis rhodani	5
	Glossosomatidae	3
	Limnephilidae	2
	Tipulidae	5
Group D - Very Pollution Tolerant	None recorded	
Group E - Most Pollution Tolerant	None recorded	

SITE B

The invertebrate community at this site, tabulated below merits a Q-rating of Q3 indicating moderately polluted conditions.

INDICATOR GROUP	TAXON	Number
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	None recorded	
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	15
	Baetis rhodani	8
	Hydropsychidae	47
	Tipulidae	1
	Dytiscidae	1
Group D - Very Pollution Tolerant	None recorded	
Group E - Most Pollution Tolerant	Tubificidae	1
Not assigned to any indicator group	Nematoda	2
	Lumbricidae	25
	Stylodrilus sp.	11

SITE C

The invertebrate community at this site, tabulated below, merits a Q-rating of Q3 indicating moderately polluted conditions.

INDICATOR GROUP	TAXON	Number
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	None recorded	
Group C - Moderately Pollution Tolerant	*Potmopyrgus antipodarum*	2
	Gammarus duebeni	10
	Baetis rhodani	5
	Chironomidae	2
	Simuliidae	1
	Tipulidae	17
Group D - Very Pollution Tolerant	None recorded	
Group E - Most Pollution Tolerant	Tubificidae	1
Not assigned to any indicator group	Lumbricidae	2
	Stylodrilus sp.	2

SITE D

The invertebrate community at this site, tabulated below merits a Q-rating of Q2-3 indicating moderately polluted conditions.

INDICATOR GROUP	TAXON	Number
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	None recorded	
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	c.100
	Baetis rhodani	1
	Limnephilidae	3
	Chironomidae	19
	Tipulidae	8
	Dytiscidae	4
Group D - Very Pollution Tolerant	*Asellus aquaticus*	4
Group E - Most Pollution Tolerant	Tubificidae	108
Not assigned to any indicator group	Lumbricidae	4
	Lumbriculus sp.	5

SITE E

The invertebrate community at this site, tabulated below merits a Q-rating of Q3 indicating moderately polluted conditions.

INDICATOR GROUP	TAXON	Number
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	None recorded	
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	c.80
	Baetis rhodani	12
	Glossosomatidae	1
	Limnephilidae	2
	Chironomidae	1
	Tipulidae	18
Group D - Very Pollution Tolerant	*Asellus aquaticus*	1
Group E - Most Pollution Tolerant	Tubificidae	5
Not assigned to any indicator group	Lumbricidae	17
	Stylodrilus sp.	2

SITE F

The invertebrate community at this site, tabulated below merits a Q-rating of Q3 indicating moderately polluted conditions.

INDICATOR GROUP	TAXON	Number
Group A - Very Pollution Sensitive	None Recorded	
Group B - Moderately Pollution Sensitive	*Baetis muticus*	3
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	51
	Baetis rhodani	41
	Limnephilidae	5
	Hydropsychidae	4
	Glossosomatidae	2
	Hydrophilidae	1
	Tipulidae	7
	Simuliidae	1
	Chironomidae (ex. *Chironomus*)	5
Group D - Very Pollution Tolerant	*Asellus aquaticus*	2
Group E - Most Pollution Tolerant	Tubificidae	2
Not assigned to any indicator group	Nematoda	1
	Enchytraeidae	2
	Lumbricidae	2
	Stylodrilus sp.	1

SITE G

The invertebrate community at this site, tabulated below merits a Q-rating of Q3 indicating moderately polluted conditions.

INDICATOR GROUP	**TAXON**	**Number**
Group A - Very Pollution Sensitive	None Recorded	
Group B - Moderately Pollution Sensitive	None recorded	
Group C - Moderately Pollution Tolerant	*Potamopyrgus antipodarum*	c.400
	Gammarus duebeni	54
	Hydracarina	1
	Baetis rhodani	7
	Limnephilidae	1
	Hydropsychidae	7
	Tipulidae	23
	Simuliidae	2
	Chironomidae (ex. *Chironomus*)	20
	Dytiscidae	2
	Elminthidae	3
	Haliplidae	1
Group D - Very Pollution Tolerant	*Glossiphonia complanata*	1
	Sphaeriidae	3
	Asellus aquaticus	1
Group E - Most Pollution Tolerant	Tubificidae	8
Not assigned to any indicator group	Lumbricidae	1

SITE H

The invertebrate community at this site, tabulated below merits a Q-rating of Q2-3 indicating moderately polluted conditions.

INDICATOR GROUP	TAXON	Number
Group A - Very Pollution Sensitive	None Recorded	
Group B - Moderately Pollution Sensitive	None recorded	
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	6
	Limnephilidae	2
	Chironomidae (ex. *Chironomus*)	77
	Dytiscidae	1
Group D - Very Pollution Tolerant	*Glossiphonia sp.*	3
	Helobdella stagnalis	11
	Sphaeriidae	c.1000
	Asellus aquaticus	7
Group E - Most Pollution Tolerant	Tubificidae	7
	Chironomus sp.	67
Not assigned to any indicator group	Nematoda	1

SITE I

The invertebrate community at this site, tabulated below merits a Q-rating of Q3/0 indicating moderately organic / nutrient pollution with an additional suspected toxic effect indicated by the abnormally low invertebrate density.

INDICATOR GROUP	TAXON	Number
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	None recorded	
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	3
	Hydropsychidae	12
	Chironomidae (ex. *Chironomus*)	39
	Simuliidae	6
Group D - Very Pollution Tolerant	Erpobdellidae	2
Group E - Most Pollution Tolerant	None recorded	
Not assigned to any indicator group	Lumbricidae	1
	Naididae	3

3.2.2 SUMMARY OF CURRENT WATER QUALITY

Site	Q-value	Pollution Status
A	Q3	Moderately Polluted
B	Q3	Moderately Polluted
C	Q3	Moderately Polluted
D	Q2-3	Moderately Polluted
E	Q3	Moderately Polluted
F	Q3	Moderately Polluted
G	Q3	Moderately Polluted
H	Q2-3	Moderately Polluted
I	Q3/0	Moderately Polluted with suspected toxic influence

3.2.3 WATER QUALITY 1971 - 2001

EPA monitoring in 2001 at sites 08/B/03/1400 (Bridge west of Five roads) and 08/B/03/1600 (Corduff Bridge) recorded a Q-rating of Q3-4 indicating slightly polluted conditions (Clabby *et al* 2002). These sites had previously been rated as Q3 (moderately polluted) at all EPA monitoring visits since 1988. Conservation Services recorded a Q-rating of Q3 at Corduff bridge and at a second site c.1km upstream in 2003. Results therefore indicate that while the main channel has been moderately polluted over a prolonged period of time, serious pollution has not been recorded and water quality is likely to have been sufficient for trout survival.

3.3 FISH

3.3.1 FISH ASSESSMENT 2005

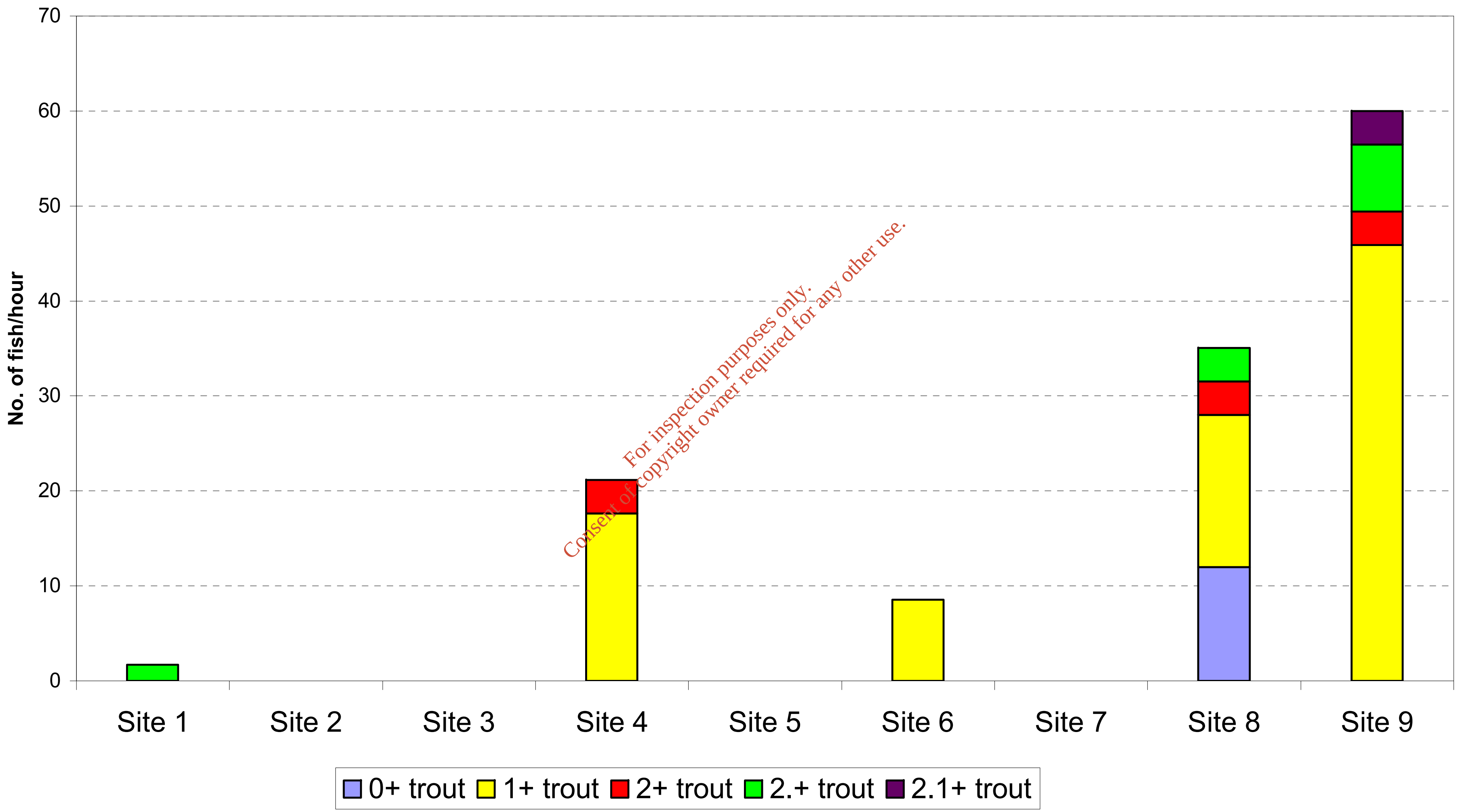
Fish were assessed at 9 sites 22nd to 24th June 2005. Sites electrofished are shown on Map 3. Summary of fish catch at each site is given in Table 2, and the catch per unit effort (CPUE) of salmonids is given in Table 3. CPUE of trout age groups at each site is illustrated in Fig. 1. The length frequency distribution of trout captured is illustrated in Fig. 2. Complete data are tabulated in Appendix 2.

3.3.1.1 Fish on the proposed landfill site

Trout were recorded at two sites within the proposed landfill site boundary but outside the proposed landfill footprint, i.e. Sites 1 and 4 which are respectively on the most northerly tributary (Stream I) and on the same stream downstream of its confluence with Stream II just before the stream leaves the proposed landfill site area.

At Site 1 a single trout was recorded in 35 minutes of electrofishing; notably this was a two year old 25cm long fish and its scale growth pattern indicated that it is likely to have spent time at sea or in the estuary during its 3rd year, making it a sea trout or estuarine ('slob') trout. At the time of the survey this trout was stranded by very low flow conditions in a c. 60cm deep pool with insufficient water depth upstream or downstream for it to leave the pool. Its presence at Site 1 indicates that some sea trout can migrate upstream under the M1 under certain flow conditions despite the unsuitability of the culverts under the new M1 motorway for upstream fish passage. The streams on the proposed landfill site have suitable habitat for juvenile trout (except in very low flow conditions) and water quality which would not be expected to exclude trout. However, the streams are unlikely to be capable of supporting a permanent population of breeding adult trout. Therefore, the absence of juvenile trout from this section of stream indicates that virtually no adult trout are able to run up into these

Fig. 1 Trout catch per unit effort



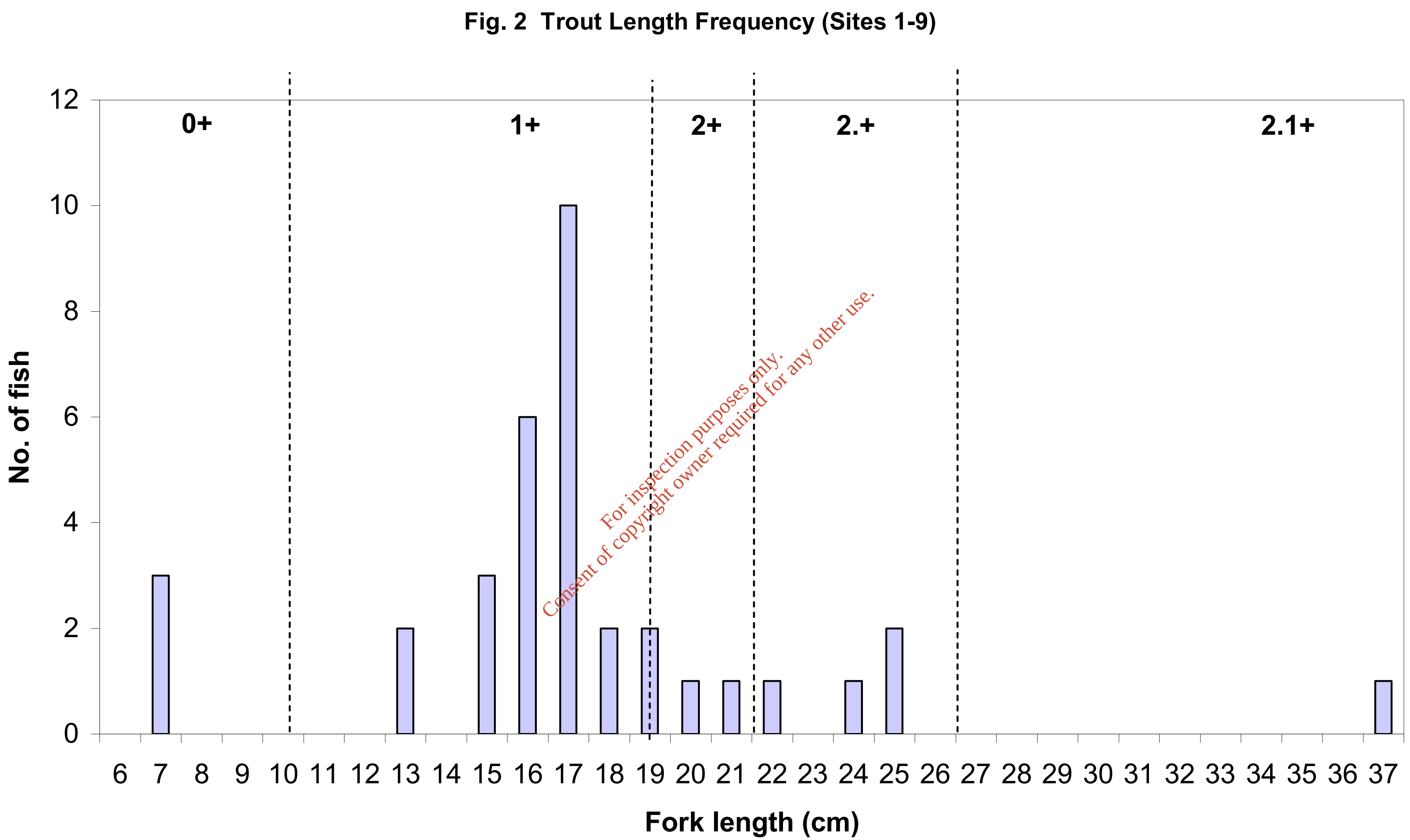


Fig. 2 Trout Length Frequency (Sites 1-9)
No. of fish
Fork length (cm)
0+
1+
2+
2.+
2.1+
0
2
4
6
8
10
12
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37

streams during the winter spawning season due to culvert on the M1, and/or that juvenile trout had already moved downstream due to very low water conditions by the time the fish survey was carried out in late June. This is also indicated by the recording of small but significant densities of juvenile (1+) trout and a single adult (2+) trout at Site 4 which has relatively deep ponded water upstream of the culvert under the slip road at the “five roads” fly over (see Photo. 5).

The conclusion that the extremely low density of juvenile trout on the proposed landfill site is due to the obstruction of upstream fish movement is supported by the conclusion of O’Grady (1995) that it is likely that the juvenile stock in the Corduff river system is being maintained largely by the spawning efforts of migratory individuals i.e. sea trout and estuarine trout (see section 3.3.2).

3.3.1.2 Fish Downstream of the Proposed Landfill Site

Trout were recorded at three of the five site electrofished downstream of the landfill. The two sites from which they were absent were Sites 5 & 7. It is likely that juvenile trout were absent from Site 5 because of the unsuitability of this section of stream for adult trout and the fact that the stream is piped at the upstream and downstream ends of this section. At Site 7 trout were not recorded despite the suitability of the habitat for both adults and juveniles. The apparent absence of trout from this site may be due to poor water quality, as a Q-rating of Q2-3 which is not regarded as suitable for trout was recorded upstream of the site at Ballough Bridge.

At Site 6 juvenile trout (1+) were recorded at very low density (CPUE of 9 fish per hour equivalent). The fish at this site were confined to the ponded water just downstream of the M1 culvert.

At Site 8 moderate densities of juvenile trout were recorded (CPUE 28 per hour equivalent), and two, two year old adult trout, one which had scale growth patterns indicating the likelihood of sea or estuarine growth (2.+).

At Site 9 good juvenile trout densities were recorded (CPUE 46 per hour equivalent) and significant densities of adult trout (CPUE 15 per hour equivalent). The largest of these was a fish of 37.5 cm length with scale growth indicating that the fish had spent a full winter season at sea (2.1+).

TABLE 2. SUMMARY OF FISH CATCH AT EACH SITE

Numbers caught are given for salmonids; where non-salmonid species were taken, their presence is recorded.

	0+ trout	1+ trout	2+ trout	2.+ trout	2.1+ trout	Eels	Stone-loach	3-spined Stickle-back
Site 1				1				+
Site 2						+		+
Site 3								+
Site 4		5	1					+
Site 5						+		+
Site 6		2				+	+	+
Site 7						+	+	+
Site 8	3	4	1	1		+	+	+
Site 9		13	1	2	1		+	+

TABLE 3. SUMMARY OF FISH CATCH PER UNIT EFFORT

To calculate catch per unit effort, the catch figures and fishing time are combined to calculate the theoretical catch per hour fishing.

	0+ trout	1+ trout	2+ trout	2.+ trout	2.1+ trout
Site 1				2	
Site 2					
Site 3					
Site 4		18	4		
Site 5					
Site 6		9			
Site 7					
Site 8	12	16	4	4	
Site 9		46	4	7	4

3.3.2 PREVIOUS FISH ASSESSMENT

The Eastern Regional Fisheries Board carried out a fish survey of the Ballough/Corduff River in 1994. In addition to stickleback, stone loach and minnow, the survey located "*good numbers of brown trout in the lower reaches of the Corduff. We also encountered a sea trout of 39.2 cm*" (Eastern Regional Fisheries Board 1994). Fish scale analysis was carried out by Dr Martin O'Grady of the Central Fisheries Board who stated "*Of the thirty three sets of scales which could be read a total of 29 fish appear to be resident fish, their scale patterns suggest that they had not left this stream since birth. All of these fish were either 1+ or 2+ years old individuals. The growth rate of these trout is good, by Irish standards, and probably reflects the enriched nature of the stream. A small number of fish including the three largest individuals in the sample would appear to be migratory individuals which could either be slob trout or true sea trout. Three of these fish appear to have gone to sea initially as 2+ year old individuals. One fish, with "B scale growth" appears to have a "transient slob phase" before going to sea. It is possible that many of the younger resident fish are potential sea trout or slob trout pre-smolts. It is likely that the juvenile stock in the stream is being maintained largely by the spawning efforts of migratory individuals*" (O'Grady 1995). Recent surveys carried out by the Eastern Regional Fisheries Board have recorded sea trout up to Corduff Bridge and brown trout further upstream at Grid Ref. O187 541 (Greta Hannigan ERFB pers. comm.). An ERFB survey in 2004 in stream sections above the M1 in Nevitt/ Rowans Little area (i.e. the area of the proposed landfill) “revealed the presence of a resident population of brown trout” (see letter in Appendix 4).

3.4 ECOLOGICAL INTEREST

Apart from Rogerstown Estuary, into which the stream flows and which is a candidate Special Area of Conservation, no protected areas exist downstream. Whereas lamprey species, which are listed in Annex II of the Habitats Directive 92/43/EEC, were not recorded in the present survey, nor were they recorded by the Eastern Regional Fisheries Board in 1994, there is a significant possibility that lampreys could occur in the Ballough/Corduff system.

It is also possible that Crayfish (*Austropotomobius pallipes*), which are protected under the Wildlife Act and listed in Annex II of the Habitats Directive, could occur in this stream. However, as crayfish have not been recorded either in the present survey or during a Conservation Services macroinvertebrate survey in 2000 (Conservation Services 2001), the likelihood of crayfish occurring in the system is low.

The sections of the Corduff River on the proposed landfill site and downstream of the site are classified as of high value, locally important.

4 AN ASSESSMENT OF POTENTIAL IMPACTS IN THE ABSENCE OF ADEQUATE MITIGATION

The main potential impacts of the proposed Fingal Landfill on the freshwater aquatic ecology of the Corduff River system will be:

1. Pollution by landfill leachate

2. Pollution with suspended solids and other substances associated with the construction and operation of the landfill

3. Pollution of river with contaminated water draining from parking and delivery areas and other paved areas

4. Loss of habitat

5. Obstruction to upstream fish movement due to construction of culverts on the proposed Nevitt Road realignment

6. Hydrological impacts

4.1 LEACHATE POLLUTION

The future impact of the proposed landfill on the Corduff River system will depend on the quantity and quality of treated or untreated leachate (if any), which enters the river in future years.

4.1.1 COMPOSITION OF LEACHATE

One of the consequences of the disposal of wastes in landfills is the generation of leachate, which is the noxious liquid that is produced as a result of the interactions in the waste as water passes through it.

The concentration of various potentially polluting substances in leachate varies depending on a variety of factors such as water content of the waste, rainfall, design and operation of the site, the age of the waste and the type of waste being disposed.

Some typical components of untreated leachates from domestic wastes at various stages of decomposition are tabulated below.

	Typical Composition (mg/l) of untreated leachates from domestic wastes in Britain D.O.E. data reproduced in Daly (1987)		
Parameter	**Untreated Leachate Recent Waste**	**Untreated Leachate Aged Waste**	**EU Maximum Admissible Concentration in receiving waters**
pH	6.2	7.5	6.0 - 9.0 (Salmonid Waters Regulations)
C.O.D.	23,800	1,160	
B.O.D.	11,900	260	<5 (Salmonid Waters Regulations)
T.O.C. (Total Organic Carbon)	8,000	465	
Fatty Acids (as C)	5,688	5	
Ammon-iacal N	790	370	1.0 mg/l total ammonium subject to complying with standard of 0.02 mg/l for non-ionised ammonia NH_3 (Salmonid Waters Regulations)
Molybdate Reactive Phosphorus	0.73	1.4	0.03 mg/l (Phosphorus Regulations)
Chloride	1,315	2,080	250 (Surface Water Regulations)
Sodium	960	1,300	150 (Drinking Water Regulations)
Magnesium	252	185	50 (Drinking Water Regulations)
Potassium	780	590	12

	Typical Composition (mg/l) of untreated leachates from domestic wastes in Britain D.O.E. data reproduced in Daly (1987)		
Parameter	**Untreated Leachate Recent Waste**	**Untreated Leachate Aged Waste**	**EU Maximum Admissible Concentration in receiving waters**
Calcium	1,820	250	200 (Drinking Water Regulations)
Manganese	27	2.1	0.05 (Surface Waters Regulations)
Iron	540	23	0.2 (Surface Waters Regulations)
Nickel	0.6	0.1	0.05 (Drinking Water Regulations)
Copper	0.12	0.03	<0.005 at hardness of 10 mg/l $CaCO_3$. <0.112 at hardness of 300 mg/l $CaCO_3$. (Salmonid Waters Regulations)
Zinc	21.5	0.4	<0.03 at hardness of 10 mg/l $CaCO_3$. <0.5 at hardness of 500 mg/l $CaCO_3$. (Salmonid Waters Regulations)
Lead	0.40	0.14	0.05 (Surface Waters Regulations)

(Sources for leachate concentrations: Daly (1987))

Many organic compounds which may be found in landfill leachate are of environmental significance in very low concentrations - parts per billion (ppb) or parts per trillion (ppt) quantities. Consequently very small amounts can cause severe pollution (Daly 1991). Of particular concern are compounds which are fat-soluble and biologically stable so that they accumulate in body fats. Such compounds may biomagnify along food chains and in some ecosystems concentration factors from water to top predators may be as high as 10 to the power of 7 (Mason 1996).

Thornton *et al* (1999) after Robinson (1986) list 3 acid organics (e.g. Phenol), 23 volatile organics (e.g. Methylene chloride, Toluene, 1,1-Dichloroethane, Trans-1,2-Dichloroethene, Ethylbenzene, Chloroform), 8 base-neutral organics (e.g. Bis(2-ethylhexyl)Phthalate, Diethylphthalate, Dibutylphthalate), 1 chlorinated pesticide, and 1 PCB in landfill leachate. The Robinson 1986 data suggest that methylene chloride (2.65 mg/l) and Trans-1,2-Dichloroethene (1.3 mg/l) are the most common synthetic organic chemicals in leachate.

4.1.1.1 Waste Electrical & Electronic Equipment (WEEE)

According to the Commission of the European Communities (2000) the most environmentally problematic substances contained in WEEE include heavy metals, such as mercury, lead, cadmium and chromium, halogenated substances, such as chloroflourocarbons (CFCs), polychlorinated biphenols (PCBs), polyvinyl chloride (PVC) and brominated flame retardants as well as asbestos and arsenic.

A significant reduction in quantities of WEEE reaching landfill can be anticipated as a result of EU Directive 2002/96/EC (on waste electrical and electronic equipment). The directive requires member states to minimise the disposal of WEEE to landfill, and to achieve by the end of 2006 separate collection of at least 4kg on average per inhabitant per year of WEEE from private households. The Directive will require producers of electrical and electronic equipment to finance the collection from collection facilities and the treatment, recovery and disposal of WEEE. In the case of WEEE other than WEEE from private households, producers will be obliged to provide for collection of such waste. Irish legislation to enact the Directive will not include a prohibition on the disposal of WEEE to landfill by private householders (Sean O'Suilleabháin, Dept. of Environment pers. comm.). For at least the first five years after the entry into force of Directive 2002/96/EC the onus will be on the householder to take the waste equipment back to its original producer/distributor or recycling collection facility. The quantities of these products entering the landfill in future will therefore depend on a range of factors including education of the public and the ease with which these products can be correctly disposed of by the public. There will be facilities at the proposed Fingal landfill for accepting "white" goods such as fridges, freezers etc. for recycling and in accordance with the WEEE Directive the County Council will be providing WEEE collection points at their Civic Amenity Sites.

EU Directive 2002/95/EC (on the restriction of the use of certain hazardous substances in electrical and electronic equipment) will result in a reduction in toxic compounds used in the manufacture of electrical and electronic equipment. From 1 January 2008, with certain exceptions, lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ether (PBDE) must be replaced by other substances. As this requirement does not come into force until 2008, and equipment manufactured until that year can be expected to enter the waste stream over the following ten years or more, the benefits of this Directive will be largely felt in ten to twenty years time.

4.1.1.2 Endocrine Disrupting Chemicals (EDCs)

Endocrine disrupters, also known as oestrogen mimicking chemicals, are substances which interfere with the hormonal systems of animals and humans. "*A range of chemical substances, designed for use in industry, agriculture and consumer products, are suspected of interfering with endocrine (hormonal) systems of humans and wildlife*". (European Union Commission Communication COM (2001) 262). Landfill leachate has been identified as a potential source of EDC pollution, in Ireland (Dempsey & Costello 1998) and abroad (Daughton & Ternes 1999).

In October 2000 the European Parliament adopted a resolution on endocrine disrupters emphasising the application of the precautionary principle and calling on the Commission to identify substances for immediate action.

Research is now underway in many countries to clarify the scale and scope of the problem. Significant endocrine disruption effects from environmental contaminants have been recorded both in laboratory tests and in the wild. (Jobling *et al* 1998).

A research team at Cork Institute of Technology has drawn a list of endocrine disruptors most likely to be present in surface and waste waters in the Irish aquatic environment. Included in the list are the following phthalates (Dr H. Tarrant, Cork Institute of Technology, pers. comm.):

Dimethyl Phthalate	Plasticiser
Diethyl Phthalate	Plasticiser
Di-n-butyl Phthalate	Plasticiser
Butyl Benzyl Phthalate	Plasticiser
Bis 2-(ethylhexyl) Phthalate	Plasticiser
Di-n-octyl phthalate	Plasticiser

Phthalates are probably the most important group of endocrine disrupting chemicals which may be present in landfill leachate. Phthalates are a major component in PVC, of which they form up to 60% of the total volume (European Commission 2000). About 50% of the total consumption of phthalates is bis(2-ethylhexyl) phthalate DEHP (Cadogen *et al* 1993 quoted in European Commission 2000). PVC forms approx. 2.5% of landfilled municipal waste in Europe (European Commission 2000).

The Final Report to the European Commission: *The Behaviour of PVC in Landfill* (European Commission 2000) indicates that a significant proportion of phthalates are degraded within landfills and are therefore not released to the environment. However, the report also states: "*Essential information is still* *lacking for an assessment of quantitative phthalate emission from landfills. … Emissions of phthalates to landfill leachates and to the aquatic environment cannot be excluded, DEHP in particular is considered to be persistent and to accumulate in sediments. …. According to the findings from the literature survey and from our own analysis with regard to emissions resulting from the disposal of PVC in landfills, a contribution to the contamination of leachate … occurs. … As there is evidence that phthalates, DEHP mainly, are not fully eliminated through current leachate treatment .. emission to aquatic ecosystems cannot be excluded. …Technical solutions for leachate treatment are feasible.*" (European Commission 2000).

Research into Endocrine Disrupters is being carried out at Cork Institute of Technology (Dr Heloise Tarrant, Cork Institute of Technology pers. comm.), Athlone Institute of Technology (Dr A. Fogarty pers. comm.), and at Sligo RTC and the University of Ulster. Until these studies are completed the scope and scale of endocrine disruption in Irish freshwaters remains unknown, and specifically the contribution (if any) of landfill leachate to the problem also remains unknown.

4.1.1.3 Risks from other chemicals and products which are permitted in the landfill

All biodegradable organic wastes which enter the landfill such as food waste, garden waste, paper and cardboard products, animal products, and a range of commercial and industrial wastes will ultimately decompose; leachate produced during this decomposition process typically has levels of B.O.D. and ammonia which are potentially lethal (in the absence of adequate treatment) to most aquatic animals and plants. Likewise decomposition of organic material frequently results in the production of phosphorus containing compounds, which if released to the aquatic environment may result in eutrophication of the receiving waters. Non organic phosphorus containing compounds disposed at the landfill may also result in phosphorus in the leachate, which if not removed by leachate treatment could result in eutrophication of receiving waters.

In addition to such well documented pollutants in landfills, a wide range of compounds enter landfill, the environmental effects of which are not known. The number of chemicals now on the market is very large and growing (royal Commission on Environmental Pollution 2003; EU MEMO 03/213). "*Extensive national, EU and international legislation and agreements prescribe requirements for testing and assessing chemicals for their potential to cause harm in the environment, but only a small proportion of chemicals on the market have been the subject of risk assessment."* (Royal Commission on Environmental Pollution 2003*).* To redress this situation the European Commission on 29/10/03 proposed a new EU regulatory framework for chemicals called REACH (Registration, Evaluation and Authorisation of Chemicals). The proposed regulation would replace over 40 existing Directives and Regulations. REACH would require companies that produce and import chemicals to assess the risks arising from their use and to take necessary measures to manage any risks they identify. (EU document IP/03/1477) The Commission estimates that it will take 11 years from the year the legislation enters into force to complete the REACH registration process (EU MEMO 03/213).

Given the large and increasing number of compounds which are on the market and which have not been tested for potential adverse environmental impacts, there is a significant likelihood that some of these compounds which are entering landfill will have significant potential for adverse environmental impact. If the EU Commission's REACH proposal is written into EU law this potential for adverse environmental impact could be expected to decrease over the next 10 – 15 years.

4.1.1.4 Risks from chemicals and products which are prohibited in the landfill

Disposal of waste classified as hazardous in the Waste Management Act 1996 will be prohibited at the proposed Fingal landfill. Evidence from Britain (Royal Commission on Environmental Pollution Report 2003) indicates that significant quantities of domestic pesticides may still be disposed of illegally to landfill in Britain. Thornton *et al* (1999) also highlight the significant potential for hazardous waste disposed of by small commercial enterprises without contracts with waste disposal companies to make its way to non hazardous waste landfills.

Whether prohibited products will be reduced to an insignificant level in non-hazardous waste landfills will depend on a range of factors including education of the public, the ease with which these products can correctly disposed of by the public, the level and thoroughness of checking of incoming wastes at landfills, and the penalties imposed on persons found to be attempting to dispose of these wastes to landfill.

4.1.2 TIMESCALE FOR LEACHATE GENERATION

The sequence of microbiological breakdown processes which occurs in landfills is now well established, in that the landfill progresses through the aerobic, acetogenic, methanogenic and finally semi-aerobic phases. Whilst these phases will ensure that organic matter is eventually completely broken down and the carbon is released in the form of methane and carbon dioxide gases, some of the end products of these degradation processes remain as soluble components of leachate. Thus, waste components which constitute pollutants in the solid phase are gradually transposed into a liquid phase and can only be eliminated from a landfill providing waste encapsulation by the removal and treatment of the leachate. Robinson and Gronow (1993) state that a large, deep, high-density domestic waste landfill, operated in a typical manner as at present in the UK, will continue to produce strong and polluting leachates well in excess of values considered acceptable for discharge to surface or ground water for a large number of decades, and possibly over timescales in excess of a century.

Investigations into potential polluting effects of PVCs in landfills (see section 4.1.1.2 above) are described in "The Final Report to the European Commission: *The Behaviour of PVC in Landfill* - European Commission 2000". This report states that; "*There is no evidence that the release of additives will come to a standstill. Thus it is expected that this process will last for a very long time …Nowadays the technical guarantee for landfill bottom liners and pipes for leachate collection is restricted to 80 years. Emissions resulting from the presence of PVC in landfills are likely to last longer than the guarantee of the technical barrier*."

One of the most difficult components of leachate to eliminate is ammonia, since this is the soluble end product of the anaerobic breakdown of nitrogenous components of wastes. Typically the ammonia content of leachates is 1000 mg/l, and for direct discharge to controlled waters a limit of say perhaps 1 mg/l would be required. Thus a dilution ratio of 1000:1 would be required for all leachate contained within a site. Walker (1993) calculates that if an engineered landfill site were capped over a depth of refuse of 10m with an average drained moisture content of 40%, then the hydraulic retention time (HRT) for the infiltration rate of 50mm per annum is given by: 10m x 0.4 ÷ 0.05m/a = 80 years. Knox (1990) calculates that for a hydraulic retention time of 80 years, the time to reduce the concentration of ammonia from 1000 mg/l to 1 mg/l is 552 years. Krumpelbeck and Ehrig (1999) report that in a study of 50 German landfills, ammonia concentrations did not show a significant decrease thirty years after closure. Thus extremely protracted time scales may be involved for the operation of leachate control measures at fully engineered sites. This conclusion is supported by Freeze and Cherry (1979) who state that "in some cases leachate production may continue for many decades or even hundreds of years". The concept of very protracted time scales for leachate control is discussed in more detail by Belvi and Baccini (1989).

4.1.3 WORST CASE SCENARIO

Pollutants remain present in landfill leachate at a concentration hazardous to the aquatic environment over prolonged periods of time. If leachate containment, collection and treatment measures were to fail or not be implemented, at any stage during this period, significant quantities of leachate entering the Corduff River system could result in contamination of the entire aquatic food chain with a variety of pollutants, a general impoverishment of aquatic flora and fauna, and the depletion or elimination of salmonid fish from some or all of the river downstream of the landfill.

4.2 POLLUTION WITH SUSPENDED SOLIDS AND OTHER SUBSTANCES ASSOCIATED WITH THE CONSTRUCTION AND OPERATION OF THE LANDFILL

Research in North America indicates that the equivalent of many decades of natural or even agricultural erosion may take place during a single year from areas cleared for construction (Wolman and Schick 1967). In the absence of adequate mitigation measures, suspended sediment due to runoff of soil from construction, excavation and landscaping areas can have severe negative impacts on invertebrate and plant life and on all life stages of salmonid fish.

- Suspended sediment can settle on spawning areas, infill the intragravel voids and smother the eggs and alevins (newly hatched fish) in the gravel.

- Bed Load (coarse material transported along the bottom of the stream) and settled sediments can infill pools and riffles, reducing the availability and quality of rearing habitat for fish.

- Suspended sediment can reduce water clarity and visibility in the stream, impairing the ability of fish to find food items.

- Settled sediments can smother and displace aquatic organisms such as macroinvertebrates, reducing the amount of food items available to fish.

- Increased levels of sediment can displace fish out of prime habitat into less suitable areas. (Chilibeck *et al* 1992)

- Suspended solids can abrade or clog the gills of salmonid fish. It takes a high concentration of solid wastes to clog a fish gill and cause asphyxiation, but only a little to cause abrasions and thus permit the possibility of infections. (Solbe 1988)

In the absence of adequate mitigation measures the potential exists for a range of other serious pollutants to enter watercourses during the construction and operation of the landfill. For example any of the following will have deleterious effects on fish, plants and invertebrates if allowed to enter watercourses.

- Raw or uncured concrete and grouts

- Wash down water from exposed aggregate surfaces, cast-in-place concrete and from concrete trucks

- Fuels, lubricants and hydraulic fluids for equipment used on the development site

- Waste from on site toilet and wash facilities

4.3 POLLUTION OF RIVER WITH CONTAMINATED WATER DRAINING FROM PARKING AND DELIVERY AREAS AND OTHER PAVED AREAS

The most serious risk posed would be from accidental spillages of transported materials with high B.O.D. or other polluting potential.

4.4 LOSS OF HABITAT

Permanent loss of aquatic and /or riparian habitat will take place where the proposed landfill and the proposed Nevitt road realignment are constructed over or in close proximity to streams. Fishery Guidelines for Local Authority Works published by the Department of the Marine and Natural Resources (Anon 1998) state that "culverts are highly inimical to stream plant and fish life and become effectively sterile". By eliminating the natural aquatic vegetation and its associated invertebrate fauna, culverts can result in a significant reduction in invertebrate drift downstream which constitutes a significant food source for salmonid fish. By changing the hydrology of a section of stream or river, culverts may also result in changes in upstream and downstream habitat, due to changes in flow conditions and substrates.

The proposed landfill will result in the loss of c. 1km of watercourse in Habitat Section III. The habitat lost does not constitute suitable habitat for salmonid fish. The proposed Nevitt road realignment will cross Streams I and II and may result in the loss of c.25m of good salmonid nursery habitat in Section IA and c.55m of good salmonid nursery habitat in Section IIB.

4.5 OBSTRUCTION TO UPSTREAM FISH MOVEMENT DUE TO CONSTRUCTION OF CULVERTS

Culverts and other artificial channels, if not appropriately designed and constructed with fish passage in mind, can totally prevent any upstream fish movement, thereby preventing adult fish from reaching favourable spawning areas.

Fishery Guidelines for Local Authority Works published by the Department of the Marine and Natural Resources recommends that *long stretches of river or* *stream should never be culverted* and that rivers or streams should be culverted for *essential reasons only* (Anon 1998). Negative effects of culverts on salmonid upstream movement have been well documented (e.g. Jackson 1950; Dane 1961; Stuart 1964; Evans and Johnston 1980; Powers and Orsborn 1985; Chilibeck 1992; Fitch 1995). The effect of a particular culvert will depend on water depth, speed and volume, length of culvert, type of culvert, species of fish, size and condition of fish etc. Above a critical flow velocity fish can only sustain progress for a limited period of time without resting. The faster the current velocity above this critical speed, the shorter the distance the fish can travel against the current. The impact of a culvert on fish movement is therefore primarily due to changes in hydrological conditions.

Stream crossing structures can be ranked as follows in order of increasingly negative effects on fish movement:

1 Bridge (without apron)
2 Open Bottom Culvert
3 Box Culvert
4 Pipe Arch Culvert
5 Stacked Round Culverts
6 Round Culvert

4.6 HYDROLOGICAL IMPACTS

Major changes in hydrology reflected in significant changes in peak and minimum flows would have significant effects on instream flora and fauna, both directly and through the effects of increased erosion.

4.7 SIGNIFICANCE OF POTENTIAL IMPACTS IN THE ABSENCE OF MITIGATION

Following the classification system outlined in Section 2.5 the significance of potential impacts is as follows:

POTENTIAL IMPACT		SIGNIFICANCE
Pollution by landfill leachate	Potential long-term extensive impact on watercourses of high local value	Major
Pollution with suspended solids and other substances associated with the construction and operation of the landfill	Potential temporary extensive impact on watercourses of high local value	Moderate
Pollution of river with contaminated water draining from parking and delivery areas and other paved areas	Potential temporary extensive impact on watercourses of high local value	Moderate
Loss of habitat	Long-term loss of c. 80m of good salmonid nursery habitat	Moderate
Obstruction to upstream fish movement due to construction of a culvert on the proposed Nevitt Road realignment	Long-term localised effect on fish movement in watercourse of high local value	Moderate
Hydrological impacts	Potential long-term localised impacts on watercourses of high local value	Moderate

5 MITIGATION MEASURES

5.1 MITIGATION OF LEACHATE POLLUTION

If adverse impacts on the ecology, fish populations and amenity value of the Corduff River system are to be avoided, it will be necessary to prevent biologically significant quantities of leachate pollutants from reaching the river system over a prolonged period of time, i.e. for as long as pollutants are present in the leachate at a concentration hazardous to the aquatic environment (see Section 4.1.2). It is proposed that this will be accomplished by total containment of leachate on the site and the disposal of treated leachate offsite via existing sewerage and waste water treatment facilities.

EC Directive 1999/31/EC on the landfill of waste requires that after landfill closure "*the operator shall be responsible for its maintenance, monitoring and control in the after-care phase for as long as may be required by the competent authority, taking into account the time during which the landfill could present a hazard*".

5.2 MITIGATION OF NON LEACHATE POLLUTION GENERATED DURING CONSTRUCTION AND OPERATION OF THE LANDFILL

i. Release of suspended solids to surface waters should be kept to a minimum. The key factors in erosion and sediment control are to intercept and manage off- and on-site runoff. This limits the potential for soils to be eroded and enter streams in runoff. Sediment control ponds should be designed for a minimum retention time of 15 hours. Activities with a significant risk of suspended solids pollution should not be carried out between the end of September and the end of April without the prior agreement of the Eastern Regional Fisheries Board.

ii. Raw or uncured waste concrete should be disposed of by removal from the site or by burial on the site in a location and in a manner that will not impact on the watercourse.

iii. Wash down water from exposed aggregate surfaces, cast-in-place concrete and from concrete trucks should be trapped on-site to allow sediment to settle out and reach neutral pH before clarified water is released to the stream or drain system or allowed to percolate into the ground.

iv. Fuels, lubricants and hydraulic fluids for equipment used on the site should be carefully handled to avoid spillage, properly secured against unauthorised access or vandalism, and provided with spill containment according to codes of practice.

v. Fuelling and lubrication of equipment should not be carried out close to water courses.

vi. Any spillage of fuels, lubricants or hydraulic oils should be immediately contained and the contaminated soil properly disposed of.

vii. Waste oils and hydraulic fluids should be collected in leak-proof containers and properly disposed of.

5.3 MITIGATION OF POLLUTION FROM RUNOFF FROM PAVED AREAS

A spill response action plan should be put in place, and spill response materials kept on site, to ensure that any spills of potentially polluting materials are prevented from entering surface waters.

5.4 MITIGATION OF PERMANENT LOSS OF HABITAT

The most effective method of mitigating habitat loss is to minimise it and where this is not possible to create new habitat.

One of the most effective methods of minimising loss of stream and riparian habitat is the establishment of Leave Strips. Leave strips are the areas of land and vegetation adjacent to watercourses that are to remain in an undisturbed state, throughout and after the development process (Chilibeck *et al* 1992). Leave strips are valuable not only because riparian vegetation is a vital component of a healthy stream ecosystem, but because this vegetation acts as an effective screen/barrier between the stream and the development area, intercepting runoff and acting as an effective filter for sediment and pollutants from the development area. Where construction is to take place close to streams, a riparian leave strip should be clearly marked and its significance explained to machinery operators.

On the proposed landfill site, leave strips should be established on all watercourses with the exception of Watercourse III. These leave strips should as a minimum include all trees, hedgerows and woodland bordering on the streams, and where practicable should be extended to 10m beyond the riparian woodland/hedgerow strip. Where the proposed landfill footprint is in close proximity to stream habitat, i.e. in habitat sections IIB & IIC, leave strips should be fenced. Where the Nevitt Road realignment is to cross Streams I and II, the length of stream and streamside vegetation to be disturbed should be kept to the minimum, and fenced leave strips should extend to as close to the proposed road crossings as is practicable.

The proposed Nevitt Road realignment will cross Stream Section IA. To prevent stream habitat loss at this location and to facilitate upstream fish movement this crossing should be by way of bridge or open bottomed culvert. To facilitate the construction of the proposed Nevitt Road Realignment it is proposed to straighten a c.55m section of stream in Section IIB. The new channel should be designed and constructed according to the following guidelines:

i. The new channel should be bio-engineered to ensure close replication of natural instream flow and substrate diversity and natural bankside cover.

ii. The new channel should be constructed in such a way as to minimise suspended solids released when the river is re-routed. Use of loose fine grained materials in the new channel construction should be strictly limited.

iii. The construction of the new channel should be carried out as far as possible in advance of the actual diversion of flow, and ideally bankside vegetation of native streamside tree and bush species should be well established.

iv. The Eastern Regional Fisheries Board should be consulted at all stages of a permanent stream diversion, from planning to execution. If fish are present in the section of watercourse to be diverted, it may be necessary for them to be removed by the Board and transferred to another location.

Any retaining walls adjacent to fish bearing or potentially fish bearing watercourses should be constructed of rock armour or other similar natural material. The use of gabion baskets is not desirable from the fisheries viewpoint and can damage fish particularly during flood conditions

5.5 MITIGATION OF OBSTRUCTION TO UPSTREAM MOVEMENT OF SALMONIDS DUE TO CONSTRUCTION OF CULVERTS

The Nevitt Road realignment should be designed and constructed in such a way as to ensure that streams remain passable for salmonids. It is recommended that the two crossings should be by way of bridge or open bottomed culvert retaining the existing stream substrate and flow regime.

5.6 MITIGATION OF HYDROLOGICAL IMPACTS

Stormwater attenuation should be included in the landfill design in order to ensure that no significant increase in peak or minimum stream flows is caused by the proposed development.

5.7 MONITORING RECOMMENDATIONS

In addition to standard biological monitoring (fish and macroinvertebrates) of surface waters in the vicinity of and downstream of the landfill; water, sediments and fish from the Corduff river should be periodically tested for a broad spectrum of potential contaminants.

The surface water pond which is to receive surface water runoff from the site should be subjected to the same monitoring regime as is applied to leachate.

6 COMPENSATION MEASURES

Compensation measures are defined by IEEM (2002) as measures taken to offset significant residual adverse impacts, i.e. those that cannot be entirely avoided or mitigated to the point that they become insignificant: for example, habitat creation or enhancement.

At present the c.1.5km of stream in Habitat Sections IC(b) (photos. 6, 7, 10 & 11) and ID (Photos. 30 – 32) is man-made channel of minimal salmonid habitat value. Furthermore, the pipe culvert under the M1 just downstream of the Nevitt flyover (see photos. 9 & 25) and the 4-pipe culvert under the M1 which carries high flows (photos. 8 & 12) are both likely to be impassable for upstream fish movement under most flow conditions, thereby preventing access by brown trout and sea-trout to potential spawning and nursery areas upstream of the M1. It is recommended that compensation measures should include the improvement of the salmonid habitat quality of this 1.5km stream section and the restoration of free upstream passage for brown trout and sea-trout under the M1.

Details of such compensation measures should be drawn up in consultation with Eastern Regional Fisheries Board. The only method of restoring free upstream fish passage for fish under the M1 without significant interference with the road would appear to be to direct the full flow of the stream through Habitat Section IC(b) to the 4-pipe culvert and to modify the culvert to allow fish passage. The necessary culvert modifications should be designed in consultation with the Dept. of Communications, Marine & Natural Resources and the Eastern Regional Fisheries Board, and may involve establishing a low flow channel through one of the four pipes by installing a c.40cm high 'weir' at the upstream end of the other three pipes, and installing 30cm high offset baffles at suitable intervals through the length of the low-flow pipe. Habitat restoration in sections IC(b) & ID should aim to increase instream flow and substrate diversity by re-establishing a sequence of riffles, glides and pools and by restoring natural bankside cover of native trees and bushes. Measures are likely to include tree planting and installation of low rock weirs, deflectors and boulders.

7 RESIDUAL IMPACTS

If all recommended mitigation and compensation measures are implemented in full the impact of the proposed Fingal landfill development on the Corduff River will be as follows:

	SIGNIFICANCE		
POTENTIAL IMPACT	**WITH FULL MITIGATION**	**WITH FULL MITIGATION AND COMPENSATION**	**BENEFIT OF COMPENSATORY MEASURE**
Pollution by landfill leachate	Not significant*	Not significant*	
Pollution with suspended solids and other substances associated with the construction and operation of the landfill	Minor Negative	Minor Negative	
Pollution of river with contaminated water draining from parking and delivery areas and other paved areas	Minor Negative	Minor Negative	
Loss of habitat	Moderate Negative	Moderate Positive	The significant loss of 80m of good trout nursery habitat in habitat section 1-A, and c.750 fair trout nursery habitat in habitat section 1-C(a) would be compensated for by a gain of c. 1.5km of good trout nursery habitat in habitat sections 1C(b) & 1D.
Obstruction to upstream fish movement	Not Significant	Moderate Positive	At present upstream movement of brown trout and sea trout to Corduff river tributaries west of the M1 is substantially obstructed by poorly designed culverts. Improvement to culverts would rectify this situation
Hydrological impacts	Not Significant	Not Significant	

*If leachate is fully contained and disposed of off site for as long as pollutants are present in the leachate at a concentration hazardous to the aquatic environment.

8 NON TECHNICAL SUMMARY

8.1 EXISTING ENVIRONMENT

The proposed Fingal landfill site is drained by four small streams, all of which converge adjacent to the eastern boundary of the site to form a tributary of the Corduff (Ballough) River, which flows for c.9km to its confluence with the Ballyboghill River c.2km upstream of Rogerstown Estuary.

Habitat assessment was carried out on the streams within the proposed landfill site and on the c. 9km of stream/river downstream of the site as far as the tidal limit. On the proposed landfill site c.4km of stream was found to have significant potential salmonid nursery habitat quality, i.e. classified as fair – good or better. A significant proportion of the stream/river downstream of the site was found to have degraded habitat and c. 6km were classified as fair or poor–fair salmonid habitat, while c. 3.5 km were classified as fair–good or better.

Biological assessment, which was carried out at nine sites throughout the potentially affected catchment, indicates moderately polluted conditions throughout the system, probably due to diffuse pollution such as runoff from intensive agricultural land. EPA monitoring of the Corduff (Ballough) river indicates that the main channel of the river has been moderately polluted at least since 1988.

Fish assessment carried out for the present report, and previous assessments carried out by the Eastern Regional Fisheries Board, indicate significant populations of brown trout in sections of the Corduff river where habitat and water quality are suitable. An Eastern Regional Fisheries Board (ERFB) survey in 1994 concluded that it is likely that the juvenile stock in the system is being maintained largely by the spawning efforts of migratory individuals i.e. sea-trout and or estuarine ('slob') trout. Sea-trout were recorded in the Corduff by the ERFB in 1994 and in more recent surveys. In the present survey two-year-old trout with scale growth patterns indicating that they are likely to have spent time at sea or in the estuary during their 3rd year, were recorded at one site on the proposed landfill area, and at two sites in the lower reaches of the river. The largest fish caught in the present survey was a sea-trout of 37.5 cm length with scale growth indicating that the fish had spent a full winter season at sea; a similar sized sea-trout of 39.2cm was recorded by ERFB in 1994.

The presence within the proposed landfill boundary of an adult trout with sea-trout or estuarine-trout scale growth patterns indicates that despite the unsuitability of the culverts under the new M1 motorway for upstream fish passage, some sea trout can migrate upstream under the M1 under certain flow conditions. The virtual absence of juvenile trout from the streams on the proposed landfill site area upstream of the M1 indicates that virtually no adult trout are able to run up into these streams during the winter spawning season due to culvert on the M1, and/or that juvenile trout had already moved downstream due to very low water conditions by the time the fish survey was carried out in late June.

8.2 POTENTIAL IMPACTS IN AND PROPOSED MITIGATION MEASURES

8.2.1 LEACHATE POLLUTION

Landfill leachate contains a large variety of potentially serious pollutants. The future impact of the proposed Fingal landfill on the Corduff River will depend on the quantity and quality of treated or untreated leachate (if any) which enters the river in future years.

If adverse impacts from the proposed landfill on the ecology and fish populations of the Corduff river are to be avoided, it will be necessary to prevent biologically significant quantities of leachate pollutants from reaching the river over a prolonged period of time, i.e. for as long as pollutants are present in the leachate at a concentration hazardous to the aquatic environment. It is proposed that this will be achieved by collecting, treating and removing all leachate for disposal elsewhere. It is proposed that this mitigation will be applied for as long as pollutants are present in the leachate at a concentration hazardous to the aquatic environment.

8.2.2 OTHER SOURCES OF POLLUTION

Detailed measures are presented to minimise or prevent pollution of surface waters by suspended solids and other pollutants during the construction and operation of the landfill.

8.2.3 HABITAT LOSS

The proposed landfill will result in the loss of c. 1km of watercourse within the area which it is proposed to landfill. The habitat lost does not constitute suitable habitat for salmonid fish.

The proposed Nevitt road realignment will cross two streams on the site. It is recommended that to prevent stream habitat loss and to facilitate upstream fish movement the more northerly crossing should be by way of bridge or open bottomed culvert. To facilitate the construction of the new road it is proposed to straighten a c. 55m section of stream at the southern crossing. The stream in this section constitutes good potential salmonid nursery habitat. Detailed recommendations are presented to maximise the habitat value of the replacement channel.

To protect watercourses and prevent the loss of riparian habitat, leave strips should be established on all watercourses within the proposed landfill area except in the immediate vicinity of the two stream crossing points for the proposed Nevitt Road realignment. These leave strips should as a minimum include all trees, hedgerows and woodland bordering on the streams, and where practicable should be extended to 10m beyond the riparian woodland/hedgerow strip.

8.2.4 OBSTRUCTION OF UPSTREAM FISH PASSAGE

The Nevitt road realignment should be designed and constructed in such a way as to ensure that streams remain passable for salmonids. It is recommended that the two crossings should be by way of bridge or open bottomed culvert retaining the existing stream substrate and flow regime.

8.2.5 HYDROLOGICAL IMPACTS

Stormwater attenuation should be included in the landfill design in order to ensure that no significant increase in peak or minimum stream flows is caused by the proposed development.

8.3 COMPENSATION MEASURES AND RESIDUAL IMPACTS

Approximately 1.5km of the Corduff system (i.e. the section adjacent to the eastern boundary of the proposed landfill and immediately upstream and downstream of the M1) is now flowing in a man-made channel with little or no salmonid habitat value. Furthermore this section of the Corduff now passes through culverts under the M1 which are likely to form a complete obstacle to upstream movement of brown trout and sea-trout under most flow conditions. In order to compensate for the moderate impact which may be caused due to limited stream habitat loss on the proposed landfill site, it is proposed that habitat improvement works should be carried out on the 1.5km of man-made channel, and free upstream passage for brown trout and sea-trout under the M1 should be restored by carrying out suitable culvert alterations. Including these compensation measures in the proposed development will result in a net moderate positive impact from the total development on salmonid habitat quality and fish passage conditions.

Providing that compensation and mitigation measures are implemented in full, and that leachate is fully contained and disposed of off site over a prolonged period of time, i.e. for as long as pollutants are present in the leachate at a concentration hazardous to the aquatic environment, the residual net impact of the proposed Fingal landfill development on the Corduff River system will be a positive impact of minor or moderate significance.

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APPENDIX 1

HABITAT AT INVERTEBRATE SITES

Site Code	A
Site Location	O1738 5829
Photograph Number	1
Width	1m
Depth	10-15 cm.
Substrate	Mud, cobble, gravel
Flow Type	Riffle 30% Glide 70%
Instream vegetation	None
Dominant Bankside Vegetation	Sycamore, Hawthorn
Estimated Summer Shade by Bankside Vegetation	65%
Adult salmonid habitat	Poor
Salmonid nursery habitat	Fair – Good
Salmonid spawning habitat	Fair
Conductivity (μS/cm)	320

Site Code	B
Site Location	O1721 5786
Photograph Number	16
Width	1 – 2 m
Depth	6 – 12 cm.
Substrate	Mud, gravel, cobble
Flow Type	Riffle 65% Glide 35%
Instream vegetation	None
Dominant Bankside Vegetation	Ash, Willow Buddleia
Estimated Summer Shade by Bankside Vegetation	45%
Adult salmonid habitat	Poor
Salmonid nursery habitat	Fair - Good
Salmonid spawning habitat	Fair
Conductivity (µS/cm)	560

Site Code	C
Site Location	O1680 5673
Width	2 m
Depth	4 – 8 m
Substrate	
Flow Type	Riffle 30 Glide 70%
Instream vegetation	None
Dominant Bankside Vegetation	Hawthorn, Ivy, Ash
Estimated Summer Shade by Bankside Vegetation	70%
Adult salmonid habitat	Poor
Salmonid nursery habitat	Poor – Fair
Salmonid spawning habitat	Poor
Conductivity (µS/cm)	530

Site Code	D
Site Location	O1787 5690
Photograph Number	18
Width	0.5m
Depth	5 – 10 cm.
Substrate	Mud, Gravel
Flow Type	Riffle 20% Glide 80%
Instream vegetation	*Rorippa nasturtium-aquaticum* 10%
Dominant Bankside Vegetation	Grass
Estimated Summer Shade by Bankside Vegetation	10%
Adult salmonid habitat	None
Salmonid nursery habitat	Poor
Salmonid spawning habitat	Poor - None
Conductivity (μS/cm)	520

Site Code	E
Site Location	O1830 5631
Photograph Number	20
Width	1 m
Depth	5 cm.
Substrate	Gravel, Mud
Flow Type	Riffle 50% Glide 50%
Instream vegetation	*Rorippa nasturtium-aquaticum* <5% *Veronica beccabunga* <5%
Dominant Bankside Vegetation	Grass
Estimated Summer Shade by Bankside Vegetation	5%
Adult salmonid habitat	None
Salmonid nursery habitat	Fair - Poor
Salmonid spawning habitat	Fair - Poor
Conductivity (µS/cm)	520

Site Code	F
Site Location	O1828 5712
Photograph Number	26
Width	2 – 4 m
Depth	10 - 15 cm.
Substrate	Mud, Gravel, Cobble
Flow Type	Riffle 30% Glide 70%
Instream vegetation	*Rorippa nasturtium-aquaticum* <5%
Dominant Bankside Vegetation	Grass, Alder
Estimated Summer Shade by Bankside Vegetation	5%
Adult salmonid habitat	Poor
Salmonid nursery habitat	Fair – Poor
Salmonid spawning habitat	Fair - Poor
Conductivity (μS/cm)	460

Site Code	G
Site Location	O1868 5568
Photograph Number	34
Width	2 – 5 m
Depth	15 cm.
Substrate	Mud, Gravel
Flow Type	Riffle 10% Glide 90%
Instream vegetation	*Apium nodiflorum* <5%
Dominant Bankside Vegetation	Briar, nettle
Estimated Summer Shade by Bankside Vegetation	5%
Adult salmonid habitat	Poor – None
Salmonid nursery habitat	Poor – None
Salmonid spawning habitat	Poor – None
Conductivity (µS/cm)	520

Site Code	H
Site Location	O1962 5511
Width	4m
Depth	30 cm.
Substrate	Mud
Flow Type	Glide 100%
Instream vegetation	None
Dominant Bankside Vegetation	Cypress, Hawthorn
Estimated Summer Shade by Bankside Vegetation	35%
Adult salmonid habitat	Poor
Salmonid nursery habitat	Poor
Salmonid spawning habitat	None
Conductivity (µS/cm)	580

Site Code	I
Site Location	O1992 5223
Photograph Number	48
Width	5 m
Depth	12 cm.
Substrate	Gravel, Cobble , Mud
Flow Type	Riffle 75% Glide 25%
Instream vegetation	Filamentous algae 5%
Dominant Bankside Vegetation	Nettle, bramble
Estimated Summer Shade by Bankside Vegetation	5%
Adult salmonid habitat	Good
Salmonid nursery habitat	Good
Salmonid spawning habitat	Fair
Conductivity (µS/cm)	540

APPENDIX 2

DETAILS OF SALMONIDS CAPTURED

Site 1

Fishing time 35 min.

Brown Trout Fork Length (cm)	Age
25.3	2.+

Site 4

Fishing time 17 min.

Brown Trout Fork Length (cm)	Age
13.0	
13.3	
15.0	1+
16.5	
17.3	
21.0	2+

Site 6

Fishing time 16 min.

Brown Trout Fork Length (cm)	Age
17.2	1+
19.0	

Site 8

Fishing time 17 min.

Brown Trout Fork Length (cm)	Age
7.2	
7.4	0+
7.5	
15.6	
16.2	1+
16.7	
17.9	
19.4	2+
25.8	2.+

Site 9

Fishing time 17 min.

Brown Trout Fork Length (cm)	Age
15.6	
16.2	
16.5	
16.6	
17.0	
17.1	
17.2	1+
17.2	
17.3	
17.5	
17.8	
18.5	
18.7	
20.1	2+
22.8	2.+
24.3	
37.5	2.1+

Fig. 1 Trout catch per unit effort

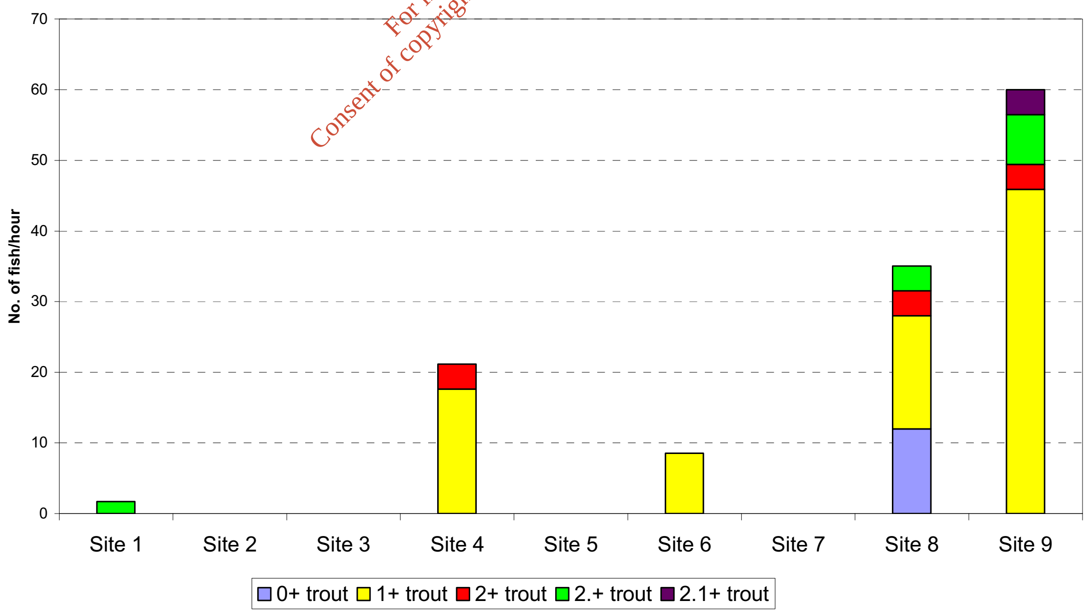
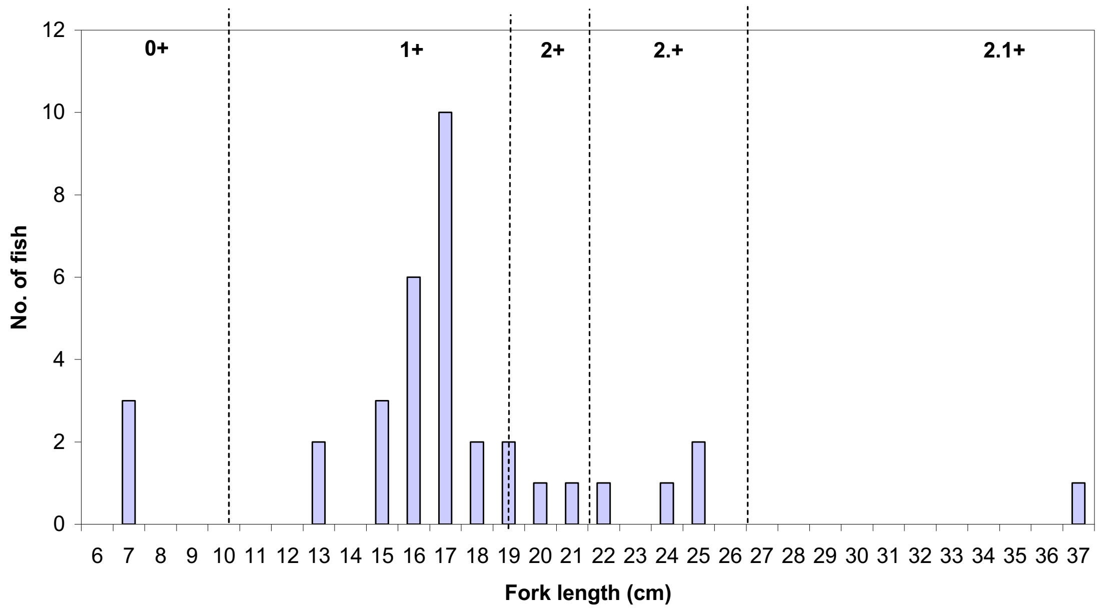


Fig. 2 Trout Length Frequency (Sites 1-9)



APPENDIX 3

SUBMISSIONS

Eastern Regional Fisheries Board
Bord Iascaigh Réigiúnach an Oirthir

Fisheries Ireland
Our Natural Heritage

Dr. Bill Quirke
Conservation Services
Tullaha, Glenflesk, Killarney,
Co. Kerry.

Your Reference: NA
Our Reference: BB/DD/270

May 12th, 2005

Re: Proposed Fingal Landfill EIS – potentially affected freshwaters.

Dear Dr. Quirke,

In relation to your letter, dated April 18th, 2005; please find the Boards comments outlined below:

- A recent survey of streams in the area subject to proposed development (specifically stream sections above the M1 in the Nevitt / Rowans Little area) has revealed the presence of a resident population of brown trout. As such, these surface waters should be afforded consideration in any EIS study as salmonid waters.

- As with any development, all measures necessary should be taken to ensure comprehensive protection of local aquatic ecological integrity, in the first place by complete impact avoidance and as a secondary approach through mitigation by reduction and remedy. As specific details of the proposal are not known at this time, the Board cannot comment on specific potential impacts.

- It should be highlighted at this early stage in the process that appropriate environmental protection measures are the responsibility of the developer and the contractor, and all works are subject to the provision of the Local Government (Water Pollution) Act 1977 (as amended) and the Fisheries (Consolidation) Act 1959 (as amended).

Yours sincerely,

Brian Beckett
Fisheries Environmental Officer – Dublin District

The Eastern Regional Fisheries Board
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DEPARTMENT OF THE ENVIRONMENT, HERITAGE AND LOCAL GOVERNMENT

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3 May2005

Our Ref.: G2005/173

Bill Quirke
Conservation Services
Tullaha
Glenflesk
Killarney
Co Kerry

Re: EIS for proposed Fingal Landfilll

Dear Bill,

I wish to acknowledge receipt of your recent letter in relation to the above.

Your enquiry has been allocated the above reference number which should be used in all correspondence with the Development Applications Unit of the Department of the Environment, Heritage and Local Government. In addition your enquiry has been circulated to the relevant individuals / Divisions for their comments and we will revert to you in due course.

While your enquiry is particular to nature conservation, it should be borne in mind that the proposed development may potentially have an impact on the built heritage (archaeology & architecture). Therefore, the applicant should ensure that the relevant assessments are undertaken to establish such impacts, if any, on the built heritage. Should the applicant wish to have the development considered from the built heritage perspective, they should submit the relevant details / documentation to the undersigned, quoting the above reference number.

If you need any further assistance please contact the undersigned.

Yours sincerely

Mairead O'Boyle
Development Applications Unit

APPENDIX 4

PHOTOGRAPHS


Photo 1


Photo 2


Photo 3


Photo 4


Photo 5


Photo 6


Photo 7


Photo 8


Photo 9


Photo 10


Photo 11


Photo 12


Photo 13


Photo 14


Photo 15


Photo 16


Photo 17


Photo 18


Photo 19


Photo 20


Photo 21


Photo 22


Photo 23


Photo 24


Photo 25


Photo 26


Photo 27


Photo 28


Photo 29


Photo 30


Photo 31


Photo 32


Photo 33


Photo 34


Photo 35


Photo 36

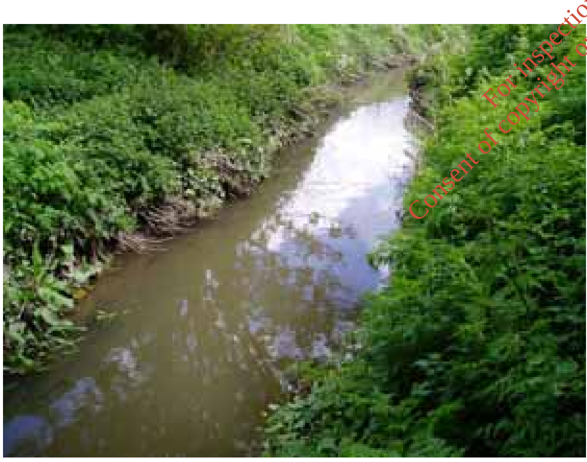
Photo 37


Photo 38


Photo 39


Photo 40


Photo 41


Photo 42


Photo 43


Photo 44


Photo 45


Photo 46


Photo 47


Photo 48


Photo 49


Photo 50


Photo 51


Photo 52


Photo 53


Photo 54


Photo 55


Photo 56