23/11/19: 09:50:00 - 10:00:00	0.50	6.27	0.32	6.21	0.75	10
23/11/19: 10:00:00 - 10:10:00	0.53	6.48	0.35	6.34	0.70	8.5
23/11/19: 10:10:00 - 10:20:00	0.50	6.41	0.29	6.10	0.82	9.5
23/11/19: 10:20:00 - 10:30:00	0.47	6.21	0.30	5.98	0.74	9
23/11/19: 10:30:00 - 10:40:00	0.66	6.60	0.42	6.44	0.92	9.5
23/11/19: 10:40:00 - 10:50:00	0.62	6.28	0.42	6.15	0.89	8.5
23/11/19: 10:50:00 - 11:00:00	0.57	6.50	0.35	6.26	0.90	9
23/11/19: 11:00:00 - 11:10:00	0.61	6.62	0.41	6.55	0.87	9
23/11/19: 11:10:00 - 11:20:00	0.70	6.62	0.43	6.41	1.23	9.5
23/11/19: 11:20:00 - 11:30:00	0.68	6.63	0.43	6.35	0.91	9
23/11/19: 11:30:00 - 11:40:00	0.69	6.28	0.46	6.42	0.94	9.5
23/11/19: 11:40:00 - 11:50:00	0.61	6.42	0.41	6.36	1.06	9
23/11/19: 11:50:00 - 12:00:00	0.67	6.31	0.44	6.30	1.18	8
23/11/19: 12:00:00 - 12:10:00	0.68	6.53	0.44	6.40	0.96	9.5
23/11/19: 12:10:00 - 12:20:00	0.61	6.69	0.38	6.34	1.07	9
23/11/19: 12:20:00 - 12:30:00	0.76	6.55	0.50	6.55	1.13	10
23/11/19: 12:30:00 - 12:40:00	0.59	6.53	0.35	5.72	1.15	8.5
23/11/19: 12:40:00 - 12:50:00	0.67	6.55	0.47	6.43	1.03	8.5
23/11/19: 12:50:00 - 13:00:00	0.67	6.52	0.41	6.10	1.14	9.5
23/11/19: 13:00:00 - 13:10:00	0.65	6.77	0.40	6.12	1.06	8.5
23/11/19: 13:10:00 - 13:20:00	0.80	6.31	0.51	6.26	1.20	8.5
23/11/19: 13:20:00 - 13:30:00	0.79	6.55	0.47	6.23	1.08	9.5
23/11/19: 13:30:00 - 13:40:00	0.75	6.33	0.44	5.94	1.18	8
23/11/19: 13:40:00 - 13:50:00	0.70	6.44	0.42	6.12	1.25	9
23/11/19: 13:50:00 - 14:00:00	0.74	6.27	0.46	6.12	1.37	9.5
23/11/19: 14:00:00 - 14:10:00	0.70	6.36	0.44	6.04	1.03	8.5
23/11/19: 14:10:00 - 14:20:00	0.73	6.42	0.43	6.13	1.25	8.5
23/11/19: 14:20:00 - 14:30:00	0.66	6.37	0.45	6.28	0.79	11
23/11/19: 14:30:00 - 14:40:00	0.68	6.27	0.44	6.34	1.04	9
23/11/19: 14:40:00 - 14:50:00	0.70	6.37	0.45	6.33	1.21	9.5
23/11/19: 14:50:00 - 15:00:00	0.64	6.36	0.39	6.12	1.03	9.5
23/11/19: 15:00:00 - 15:10:00	0.80	6.52	0.51	6.29	1.11	9.5
23/11/19: 15:10:00 - 15:20:00	0.77	6.48	0.48	6.25	1.07	8.5
23/11/19: 15:20:00 - 15:30:00	0.66	6.42	0.43	6.29	0.99	8.5
23/11/19: 15:30:00 - 15:40:00	0.66	6.40	0.44	6.35	1.03	9.5
23/11/19: 15:40:00 - 15:50:00	0.51	6.37	0.35	6.27	0.68	11
23/11/19: 15:50:00 - 16:00:00	0.54	6.31	0.34	5.65	0.72	8.5
23/11/19: 16:00:00 - 16:10:00	0.57	6.47	0.37	6.27	0.77	10
23/11/19: 16:10:00 - 16:20:00	0.55	6.37	0.35	6.33	0.82	9
23/11/19: 16:20:00 - 16:30:00	0.49	6.29	0.29	5.82	0.66	8.5
23/11/19: 16:30:00 - 16:40:00	0.58	6.31	0.38	6.23	0.82	10
23/11/19: 16:40:00 - 16:50:00	0.49	6.33	0.30	6.08	0.77	9.5
23/11/19: 16:50:00 - 17:00:00	0.47	6.42	0.32	6.22	0.63	10.5
23/11/19: 17:00:00 - 17:10:00	0.42	6.26	0.27	5.96	0.67	9
23/11/19: 17:10:00 - 17:20:00	0.52	6.12	0.31	5.80	0.88	8.5
23/11/19: 17:20:00 - 17:30:00	0.53	6.41	0.33	6.10	0.90	9
23/11/19: 17:30:00 - 17:40:00	0.52	6.16	0.33	6.23	0.75	10
23/11/19: 17:40:00 - 17:50:00	0.48	6.32	0.30	5.93	0.74	9
23/11/19: 17:50:00 - 18:00:00	0.40	6.25	0.26	6.07	0.59	9.5
23/11/19: 18:00:00 - 18:10:00	0.37	6.09	0.24	5.87	0.59	8.5
23/11/19: 18:10:00 - 18:20:00	0.42	6.27	0.27	5.92	0.59	9
23/11/19: 18:20:00 - 18:30:00	0.37	6.06	0.22	5.56	0.58	10
23/11/19: 18:30:00 - 18:40:00	0.40	6.23	0.27	6.19	0.68	8.5
23/11/19: 18:40:00 - 18:50:00	0.36	6.23	0.23	5.86	0.51	8.5
23/11/19: 18:50:00 - 19:00:00	0.35	6.10	0.23	5.79	0.48	10
23/11/19: 19:00:00 - 19:10:00	0.37	6.07	0.23	5.69	0.63	9.5
23/11/19: 19:10:00 - 19:20:00	0.35	5.97	0.21	5.77	0.55	8.5
23/11/19: 19:20:00 - 19:30:00	0.31	5.79	0.20	5.73	0.49	10
23/11/19: 19:30:00 - 19:40:00	0.34	6.06	0.23	5.82	0.46	9
23/11/19: 19:40:00 - 19:50:00	0.33	6.12	0.21	5.79	0.46	11
23/11/19: 19:50:00 - 20:00:00	0.28	5.96	0.17	5.57	0.38	9.5
23/11/19: 20:00:00 - 20:10:00	0.30	5.94	0.18	5.51	0.44	10.5
23/11/19: 20:10:00 - 20:20:00	0.24	5.79	0.13	5.14	0.38	8.5
23/11/19: 20:20:00 - 20:30:00	0.22	6.04	0.13	5.29	0.30	10
23/11/19: 20:30:00 - 20:40:00	0.23	5.96	0.14	5.57	0.36	8.5
23/11/19: 20:40:00 - 20:50:00	0.26	5.84	0.17	5.75	0.34	9
23/11/19: 20:50:00 - 21:00:00	0.25	5.96	0.15	5.26	0.42	9
23/11/19: 21:00:00 - 21:10:00	0.22	5.90	0.14	5.77	0.31	11
23/11/19: 21:10:00 - 21:20:00	0.20	5.92	0.13	5.38	0.32	10
23/11/19: 21:20:00 - 21:30:00	0.18	5.68	0.12	5.46	0.29	10.5

23/11/19: 21:30:00 - 21:40:00	0.15	6.31	0.09	5.27	0.22	10
23/11/19: 21:40:00 - 21:50:00	0.19	6.08	0.11	5.16	0.28	10
23/11/19: 21:50:00 - 22:00:00	0.18	5.60	0.11	5.40	0.26	10
23/11/19: 22:00:00 - 22:10:00	0.19	5.85	0.11	5.30	0.35	10
23/11/19: 22:10:00 - 22:20:00	0.15	5.82	0.09	5.21	0.20	10
23/11/19: 22:20:00 - 22:30:00	0.16	5.68	0.10	5.09	0.26	8
23/11/19: 22:30:00 - 22:40:00	0.15	5.65	0.09	5.33	0.22	11
23/11/19: 22:40:00 - 22:50:00	0.15	5.51	0.10	5.31	0.24	10
23/11/19: 22:50:00 - 23:00:00	0.18	5.54	0.11	5.29	0.27	9
23/11/19: 23:00:00 - 23:10:00	0.18	5.62	0.11	5.29	0.31	10
23/11/19: 23:10:00 - 23:20:00	0.17	5.61	0.10	4.96	0.27	11.5
23/11/19: 23:20:00 - 23:30:00	0.15	5.80	0.10	5.23	0.24	9
23/11/19: 23:30:00 - 23:40:00	0.17	5.46	0.11	5.15	0.30	10
23/11/19: 23:40:00 - 23:50:00	0.18	5.51	0.11	5.23	0.30	13
23/11/19: 23:50:00 - 00:00:00	0.21	5.43	0.14	5.27	0.31	8.5
24/11/19: 00:00:00 - 00:10:00	0.22	5.15	0.13	4.93	0.39	7.5
24/11/19: 00:10:00 - 00:20:00	0.17	5.65	0.11	5.46	0.31	11.5
24/11/19: 00:20:00 - 00:30:00	0.16	5.44	0.10	4.91	0.30	11.5
24/11/19: 00:30:00 - 00:40:00	0.16	5.84	0.10	5.18	0.28	10
24/11/19: 00:40:00 - 00:50:00	0.19	5.47	0.13	5.27	0.29	11.5
24/11/19: 00:50:00 - 01:00:00	0.17	5.59	0.10	5.17	0.35	10
24/11/19: 01:00:00 - 01:10:00	0.16	5.69	0.10	5.06	0.23	11
24/11/19: 01:10:00 - 01:20:00	0.14	5.50	0.09	5.11	0.23	11
24/11/19: 01:20:00 - 01:30:00	0.17	5.38	0.10	4.88	0.26	11
24/11/19: 01:30:00 - 01:40:00	0.14	5.49	0.09	4.97	0.24	11
24/11/19: 01:40:00 - 01:50:00	0.13	5.09	0.08	4.60	0.21	10
24/11/19: 01:50:00 - 02:00:00	0.15	5.17	0.09	4.74	0.23	9
24/11/19: 02:00:00 - 02:10:00	0.15	5.16	0.10	4.78	0.21	13
24/11/19: 02:10:00 - 02:20:00	0.15	5.64	0.09	4.88	0.23	12.5
24/11/19: 02:20:00 - 02:30:00	0.15	5.13	0.10	4.58	0.21	16
24/11/19: 02:30:00 - 02:40:00	0.14	5.46	0.08	4.89	0.21	11
24/11/19: 02:40:00 - 02:50:00	0.14	5.01	0.08	4.43	0.22	9
24/11/19: 02:50:00 - 03:00:00	0.16	5.10	0.10	4.97	0.23	14
24/11/19: 03:00:00 - 03:10:00	0.13	5.38	0.08	4.52	0.20	10.5
24/11/19: 03:10:00 - 03:20:00	0.13	5.55	0.09	4.72	0.21	11.5
24/11/19: 03:20:00 - 03:30:00	0.13	5.15	0.08	4.53	0.21	12
24/11/19: 03:30:00 - 03:40:00	0.12	5.23	0.07	4.56	0.16	10
24/11/19: 03:40:00 - 03:50:00	0.13	5.23	0.08	4.67	0.20	9
24/11/19: 03:50:00 - 04:00:00	0.12	5.24	0.08	4.71	0.16	12
24/11/19: 04:00:00 - 04:10:00	0.10	4.97	0.06	4.26	0.15	7.5
24/11/19: 04:10:00 - 04:20:00	0.10	5.28	0.06	4.53	0.16	9.5
24/11/19: 04:20:00 - 04:30:00	0.10	5.01	0.06	4.29	0.19	11
24/11/19: 04:30:00 - 04:40:00	0.10	5.49	0.06	4.42	0.13	10.5
24/11/19: 04:40:00 - 04:50:00	0.09	5.41	0.06	4.21	0.15	9
24/11/19: 04:50:00 - 05:00:00	0.09	5.51	0.06	4.46	0.14	12
24/11/19: 05:00:00 - 05:10:00	0.09	5.66	0.05	4.61	0.17	12
24/11/19: 05:10:00 - 05:20:00	0.09	5.36	0.05	4.36	0.15	10.5
24/11/19: 05:20:00 - 05:30:00	0.09	5.52	0.06	4.71	0.12	13
24/11/19: 05:30:00 - 05:40:00	0.09	5.48	0.05	4.92	0.15	11
24/11/19: 05:40:00 - 05:50:00	0.09	5.24	0.05	4.59	0.15	9.5
24/11/19: 05:50:00 - 06:00:00	0.08	5.33	0.05	4.52	0.16	11
24/11/19: 06:00:00 - 06:10:00	0.08	5.77	0.05	4.40	0.12	12.5
24/11/19: 06:10:00 - 06:20:00	0.08	5.47	0.05	4.59	0.12	12
24/11/19: 06:20:00 - 06:30:00	0.07	5.92	0.04	4.28	0.11	10
24/11/19: 06:30:00 - 06:40:00	0.08	6.29	0.05	5.12	0.16	13
24/11/19: 06:40:00 - 06:50:00	0.08	6.17	0.05	4.49	0.13	11
24/11/19: 06:50:00 - 07:00:00	0.07	6.13	0.05	4.66	0.11	11
24/11/19: 07:00:00 - 07:10:00	0.07	6.33	0.04	4.63	0.10	12.5
24/11/19: 07:10:00 - 07:20:00	0.06	6.56	0.04	4.63	0.11	10.5
24/11/19: 07:20:00 - 07:30:00	0.06	6.23	0.04	4.55	0.08	11.5
24/11/19: 07:30:00 - 07:40:00	0.07	7.54	0.04	4.94	0.09	13
24/11/19: 07:40:00 - 07:50:00	0.07	8.82	0.04	5.19	0.11	13.5
24/11/19: 07:50:00 - 08:00:00	0.08	8.78	0.04	5.25	0.12	14
24/11/19: 08:00:00 - 08:10:00	0.07	6.29	0.04	4.64	0.12	12.5
24/11/19: 08:10:00 - 08:20:00	0.08	8.69	0.05	5.78	0.14	13
24/11/19: 08:20:00 - 08:30:00	0.07	8.75	0.04	5.74	0.12	15
24/11/19: 08:30:00 - 08:40:00	0.09	9.29	0.05	5.98	0.14	14
24/11/19: 08:40:00 - 08:50:00	0.08	9.10	0.05	5.79	0.13	16.5
24/11/19: 08:50:00 - 09:00:00	0.09	10.05	0.05	6.56	0.13	13
24/11/19: 09:00:00 - 09:10:00	0.07	9.11	0.04	5.58	0.13	14

24/11/19: 09:10:00 - 09:20:00	0.08	10.26	0.04	6.40	0.11	13
24/11/19: 09:20:00 - 09:30:00	0.08	9.02	0.05	5.95	0.15	13.5
24/11/19: 09:30:00 - 09:40:00	0.09	9.21	0.05	6.28	0.13	14.5
24/11/19: 09:40:00 - 09:50:00	0.09	9.40	0.05	5.68	0.14	15.5
24/11/19: 09:50:00 - 10:00:00	0.08	8.74	0.04	5.56	0.16	14
24/11/19: 10:00:00 - 10:10:00	0.08	10.00	0.04	5.58	0.14	14
24/11/19: 10:10:00 - 10:20:00	0.08	8.85	0.04	5.47	0.15	13.5
24/11/19: 10:20:00 - 10:30:00	0.08	10.30	0.04	6.23	0.13	14.5
24/11/19: 10:30:00 - 10:40:00	0.06	8.87	0.04	5.61	0.12	12.5
24/11/19: 10:40:00 - 10:50:00	0.07	9.78	0.04	6.10	0.09	16.5
24/11/19: 10:50:00 - 11:00:00	0.07	9.62	0.04	5.89	0.12	15.5
24/11/19: 11:00:00 - 11:10:00	0.09	10.93	0.05	6.85	0.15	14
24/11/19: 11:10:00 - 11:20:00	0.08	10.61	0.04	6.19	0.13	16
24/11/19: 11:20:00 - 11:30:00	0.07	9.63	0.04	5.86	0.12	16
24/11/19: 11:30:00 - 11:40:00	0.07	8.73	0.04	5.25	0.13	14
24/11/19: 11:40:00 - 11:50:00	0.09	9.62	0.05	6.74	0.13	14.5
24/11/19: 11:50:00 - 12:00:00	0.08	9.13	0.05	6.28	0.14	15.5
24/11/19: 12:00:00 - 12:10:00	0.08	8.96	0.04	5.62	0.17	13.5
24/11/19: 12:10:00 - 12:20:00	0.07	8.13	0.04	5.65	0.12	13
24/11/19: 12:20:00 - 12:30:00	0.08	7.84	0.04	5.00	0.12	12
24/11/19: 12:30:00 - 12:40:00	0.07	8.78	0.04	5.30	0.12	12.5
24/11/19: 12:40:00 - 12:50:00	0.07	8.51	0.04	5.35	0.11	15
24/11/19: 12:50:00 - 13:00:00	0.07	9.08	0.04	5.34	0.12	13.5
24/11/19: 13:00:00 - 13:10:00	0.06	7.99	0.04	5.20	0.10	12.5
24/11/19: 13:10:00 - 13:20:00	0.08	9.43	0.04	5.43	0.14	15.5
24/11/19: 13:20:00 - 13:30:00	0.07	8.71	0.04	5.66	0.11	14
24/11/19: 13:30:00 - 13:40:00	0.07	9.41	0.04	5.96	0.11	17.5
24/11/19: 13:40:00 - 13:50:00	0.06	8.85	0.04	5.39	0.11	14
24/11/19: 13:50:00 - 14:00:00	0.08	9.81	0.04	5.62	0.12	16
24/11/19: 14:00:00 - 14:10:00	0.06	8.83	0.04	5.17	0.09	14
24/11/19: 14:10:00 - 14:20:00	0.07	8.44	0.04	5.56	0.13	13.5
24/11/19: 14:20:00 - 14:30:00	0.08	9.15	0.05	5.98	0.13	15
24/11/19: 14:30:00 - 14:40:00	0.08	8.86	0.04	5.92	0.12	13.5
24/11/19: 14:40:00 - 14:50:00	0.07	9.88	0.04	6.04	0.12	16
24/11/19: 14:50:00 - 15:00:00	0.06	9.32	0.03	4.92	0.11	14
24/11/19: 15:00:00 - 15:10:00	0.07	9.65	0.04	5.90	0.10	13
24/11/19: 15:10:00 - 15:20:00	0.08	9.88	0.04	6.11	0.11	12.5
24/11/19: 15:20:00 - 15:30:00	0.06	8.43	0.04	5.50	0.10	14
24/11/19: 15:30:00 - 15:40:00	0.06	9.71	0.04	5.66	0.11	13.5
24/11/19: 15:40:00 - 15:50:00	0.05	7.81	0.03	4.57	0.10	13
24/11/19: 15:50:00 - 16:00:00	0.07	8.77	0.04	5.57	0.11	13.5
24/11/19: 16:00:00 - 16:10:00	0.06	8.65	0.04	5.47	0.10	12.5
24/11/19: 16:10:00 - 16:20:00	0.06	9.63	0.03	5.19	0.10	14
24/11/19: 16:20:00 - 16:30:00	0.06	8.68	0.03	5.42	0.10	13
24/11/19: 16:30:00 - 16:40:00	0.06	8.83	0.04	5.46	0.13	20
24/11/19: 16:40:00 - 16:50:00	0.05	8.62	0.03	5.21	0.08	16.5
24/11/19: 16:50:00 - 17:00:00	0.06	7.45	0.03	4.56	0.11	12.5
24/11/19: 17:00:00 - 17:10:00	0.07	7.65	0.04	4.99	0.12	12
24/11/19: 17:10:00 - 17:20:00	0.07	6.97	0.04	5.24	0.13	11.5
24/11/19: 17:20:00 - 17:30:00	0.07	7.21	0.04	5.26	0.13	11.5
24/11/19: 17:30:00 - 17:40:00	0.07	7.82	0.04	4.68	0.11	12
24/11/19: 17:40:00 - 17:50:00	0.07	7.75	0.04	5.76	0.11	12.5
24/11/19: 17:50:00 - 18:00:00	0.06	7.94	0.03	4.53	0.11	10.5
24/11/19: 18:00:00 - 18:10:00	0.07	7.56	0.04	4.75	0.12	10.5
24/11/19: 18:10:00 - 18:20:00	0.06	7.77	0.03	4.66	0.10	11
24/11/19: 18:20:00 - 18:30:00	0.06	7.62	0.03	4.81	0.12	11
24/11/19: 18:30:00 - 18:40:00	0.07	8.06	0.04	5.46	0.13	12.5
24/11/19: 18:40:00 - 18:50:00	0.07	7.68	0.04	5.27	0.12	12
24/11/19: 18:50:00 - 19:00:00	0.06	7.55	0.03	4.60	0.13	12.5
24/11/19: 19:00:00 - 19:10:00	0.06	7.80	0.04	5.26	0.10	14
24/11/19: 19:10:00 - 19:20:00	0.07	7.76	0.03	4.83	0.13	11
24/11/19: 19:20:00 - 19:30:00	0.07	7.86	0.04	5.52	0.12	13.5
24/11/19: 19:30:00 - 19:40:00	0.07	8.49	0.04	5.55	0.11	11
24/11/19: 19:40:00 - 19:50:00	0.07	7.21	0.04	4.94	0.12	13
24/11/19: 19:50:00 - 20:00:00	0.08	7.29	0.04	5.38	0.13	11
24/11/19: 20:00:00 - 20:10:00	0.07	7.32	0.04	4.79	0.13	11
24/11/19: 20:10:00 - 20:20:00	0.06	7.60	0.04	4.87	0.10	11
24/11/19: 20:20:00 - 20:30:00	0.10	7.36	0.06	5.56	0.19	11
24/11/19: 20:30:00 - 20:40:00	0.10	7.86	0.06	5.97	0.15	11.5
24/11/19: 20:40:00 - 20:50:00	0.09	7.19	0.05	5.29	0.18	12

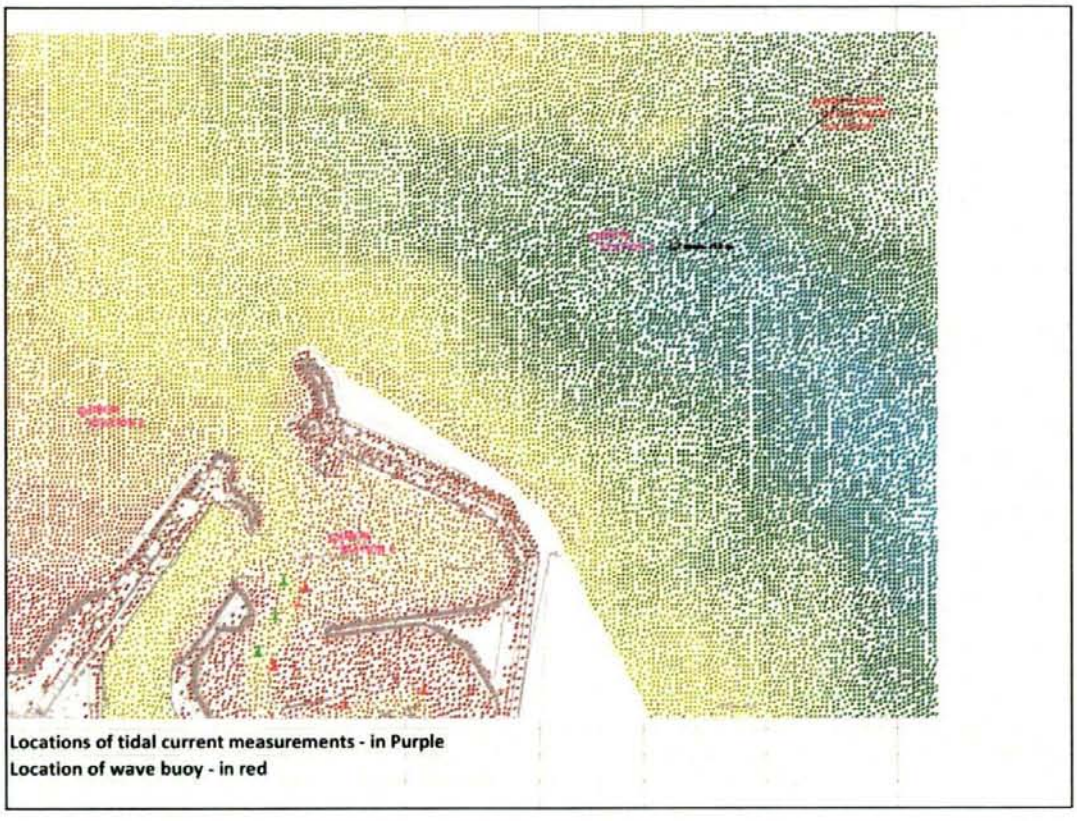
24/11/19: 20:50:00 - 21:00:00	0.08	7.82	0.04	5.35	0.12	11.5
24/11/19: 21:00:00 - 21:10:00	0.09	8.29	0.05	5.70	0.18	13.5
24/11/19: 21:10:00 - 21:20:00	0.09	7.68	0.06	5.78	0.16	12
24/11/19: 21:20:00 - 21:30:00	0.09	8.04	0.05	5.76	0.17	12
24/11/19: 21:30:00 - 21:40:00	0.08	8.56	0.05	5.56	0.15	13
24/11/19: 21:40:00 - 21:50:00	0.09	7.83	0.05	5.48	0.14	13
24/11/19: 21:50:00 - 22:00:00	0.08	7.56	0.05	5.44	0.12	13.5
24/11/19: 22:00:00 - 22:10:00	0.09	7.43	0.06	5.13	0.18	13.5
24/11/19: 22:10:00 - 22:20:00	0.09	6.46	0.05	4.77	0.13	11.5
24/11/19: 22:20:00 - 22:30:00	0.09	6.42	0.06	5.02	0.13	11.5
24/11/19: 22:30:00 - 22:40:00	0.09	6.82	0.06	4.87	0.15	12
24/11/19: 22:40:00 - 22:50:00	0.12	6.07	0.08	5.21	0.20	10.5
24/11/19: 22:50:00 - 23:00:00	0.13	6.01	0.08	5.19	0.22	12.5
24/11/19: 23:00:00 - 23:10:00	0.13	5.63	0.08	4.70	0.24	12.5
24/11/19: 23:10:00 - 23:20:00	0.15	5.36	0.10	5.25	0.24	12.5
24/11/19: 23:20:00 - 23:30:00	0.20	5.71	0.11	4.88	0.33	10.5
24/11/19: 23:30:00 - 23:40:00	0.21	5.50	0.13	5.12	0.43	10
24/11/19: 23:40:00 - 23:50:00	0.23	5.58	0.15	5.19	0.34	9.5
24/11/19: 23:50:00 - 00:00:00	0.23	5.42	0.15	5.43	0.38	9.5
25/11/19: 00:00:00 - 00:10:00	0.25	5.58	0.16	5.29	0.36	8
25/11/19: 00:10:00 - 00:20:00	0.27	5.68	0.16	5.13	0.40	9.5
25/11/19: 00:20:00 - 00:30:00	0.33	5.51	0.21	5.62	0.47	10
25/11/19: 00:30:00 - 00:40:00	0.32	5.69	0.20	5.73	0.56	12
25/11/19: 00:40:00 - 00:50:00	0.33	5.89	0.21	5.62	0.54	8
25/11/19: 00:50:00 - 01:00:00	0.36	5.64	0.22	5.34	0.59	8.5
25/11/19: 01:00:00 - 01:10:00	0.34	5.68	0.21	5.39	0.59	10
25/11/19: 01:10:00 - 01:20:00	0.36	5.60	0.23	5.62	0.52	8
25/11/19: 01:20:00 - 01:30:00	0.31	5.69	0.20	5.33	0.47	8
25/11/19: 01:30:00 - 01:40:00	0.38	5.76	0.23	5.56	0.58	11.5
25/11/19: 01:40:00 - 01:50:00	0.30	5.53	0.18	5.32	0.46	7.5
25/11/19: 01:50:00 - 02:00:00	0.27	5.47	0.18	5.20	0.43	8
25/11/19: 02:00:00 - 02:10:00	0.30	5.61	0.19	5.50	0.44	10
25/11/19: 02:10:00 - 02:20:00	0.29	5.64	0.18	5.21	0.52	8
25/11/19: 02:20:00 - 02:30:00	0.35	5.67	0.22	5.39	0.69	8
25/11/19: 02:30:00 - 02:40:00	0.28	5.55	0.17	5.09	0.41	8
25/11/19: 02:40:00 - 02:50:00	0.32	5.55	0.21	5.23	0.55	9.5
25/11/19: 02:50:00 - 03:00:00	0.30	5.23	0.19	5.24	0.51	9
25/11/19: 03:00:00 - 03:10:00	0.29	5.65	0.19	5.34	0.45	8
25/11/19: 03:10:00 - 03:20:00	0.30	5.55	0.18	5.21	0.54	10.5
25/11/19: 03:20:00 - 03:30:00	0.29	5.47	0.19	5.15	0.42	9.5
25/11/19: 03:30:00 - 03:40:00	0.32	5.50	0.21	5.15	0.53	10
25/11/19: 03:40:00 - 03:50:00	0.30	5.43	0.19	5.20	0.37	9
25/11/19: 03:50:00 - 04:00:00	0.29	5.14	0.18	5.07	0.44	8.5
25/11/19: 04:00:00 - 04:10:00	0.25	5.43	0.16	5.30	0.36	9.5
25/11/19: 04:10:00 - 04:20:00	0.28	5.33	0.18	5.19	0.41	8.5
25/11/19: 04:20:00 - 04:30:00	0.26	5.50	0.15	4.73	0.47	8
25/11/19: 04:30:00 - 04:40:00	0.27	5.46	0.17	5.14	0.38	10
25/11/19: 04:40:00 - 04:50:00	0.27	5.38	0.18	5.27	0.38	7.5
25/11/19: 04:50:00 - 05:00:00	0.24	5.31	0.17	5.05	0.33	8
25/11/19: 05:00:00 - 05:10:00	0.32	5.31	0.20	5.00	0.60	8
25/11/19: 05:10:00 - 05:20:00	0.30	5.51	0.19	5.28	0.51	9.5
25/11/19: 05:20:00 - 05:30:00	0.31	5.45	0.19	5.12	0.42	8
25/11/19: 05:30:00 - 05:40:00	0.29	5.54	0.18	5.35	0.38	8.5
25/11/19: 05:40:00 - 05:50:00	0.31	5.41	0.20	5.22	0.42	9
25/11/19: 05:50:00 - 06:00:00	0.25	5.42	0.16	5.17	0.40	8.5
25/11/19: 06:00:00 - 06:10:00	0.26	5.27	0.16	4.84	0.36	7.5
25/11/19: 06:10:00 - 06:20:00	0.23	5.29	0.14	5.00	0.35	8
25/11/19: 06:20:00 - 06:30:00	0.23	5.24	0.15	5.23	0.43	8.5
25/11/19: 06:30:00 - 06:40:00	0.19	5.37	0.13	5.03	0.30	8
25/11/19: 06:40:00 - 06:50:00	0.20	5.58	0.13	5.14	0.28	9
25/11/19: 06:50:00 - 07:00:00	0.23	5.45	0.15	5.28	0.38	9
25/11/19: 07:00:00 - 07:10:00	0.23	5.54	0.16	5.46	0.41	9
25/11/19: 07:10:00 - 07:20:00	0.24	5.53	0.14	5.19	0.46	8
25/11/19: 07:20:00 - 07:30:00	0.21	5.57	0.13	5.36	0.33	9
25/11/19: 07:30:00 - 07:40:00	0.23	5.79	0.15	5.26	0.33	9
25/11/19: 07:40:00 - 07:50:00	0.23	5.93	0.14	5.51	0.35	9
25/11/19: 07:50:00 - 08:00:00	0.27	5.74	0.17	5.67	0.38	13
25/11/19: 08:00:00 - 08:10:00	0.28	6.44	0.17	5.64	0.51	9
25/11/19: 08:10:00 - 08:20:00	0.25	5.97	0.16	5.51	0.43	9
25/11/19: 08:20:00 - 08:30:00	0.25	6.12	0.16	5.97	0.48	10

25/11/19: 08:30:00 - 08:40:00	0.25	6.39	0.16	5.89	0.41	11
25/11/19: 08:40:00 - 08:50:00	0.25	6.17	0.16	5.94	0.34	9.5
25/11/19: 08:50:00 - 09:00:00	0.28	6.58	0.17	5.96	0.52	10
25/11/19: 09:00:00 - 09:10:00	0.33	6.77	0.20	6.04	0.52	10
25/11/19: 09:10:00 - 09:20:00	0.28	7.00	0.18	6.15	0.38	10.5
25/11/19: 09:20:00 - 09:30:00	0.34	7.00	0.22	6.31	0.51	10
25/11/19: 09:30:00 - 09:40:00	0.34	7.29	0.20	6.31	0.47	9.5
25/11/19: 09:40:00 - 09:50:00	0.38	7.52	0.25	7.36	0.70	11
25/11/19: 09:50:00 - 10:00:00	0.32	7.19	0.21	6.67	0.44	10.5
25/11/19: 10:00:00 - 10:10:00	0.34	7.48	0.21	6.62	0.50	10
25/11/19: 10:10:00 - 10:20:00	0.41	7.78	0.25	7.16	0.56	11
25/11/19: 10:20:00 - 10:30:00	0.40	7.67	0.27	7.40	0.58	11
25/11/19: 10:30:00 - 10:40:00	0.35	7.70	0.22	7.11	0.52	10
25/11/19: 10:40:00 - 10:50:00	0.35	7.67	0.22	6.69	0.60	10.5
25/11/19: 10:50:00 - 11:00:00	0.41	7.96	0.26	7.26	0.62	10.5
25/11/19: 11:00:00 - 11:10:00	0.35	7.56	0.23	6.40	0.45	10.5
25/11/19: 11:10:00 - 11:20:00	0.33	7.59	0.21	6.86	0.55	10.5
25/11/19: 11:20:00 - 11:30:00	0.33	7.80	0.21	7.09	0.46	10.5
25/11/19: 11:30:00 - 11:40:00	0.26	7.55	0.17	7.11	0.38	12
25/11/19: 11:40:00 - 11:50:00	0.28	7.68	0.18	6.22	0.40	10.5
25/11/19: 11:50:00 - 12:00:00	0.29	7.48	0.20	6.85	0.44	10.5
25/11/19: 12:00:00 - 12:10:00	0.29	7.18	0.19	6.40	0.49	12
25/11/19: 12:10:00 - 12:20:00	0.35	7.73	0.22	7.10	0.50	13
25/11/19: 12:20:00 - 12:30:00	0.29	7.37	0.18	6.43	0.53	11
25/11/19: 12:30:00 - 12:40:00	0.34	7.45	0.21	6.45	0.57	11
25/11/19: 12:40:00 - 12:50:00	0.34	7.79	0.21	7.01	0.50	11.5
25/11/19: 12:50:00 - 13:00:00	0.33	7.66	0.21	6.75	0.51	10.5
25/11/19: 13:00:00 - 13:10:00	0.33	7.12	0.20	6.62	0.49	11.5
25/11/19: 13:10:00 - 13:20:00	0.28	7.59	0.19	6.71	0.42	11.5
25/11/19: 13:20:00 - 13:30:00	0.32	7.80	0.21	6.86	0.46	11
25/11/19: 13:30:00 - 13:40:00	0.27	7.60	0.17	6.55	0.47	12
25/11/19: 13:40:00 - 13:50:00	0.28	7.22	0.19	6.56	0.47	10.5
25/11/19: 13:50:00 - 14:00:00	0.31	7.23	0.19	6.29	0.45	11.5
25/11/19: 14:00:00 - 14:10:00	0.33	7.47	0.22	6.60	0.52	11
25/11/19: 14:10:00 - 14:20:00	0.31	6.43	0.19	5.83	0.45	11
25/11/19: 14:20:00 - 14:30:00	0.29	7.45	0.18	6.16	0.49	11
25/11/19: 14:30:00 - 14:40:00	0.28	6.83	0.18	6.03	0.40	10.5
25/11/19: 14:40:00 - 14:50:00	0.28	6.35	0.17	5.80	0.46	11
25/11/19: 14:50:00 - 15:00:00	0.29	6.12	0.20	5.82	0.39	10.5
25/11/19: 15:00:00 - 15:10:00	0.29	6.53	0.18	5.84	0.44	12.5
25/11/19: 15:10:00 - 15:20:00	0.23	6.39	0.14	5.38	0.34	11.5
25/11/19: 15:20:00 - 15:30:00	0.22	6.26	0.14	5.50	0.32	12
25/11/19: 15:30:00 - 15:40:00	0.25	6.33	0.16	5.58	0.36	12
25/11/19: 15:40:00 - 15:50:00	0.26	6.82	0.16	5.52	0.38	10.5
25/11/19: 15:50:00 - 16:00:00	0.26	6.39	0.16	5.62	0.38	12
25/11/19: 16:00:00 - 16:10:00	0.24	6.42	0.15	5.36	0.41	11.5
25/11/19: 16:10:00 - 16:20:00	0.24	6.07	0.15	5.60	0.42	11.5
25/11/19: 16:20:00 - 16:30:00	0.26	5.88	0.16	5.36	0.37	12
25/11/19: 16:30:00 - 16:40:00	0.25	6.33	0.16	5.47	0.35	9.5
25/11/19: 16:40:00 - 16:50:00	0.25	6.17	0.16	5.54	0.41	9.5
25/11/19: 16:50:00 - 17:00:00	0.27	5.49	0.18	5.36	0.44	10
25/11/19: 17:00:00 - 17:10:00	0.22	5.81	0.15	5.34	0.34	10.5
25/11/19: 17:10:00 - 17:20:00	0.23	6.39	0.14	5.37	0.32	9.5
25/11/19: 17:20:00 - 17:30:00	0.24	5.70	0.15	5.34	0.42	9.5
25/11/19: 17:30:00 - 17:40:00	0.21	5.85	0.13	5.44	0.30	10.5
25/11/19: 17:40:00 - 17:50:00	0.19	5.63	0.12	5.10	0.35	8.5
25/11/19: 17:50:00 - 18:00:00	0.20	5.83	0.12	5.18	0.33	9.5
25/11/19: 18:00:00 - 18:10:00	0.20	6.01	0.13	5.31	0.30	10
25/11/19: 18:10:00 - 18:20:00	0.19	5.92	0.11	5.15	0.28	10.5
25/11/19: 18:20:00 - 18:30:00	0.17	5.97	0.11	5.52	0.26	10
25/11/19: 18:30:00 - 18:40:00	0.16	6.34	0.10	5.29	0.24	9.5
25/11/19: 18:40:00 - 18:50:00	0.14	6.64	0.09	5.51	0.25	10.5
25/11/19: 18:50:00 - 19:00:00	0.15	7.23	0.09	5.66	0.23	11
25/11/19: 19:00:00 - 19:10:00	0.17	7.28	0.11	6.13	0.26	12
25/11/19: 19:10:00 - 19:20:00	0.14	6.78	0.09	5.74	0.18	12.5
25/11/19: 19:20:00 - 19:30:00	0.16	7.57	0.10	5.83	0.27	11.5
25/11/19: 19:30:00 - 19:40:00	0.17	7.47	0.11	6.40	0.24	12
25/11/19: 19:40:00 - 19:50:00	0.14	7.59	0.09	6.14	0.23	11
25/11/19: 19:50:00 - 20:00:00	0.17	7.80	0.11	6.58	0.26	15
25/11/19: 20:00:00 - 20:10:00	0.14	7.84	0.09	6.34	0.21	14

25/11/19: 20:10:00 - 20:20:00	0.19	8.05	0.12	6.88	0.27	14.5
25/11/19: 20:20:00 - 20:30:00	0.16	7.53	0.10	5.98	0.25	11.5
25/11/19: 20:30:00 - 20:40:00	0.17	8.02	0.11	6.83	0.29	13
25/11/19: 20:40:00 - 20:50:00	0.18	7.83	0.11	6.57	0.29	15
25/11/19: 20:50:00 - 21:00:00	0.24	8.16	0.13	6.73	0.38	12
25/11/19: 21:00:00 - 21:10:00	0.22	8.83	0.13	7.14	0.33	18
25/11/19: 21:10:00 - 21:20:00	0.22	10.37	0.13	7.60	0.34	16.5
25/11/19: 21:20:00 - 21:30:00	0.26	9.96	0.17	8.11	0.33	16
25/11/19: 21:30:00 - 21:40:00	0.23	8.82	0.15	7.69	0.31	16.5
25/11/19: 21:40:00 - 21:50:00	0.26	9.27	0.17	7.93	0.36	18
25/11/19: 21:50:00 - 22:00:00	0.28	9.91	0.17	8.52	0.46	19
25/11/19: 22:00:00 - 22:10:00	0.29	11.55	0.19	9.02	0.42	18.5
25/11/19: 22:10:00 - 22:20:00	0.27	10.77	0.15	8.25	0.51	15.5
25/11/19: 22:20:00 - 22:30:00	0.26	8.96	0.17	8.03	0.41	19
25/11/19: 22:30:00 - 22:40:00	0.33	10.63	0.20	8.44	0.44	18
25/11/19: 22:40:00 - 22:50:00	0.27	9.90	0.16	8.15	0.40	16.5
25/11/19: 22:50:00 - 23:00:00	0.24	10.87	0.15	8.54	0.34	20.5
25/11/19: 23:00:00 - 23:10:00	0.29	11.02	0.17	8.34	0.44	19.5
25/11/19: 23:10:00 - 23:20:00	0.27	11.00	0.17	9.05	0.36	18
25/11/19: 23:20:00 - 23:30:00	0.25	10.00	0.16	8.59	0.43	17
25/11/19: 23:30:00 - 23:40:00	0.22	12.17	0.13	8.41	0.36	19
25/11/19: 23:40:00 - 23:50:00	0.24	10.77	0.15	8.75	0.41	18.5
25/11/19: 23:50:00 - 00:00:00	0.24	9.98	0.16	8.35	0.30	15.5
26/11/19: 00:00:00 - 00:10:00	0.28	15.53	0.17	10.31	0.47	18
26/11/19: 00:10:00 - 00:20:00	0.17	11.32	0.10	7.73	0.21	18
26/11/19: 00:20:00 - 00:30:00	0.28	13.42	0.17	10.23	0.33	20
26/11/19: 00:30:00 - 00:40:00	0.27	12.28	0.17	9.62	0.34	24.5
26/11/19: 00:40:00 - 00:50:00	0.24	10.79	0.16	9.41	0.29	19
26/11/19: 00:50:00 - 01:00:00	0.23	12.52	0.14	9.02	0.28	20
26/11/19: 01:00:00 - 01:10:00	0.22	12.18	0.14	8.88	0.30	20
26/11/19: 01:10:00 - 01:20:00	0.23	10.46	0.14	8.07	0.34	16
26/11/19: 01:20:00 - 01:30:00	0.21	10.56	0.13	8.10	0.28	17.5
26/11/19: 01:30:00 - 01:40:00	0.26	13.18	0.16	9.61	0.35	19
26/11/19: 01:40:00 - 01:50:00	0.25	11.80	0.16	8.86	0.35	18
26/11/19: 01:50:00 - 02:00:00	0.21	11.00	0.13	7.85	0.34	17.5
26/11/19: 02:00:00 - 02:10:00	0.28	13.00	0.18	9.67	0.39	19
26/11/19: 02:10:00 - 02:20:00	0.30	11.88	0.18	9.19	0.39	17.5
26/11/19: 02:20:00 - 02:30:00	0.28	12.73	0.17	8.70	0.38	18
26/11/19: 02:30:00 - 02:40:00	0.29	12.95	0.19	9.80	0.47	20.5
26/11/19: 02:40:00 - 02:50:00	0.24	11.65	0.15	8.32	0.39	18.5
26/11/19: 02:50:00 - 03:00:00	0.25	12.14	0.16	8.83	0.37	18
26/11/19: 03:00:00 - 03:10:00	0.23	11.72	0.14	8.44	0.36	19
26/11/19: 03:10:00 - 03:20:00	0.24	13.09	0.14	8.60	0.50	18
26/11/19: 03:20:00 - 03:30:00	0.25	13.04	0.15	8.49	0.37	17
26/11/19: 03:30:00 - 03:40:00	0.22	11.15	0.13	8.07	0.32	16
26/11/19: 03:40:00 - 03:50:00	0.23	10.91	0.14	8.68	0.33	17
26/11/19: 03:50:00 - 04:00:00	0.27	11.71	0.16	9.38	0.39	20
26/11/19: 04:00:00 - 04:10:00	0.27	11.92	0.17	9.37	0.36	17.5
26/11/19: 04:10:00 - 04:20:00	0.21	12.67	0.13	8.44	0.28	16.5
26/11/19: 04:20:00 - 04:30:00	0.21	12.08	0.12	7.84	0.33	15
26/11/19: 04:30:00 - 04:40:00	0.20	10.72	0.12	8.24	0.34	16
26/11/19: 04:40:00 - 04:50:00	0.24	12.64	0.14	8.75	0.41	15.5
26/11/19: 04:50:00 - 05:00:00	0.19	10.52	0.11	7.87	0.25	14.5
26/11/19: 05:00:00 - 05:10:00	0.16	9.63	0.09	7.27	0.22	15.5
26/11/19: 05:10:00 - 05:20:00	0.18	10.13	0.11	7.99	0.27	15.5
26/11/19: 05:20:00 - 05:30:00	0.19	10.08	0.12	7.50	0.26	15
26/11/19: 05:30:00 - 05:40:00	0.20	9.80	0.12	7.14	0.26	15
26/11/19: 05:40:00 - 05:50:00	0.21	9.07	0.13	6.76	0.35	13
26/11/19: 05:50:00 - 06:00:00	0.17	9.96	0.11	7.05	0.25	14
26/11/19: 06:00:00 - 06:10:00	0.19	9.50	0.12	7.15	0.28	14.5
26/11/19: 06:10:00 - 06:20:00	0.18	8.91	0.11	6.68	0.29	13
26/11/19: 06:20:00 - 06:30:00	0.17	9.18	0.11	7.02	0.26	13.5
26/11/19: 06:30:00 - 06:40:00	0.16	8.82	0.10	6.38	0.24	14
26/11/19: 06:40:00 - 06:50:00	0.16	8.55	0.10	6.90	0.22	15.5
26/11/19: 06:50:00 - 07:00:00	0.17	9.87	0.10	7.10	0.25	14
26/11/19: 07:00:00 - 07:10:00	0.17	10.35	0.11	7.37	0.23	14
26/11/19: 07:10:00 - 07:20:00	0.16	9.38	0.10	6.74	0.21	14
26/11/19: 07:20:00 - 07:30:00	0.14	8.41	0.09	6.67	0.26	13
26/11/19: 07:30:00 - 07:40:00	0.17	8.50	0.10	6.14	0.28	12.5
26/11/19: 07:40:00 - 07:50:00	0.18	8.52	0.11	5.99	0.33	12.5

26/11/19: 07:50:00 - 08:00:00	0.18	8.32	0.11	6.34	0.24	11.5
26/11/19: 08:00:00 - 08:10:00	0.17	6.84	0.11	5.64	0.29	11
26/11/19: 08:10:00 - 08:20:00	0.19	7.09	0.12	5.87	0.31	15
26/11/19: 08:20:00 - 08:30:00	0.21	7.34	0.13	5.92	0.34	16
26/11/19: 08:30:00 - 08:40:00	0.25	7.28	0.15	5.82	0.36	12.5
26/11/19: 08:40:00 - 08:50:00	0.23	6.39	0.15	5.60	0.36	13.5
26/11/19: 08:50:00 - 09:00:00	0.25	5.82	0.17	5.40	0.46	13.5
26/11/19: 09:00:00 - 09:10:00	0.29	6.31	0.19	5.71	0.43	12
26/11/19: 09:10:00 - 09:20:00	0.34	6.15	0.22	5.77	0.58	10.5
26/11/19: 09:20:00 - 09:30:00	0.32	6.26	0.22	5.76	0.48	13
26/11/19: 09:30:00 - 09:40:00	0.38	5.90	0.25	5.73	0.56	10.5
26/11/19: 09:40:00 - 09:50:00	0.39	6.93	0.25	5.89	0.61	11.5
26/11/19: 09:50:00 - 10:00:00	0.42	6.15	0.27	5.89	0.64	11
26/11/19: 10:00:00 - 10:10:00	0.37	6.17	0.25	6.22	0.61	11.5
26/11/19: 10:10:00 - 10:20:00	0.46	6.19	0.31	6.08	0.69	14.5
26/11/19: 10:20:00 - 10:30:00	0.53	6.38	0.33	5.92	0.85	11
26/11/19: 10:30:00 - 10:40:00	0.43	6.47	0.29	6.35	0.63	13
26/11/19: 10:40:00 - 10:50:00	0.48	6.24	0.34	6.29	0.87	12.5
26/11/19: 10:50:00 - 11:00:00	0.57	6.72	0.34	6.09	0.83	14.5
26/11/19: 11:00:00 - 11:10:00	0.56	6.42	0.35	6.23	0.81	11
26/11/19: 11:10:00 - 11:20:00	0.52	6.55	0.33	6.67	0.73	14.5
26/11/19: 11:20:00 - 11:30:00	0.50	6.40	0.32	6.35	0.91	12.5
26/11/19: 11:30:00 - 11:40:00	0.55	6.61	0.36	6.31	0.79	13
26/11/19: 11:40:00 - 11:50:00	0.52	6.55	0.35	6.57	0.83	11.5
26/11/19: 11:50:00 - 12:00:00	0.52	6.84	0.32	6.20	1.05	12
26/11/19: 12:00:00 - 12:10:00	0.47	6.58	0.30	6.29	0.64	10
26/11/19: 12:10:00 - 12:20:00	0.58	6.83	0.39	6.61	0.80	10
26/11/19: 12:20:00 - 12:30:00	0.62	7.00	0.39	6.88	0.88	10.5
26/11/19: 12:30:00 - 12:40:00	0.60	6.83	0.36	6.59	1.01	11.5
26/11/19: 12:40:00 - 12:50:00	0.62	6.19	0.41	6.73	1.01	9.5
26/11/19: 12:50:00 - 13:00:00	0.64	7.25	0.41	6.95	1.26	13.5
26/11/19: 13:00:00 - 13:10:00	0.70	7.02	0.42	6.71	1.20	11.5
26/11/19: 13:10:00 - 13:20:00	0.61	6.97	0.39	6.61	0.95	14
26/11/19: 13:20:00 - 13:30:00	0.63	6.85	0.40	6.63	0.89	10.5
26/11/19: 13:30:00 - 13:40:00	0.59	7.07	0.36	6.70	0.94	11.5
26/11/19: 13:40:00 - 13:50:00	0.59	6.84	0.39	6.39	0.87	11
26/11/19: 13:50:00 - 14:00:00	0.63	6.63	0.39	6.53	0.81	11
26/11/19: 14:00:00 - 14:10:00	0.60	6.60	0.39	6.66	1.07	12
26/11/19: 14:10:00 - 14:20:00	0.59	7.05	0.39	6.77	0.85	15
26/11/19: 14:20:00 - 14:30:00	0.63	7.07	0.39	6.67	0.99	12.5
26/11/19: 14:30:00 - 14:40:00	0.66	7.03	0.44	6.78	1.06	12.5
26/11/19: 14:40:00 - 14:50:00	0.66	6.64	0.43	7.01	1.35	11
26/11/19: 14:50:00 - 15:00:00	0.55	6.97	0.34	6.36	0.75	10
26/11/19: 15:00:00 - 15:10:00	0.60	7.10	0.39	6.78	0.80	12.5
26/11/19: 15:10:00 - 15:20:00	0.62	7.02	0.38	6.63	0.99	11
26/11/19: 15:20:00 - 15:30:00	0.63	7.11	0.40	6.97	0.91	11.5
26/11/19: 15:30:00 - 15:40:00	0.67	7.46	0.43	7.14	1.08	12.5
26/11/19: 15:40:00 - 15:50:00	0.67	7.52	0.44	6.99	0.95	10.5
26/11/19: 15:50:00 - 16:00:00	0.71	7.63	0.46	7.02	1.12	11.5
26/11/19: 16:00:00 - 16:10:00	0.68	7.61	0.43	7.01	1.00	11
26/11/19: 16:10:00 - 16:20:00	0.78	7.73	0.49	7.36	1.20	12.5
26/11/19: 16:20:00 - 16:30:00	0.79	7.85	0.50	7.35	1.46	11
26/11/19: 16:30:00 - 16:40:00	0.69	7.73	0.43	7.06	1.15	13
26/11/19: 16:40:00 - 16:50:00	0.74	7.88	0.48	7.40	1.03	12.5
26/11/19: 16:50:00 - 17:00:00	0.54	7.40	0.34	6.69	0.81	11
26/11/19: 17:00:00 - 17:10:00	0.72	7.69	0.46	7.14	1.16	12
26/11/19: 17:10:00 - 17:20:00	0.56	8.27	0.36	6.93	0.68	11.5
26/11/19: 17:20:00 - 17:30:00	0.58	7.85	0.39	7.34	0.74	11
26/11/19: 17:30:00 - 17:40:00	0.67	8.15	0.42	7.34	0.94	11.5
26/11/19: 17:40:00 - 17:50:00	0.63	7.36	0.40	6.78	1.03	12
26/11/19: 17:50:00 - 18:00:00	0.53	7.72	0.36	7.26	0.80	11
26/11/19: 18:00:00 - 18:10:00	0.55	7.74	0.35	7.07	1.11	11
26/11/19: 18:10:00 - 18:20:00	0.65	8.34	0.38	6.97	0.87	11.5
26/11/19: 18:20:00 - 18:30:00	0.59	8.70	0.38	7.18	0.95	11.5
26/11/19: 18:30:00 - 18:40:00	0.56	8.44	0.35	7.43	0.88	13.5
26/11/19: 18:40:00 - 18:50:00	0.59	8.13	0.38	7.13	0.86	12
26/11/19: 18:50:00 - 19:00:00	0.72	8.96	0.49	8.30	1.07	13.5
26/11/19: 19:00:00 - 19:10:00	0.62	8.66	0.43	7.87	1.29	12.5
26/11/19: 19:10:00 - 19:20:00	0.69	8.80	0.46	8.28	1.00	14
26/11/19: 19:20:00 - 19:30:00	0.56	9.42	0.35	7.48	0.79	14.5

26/11/19: 19:30:00 - 19:40:00	0.67	9.46	0.43	8.30	0.95	14
26/11/19: 19:40:00 - 19:50:00	0.59	9.54	0.39	8.52	0.85	14.5
26/11/19: 19:50:00 - 20:00:00	0.61	9.50	0.37	7.49	0.85	13.5
26/11/19: 20:00:00 - 20:10:00	0.65	9.14	0.42	8.65	1.16	14.5
26/11/19: 20:10:00 - 20:20:00	0.58	9.81	0.36	8.07	0.95	13.5
26/11/19: 20:20:00 - 20:30:00	0.66	10.05	0.42	9.41	1.04	15
26/11/19: 20:30:00 - 20:40:00	0.55	9.89	0.35	8.32	0.81	14.5
26/11/19: 20:40:00 - 20:50:00	0.63	9.95	0.41	8.82	0.87	16.5
26/11/19: 20:50:00 - 21:00:00	0.67	9.48	0.43	8.70	1.13	15.5
26/11/19: 21:00:00 - 21:10:00	0.64	9.93	0.41	8.74	0.94	15
26/11/19: 21:10:00 - 21:20:00	0.67	9.10	0.39	7.93	1.11	15.5
26/11/19: 21:20:00 - 21:30:00	0.58	10.00	0.37	8.45	0.75	14
26/11/19: 21:30:00 - 21:40:00	0.66	11.33	0.44	9.49	0.90	16.5
26/11/19: 21:40:00 - 21:50:00	0.58	10.10	0.36	8.30	0.83	16.5
26/11/19: 21:50:00 - 22:00:00	0.60	9.89	0.40	8.68	0.96	15.5
26/11/19: 22:00:00 - 22:10:00	0.62	10.07	0.39	9.15	1.03	16
26/11/19: 22:10:00 - 22:20:00	0.79	11.17	0.49	9.42	1.36	17
26/11/19: 22:20:00 - 22:30:00	0.65	9.50	0.42	8.86	1.04	14
26/11/19: 22:30:00 - 22:40:00	0.68	10.76	0.45	8.98	0.99	17
26/11/19: 22:40:00 - 22:50:00	0.66	10.11	0.41	8.56	0.95	18.5
26/11/19: 22:50:00 - 23:00:00	0.61	10.80	0.38	8.39	1.07	14.5
26/11/19: 23:00:00 - 23:10:00	0.67	10.16	0.43	8.81	1.14	16.5
26/11/19: 23:10:00 - 23:20:00	0.67	10.04	0.40	8.44	1.32	16.5
26/11/19: 23:20:00 - 23:30:00	0.57	10.00	0.35	8.52	0.82	16.5
26/11/19: 23:30:00 - 23:40:00	0.70	11.38	0.43	9.35	1.04	16
26/11/19: 23:40:00 - 23:50:00	0.59	10.31	0.36	9.27	0.87	17.5
26/11/19: 23:50:00 - 00:00:00	0.59	11.43	0.36	9.60	1.06	16
27/11/19: 00:00:00 - 00:10:00	0.61	10.24	0.39	9.14	0.76	16.5
27/11/19: 00:10:00 - 00:20:00	0.65	10.85	0.44	9.46	0.79	15
27/11/19: 00:20:00 - 00:30:00	0.57	9.67	0.38	8.26	0.72	15.5
27/11/19: 00:30:00 - 00:40:00	0.58	10.11	0.37	8.47	0.83	16
27/11/19: 00:40:00 - 00:50:00	0.59	9.64	0.37	7.84	0.84	18.5
27/11/19: 00:50:00 - 01:00:00	0.59	9.54	0.37	8.35	0.88	15.5
27/11/19: 01:00:00 - 01:10:00	0.72	10.98	0.48	9.22	0.89	17.5
27/11/19: 01:10:00 - 01:20:00	0.58	10.83	0.40	9.84	0.81	17.5
27/11/19: 01:20:00 - 01:30:00	0.51	10.33	0.35	9.11	0.66	17
27/11/19: 01:30:00 - 01:40:00	0.53	8.94	0.34	7.69	0.79	17.5
27/11/19: 01:40:00 - 01:50:00	0.54	9.40	0.36	8.23	0.76	14
27/11/19: 01:50:00 - 02:00:00	0.56	9.96	0.34	7.76	0.89	16
27/11/19: 02:00:00 - 02:10:00	0.49	10.10	0.30	7.92	0.74	16
27/11/19: 02:10:00 - 02:20:00	0.56	10.26	0.36	8.38	0.80	15
27/11/19: 02:20:00 - 02:30:00	0.52	8.67	0.32	7.22	1.13	13
27/11/19: 02:30:00 - 02:40:00	0.51	8.96	0.34	7.64	0.68	14.5
27/11/19: 02:40:00 - 02:50:00	0.53	9.48	0.34	7.36	0.71	16
27/11/19: 02:50:00 - 03:00:00	0.51	10.18	0.35	7.88	0.95	16
27/11/19: 03:00:00 - 03:10:00	0.53	9.37	0.36	8.25	0.64	18
27/11/19: 03:10:00 - 03:20:00	0.52	10.17	0.34	8.32	0.64	20.5
27/11/19: 03:20:00 - 03:30:00	0.56	9.17	0.36	7.40	0.89	15.5
27/11/19: 03:30:00 - 03:40:00	0.58	10.02	0.40	8.34	0.76	15.5
27/11/19: 03:40:00 - 03:50:00	0.49	9.52	0.34	7.90	0.66	14
27/11/19: 03:50:00 - 04:00:00	0.48	9.67	0.30	7.58	0.66	14
27/11/19: 04:00:00 - 04:10:00	0.45	9.48	0.30	8.09	0.58	17
27/11/19: 04:10:00 - 04:20:00	0.47	9.90	0.30	7.43	0.62	13.5
27/11/19: 04:20:00 - 04:30:00	0.43	9.44	0.29	8.03	0.66	17.5
27/11/19: 04:30:00 - 04:40:00	0.41	10.86	0.26	7.84	0.64	15.5
27/11/19: 04:40:00 - 04:50:00	0.39	9.39	0.24	7.11	0.56	12



Locations of tidal current measurements - in Purple
Location of wave buoy - in red

Appendix 5

Marine Mammal Risk Assessment

MARINE MAMMAL RISK ASSESSMENT FOR DREDGING AND RECLAMATION WORKS AT HOWTH FISHERY HARBOUR, CO DUBLIN

Prepared by
Simon Berrow and Dave Wall

IWDG Consulting

IWDG Consulting, Merchants Quay, Kilrush, Co Clare

1 | INTRODUCTION

Howth Fishery Harbour Centre (FHC) was last dredged in the 1980s, and due to build-up of siltation, it is necessary to dredge the existing basins and approach channels in Howth Harbour in order to provide safe access, navigation and berthing to the vessels currently using the harbour, and to provide for appropriate maintenance of same into the future through a programme of measurement and maintenance dredging.

For the bulk dredge it is proposed to dredge circa 240,000 m^3, treat and re-use the material to the west of the West Pier in order to create and additional circa 48,000 $m^3$of land area. It is envisaged that, like the rest of the FHC, this infill area will incorporate a mixture of fishing and industrial elements, light industrial / commercial and public realm spaces. The aim of the overall project is to increase the depth of water in order to provide safe access and harbour, to the largest range of vessel size and type on the widest range of tides, within the structural parameters of the existing harbour quay structures and where possible to treat and re-use or dispose of dredge material in an environmentally sensitive and cost effective manner.

Figure 1. Howth Harbour, Co Dublin and adjacent waters

Due to the presence of a range of marine mammals in the vicinity, and especially in Howth Harbour and the proximity of the Rockabill to Dalkey Island SAC which includes harbour porpoise as a qualifying interest, the Irish Whale and Dolphin Group (IWDG) were contracted by Malachy Walsh Consultants to prepare a Marine Mammal Risk Assessment for the proposed works at Howth Harbour and Pier, Co Dublin.

Proposed area to be dredged

Howth Fishery Harbour Centre can be divided into a number of areas based on use:

- West Trawler Basin. This area is used almost solely for fishery activities. The only exception being the use of the northwest corner for ferry boat activities.
- Approach Channel. This is the area between and just south of the heads of the East and West Piers. It is used by all harbour users to enter and exit the harbour.
- Mooring Area. This is an area to the north east of the harbour. It is presently used during the summer period by some 170 leisure craft on swing moorings.
- Marina Area. Within this area there is an area leased to Howth Yacht Club in which is the marina operator of the pontoons and facilities for some 300 leisure craft. The adjacent area is used by DAFM, the public and the Royal National Lifeboat Institution (RNLI).
- Marina Approach Channel. Is an area north and east of the existing area leased by Howth Yacht Club (HYC)

A site location plan showing the areas to be dredged and potential extent of a reclamation area to the west of the West Pier is shown (Fig 2).

Figure 2. Howth Harbour, Co Dublin and adjacent waters

The proposed works are anticipated to take 24 months with a likely start date of Summer 2022 with a likely finish date in Summer 2024, subject to planning permission.

2 | METHODS

The risk assessment was based on a review of the available literature and data sources. Maps of the distribution of cetacean sightings adjacent to Howth were prepared using data from the Irish Whale and Dolphin Group's casual sightings database (IWDG, accessed June 2019).

3 | LEGAL STATUS

Irish cetaceans and pinnipeds are protected under national legislation and under a number of international directives and agreements which Ireland is signatory to. All cetaceans as well as grey and harbour seals are protected under the Wildlife Act (1976) and amendments (2000, 2005, 2010 and 2012). Under the act and its amendments it is an offence to hunt, injure or wilfully interfere with, disturb or destroy the resting or breeding place of a protected species (except under license or permit). The act applies out to the 12 nm limit of Irish territorial waters.

All cetaceans and pinnipeds are protected under the EC Habitats Directive. All cetaceans are included in Annex IV of the Directive as species 'in need of strict protection'. Under this Directive, the harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) are designated Annex II species which are of community interest and whose conservation requires the designation of special areas of conservation. Ireland is also signatory to conservation agreements such as the Bonn Convention on Migratory Species (1983), the OSPAR Convention for the Protection of the Marine Environment of the northeast Atlantic (1992) and the Berne Convention on Conservation of European Wildlife and Natural Habitats (1979).

In 2007, the National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht produced a *'Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters* (NPWS, 2007). These were subsequently reviewed and amended to produce *'Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters'* (NPWS, 2014) which include mitigation measures specific to dredging. The guidelines recommend that listed coastal and marine activities (including dredging) be subject to a risk assessment for anthropogenic sound-related impacts on relevant protected marine mammal species to address any area-specific sensitivities, both in timing and spatial extent, and to inform the consenting process.

Once the listed activity has been subject to a risk assessment, the regulator may decide to refuse consent, to grant consent with no requirement for mitigation, or to grant consent subject to specified mitigation measures.

4 | BASELINE ENVIRONMENT

4.1 | Ambient Noise Levels

The ambient noise levels at the site is not known but measurements from other sites adjacent to Howth suggest it will be elevated. Ambient noise in Dublin Bay has been estimated at around 113 db by Beck *et al.* (2013) and by McKeown (2014). This level is higher than that reported from Galway Bay and the Shannon Estuary and reflects the greater vessel traffic at this site. Ambient noise off Howth Harbour is expected to be dominated by

environmental noise (e.g. tidal movement of water and sediment, and wind and wave noise) and shipping noise, especially with peaks in noise due to small vessels proceeding to Howth and large vessels to Dublin Port.

4.2 | Cetaceans

A review of cetacean (whale, dolphin and porpoise records) submitted to the IWDG during the period 1 January 2000 to present was accessed on 13 June 2017 and mapped. To date, 433 validated records were available. Most records were of harbour porpoise (372 or 86% of all records), bottlenose (17 records) and minke whale (8 records). There were also sightings of common dolphin (3 records) and a humpback whale.

Species	No. sightings	No. individuals	Comments
Harbour porpoise	372	1318	Mean group size 3.5
Bottlenose dolphin	17	142	
Common dolphin	3	16	
Dolphin sp. Possibly harbour porpoise	19	57	Most likely to be harbour porpoise
Dolphin sp.	8	48	
Minke whale	8	8	
Humpback whale	1	1	
Medium whale	2	2	
Whale sp.	3	3	
Cetacean sp.	1	1	
Total	**433**	**1596**	

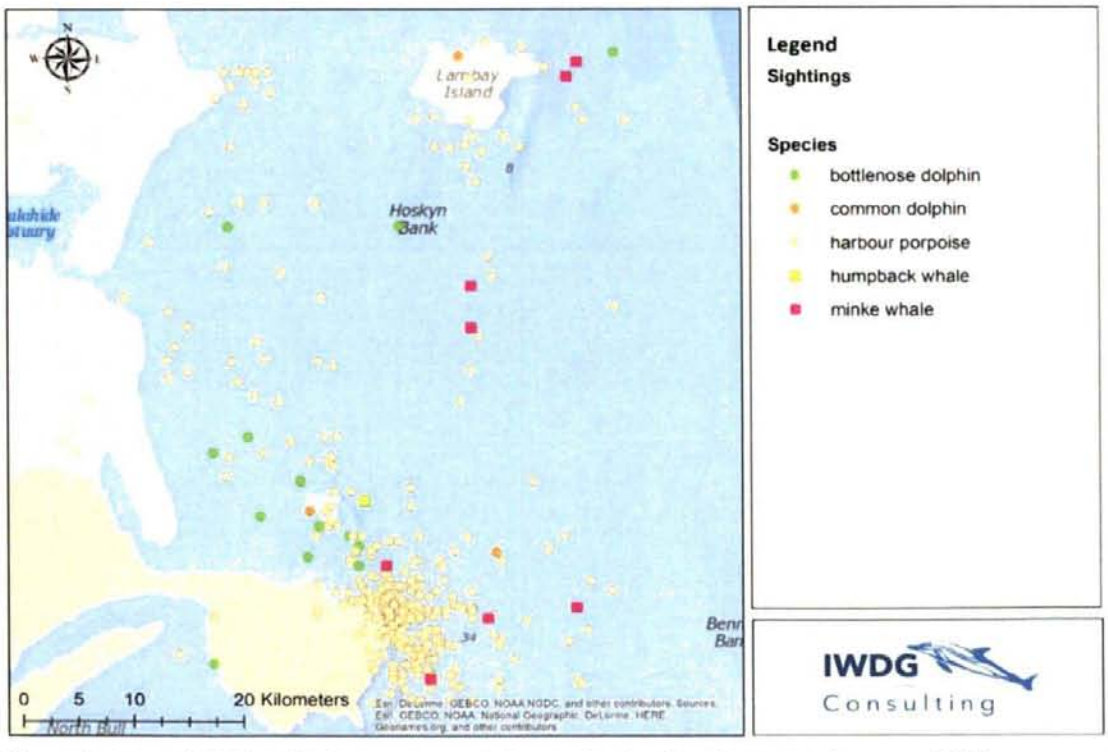


Figure 2. Map of all identified cetacean sightings submitted to the IWDG between 2000 to present

Most records were from Howth Head, which reflects observer effort as the distribution of cetaceans spreads over a wider area including off Portmarknock and north to Lambay Island. A more detailed assessment of the most frequently recorded species is presented below:

Harbour porpoise

Harbour porpoise are the most widespread and abundant cetacean in inshore Irish waters, with highest abundance in the Irish Sea (Berrow et al. 2010). North County Dublin including off Howth support some of the highest densities of this species recorded in Ireland (Berrow et al. 2014) and an area of 273 km^2 was recently designated as a Special Area of Conservation to protect harbour porpoise and their habitats. The Rockabill to Dalkey Island SAC (Site Code 003000) extends from Dalkey to Rockabill with the boundary only 1km from the entrance to Howth Harbour at its closest point.

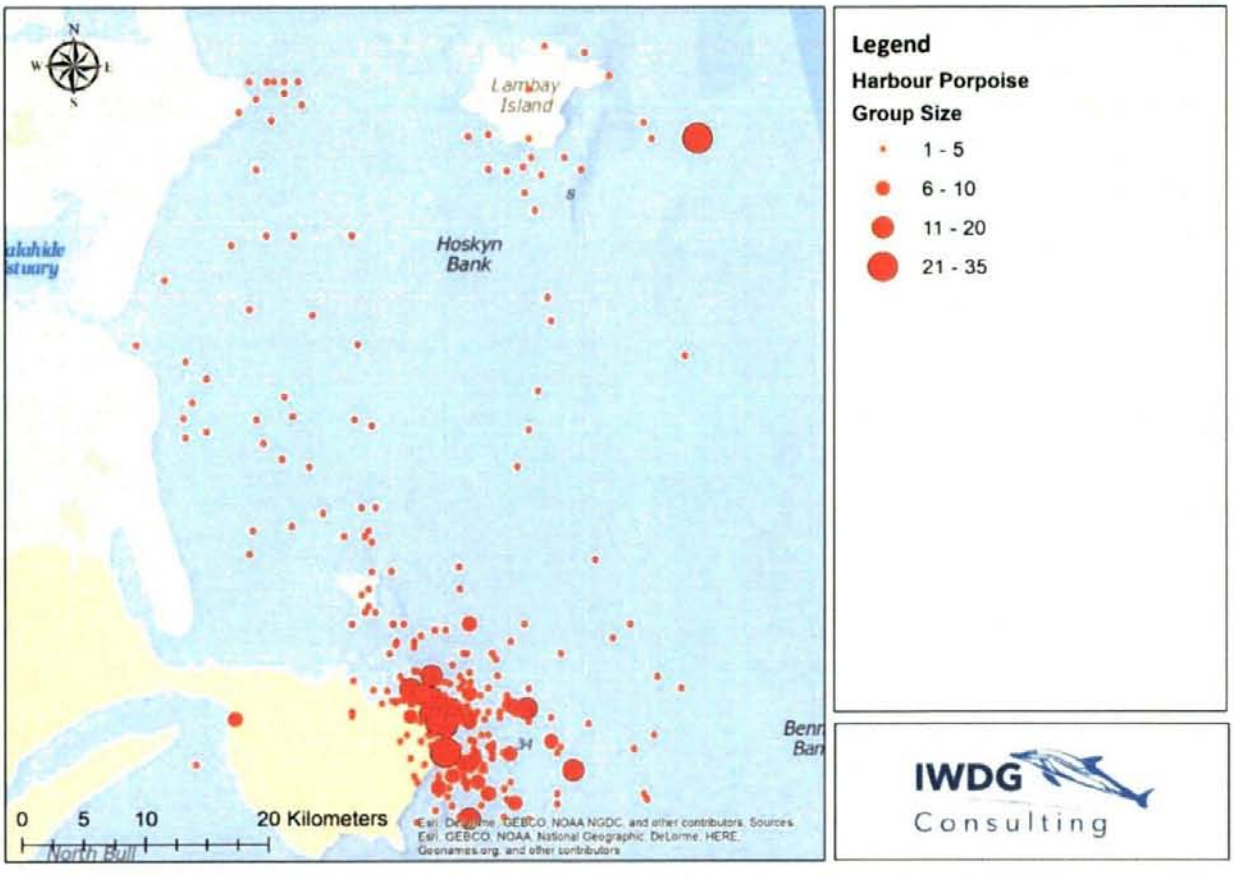


Figure 3. Sighting records of harbour porpoise (from IWDG accessed June 2019)

Harbour porpoise are known to particularly associate with areas of strong tidal currents and can be regularly seen foraging off Howth Head. Sighting rates of harbour porpoise off Howth Head is around 60% with the lowest rate recorded in May and June which is consistent with the calving period (Berrow et al. 2010). There is one record of a single harbour porpoise within Howth Harbour (Fig. 3) and O'Brien and Berrow (2016) recorded a small group of harbour porpise at the entrance to Howth Harbour during dedicated porpoise surveys on behalf of the NPWS.

Bottlenose dolphin

Bottlenose dolphins are regularly recorded north County Dublin and close to the coast off Howth Harbour, with 16 records to date. This probably under records their presence but this population is highly mobile. Bottlenose dolphins are widespread and relatively abundant off the Irish coast with most sightings along the western seaboard (Berrow *et al.* 2010). Recent genetic evidence (Mirimin *et al.* 2011) suggests the existence of three discrete populations of bottlenose dolphins in Ireland: the Shannon Estuary, an inshore population and an offshore population that ranges from the Bay of Biscay and the Azores (Louis *et al.* 2014). Photo-identification has shown individuals recorded Co Dublin to be part of the inshore population (O'Brien et al. 2009).

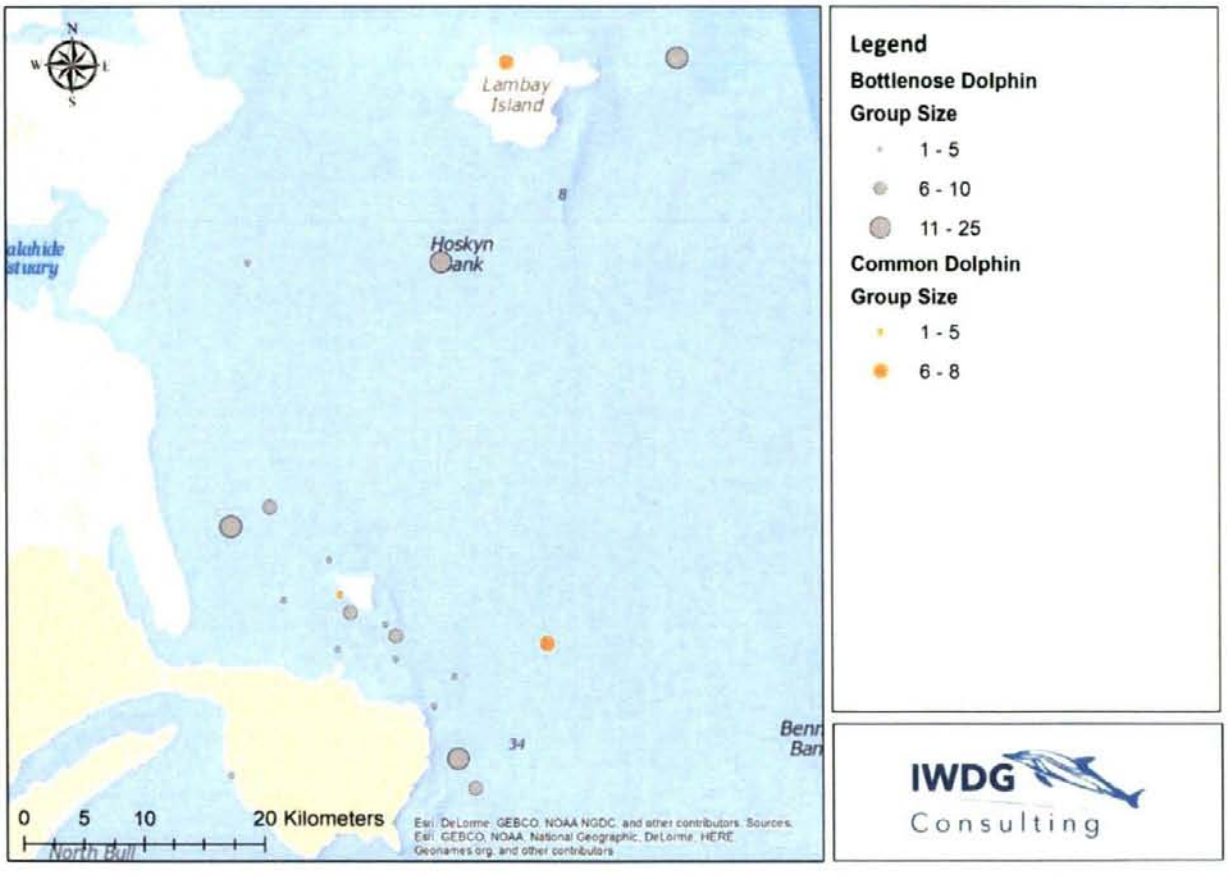


Figure 4. Sighting records of bottlenose and common dolphin (from IWDG accessed June 2019)

Minke and Humpback whale

Minke whales are widespread and abundant in inshore Irish waters from May to October (Berrow et al. 2000). The summer distribution tends to be concentrated around southwest Ireland. Minke whales were widespread in the area from Howth Head to Lambay Island. There are two records of humpback whales off Howth both in July 2010, presumably of the same animal.

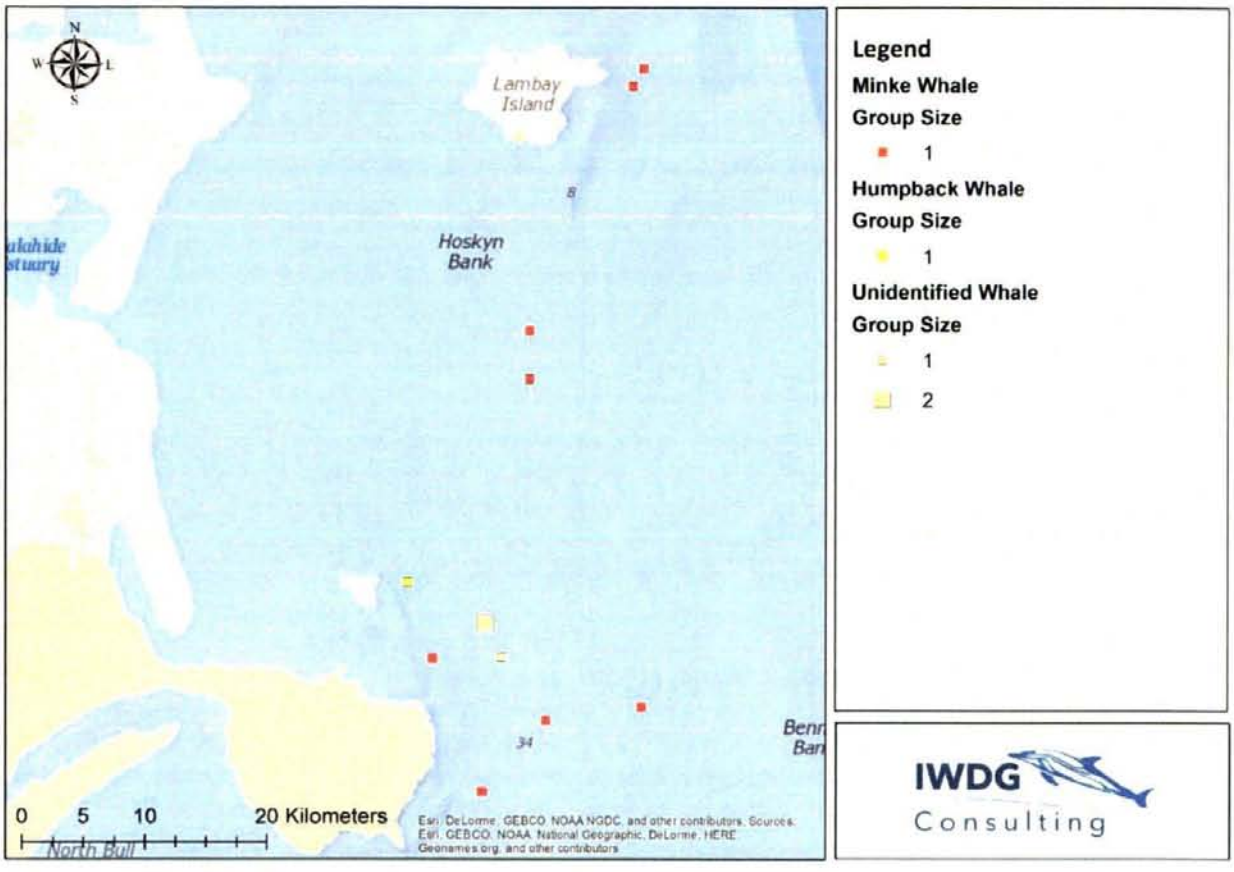


Figure 5. Sighting records of minke and humpback whale (from IWDG accessed June 2019)

4.3 | Pinnipeds

Both grey and harbour, or common, seals have been reported from north County Dublin and Howth Harbour, but the most abundant are grey seals (Lyons (2004). Lambay Island 10km to the north of Howth is a well-known pupping and haul out site for grey seals and is designated as an SAC (site code 000204) with both grey and harbour seals, as qualifying interests. The conservation status of grey and harbour seals in Ireland has been assessed as favourable (NPWS 2014), although excessive disturbance at key breeding and haul-out sites can have a significant negative impact (NPWS 2008).

Grey Seal (Halichoerus grypus)

During 2005, grey seal breeding sites were identified at Lambay Island and Irelands Eye, during a national census of the grey seal population (Ó Cadhla *et al.* 2007). The numbers of pups present were small (less than 3) apart from Lambay Island where 49 pups were counted. Further surveys conducted in 2009 recorded 77 pups on Lambay Island and Ireland's Eye (Ó Cadhla *et al.* 2013). Grey seals are present in Howth Harbour nearly all the time. They forage and scavenge around fishing boats returning to port and have accommodated to human presence including boat traffic.

Harbour Seal *(Phoca vitulina)*

Approximately 30 harbour seals were recorded on Lambay Island during a national census in 2003 (Cronin *et al.* 2004) and 2012 (Duck and Morris, 2013).

PREVIOUS MMO MONITORING IN HOWTH HARBOUR

IWDG have carried out two recent MMO contracts in Howth Harbour which proceeded despite the regular occurrence of seals. Extracts from the MMO reports provide an insight into the occurrence of seals in Howth Harbour.

Western Trawler Basin - October 2015 (Meade 2015)

Meade (2015) recorded marine mammal sightings in Howth Harbour during drilling of a pontoon and gangway development in the trawler basin at Howth Harbour on 12 days in October 2015. Grey seals were the only species recorded with a total of 67 sightings comprising of 90 individuals (85 adults and 5 juveniles). They were regularly sighted swimming, socialising and feeding within the inner harbour. The drilling process did not seem to cause the seals to change their behaviour and some of the individuals would swim in close proximity to the active works.

Trawler Basin Pontoon – November 2016 (Levesque (2016)

Marine mammals were recorded during dedicated watches on all five days in November 2016 during construction of a trawler basin pontoon. Grey seals were the only species recorded during monitoring and were regularly sighted swimming and foraging within the basin. A total of 26 sightings were recorded, the majority of which comprised a group of the same five reoccurring individuals: one juvenile, two males and two females. 15 sightings were recorded while drilling activities were underway. Feeding behaviours were observed on seven different occasions occurring as close as 100m from drilling activity. The drilling appeared to have little effect on them as they came right up to the barge on which the drilling rig was located checking out the site on many occasions. Marine mammals occurred within the mitigation zone during the 30-minute pre-watch on five occasions, although all were seen exiting the zone before drilling activities commenced.

Grey seals in Howth Harbour (from Levesque 2016)

5 | IMPACT ASSESSMENT

5.1 | Description of Activities

Construction works which are expected to take 24 months with an estimated start date for the project of August 2020. As part of the proposed site works the activities likely to impact on marine mammals include:

5.1.1 Dredging

The method of dredging will be via a long reach excavator from a jack-up barge. Spoil would be placed into an open barge which would be towed to the quayside where the spoil would be taken on-shore and transported to the reclamation site. Each barge will hold 150m^3, so based on dredging of 240,000m3 of dredge material this will require 1600 barge trips during this project.

5.1.2 Rock Breaking

Approximately, 10% of the dredge material will be bedrock, which is estimated to be around 24,000 m^3. It will be necessary to break this rock prior to excavation. Breaking will be carried out by a long reach excavator using a rock breaker attachment such as a Sandvik G130. The broken rock will then be excavated from the bed by the long reach excavator with a bucket attachment.

Rock breaking will occur concurrent with dredging. The extent of the rock breaking will be in the whole area of the inner harbor, similar to dredging. The time frame for the rock breaking will be the same as the time frame for the whole dredge operation (24 months, on and off as the rock is broken and then removed).

5.1.3 Increased vessel traffic

There will be some increased vessel traffic as all spoil will be towed to the shore or reclamation site in an open barge.

5.1.4 Increased turbidity

Turbidity in the harbour is likely to increase as sediment is suspended.

5.2 | Potential Impacts of Dredging on Marine Mammals

There have been few studies on the effects of marine dredging on marine mammals (Thomsen *et al.* 2006; Nowacek *et al.* 2007). Richardson *et al.* (1995) identified only two studies on the effects of dredging on marine mammals and both were on large baleen whales (bowhead and northern right whales). Physical injury or mortality from collisions, noise production, and increased turbidity are the main ways dredging can affect marine mammals directly, while indirect impacts include changes to their physical environment, or to their prey (Todd *et al.* 2014).

Seals are almost continuously present at the dredge site but both Odontocetes (toothed whales) and Mysticetes (baleen whales) have been recorded adjacent to Howth Harbour, so here we have considered the effects on both groups as well as seals.

Baleen whales

During a controlled exposure experiment on Bowhead whales received broadband levels of <113 – 131 dB re 1 µPa (<11 – 30 dB above ambient) from a suction dredge were created leading to weak and inconspicuous avoidance, however the low frequency components were under-represented. Off the southeast coast of the US Northern Right whales exposed to intensive dredging by noisy hopper dredges apparently show some tolerance of this noise (cited in Richardson *et al.* 1995). The best documented case of long-term change by baleen whales is from Baja California where Gray whales breeding in lagoons subjected to industrial activities, including dredging were virtually absent during years with shipping which led to the suggestion that the constant dredging may have been the main source of disturbance (cited in Richardson *et al.* 1995). Marine mammals are often seen in close proximity to human activity and exhibit some tolerance to anthropogenic noise and other stimuli (Richardson *et al.* 1995). Baleen whales use shipping lanes and feed in rich fishing grounds occupied by large fishing vessels.

The main species of baleen whale in the waters adjacent to Howth is the minke whale but it only occurs during the summer and typically many kilometres from the harbour .

Odontocetes

Belugas, which are toothed odontocetes, showed less reaction to stationary dredges than moving barges in the Mackenzie estuary, Canada and it was concluded that passage of belugas along a shoreline was temporarily blocked by a dredging operation involving frequent barge traffic but not by a dredging operation with little barge traffic (cited in Richardson *et al.* 1995). More recently, Diederichs *et al.* (2010) through the use of acoustic monitoring with click detectors, showed that porpoises temporarily avoided an area where sand extraction took place off the Island of Sylt in Germany. The authors found that when the dredging vessel was closer than 600m to the monitoring location, it took three times longer before a porpoise was again detected compared with times without sand extraction. However, the material to be dredged from Howth is soft sediment not sand and noise generated through its movement will be less.

Harbour porpoise are by far the most frequently recorded odontocete species and have been regularly sighted just outside Howth Harbour.

Seals

There are also few studies of the effects of dredging on seals. Studies so far suggest that effects of dredging sound on pinnipeds may be limited. Between 2002 and 2003, during observations of dredging operations in Geraldton, Western Australia, it was reported that New Zealand fur seals and Australian sea lions showed no sign of disturbance reactions, despite the relative closeness of the dredging to popular haul-out sights (EPA, 2007; cited in Todd *et al.* 2014). Similarly, Hawaiian monk seals showed no adverse reactions to bucket dredgers around Tern Island (Gilmartin, 2003; cited in Todd *et al.* 2014).

Seals (grey) occur within the harbour and in adjacent waters.

5.2 | Potential Impacts of Vessel noise

Marine mammals are often very tolerant of shipping noise, being repeatedly exposed to many vessels, small and large. Pinnipeds also exhibit much tolerance and often haul out on man-made structures where there is considerable human activity. This exposure may lead to some chronic exposure to man-made noise, with which they tolerate. Ecological or physiological requirements may leave some marine mammals with no choice but to remain in these areas and continue to become chronically exposed to the effects of noise. In areas with repeated exposure, mammals may become habituated with a decline in avoidance responses and thus become less sensitive to noise and disturbance (Richardson *et al.* 1995).

Thus dredging seems to have less effect on marine mammals than moving sound sources although avoidance behaviour of marine mammals exposed to high levels of activity have been documented. Reactions, when measured have only occurred when received sound levels are well above ambient levels.

5.3 | Risk Assessment

The total amount to be dredged is estimated at 240,000 m^3 and with a full barge load only holding 150m^3 this will require 1600 open barge movements will be required.

5.3.1 Acoustic disturbance

The potential for disturbance to marine mammals is greatest when elevated levels of underwater noise are considered. Marine mammals, especially cetaceans, have well developed acoustic capabilities and are sensitive to sound at much higher frequencies than humans (Richardson *et al.* 1995). They are less sensitive to the lower frequencies but there is still great uncertainty over the effects of sound pressure levels on marine mammals and thus the assessment of its impact. Sources of noise include that generated by the vessel during dredging and transiting to and from the dump site, the noise generated by dredging and rock breaking and that generated during dumping.

Received levels of dredging noise by marine mammals can exceed ambient levels to considerable distances depending on the type of dredger used (Richardson *et al.* 1995). Hopper dredges produced broadband sound between 20-1000 Hz and the highest levels occurred during loading. Evans (2000) suggested dredging activities produce sounds varying from 172-185 db re 1 µPa at 1 metre over the broadband range 45 Hz to 7 kHz but there have been no studies examining the reaction of odontocetes to this activity. Audiograms for bottlenose dolphins show peak sensitivity between 50-60 kHz and no sensitivity below 2 kHz and above around 130 Khz (Richardson

et al. 1995). Because of rapid attenuation of low frequencies in shallow water dredge noise normally is undetectable underwater at ranges beyond 20-25km (Richardson *et al.* 1995). The effects of low frequency (4-8 kHz) noise level and duration in causing threshold shifts in bottlenose dolphins were predicted by Mooney *et al.* (2009). They found that if the Sound Exposure Level was kept constant significant shifts were induced by longer duration exposures but not for shorter exposures.

Recently Todd *et al.* (2014) reviewed the impacts of dredging on marine mammals and suggested a back-calculated source level of 163 dB re 1 mPa at 1 metre (bandwidth ¼ 20 Hz–100 kHz) for a backhoe dredging operation off the Shetlands of 179 dB re 1 mPa at 1 metre (bandwidth ¼ 3 Hz – 20 kHz). A second study estimated a source level of 179 dB re 1 mPa at 1 metre (bandwidth ¼ 3 Hz – 20 kHz) but used different scaling. Despite these elevated levels, they are mainly low frequency and below the peak frequency for echolocation and would attenuate quickly. There are no measurements available for long reach excavators but it's likely to be considerably less than these levels reported.

NPWS (2014) identify increased sound pressure levels above ambient do occur due to dredging which could be detected up to 10km from shore. These levels are thought to potentially cause masking or behavioural effects but are not thought to cause injury to a marine mammal. There is no guidance on the effects of noise generated by dumping of dredge material on marine mammals.

A limited amount of rock breaking (10%) will also be carried out. Though not covered under the NPWS (2014) Guidelines we are treating the sound pressure produced as similar to dredging and potential impacts consistent with those proposed for dredging. Rock breaking and dredging will be carried out concurrently and in the same areas so noise output with proposed marine works is consistent.

Noise associated with increased vessel traffic

Shipping produces low broadband and "tonal" narrowband sounds. The primary sources are propeller cavitation and singing and propulsion of other machinery (Richardson *et al.* 1995). For large and medium vessels tones dominate up to around 50Hz and broadband components may extend to 100Hz.

There will be very limited noise entering the marine environment during towing of an open barge with spoil to land for reclamation. Small vessels frequently enter and exit the harbour daily, so the presence of an additional vessel towing a barge will not be significant.

5.3.2 Physical Disturbance

The risk of injury or mortality is considered extremely low as any marine mammals (seals) in the harbour and in the immediate vicinity of the vessel are exposed to low frequency noise on a regular basis and would be accommodated to some degree. Harbour porpoises outside the harbour will not be exposed to physical disturbance.

5.3.3 Turbidity

Seabed disturbance through extraction, rejection, and disposal of sediments, along with outwash of excess materials, can result in increased turbidity and creation of sediment plumes. Sediment plumes have the ability to extend the impact of dredging over larger areas that would otherwise remain unaffected (Todd *et al.* 2014). Marine mammals often inhabit turbid environments and many utilize acoustic techniques to communicate and navigate.

5.3.4 Potential disturbance to life-cycle

The risk of disrupting the life cycle of marine mammals in the area is considered extremely low. Harbour porpoise dolphins and seals are primarily using the area for foraging throughout the year, minke whales during summer months and fin and humpbacks during winter. Marine mammals range over a wide area when foraging and there is no evidence (high sighting rates) that the dump site is an important foraging area.

The activity of a dredger and rock breaking could cause temporary displacement from the immediate area but is only likely to affect local seals inside the harbour and even then the effects will be very localized.

5.4 | NPWS Assessment Criteria

1. Do individuals or populations of marine mammal species occur within the proposed area?

There are a number of marine mammal species recorded in the area, especially harbour porpoise and grey seal. Grey seal regularly occur at the site. All are part of a larger population and very mobile.

2. Is the plan or project likely to result in death, injury or disturbance of individuals?

The project will not cause injury or death but could lead to very local disturbance, from noise associated with the project.

Noise Impact

The dredging activities proposed during this project will occur through a long reach excavator on a barge with some increased marine traffic associated with sea-going barges. It is very unlikely any noise generated will be capable of causing permanent or temporary hearing injury to a marine mammal. Localised disturbance to marine mammals in the works area may occur during operations, which will be predominantly seals, but is expected to be limited by:

- The sheltered location of the site. All cetaceans are recorded outside the harbour with only a small number of "resident" seals present within which are accommodated to human activities. Noise transmission to the wider bay is very unlikely.
- The very shallow nature of the construction site.
- The relatively high ambient noise levels, due to fishing and recreational vessel movements.
- The activities are planned to occur for 24 months which will included coinciding with grey seal breeding and moulting seasons and the calving period for harbour porpoise. Pupping for grey seals occurs between August and November and the local population will be expected to breed on Lambay Island and Ireland's Eye and not in the harbour and harbour porpoise are thought to move offshore to calve and thus breeding females will not be in the vicinity.

Physical Impact

The risk of injury or mortality is considered low as marine mammals in the in the immediate vicinity of the site are exposed to human activity on a daily basis and would be accommodated. The barges transporting

spoil are slow moving and thus any animals in the area would have sufficient time to avoid any collisions and thus injury or mortality.

3. Is it possible to estimate the number of individuals of each species that are likely to be affected?

The number of harbour porpoise in the Rockabill to Dalkey Island SAC has been estimated at around 400 individuals based on two dedicated surveys (O'Brien and Berrow 2016). Grey and harbour populations are also surveyed regularly with small numbers <10 present or hauled out in the harbour and at adjacent haul out sites. Lambay Island has the highest population of seals during the grey seal pupping season and moult period.

4. Will individuals be disturbed at a sensitive location or sensitive time during their life cycle?

It is proposed that works will be carried out from August 2020 to December 2021 through the whole annual life cycle. This includes grey seal pupping and breeding seasons and harbour porpoise calving and rearing periods. Grey seals breeding and moulting sites are mainly Lambay Island, 10km to the north with some individual potentially using Ireland's Eye and thus away from the construction activity. The works also occur within the peak pupping period for common seals but breeding females will be on the breeding grounds (locally mainly Lambay Island).

Although the works coincide with the peak harbour porpoise calving period it is not likely to have any affect as porpoise move offshore to calve and are thus not in the vicinity of the works. Neither grey nor common seals nor harbour porpoise are thought to be affected by the works.

5. Are the impacts likely to focus on a particular section of the species' population, e.g., adults vs. juveniles, males vs. females?

There are no data to suggest that any particular seal or cetacean gender or age group predominates in the around Howth Harbour. Both adult and juvenile grey seals have been recorded inside Howth Harbour.

6. Will the plan or project cause displacement from key functional areas, e.g., for breeding, foraging, resting or migration?

While grey seals frequently and regularly occur inside Howth Harbour in small numbers there may be local disturbance to these but they are accommodated to human activities and are likely to not be affected. Outside Howth Harbour it is unlikely there will be any disturbance to cetaceans or seals.

7. How quickly is the affected population likely to recover once the plan or project has ceased?

Seals inside Howth Harbour in small numbers there may be temporary disturbance to these but they are accommodated to human activities and are likely to not be affected. Outside Howth Harbour no marine mammals are likely to be affected.

5.5 | Mitigation

Grey seals within the harbour can potentially be affected by proposed operations. Harbour porpoise are considered as being particularly sensitive species to noise from demolition and dumping operations. Harbour

porpoise occur in the vicinity and have been recorded close to Howth Harbour but are unlikely to be exposed to construction activities.

Seals are a regular occurrence within Howth Harbour in small numbers and also occur outside the harbour and are the marine mammals most at risk from the proposed works. The mitigation measures recommended by the NPWS are for the presence of a trained and experienced Marine Observer (MMO) and the use of "ramp up" procedures for noise and vibration emitting operations. The proposed mitigation measures (Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters) recommended by the Department of Arts, Heritage and the Gaeltacht in 2014 are designed to mitigate any possible effects.

The following mitigation measures are proposed to minimise the potential impacts on marine mammals and to allow animals move away from the construction area:

1. All personnel will be appropriately trained about environmental issues prior to the start of the operation.
2. All equipment will be in good condition to avoid spillage or discharge of oil, smoke and excessive noise.
3. Refuelling will be carried out by competent and trained people away from any environmentally sensitive areas; and sea-going craft to be moored up securely.
4. An appropriate waste container will be placed to collect waste before the final disposal by authorised company and hazardous material storage areas will be identified, labelled, and properly marked and fitted with spill containment systems;
5. Excavators and barges will be checked for any fuel / oil leaks on a regular basis by the crew.
6. Any spills we be reported immediately to the site agent/authorities
7. In the event of a major spill due to damage to the sea-going craft. Locate and isolate, inform harbour authorities, Project Manager and environmental agency.
8. A dedicated Marine Mammal Observer will conduct a 15 minute watch for marine mammals within 200m of the dredger prior to start up. If a seal or cetacean (or otter) is sighted within 100m of the dredger, start-up must be delayed until the animal(s) is/are observed to move outside the mitigation zone or the 15 minutes has passed without the animal being sighted within the mitigation zone.
9. The long reach excavator will be started at lowest revs and increased over a 5 minute period to allow wildlife an opportunity to move further away from the excavator reaching full power.

5.6 | Residual Impacts

With implementation of the above mitigation measures, it is very unlikely that there will be negative residual impacts from the proposed construction activity on marine mammals in the area. It is also very unlikely that any animals will be injured or killed as a result of the proposed works. Seals using the harbour already show a high tolerance for shipping and other vessel noise and any animals which might be displaced from the vicinity of the excavator or barge can be expected to quickly re-establish use of the area following cessation of the works.

Cetaceans are not present within the harbour and are occur occasionally outside the harbour though are abundant in the vicinity and especially off Howth Head. They are therefore very unlikely to be impacted on by the works.

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Appendix 6

Benthic survey (Howth harbour Biological survey 2019 ASU)

Howth Harbour Biological Survey

ASU Report 07/19-1

Biological Survey

(June 2019)

Commissioned by: Malachy Walsh & Partners
Carried out by: Aquatic Service Unit

August 2019

1. Introduction and Brief

On behalf of Malachy Walsh and Partners, Aquatic Services Unit undertook a survey of the intertidal and sub-tidal benthos within the Howth Marina area and environs to identify the biological communities in the footprint of the proposed dredge area within the harbour and the disposal area outside immediately to the north.

2. Methodology

Fieldwork was carried out on the 4th June 2019. Benthic samples were taken by means of a $0.1m^2$, stainless steel, weighted Van-Veen grab. In addition, a shoreline survey was carried out in the immediate vicinity of the existing pier. Intertidal rocky shore transects were carried out where appropriate, and a single intertidal core was taken by means of a $0.028m^2$ stove pipe core to a depth of 15cm. All sampling stations were positioned using a Trimble Pro-XRS differential GPS. A complete list of stations sampled and the stations displayed on a map are given in Table I and Figure 1. Habitats were identified using the JNCC Marine Habitat Classification System (Connor *et al.*, 2004)

2.1 Benthic samples

A total of 19 sub-tidal stations were sampled for benthic faunal analysis, granulometric analysis and organic carbon analysis. Samples were taken exclusively where there was sufficient penetration of the Van-Veen grab.

- 1x $0.1m^2$ Van-Veen replicate grab samples were collected for benthic faunal analysis, and the samples were transferred to separate, labelled, 10 litre buckets. From each a small subsample (<100g) was collected for granulometric and Loss on Ignition analysis. (19 Samples).

Sample locations were chosen from within the areas to be dredged and areas where dredge spoil is to be disposed (Table II). In addition, control locations were selected in areas adjacent to the dredge and disposal zones where no dredging or disposal is to be undertaken. Figure 3 outlines the location of the proposed dredging and disposal activities on site.

A single core was taken in the intertidal area adjacent to the disposal area outside the harbour off Claremount Strand. A single $0.028m^2$ stove pipe core was collected.

2.2 Shore Survey

A walk-over survey of intertidal habitats and associated biological communities was undertaken along the northern side of the Howth West Pier during low spring tide on June 7th 2019. The survey was undertaken in fine weather under ideal conditions. The survey was largely confined to the hard substrate intertidal with just general observations on the wider soft sediment intertidal areas, a very large expanse of which, exposed during low tide, lies immediately to the west and north-west within the Baldoyle Estuary SAC but outside the immediate development area.

2.3 Sample Processing

Granulometric analysis was carried out on oven dried sediment samples from each station using the protocols described by Holme & McIntyre (1984). The sediment was passed through a series of nested brass test sieves with the aid of a mechanical shaker. The brass sieves chosen were 4mm, 2mm, 1mm, 500µm, 250µm, 125µm and 63µm. The sediments were then divided into three fractions: % Gravel (>2mm), % Sand (<2.0mm >63µm) and % Silt-Clay (<63µm). Further analysis of the sediment data was undertaken using the Gradistat package (Blott & Pye, 2001).

Organic matter was estimated using the Loss on Ignition (LOI) method. One gram of dried sediment was ashed at 450°C for 6 hours and organic carbon was calculated as % sediment weight loss.

On returning to the laboratory all faunal samples were sieved on a 1.0mm mesh sieve, preserved in buffered formalin and subsequently sorted by eye. All fauna were identified to the lowest taxonomic level possible using standard keys to north-west European fauna.

A number of biotic indices were calculated from the species / abundance matrix from the grab samples. These indices included Simpson's Dominance Index (where values range from low dominance [0] to high dominance [1]), Shannon-Wiener Diversity Index (Values ranging from low diversity [0] to high diversity [4]) and Pielou's Evenness Index (values ranging from low i.e. dominated by a few species [0] to high evenness i.e. a more even spread of species [1]).

Site	Northing	Easting	Site	Northing	Easting
S01	239918	328567	S11	239700	328781
S02	239805	328467	S12	239666	328879
S03	239754	328458	S13	239518	328614
S04	239644	328389	S14	239502	328829
S05	239604	328283	S15	239449	328746
S06	239728	328143	S16	239431	328670
S07	239792	328249	S17	239386	328455
S08	239852	328390	S18	239512	328442
S09	239793	328608	S19	239637	328507
S10	239670	328613	Core 01	239570	328135

Table I Location of sampling sites in Howth Harbour, Co. Dublin. All locations are given in Irish National Grid Co-ordinates.

Figure 1 Map showing positions of sampling stations in connection with the sub-tidal faunal sampling.

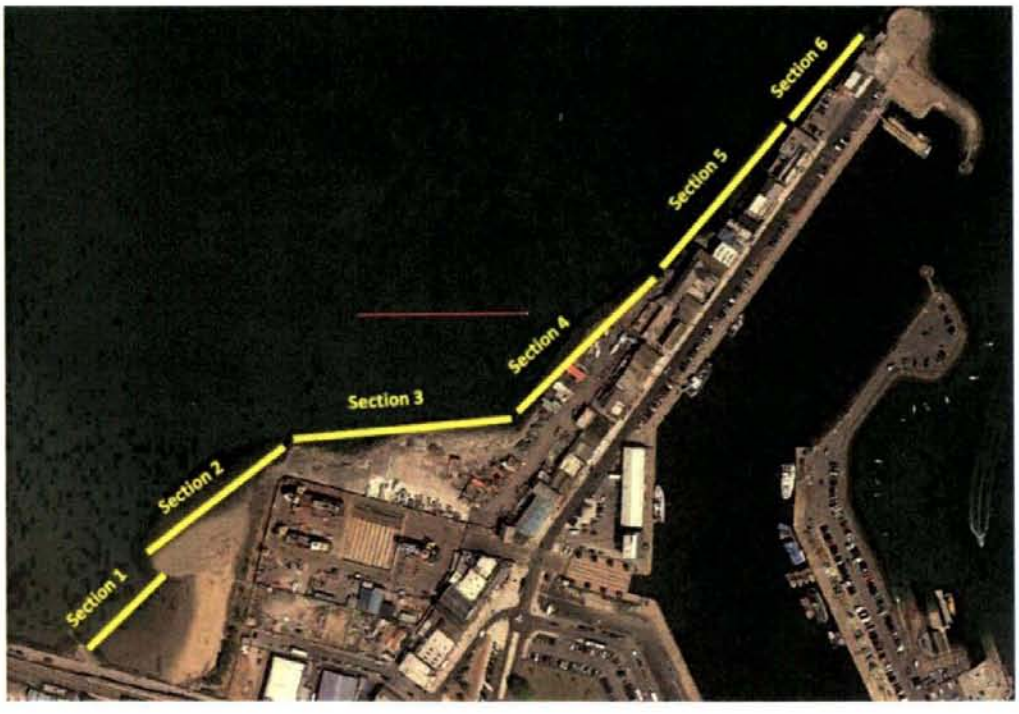

Figure 2 Study area showing survey sections from Intertidal hard benthos survey.

Site Name	Site Location	Site Name	Site Location
S01	Dredge Control	S11	Moorings Dredge
S02	Marina Spoil Disposal	S12	Moorings Dredge
S03	Moorings Disposal	S13	Marina Approach Channel Dredge
S04	Marina Approach Disposal	S14	Dredge Control
S05	Trawler Basin Disposal	S15	Marina Dredge
S06	Disposal Site Control	S16	Marina Dredge
S07	Disposal Site Control	S17	Trawler Basin Dredge
S08	Disposal Site Control	S18	Trawler Basin Dredge
S09	Approach Channel Dredge	S19	Trawler Basin Dredge
S10	Approach Channel Dredge	Core 01	Disposal Site Control

Table II Sampling locations in relation to dredging and disposal activities in Howth Harbour (See Figure 3 for indicative locations of activities)

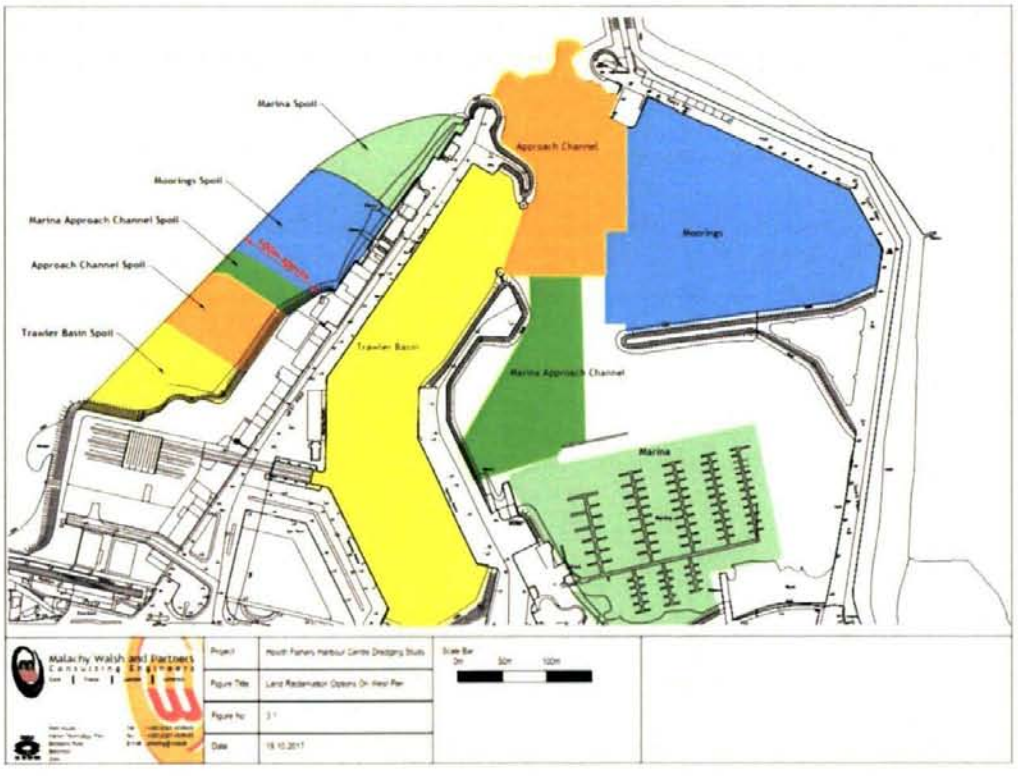

Figure 3 Location of dredge and disposal activities in Howth Harbour.

3. Results

3.1. Intertidal Shore Survey

The shore was walked from Claremount Strand at the landward end of the survey stretch out as far as the most seaward (easterly) end of the pier near to the harbour entrance. In the following section report the survey results are presented in sections based on the dominant type of shoreline substrate type and structure, the locations of which are shown in Figure 2.

Section 1 – Claremount Strand and Walkway Embankment

This strand is tucked into the south east corner of the survey stretch and outside of the area earmarked for sediment disposal. The upper shore section is topped on the landward side by mainly non-native terrestrial plants and species typical of more disturbed ground. The upper sand beach is barren medium sand which appears to be regularly managed by a digger (Plate 1A). Farther down the shore the sand-dominated intertidal area shows locally dense and active lugworm (*Arenicola marina*) burrows and casts (Plate 1B). This area is flanked along its landward western margin by a narrow, sloped, concrete and stone embankment which marks the edge of the Claremount Strand walkway (Plate 1C). It has a typical sheltered fucoid (brown seaweed) community with narrow bands of *Pelvetia canaliculata*, *Fucus spiralis* and *F. vesiculosus* topped with a band of the black lichen *Verrucaria maura*.

Section 2 – Low sloping intertidal mixed sediment shore.

This predominantly cobble and gravel, low gradient intertidal stretches from the Claremount sandy beach as far as the north west corner of steep rock-armour embankment fringing the boat repair yard (Figure 2). This shore is topped by barren gravel and cobble toward its southern end (Plate 4) and larger rock armour elements toward its norther extent. The main intertidal area is completely dominated by *Fucus vesiculosus* anchored on large angular cobbles and small boulders (Plate 2A) interspersed by patches of largely barren gravel. Farther up on this shore, sand hoppers occur frequently under stones while the winkles *Littorina saxatilis* and *Littorina littorea* are also present but in low densities. The barnacle *Semibalanus balanoides* is locally common on boulders with some scattered *Austrominius modestus* and limpets (*Patella vulgata*) also present. Juvenile green crabs (*Carcinus maenas*) occur frequently under seaweed and stoned toward the tide line along with very occasional beadlet anemones (*Actinia equina*). Toward the tideline also, the sand mason worm (*Lanice conchilega*) occurs between and under stones on sandy substrate. The north western edge of this section of shore gives way in the lower shore to a wide expanse of sandy intertidal with surface casts of *Arenicola* and *Lanice* tubes visible over large expanses (Plate 2B). The hard substrate section of this part of the shore, which is not earmarked for reclamation, can be classified as a moderate to low diversity example of the JNCC Habitat Type: LR.LLR.F.Fves.X *Fucus vesiculosus on mid eulittoral mixed substrata*. The main hard-substrate section of this shore ranges from 15-20m in width.

Section 3 – New Rock Armour Shore Adjoining the Boat Yard.

This section of shore is very steep and built from very large rock armour elements which form part of the seaward boundary of the boat-repair yard (Figure 2). It has only be in place for 2 or 3 years and is dominated by a very low diversity community which is clearly in the very early stages of colonisation and succession. In time the diversity will likely increase especially toward the lower shore fringe. The community present is dominated along the upper shore fringe by a sparse covering of the green alga Ulva sp. (most likely *U. intestinalis*)

(Plate 3A). Below this as far as the water line the shore is dominated by a virtual monoculture of *Fucus vesiculosus*, interspersed with *Ulva* and with a very patch understorey of the barnacles *S. balanoides* and *A. modestus*. Given the very low diversity and early succession stage of this section of shore it cannot be given a JNCC habitat classification with any degree of confidence. However, it will probably develop in time into a low diversity, sheltered to moderately exposed *Fucus vesiculosus* dominated rock shore. The low diversity will be determined by the very large rock-armour elements which provide very few micro-habitats. Moreover, the shore doesn't extend into a hard benthos infralittoral fringe where a greater diversity would be anticipated. This shore ranges from 5.5 -6m in width.

Section 4 – Older Rock Armour Shore

This section of rock armour shore is steep and extends into a narrow infralittoral fringe where a narrow kelp band including *Saccharina latissima* and *Laminaria digitata* are present. The upper shore is dominated by the black lichen *Verrucaria maura* with some yellow lichen (*Caloplaca marina*) also present in places (Plate 4A) followed by a steep barnacle and limpet dominated shore (Plate 4B) with a narrow Fucus serratus dominated lower shore – infralittoral fringe. Toward the north-western end of this section the gradient is less steep and the larger rock armour element act as 'benches' to accommodate more brown seaweed, *Fucus vesiculosus* above and *F. serratus* closer to the low waterline (Plate 4C). The mid shore in the barnacle-dominated areas has an almost complete cover of *S. balanoides* with occasional to frequent *A. modestus* both interspersed by limpets (*P. vulgata*), scattered dog whelks (*Nucella lapillus*) and *Littorina saxatilis*. The upper shore also had scattered clumps of *Pelvetia* and *Fucus spiralis*, along with patches of *Ulva intestinalis*. The lower shore, dominated by *Fucus serratus*, was the most diverse part of the shore with a variety of other algae also present including *Mastocarpus stellatus* and *Ceramium virgatum*, *Lomentaria articulata* and *Ulva lactuca*. Fauna present included occasional winkles and top shells (*Littorina mariae*, and *Gibbula cineraria*), and barnacles *Balanus crenatus* and keel worm (*Pomatoceros* sp.). Small shaded crevices / overhangs had the algae *Plumaria plumosa*, *Lomentaria articulata*, *Ulva* and *Chondrus crispus* and the orange sponge *Hymeniacidon perleve* (Plate 4D). This section of shore varies from 5.5-6m in width.

The principal habitat types along this stretch include: VLR.FLR.Lic.Ver.Ver Verrucaria maura on very exposed to very sheltered upper littoral fringe rock on the upper shore, LR.HLR.MusB.Sem.Sem Semibalanus balanoides, Patella vulgata and Littorina spp. on exposed to moderately exposed or vertical sheltered eulittoral rock on most of the middle to lower shore with elements of the related: LR.MLR.BF.FvesB Fucus vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock present at the seaward end of this section where Fucus vesiculosus is more common. The extreme lower shore was dominated by Fucus serratus was characterised by: LR.MLR.BF.Fser.Bo Fucus serratus and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders mixed with a very narrow band of Laminaria digitata and Saccharina latissima fringing the main subtidal soft sediment sandy habitat.

Section 5 – Upper Shore of Sloping Concrete and Laid Stone and Lower Shore of Scattered large Cobbles/Small Boulders

This section of shore is less steep and lacks the dominant rock armour elements of the previous sections (Figure 2). The upper and upper mid shore comprises a relatively smooth sloping substrate of concrete and flat pointed stone followed by a mid to lower shore dominated by angular barnacle covered boulders (Plate 5B) largely free of any fucoids with a lower shore fringe of *Fucus serratus*. The upper upper-mid shore is characterised by a

typical sheltered to moderately exposed shore-line zonation with *Verrucaria maura* on top followed by intermittent and more continuous narrow bands of *Fucus spiralis* and *Fucus vesiculosus* with some *Ascophyllum nodosum* with the red epiphytic *Polysiphonia lanosa*, in that order descending the shore (Plate 5A). The central lower section of the shore is dominated by *S. balanoides* covered boulders along with many limpets, periwinkles (*L. littorea*), dog whelks, (*N. lapillus*) and top shells (*Gibbula umbilicalis*) (Plate 5C). The *Fucus serratus*-dominated lower shore fringe had the following associated algae and fauna: *Mastocarpus stellatus, Chondrus crispus, Ulva lactuca, Dumontia contorta, Ceramium, Membranoptera alata* (Plate 5D). The barnacle *B. crenatus*, the sponge *Hymeniacidon perleve* and a colonial ascidian (*Botryllus* sp.) were also encrusting on the algae covered rocks (Plate 5D). The lower shore merges into an upper subtidal dominated by a fringe of boulders covered in *Laminaria digitata* or interspersed with *Saccharina latissima*. The main habitats on the shore were the narrow upper shore bands of black lichen and fucoids followed by the main central and lower shore barnacle dominated section which can be classified as a slight variant of: LR.HLR.MusB.Sem.LitX *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles. The narrow lower shore band of *Fucus serratus* habitat can be classified as: LR.MLR.BF.Fser *Fucus serratus* on moderately exposed lower eulittoral rock. This section of shore varies from 12-16m in width.

Section 6 – Upper Shore of Sloping Concrete/Laid Stone and lower shore of large barnacle-dominated boulders merging to narrow sub-tidal kelp zone.

This outermost section of the survey area is very similar in most respects to Section 5 except that the lower mid- and lower shore is dominated by larger boulders. The upper shore has distinct *Verrucaria maura, Pelvetia, Fucus spiralis* and *Fucus vesiculosus* and *Fucus serratus* with *Cladophora rupestris* on a smooth surface (Plate 6A). These regular algae bands were followed by an abrupt drop off into barnacle and limpet dominated lower shore (Figure 6B) which merges into a narrow *Fucus serratus* fringe which in turn merges into a *Laminaria digitata*-dominated infralittoral fringe (Plate 6C). The *Fucus serratus* zone reds include all the same species previously noted in Sections 4 and 5 in the same zone as well as *Palmaria palmata* (Plate 6D). Beneath and between algal patches encrusting colonies of sponges, bryozoans and barnacles, saddle oysters etc. Porcelain crabs (*Porcellana platycheles*) were also frequently encountered here where the highest diversity of organisms was evident within the survey reach (Plate 6E). This latter habitat can be classified as: LR.MLR.BF.Fser.Bo *Fucus serratus and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders*. This section of shore varies from 10-12m in width.

Plate 1 A
Section 1 – Claremount strand

Plate 1B
Section 1 – intertidal soft sediment with *Arenicola* bed

Plate 1 C
Section 1 – Claremount strand – rock armour

Plate 2A
Section 2 – *Fucus vesiculosus* on mid-shore cobble and boulders

Plate 2B
Section 3- clean rippled sand shore (view north)

Plate 3A
Section 3 – species poor rock armour

Plate 4A
Section 4 – *Verrucaria* with *Caloplaca*

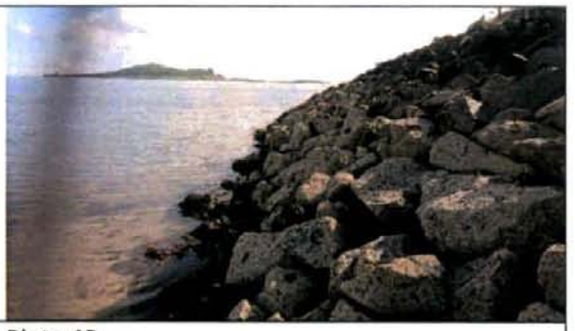

Plate 4B
Section 4 – Barnacles on rock armour

Plate 4C
Section 4 – *F. vesiculosus* on lower rock armour mid-lower shore

Plate 4D
Section 4 – *F. serratus* & Laminaria – Extreme lower shore

Plate 5A
Section 5/6 – Upper shore fucoid - dominated

Plate 5B
Section 5 – mid-lower barnacle dominated boulders

Plate 5C
Section 5 – closeup of barnacle and mollusc mid-lower shore

Plate 5D
Section 5 – Lower shore: *F. serratus*, with reds and *Ulva*

Plate 6A
Section 6 – Upper to Mid shore fucoid zones

Plate 6B
Section 6 – Large barnacle-covered boulders

Plate 6C
Section 6 – Lower shore (*F.serratus & L.digitata*)

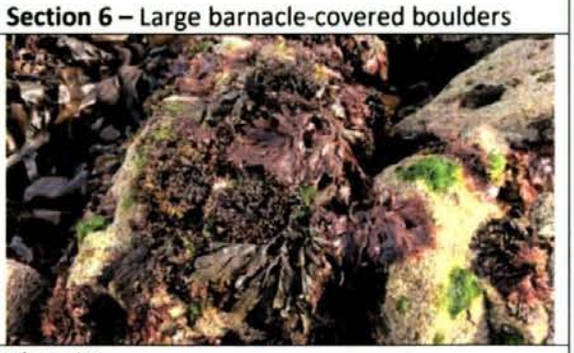

Plate 6D
Section 6 - Lower shore Red algal turfs

Overview of Site

The survey area was characterised by a fairly wide range of typical rocky / boulder hard benthos intertidal habitats. Sections 1 and 2, both immediately southwest of the proposed area for spoil deposition comprise essential moderate to low diversity habitats ranging from barren sand and barren gravel/small cobbles to low diversity fucoid seaweed covered large cobbles/small boulders. Section 2, the steep rock-armour embankment adjoining the boat repair yard is the least biologically diverse sections of the survey area and the first within the section earmarked for dredge spoil deposition.

Sections 4 to 6 are essentially very similar in shore zonation and species diversity with Section 4 still dominated by large rock armour elements throughout the shore, whereas the remaining 2 sections, differing in only fairly subtle respects, can be conveniently denoted by having a upper and mid-shore dominated by a more or less uniform smooth sloping section of laid stone and concrete substrate, abruptly succeeded in the mid to mid-lower section of the shore by larger or smaller barnacle covered boulders. In terms of species diversity the lower shore *Fucus serratus* fringe which subtended all sections from 4 to 6 inclusive was by far the most diverse habitat particularly in terms of red algae but also encrusting fauna such as barnacles, sponges, bryozoans etc. A feature of this lowest shore habitat was the apparent absence of calcareous red algal crusts which may relate in some way to the nature of the rock type present. The Fucus serratus fringe merged into an upper subtidal band of kelp dominated mainly by *Laminaria digitata* but with much *Saccharina latissima* also present and very occasional *Chorda filum*. This latter habitat began in Section 4 as an extremely narrow fringe and gradually widened out toward the end of Section 6 toward the head of the pier.

3.2 Sub-tidal Benthic Survey

3.2.1 Fauna

In total 55 taxa were encountered in the soft sediment samples. A full list of the species and their densities are given in Table V. Derived indices for each station is presented in Table III.

Stations S01 and S02 contained the highest number of taxa per site compared to all other sites, with numbers of 23 and 17 respectively (Table III). Three stations had only 2 taxa (Stations S16, S17 & S18). All sites located outside of the Howth Harbour basin had more diversity compared to all sites within the basin, with the exception of S09, which is located at the Harbour entrance.

The bivalve mollusc *Abra alba* is the most common taxa within the survey area, being present at 13 sites with 384 individuals identified (Table V). Other common taxa present across the survey area include the polychaete worms *Nephtys hombergii* (70 individuals across 12 sites), *Lanice conchilega* (51 individuals across 8 sites), *Owenia borealis* (36 individuals across 9 sites), the gastropod mollusc *Peringia ulvae* (269 individuals across 6 sites) and the bivalve molluscs *Fabulina fabula* (80 individuals across 8 sites) and *Corbula gibba* (13 individuals across 7 sites)

	Number of Species (S)	Number of Individuals (N)	Shannon-Wiener Diversity (H')	Pielou's Evenness (E)	Simpson's Dominance (D)
S01	23	380	1.38	0.439	0.483
S02	17	52	2.41	0.852	0.12
S03	13	54	1.83	0.712	0.256
S04	9	29	2.05	0.933	0.141
S05	9	19	1.88	0.857	0.197
S06	8	25	1.8	0.864	0.206
S07	9	47	1.37	0.622	0.41
S08	12	57	1.79	0.721	0.288
S09	11	35	2.05	0.855	0.167
S10	7	17	1.71	0.877	0.211
S11	7	169	0.926	0.476	0.533
S12	7	57	1.48	0.761	0.288
S13	5	53	1.17	0.73	0.36
S14	5	127	0.384	0.239	0.838
S15	4	7	1.28	0.921	0.306
S16	3	7	0.796	0.725	0.551
S17	2	2	0.693	1	0.5
S18	2	5	0.673	0.971	0.52
S19	2	5	0.5	0.722	0.68
Core 1	11	28	2.04	0.851	0.173

Table III Derived indices calculated for all stations in the survey area.

3.2.2 Granulometry & Organic Carbon

Results from the particle size analysis indicate the presence of two distinct sediment types in the area based on location in relation to the Howth Harbour Basin (Table V), Figure 4). Samples collected from within the Harbour basin consist of fine muds and sandy muds, while samples collected from outside the harbour basin consist of fine sands and muddy sands. This is reflected in the loss on ignition results for the site with higher loss on ignition results from all samples collected within the Harbour. This reflects the muddier nature and associated higher organic matter content of the sediment at these sites.

Station Number	Coarse %>2mm	Sand %<2mm>63µm	Silt-Clay %<63µm	LOI %	Substrate Type
S01	0.086%	41.907%	58.007%	2.46%	Slightly Gravelly Sandy Mud
S02	0.000%	64.789%	35.211%	2.74%	Muddy Sand
S03	0.949%	86.738%	12.313%	0.94%	Slightly Gravelly Muddy Sand
S04	0.000%	94.757%	5.243%	0.38%	Fine Sand
S05	0.000%	94.855%	5.145%	0.68%	Fine Sand
S06	0.000%	95.839%	4.161%	0.36%	Fine Sand
S07	0.000%	93.040%	6.960%	0.30%	Fine Sand
S08	0.051%	92.435%	7.513%	1.00%	Slightly Gravelly Sand
S09	0.391%	18.131%	81.478%	6.19%	Slightly Gravelly Sandy Mud
S10	0.000%	6.146%	93.854%	7.60%	Mud
S11	0.042%	5.513%	94.445%	6.85%	Slightly Gravely Mud
S12	0.094%	8.558%	91.348%	7.00%	Slightly Gravely Mud
S13	0.027%	3.772%	96.201%	7.32%	Slightly Gravely Mud
S14	0.000%	12.531%	87.469%	5.76%	Sandy Mud
S15	0.000%	1.549%	98.451%	8.51%	Mud
S16	0.043%	1.643%	98.314%	8.25%	Slightly Gravely Mud
S17	0.000%	1.834%	98.166%	9.00%	Mud
S18	0.467%	2.673%	96.860%	8.22%	Slightly Gravely Mud
S19	0.000%	3.993%	96.007%	6.77%	Mud

Table IV Sediment analysis results for organic carbon and granulometry from Howth Harbour.

	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	CORE1
Actiniaria indet.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemertea indet.	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Malmgrenia indet.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eteone indet.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eteone foliosa	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phyllodoce mucosa	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eumida sanguinea	-	1	5	6	6	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1
Glycera sp. A	-	3	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Glycera alba	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glycera rouxii	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nereis diversicolor	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Nereis virens	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Nephtys caeca	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nephtys hombergii	20	11	11	-	5	-	4	2	2	4	5	3	2	-	-	-	-	-	-	1
Scoloplos armiger	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Malacoceros vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	2	-	-
Pseudopolydora pulchra	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magelona johnstoni	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Magelona filiformis	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	4
Chaetozone christiei	-	-	-	4	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaetozone gibber	12	-	-	-	-	-	2	-	-	-	7	15	-	-	-	-	-	-	-	-
Diplocirrus glaucus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Capitella capitata (complex)	-	-	-	-	-	-	-	-	10	-	-	-	-	-	1	1	1	-	-	-
Mediomastus fragilis	3	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Notomastus latericeus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	CORE1
Ophelina acuminata	9	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Owenia borealis	9	1	3	4	2	4	6	2	-	-	-	-	-	-	-	-	-	-	-	5
Lagis koreni	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Melinna palmata	36	2	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Terebellides stroemi	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lanice conchilega	-	8	24	2	1	4	2	1	-	-	-	-	-	-	-	-	-	-	-	9
Tubificoides benedii	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-
Tubificoides pseudogaster	5	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Ampelisca brevicornis	1	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Gammarus indet.	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Aora gracilis	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Iphinoe trispinosa	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crangon crangon	-	-	1	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-
Carcinus maenas	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acrocnida branchialis	2	1	-	-	-	-	-	4	1	-	-	-	-	-	-	-	-	-	-	2
Peringia ulvae	-	-	-	-	-	-	-	-	-	-	118	7	23	116	2	-	-	3	-	-
Auriculinella bidentata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Nucula nitidosa	3	-	-	-	-	1	-	2	-	-	1	-	-	-	-	-	-	-	-	-
Goodallia triangularis	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Thyasira flexuosa	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Abra nitida	-	-	-	-	-	-	-	-	-	4	-	5	6	2	-	-	-	-	-	-
Abra alba	260	9	2	-	-	-	-	6	4	5	35	25	21	7	-	5	-	-	4	1
Moerella pygmaea	4	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Limecola balthica	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	1	-
Phaxas pellucidus	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	CORE1
Macomangulus tenuis	-	4	-	5	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Fabulina fabula	3	4	1	4	1	9	29	29	-	-	-	-	-	-	-	-	-	-	-	-
Kurtiella bidentata	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2
Chamelea striatula	-	1	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corbula gibba	3	1	-	-	-	-	-	4	-	1	2	1	1	-	-	-	-	-	-	-

Table V List of species recorded from soft sediment samples. All values expressed as numbers per Van-Veen Grab ($0.1m^2$) except Core1 which is expressed per $0.028m^2$.

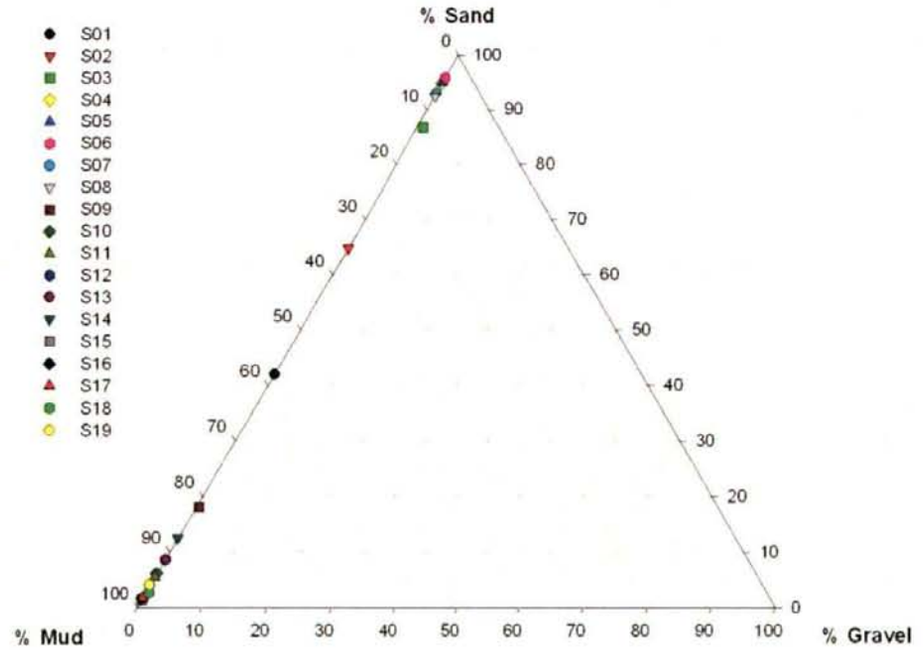

Figure 4 Ternary plot of granulometry results for faunal sampling.

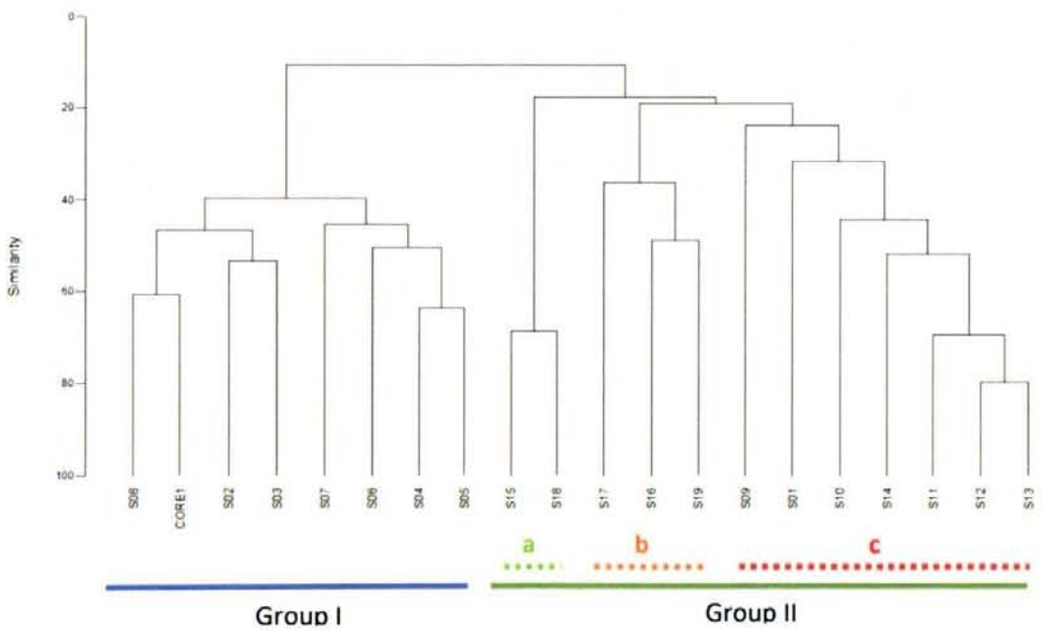

Figure 5 Cluster diagram identifying the presence of 2 faunal groups in the Howth Harbour study area. Group II contains three discrete faunal assemblages within the basin (marked in dashed lines)

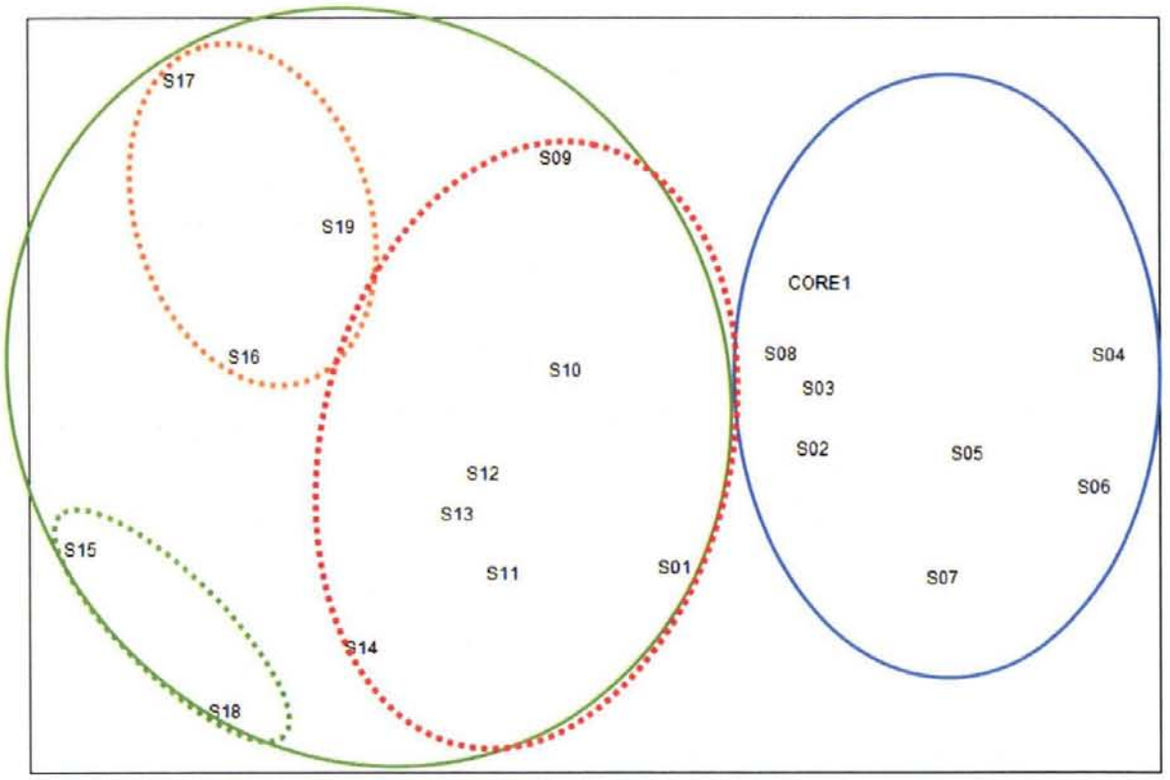

Figure 6 MDS plot highlighting the 2 faunal groups identified in the Howth Harbour study. (Group I is solid blue; Group II is solid green). Three discrete faunal groups have been identified in the Howth Harbour Basin, identified using the dashed lines.

GROUP I: (Average Similarity: 44.17)

Owenia borealis	*Nephtys hombergii*	*Abra alba*
Lanice conchilega	*Eumida sanguinea*	*Glycera* sp. A
Tellina fabula	*Macomangulus tenuis*	*Chamelea striatula*

GROUP II: (Average Similarity: 27.18)

Abra alba	*Capitella capitata* (complex)	*Corbula gibba*
Peringia ulvae	*Malococeros vulgaris*	
Nephtys hombergii	*Abra nitida*	

Table VI: Results from multivariate analysis of the fauna identified in each faunal group identified in the survey area.

3.2.3 Habitat Assessment

Multivariate analysis of the faunal data set identified the presence of 2 faunal groupings (Figures 5 and 6; Table VI). The distribution of these two groups is relative to their positions within or outside the Howth Harbour basin.

Group I consists of fauna typical of fine sands and muddy sands and reflects the nature of the sediment identified at these sites. All sites in this group are outside the Howth Harbour Basin. This group is dominated by the polychaetes *Owenia borealis*, *Lanice conchilega* and

Nephtys hombergii, *Eumida sanguinea* and *Glycera* sp, as well as the bivalve molluscs *Fabulina fabula*, *Macomangulus tenuis*, *Abra alba* and *Chamelea striatula*. This group has been identified as the Infralittoral muddy sand (SS.SSa.IMuSa) habitat (Connor *et al.*, 2004)

Group II consists of fauna typical of muds and sandy muds. The stations within this group are located within, and at the mouth of the Howth Harbour basin. Overall, diversity and abundances are lower in this group compared to Group I. This group is dominated by the bivalve mollusc *Abra alba* and the gastropod mollusc *Peringia ulvae*. Other species present within the basin, but in lower numbers, are the bivalve molluscs *Abra nitida*, *Corbula gibba* and the polychaetes *Nephtys hombergii*, *Malococeros vulgaris* and *Capitella capitata*. Three discrete groups are present within the basin (Figures 5 & 6). One discrete group (c) is located at the mouth and in more exposed areas of the basin (Stations S01 and S09-S14). Sites in this discrete group show more diversity than the remaining sites within the basin. The other discrete groups (a & b) are located in the more sheltered areas of the basin and contain low species diversity and abundances a these sites (S15-S19). Group II has been classified as the Infralittoral Fine Mud (SS.SMu.IFiMu) habitat which is a common habitat in harbours in Ireland and the UK (Connor *et al.*, 2004).

Conclusions

All species and habitats identified in the survey area are common in Irish coastal waters. In soft sediment areas within the basin, dominated by fine muds, abundances and diversities are low. Samples taken from within the areas to be dredged are similar to those taken as dredge site controls. Areas located outside the basin consist of sands and muddy sands, with no differences in habitat noted between the proposed disposal areas and the disposal control areas. Diversity is higher in samples collected outside the Howth basin.

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Appendix 7

Sea bird 2019/2020 Report Woodrow

Howth Harbour FHC Dredging
And Reclamation Works
Bird Surveys 2019 / 2020 Report

Report produced by Woodrow Sustainable Solutions Ltd.

For Malachy Walsh and Partners

On Behalf of Department of Agriculture, Food and the Marine

Woodrow Sustainable Solutions Ltd.

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June 2020

DOCUMENT CONTROL

Document	Howth Harbour Bird Surveys 2019 / 2020
Client	Report produced by Woodrow Sustainable Solutions Ltd. For Malachy Walsh and Partners On Behalf of Department of Agriculture
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Checked by client	MWP 17.04.2020
Status / Version / Date	Final / R02 / 15.06.2020

STATEMENT OF AUTHORITY

This report is written by Róisín NigFhloinn BA Mod (Hons) MSc, MCIEEM, and Mike Trewby BSc, MCIEEM. The report has undergone review and checking by Mike Trewby, and has been approved by Will Woodrow MSc MSc(Arch) CEcol MCIEEM.

Róisín NigFhloinn is a Senior Ecologist with Woodrow. Róisín has completed an honours B.Sc. specialising in Botany and a M.Sc. in Ecology and Management of the Natural Environment. She is a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM). She regularly carries out reporting on Ecological Impact Assessment and to inform Natura Impact Assessments / Appropriate Assessments carried out by statutory authorities. Furthermore, she has more than ten years' experience in habitat, mammal, bird and bat surveys for a number of large infrastructure schemes, commercial and residential projects. Róisín is an experienced Ecological Clerk of Works (ECoW).

Mike Trewby is a Senior Ecologist and Field Work Manager for Woodrow. He is an experienced ecologist with over 20 year's fieldwork & research experience. He is a full member of the CIEEM and conducts detailed, technical ecological assessments of projects including for windfarm and quarry developments, as well as for other large and smaller scale infrastructure and development projects, delivering ecological reporting to a high standard. He has developed his technical expertise in conducting faunal surveys to inform detailed impact assessment and compliance monitoring reports. Mike is an experienced ornithologist, with more than 20 years bird surveys experience in bird surveying for non-governmental organisations, as well as for ecological consultancy. Mike is regarded as one of the leading experts on chough *Pyrrhocorax pyrrhocorax* ecology in Ireland, having produced reports detailing the ecology of several regional chough populations, assisting in the designation of Special Protection Areas (SPAs) for this unique species. As a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM), he employs a high degree of competence and professional standard in his approach to environmental assessment.

The report has been checked and approved by Will Woodrow. Will is a Director at Woodrow Sustainable Solutions Ltd. He is an experienced ecologist, and ornithologist, with over 30 years of experience in ecological surveys and assessment. Will is a full member of the Chartered Institute of Ecology and Environmental Management and a Chartered Ecologist.

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B.A. Mod (Hons) – Natural Sciences (specialising in Botany), Trinity College, Dublin, 2008.

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Table of Contents

1 INTRODUCTION

This survey and report has been undertaken by Woodrow Sustainable Solutions Ltd. ('Woodrow') on behalf of Malachy Walsh and Partners ('MWP'). Woodrow were commissioned by MWP on behalf of The Department of Agriculture, Food and the Marine (DAFM) to undertake breeding bird and wintering bird surveys to inform a proposal at Howth Harbour, Co. Dublin. In addition, terrestrial habitat, otter and bat surveys were undertaken by Woodrow in 2019 to inform this work, and the results of this are provided within the *'Howth Harbour FHC Proposed Dredging and Reclamation Works – Terrestrial Habitat, Otter and Bat Survey Report 2019.'* (Woodrow, 2020).

The results of the bird surveys shall be used to inform the Ornithological Assessment of the Environmental Impact Assessment Report (EIAR) and Natura Impact Statement (NIS) for a proposed dredging project in Howth Harbour. The aim of this report is to provide bird survey results and data from across both the breeding and wintering season, and brief recommendations to inform this work. The detailed impact assessment and proposed mitigation for the project is not included here and will be carried out by MWP within their assessments for this scheme.

The report summarises the findings of the breeding and wintering bird surveys that were undertaken by Woodrow in 2019 and 2020 within the Survey Area for the Howth Harbour FHC Proposed Dredging and Reclamation Works.

Surveys were undertaken during the following periods:

- Breeding season: May 2019 – August 2019; and,
- Non-breeding season: October 2019 – March 2020.

1.1 Aim of the Bird Surveys in 2019 and 2020

The results of the ecology surveys conducted at the Application Site will inform the Biodiversity Chapter of the Environmental Impact Assessment Report (EIAR) being conducted by Malachy Walsh and Partners (MWP). In addition, data from these surveys will be used to inform a Natura Impact Statement (NIS) to be carried out for the Proposed Development. As such, Woodrow were requested to undertake breeding bird and winter bird surveys within the Howth Harbour area to assess the potential ecological constraints at this site, and to ascertain the risk of potential impacts upon birds utilising the environment in the vicinity of the works. This data is also being used to inform a Natura Impact Statement (NIS) in order to ascertain if the proposal may adversely affect the integrity of any European Sites.

This report outlines the surveys that were undertaken in relation to birds for the proposed Howth Harbour dredging and Reclamation works by Woodrow during May 2019 to March 2020. The results of these surveys are detailed here and have been interpreted, to provide general recommendations to inform this proposal. The report includes information from a desk study review, which lists recent or historic records within proximity of the site. A detailed assessment of the bird survey results is being carried out by MWP within their Natura Impact Statement (NIS) (MWP, 2020a).

The survey methodology is described in **Section 3** of this report, with the results of these surveys being presented in **Section 4** below. Conclusions and general recommendations are provided in **Section 5**.

1.1.1 Site Description and Context

Howth Harbour is situated on the north side of Howth Peninsula, to the north of Dublin Bay as illustrated in **Figure 1** below. The Harbour itself comprises of three main areas; a trawler basin entered between two bull-noses to the north, swing moorings area to the east and the yacht club marina.

For the purposes of the dredging project the Harbour is considered to comprise of five areas:

1. *Trawler Basin;*
2. *Harbour Approach Channel;*
3. *Mooring area;*
4. *Marina Approach Channel; and,*
5. *Marina Area.*

Howth Harbour operates as a Fishery Harbour Centre under the Department of Agriculture, Food and the Marine. The core fishing fleet is *c.* 65 vessels, and there is significant marine leisure activity including the Howth Yacht Club and the Howth Sailing and Boating Club, in addition to other local water-sports activities undertaken in this area by both locals, visitors and tourists. There are also a number of restaurants and shops along the West Pier. Fish processing and boat repair works are also undertaken on the Harbour.

The proposed site is situated in close proximity to 4 no. Special Protection Areas (SPA's) including:

Ireland's Eye SPA [Site Code: 004117]; Howth Head Coast SPA [Site Code: 004113]; Baldoyle Bay SPA [Site Code: 004016] and North Bull Island SPA [Site Code: 004006].

This report focuses on nearby SPA's which are protected for their ornithological interests, including wetland birds and waterbirds.

Nearby SPA locations are illustrated in **Figure 2** below.

1.1.2 Nearby Special Protection Areas (SPAs)

The Application Site is located immediately adjacent to the following Special Protection Areas (SPAs):

Ireland's Eye SPA [Site Code: 004117]

This SPA site lies approximately 358 m north of Howth Harbour and is designated for the following Special Conservation Interests (SCIs):

- Cormorant *(Phalacrocorax carbo)* [A017]
- Herring Gull *(Larus argentatus)* [A184]
- Kittiwake *(Rissa tridactyla)* [A188]
- Guillemot *(Uria aalge)* [A199]
- Razorbill *(Alca torda)* [A200]

"Ireland's Eye SPA, though a relatively small island, is of high ornithological importance, with five seabird species having populations of national importance. The regular presence of a breeding pair of Peregrine, an Annex I species, is also of note." (NPWS, 2011a)

The Site Synopsis for Ireland's Eye SPA can be obtained here: https://www.npws.ie/protected-sites/spa/004117

Howth Head Coast SPA [Site Code: 004113]

This SPA site lies *c.* 467 m east of East Pier and is designated for the following Special Conservation Interests (SCIs):

- Kittiwake *(Rissa tridactyla)* [A188]

Howth Head Coast SPA is of high ornithological importance as it supports a nationally important population of Kittiwake. It is also a traditional nesting site for Peregrine Falcon, a species that is listed on Annex I of the E.U. Birds Directive. The site is easily accessible and has important amenity and educational value due to its proximity to Dublin City. (NPWS, 2011b)

The Site Synopsis for Howth Head Coast SPA can be obtained here: https://www.npws.ie/protected-sites/spa/004113

Baldoyle Bay SPA [Site Code: 004016]

This SPA site lies *c.* 2.1 km west of West Pier and is designated for the following Special Conservation interests (SCIs):

- Light-bellied Brent Goose *(Branta bernicla hrota)* [A046]
- Shelduck *(Tadorna tadorna)* [A048]
- Ringed Plover *(Charadrius hiaticula)* [A137]
- Golden Plover *(Pluvialis apricaria)* [A140]
- Grey Plover *(Pluvialis squatarola)* [A141]
- Bar-tailed Godwit *(Limosa lapponica)* [A157]
- Wetland and Waterbirds [A999]

Baldoyle Bay SPA is of high conservation importance, for supporting internationally important numbers of Light-bellied Brent Goose as well as nationally important populations of a further five species, including Golden Plover and Bar-tailed Godwit, both species that are listed on Annex I of the E.U. Birds Directive. The inner part of the site is a Statutory Nature Reserve and also designated as a wetland of international importance under the Ramsar Convention. (NPWS, 2014a)

The Site Synopsis for Baldoyle Bay SPA can be obtained here: https://www.npws.ie/protected-sites/spa/004016

North Bull Island SPA [Site Code: 004006]

This SPA site lies *c.* 1.9 km south-west of West Pier (overland, adjacent to Sutton Cross and parallel to Carrickbrack Road). It is an internationally important SPA site and is designated for the following Special Conservation interests (SCIs):

- Light-bellied Brent Goose *(Branta bernicla hrota)* [A046]
- Shelduck *(Tadorna tadorna)* [A048]
- Teal *(Anas crecca)* [A052]
- Pintail *(Anas acuta)* [A054]
- Shoveler *(Anas clypeata)* [A056]
- Oystercatcher *(Haematopus ostralegus)* [A130]
- Golden Plover *(Pluvialis apricaria)* [A140]
- Grey Plover *(Pluvialis squatarola)* [A141]
- Knot *(Calidris canutus)* [A143]
- Sanderling *(Calidris alba)* [A144]
- Dunlin *(Calidris alpina)* [A149]
- Black-tailed Godwit *(Limosa limosa)* [A156]
- Bar-tailed Godwit *(Limosa lapponica)* [A157]
- Curlew *(Numenius arquata)* [A160]
- Redshank *(Tringa totanus)* [A162]
- Turnstone *(Arenaria interpres)* [A169]
- Black-headed Gull *(Chroicocephalus ridibundus)* [A179]
- Wetland and Waterbirds [A999]

"The North Bull Island SPA is an excellent example of an estuarine complex and is one of the top sites in Ireland for wintering waterfowl. It is of international importance on account of both the total number of waterfowl and the individual populations of Light-bellied Brent Goose, Black-tailed Godwit and Bar-tailed Godwit that use it. Also of significance is the regular presence of several species that are listed on Annex I of the E.U. Birds Directive, notably Golden Plover and Bar-tailed Godwit, but also Ruff and Short-eared Owl. North Bull Island is a Ramsar Convention site, and part of the North Bull Island SPA is a Statutory Nature Reserve and a Wildfowl Sanctuary." (NPWS, 2014b)

The Site Synopsis for North Bull Island SPA can be obtained here: https://www.npws.ie/protected-sites/spa/004006.

Other European Sites exist within the wider area – these are discussed in more detail within the Natura Impact Statement (NIS) for the project (MWP, 2020a).

Plate 1: View of Howth Harbour Marina and Howth Yacht Club

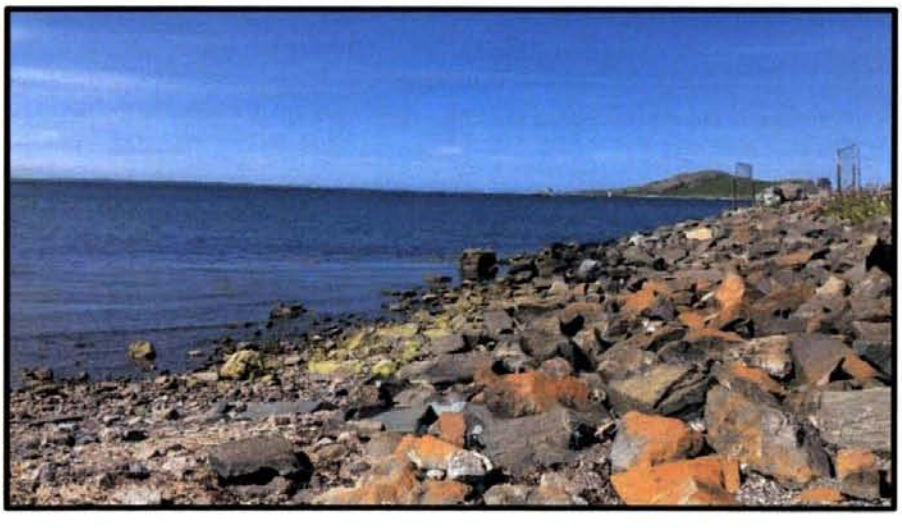
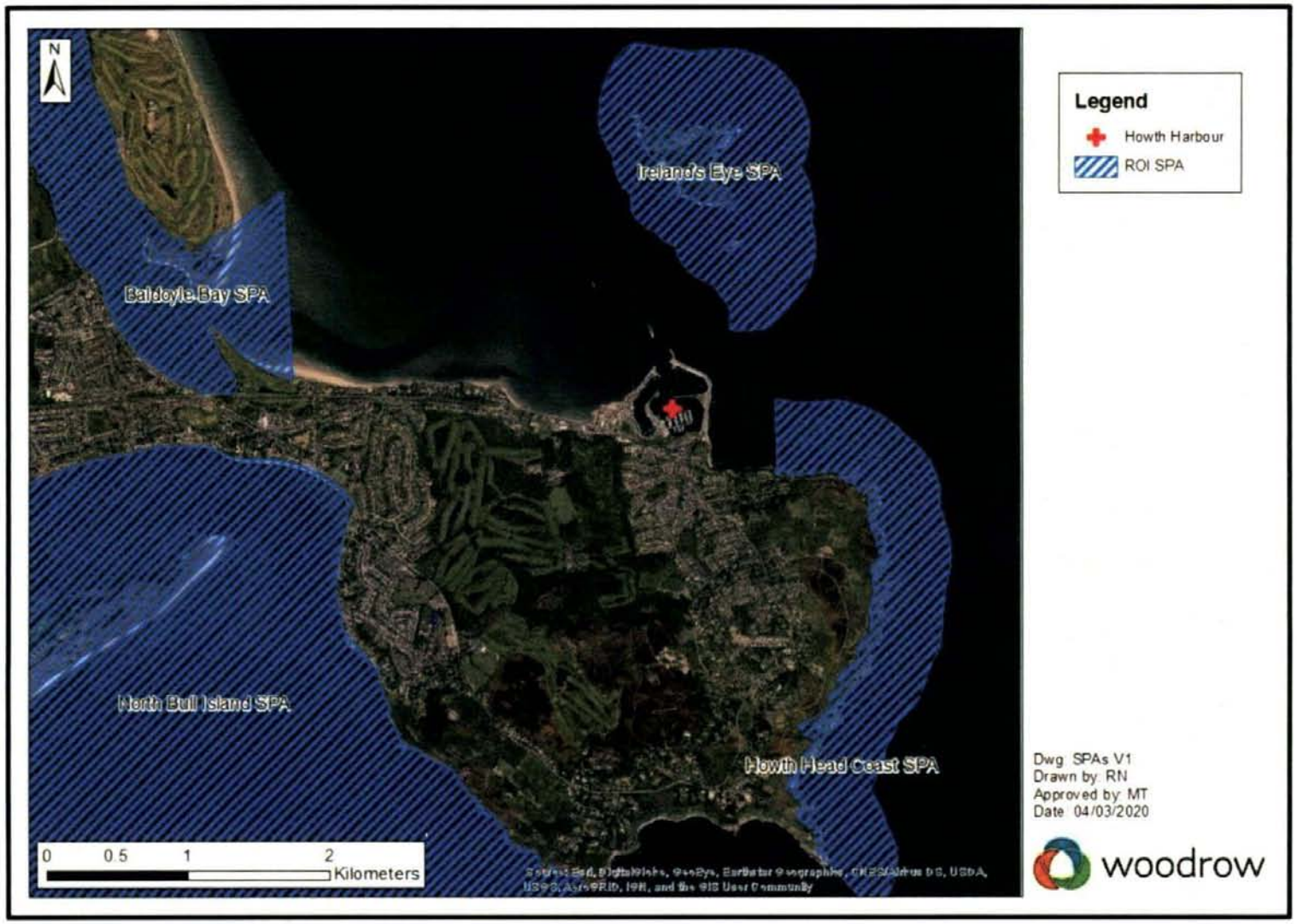


Plate 2: View from west of West Pier looking north towards Ireland's Eye

Figure 1 Site Location (Source: MWP, 2020)

Figure 2 Howth Harbour location in relation to Special Protection Areas (SPAs)



1.2 Brief Project Description

The full details and plans for the proposed project are available within the EIAR for the scheme (MWP, 2020b). However, a brief project description is provided here to contribute more background information to this survey results report.

Howth Fishery Harbour Centre (FHC) was last dredged in the 1980s, and due to build-up of silt, it is necessary to dredge the existing basins and approach channels in Howth Harbour in order to provide safe access, navigation and berthing to the vessels currently using the Harbour.

It is proposed to dredge *circa* 240,000 m^3 of material from the seabed within Howth FHC, process and re-use this material to the west of the West Pier in order to create an additional *circa* 4.8 Ha of land area. The aim of the overall project is to increase the depth of water in the Harbour in order to provide safe access for the largest range of vessel sizes and types on the widest range of tides, within the structural parameters of the existing Harbour quay structures; and, where possible to process and re-use or dispose of dredge material in an environmentally sensitive and cost effective manner.

Woodrow were commissioned to conduct a terrestrial habitat survey, otter, bat and bird surveys at Howth Harbour in 2019[1] in relation to the following proposed dredge and Reclamation design as summarised below (source: MWP, 2020b):

The proposed development involves the following main elements:

- Dredging the Harbour;
  - Standard hours for dredging are proposed to be 24/7;
  - Work compound will be lit at night;
- Claiming of land on the west side of the West Pier using dredge material;
- Coastal protection works to the perimeter of the Reclamation area;
- Landscaping on the Reclamation area;
- Pavements e.g. footways, roadways and parking areas;
- Slipway for access to the water;
- Storage areas for Harbour activities; and,
- Provision of services.

Equipment proposed to be used during night work includes:

- Long reach excavator;
- Pump with 500 m^3/ day capacity;
- Mixing / processing plant;
- An excavator on shore; and,
- A work boat for moving barges and a safety boat for emergencies.

Based on sediment sampling and testing results, the dredge material has been found to contain both Class 2 and Class 3 contamination levels. Contaminant levels are such that the vast majority of the material cannot be disposed of at sea directly.

[1] Winter bird surveys are on-going into March 2020 (Woodrow, 2020).

The proposed construction works can be divided into 4 stages as follows:

- Stage 1: Construction of a perimeter embankment and rock armour revetment to the seawards edge of the proposed Reclamation area;
- Stage 2: Dredging of Howth Harbour;
- Stage 3: Claim of land up to ground level; and,
- Stage 4: Finishings.

Full details regarding the Stages of this proposal are included within Chapter 2 of the EIAR - Description of The Proposed Development (MWP, 2020).

Monitoring of water quality (i.e. suspended sediments and turbidity) will be carried out on the outside of the dredge site at selected locations. Limits will be set based on background levels recorded prior to the works. Contingency plans will be in place for when the limits are exceeding by dredging activities. These will include ceasing works until the source is identified and adjustment of methodology until levels can be reduced below the limit levels.

Approximately, 10% of the dredge material will be bedrock. It will be necessary to break this rock prior to excavation. Breaking will be carried out by a long reach excavator using a rock breaker attachment such as a Sandvik G130. The broken rock will then be excavated from the bed by the long reach excavator with a bucket attachment. (No rock breaking will occur during night time hours).

Dredge spoil will be transferred into floating dump barges from the floating pontoon/ dredger. Once loaded, the barges will be towed to an unloading quay side point within the harbour. The unloading point will be located adjacent to the stabilisation and solidification process facility. The locations of dredging, quantities, times etc. will be recorded.

Bathymetric surveys will be used to ensure the correct dredge depths are achieved and to identify high-spots for further dredging.

1.2.1 Area to be Dredged

Howth Fishery Harbour Centre can be divided into a number of areas based on use:

- West Trawler Basin. This area is used almost solely for fishery activities. The only exception being the use of the north-west corner for ferry boat activities.
- Approach Channel. This is the area between and just south of the heads of the East and West Piers. It is used by all Harbour users to enter and exit the Harbour.
- Mooring Area. This is an area to the north east of the Harbour. It is presently used during the summer period by some 170 leisure craft on swing moorings.
- Marina Area. Within this area there is an area leased to Howth Yacht Club in which is the marina operator of the pontoons and facilities for some 300 leisure craft. The adjacent area is used by DAFM, the public and the Royal National Lifeboat Institution (RNLI).
- Marina Approach Channel. This is an area north and east of the existing area leased by Howth Yacht Club (HYC)

A site location plan showing the areas to be dredged and potential extent of an area proposed for Reclamation to the west of the West Pier is shown in **Figure 3** below. This drawing outlines the areas where works are proposed to be completed. This drawing was issued to Woodrow in March 2019, and was used to inform the Survey Area for the ecology surveys that were commissioned here in 2019 / 2020.

1.2.2 Reuse of Treated Contaminated Material Used in Reclamation West of the West Pier

The option of re-using the contaminated material, following treatment in Reclamation, is being considered and the area immediately to the west of the West Pier has been identified as the most suitable Reclamation location. The Reclamation area will be developed for mixed use.

This reuse option involves pre-treatment of the dredged contaminated material to de-water and lock-in the contaminants. The proposed Reclamation works to the west of West Pier will also require protection works in the form of a rock armour revetment.

The potential programme of works is outlined in **Table 1** below.

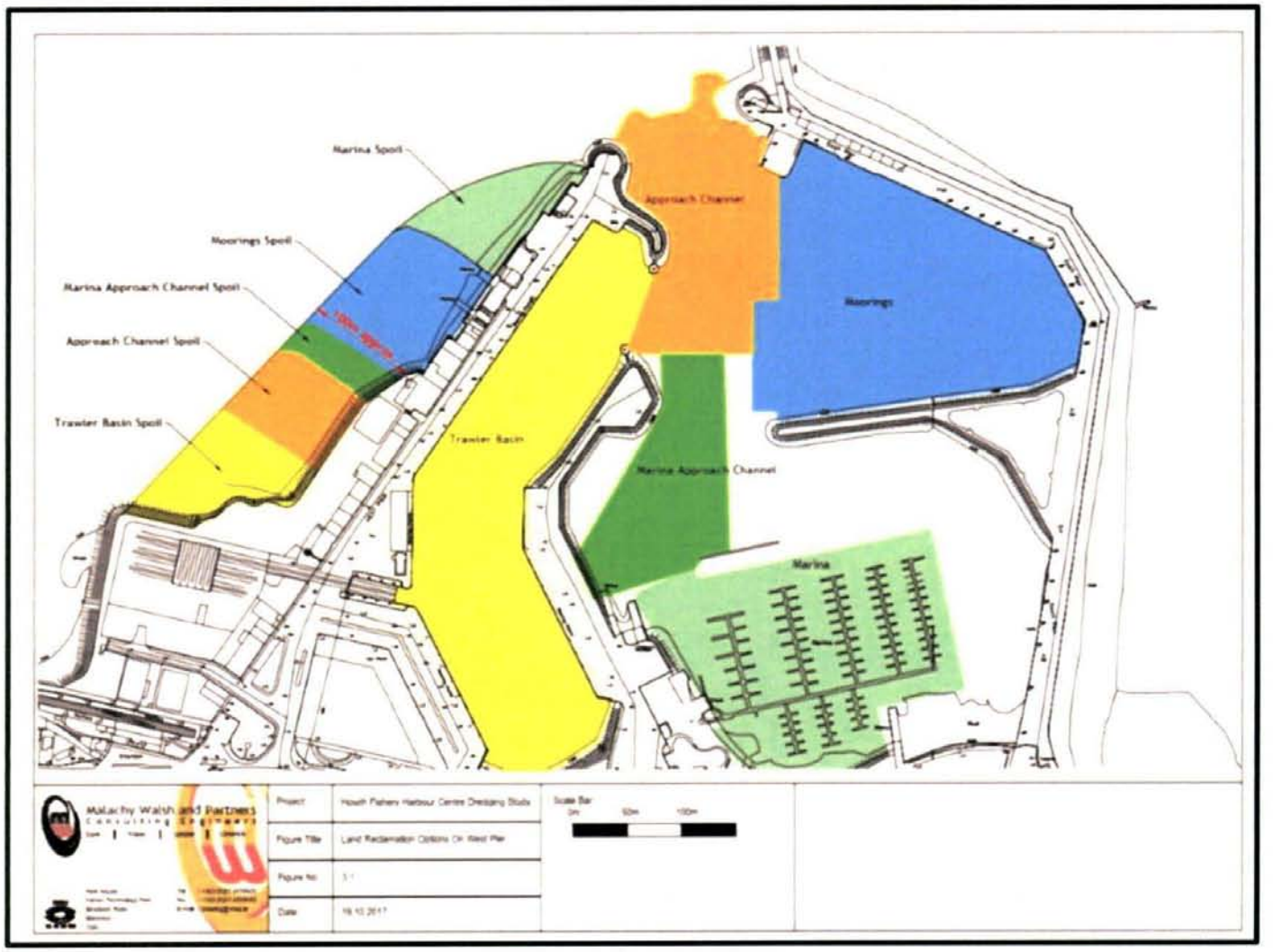
Plate 3: A black guillemot *Cepphus grylle* in Howth Harbour (Photo courtesy of John Fox)

Table 1: The proposed Programme of Works is likely to be as follows, but in accordance with any required mitigation (Source: MWP, 2020):

Year	1												2											
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Stage1 – Perimeter Embankment																								
Stage2 - Dredging of Howth Harbour																								
Stage3 - Reclamation of land up to ground level																								
Stage4 - Finishings																								

Figure 3 Proposed Dredging and Reclamation Option (Source: MWP, April 2019)

Note – this preliminary design is subject to amendments and was used to inform the surveys in 2019.



2 LEGISLATIVE PROTECTION, POLICIES AND GUIDANCE

2.1 Birds

2.1.1 EU Habitats Directive 92/43/EEC, European Communities (Natural Habitats) Regulations 1997, European Communities (Birds and Natural Habitats) Regulations 2011

The Habitats Directive provides the basis of protection for European Sites, namely Special Protection Areas ("SPAs") and Special Areas of Conservation ("SACs"). Article 6 of the EU Habitats Directive requires that any proposal that may have a significant effect on a European Site must be subject to an Appropriate Assessment. If there are likely significant effects identified within the screening stage, an Appropriate Assessment is required in order to ascertain the potential impact of a proposal on the reasons for which the site is designated i.e. the sites Qualifying Interest (QI) species / habitats and Special Scientific Interests (SCI) for which there are listed Conservation Objectives. The assessment must thereby ascertain the potential for adverse impacts on the integrity of the site. A proposal that may adversely impact the integrity of the site may not be consented except in the absence of *'Feasible Alternative Solutions'* and in the event of *'Imperative Reasons of Overriding Public Interest'*. This can only progress if compensation measures can be agreed and secured that would maintain integrity of the European site(s) concerned.

The Habitats Directive was transposed in to Irish law by the European Communities (Natural Habitats) Regulations 1997 and subsequently amended in the European Communities (Birds and Natural Habitats) Regulations 2011. Regulation 42 of the 2011 regulations requires that any proposal likely to have a significant effect on a European Site, alone or in combination with other operations or activities, needs to be assessed with respect to its potential impact on the site's conservation objectives (through an Appropriate Assessment) and that the decision-making authority should be furnished with a Natura Impact Statement that incorporates a Screening Assessment and Appropriate Assessment as necessary.

The Habitats Directive also provides for the protection of species listed under Annex IV of the Directive wherever they occur. As such, member states must ensure that a strict protection regime is applied across their entire natural range within the EU, both within and outside European Sites.

2.1.2 EU Birds Directive 79/409/EEC

EU Birds Directive 79/409/EEC ("the Birds Directive") establishes a system of general protection for all wild birds throughout the European Union. Annex I of the Birds Directive comprises 175 bird species that are rare, vulnerable to habitat changes or in danger of extinction within the European Union. Article 4 establishes clearly that, wherever those species occur, they should be the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in the area of distribution. Similar actions should be taken by Member States regarding migratory species, even if they are not listed in Annex I.

2.1.3 Bern and Bonn Convention

The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1982) exists to conserve all species and their habitats. The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979, enacted 1983) was instigated to protect migrant species across all European boundaries.

2.1.4 The Wildlife Act (1976) as amended (2000)

The Wildlife Act 1976 gives protection to a wide variety of birds, animals and plants in the Republic of Ireland. It is unlawful to disturb, injure or cause damage to their breeding or resting place wherever these occur without an appropriate licence from National Parks and Wildlife Service ("NPWS"). All birds, their nests and eggs are protected under law in Ireland through the Wildlife Act 1976 (as amended in 2000). Wilful destruction of an active nest from the building stage until the chicks have fledged is an offence. The act also provides a mechanism to give statutory protection to Natural Heritage Areas ("NHAs"). The amendment in 2000 broadens the scope of the Wildlife Acts to include most species, including the majority of fish and aquatic invertebrate species which were excluded from the 1976 Act.

2.2 Polices

2.2.1 The SEA Directive

Local planning authorities are required to give due consideration to nature conservation interests under the guidance of the SEA Directive 2001/42/EC. This directive states that the protected status afforded to species, such as breeding birds or those listed under EU Directives, means that planning authorities must consider their presence in order to reduce the impact of developments through mitigation measures.

2.2.2 The National Biodiversity Plan

This plan confers general responsibilities on all participants in the development process to take account of protected species. *"The overall objective is to secure the conservation, and where possible the enhancement, and sustainable use of biological diversity in Ireland and to contribute to conservation and sustainable use of biodiversity globally"*. The current plan was launched for the period of 2013 – 2021 (NPWS, 2013). A new third plan is currently under review. Action 28 of the current plan requires Ireland, in consultation with Northern Ireland, to control introduced species and to prevent, or minimise, future (accidental or deliberate) introduction of alien species, which might threaten biodiversity.

2.3 Guidance

2.3.1 CIEEM Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal

The 'CIEEM Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine' (2018, updated in 2019) ("the CIEEM Guidelines"), published by the Chartered Institute of Ecology and Environmental Management ("CIEEM"), are the acknowledged reference on ecological impact assessment and reflect the current thinking on good practice in ecological impact assessment across the UK and Ireland. They are consistent with the British Standard on Biodiversity, which provides recommendations on topics such as professional practice, proportionality, pre-application discussions, ecological surveys, adequacy of ecological information, reporting and monitoring.

These CIEEM Guidelines have the endorsement of the Institute of Environmental Management and Assessment ("IEMA"), the Chartered Institute of Water and Environmental Management, Northern Ireland Department of the Environment ("NIEA"), Scottish Natural Heritage ("SNH"), The Wildlife Trusts and other leading environmental organisations such as the National Parks and Wildlife Service ("NPWS").

3 METHODOLOGY

3.1 Desktop Study

A desktop study was undertaken to gather information on the likely distribution of species and habitats in the general area prior to the field survey visits, so that a more targeted approach to surveying could be undertaken. This involved a search of records provided by the National Biodiversity Data Centre (NBDC) and National Parks and Wildlife Service (NPWS), a review of IWeBS Site Summary reports[2], and information from the NPWS website regarding local designated sites, particularly Special Protection Areas (SPAs). The search was conducted as follows:

- NBDC and NPWS records of Birds within the 10 km NGR Square of Howth Harbour;
- The Baldoyle Bay SPA Supporting Document[3] was consulted with particular attention being given the records for roosting birds using the count areas of OUL38; OUL37 and OUL36 which lie in close proximity to the West Pier and the proposed Reclamation Site (see **Figure I-I**, **Appendix I**);
- I-WeBS summary site data for the count areas that lie in closest proximity to Howth Harbour [please note, the Application Site does not lie within an I-WeBS count site] (see **Figure II-I**, **Appendix II**); and,
- Supporting information for other designated sites which lie immediately adjacent to Howth Harbour were also consulted (i.e. documents listed on the NPWS website for Ireland's Eye SPA [Site Code: 004117][4]; Howth Head Coast SPA [Site Code: 004113][5]; and, North Bull Island SPA [Site Code: 004006][6]).

The results of this desk-based assessment are provided in **Section 3** below.

Plate 4: A pair of purple sandpiper *Calidris maritima* in Howth Harbour (Photo courtesy of John Fox)

[2] Available at: https://birdwatchireland.ie/our-work/surveys-research/research-surveys/irish-wetland-bird-survey/
[3] NPWS (2012) Baldoyle Bay Special Protection Area (SPA) – Site Code 4016. Conservation Objectives Supporting Document. Version 1. Available at: https://www.npws.ie/sites/default/files/publications/pdf/004016_Baldoyle%20Bay%20SPA%20Supporting%20Doc_V1.pdf (please note there is no detailed Supporting Document currently available for Howth Head Coast SPA).
[4] Available at: https://www.npws.ie/protected-sites/spa/004117
[5] Available at: https://www.npws.ie/protected-sites/spa/004113
[6] Available at: https://www.npws.ie/protected-sites/spa/004006

3.2 Existing Ecological Records

Online databases were consulted in order to establish historic records of important and protected species of, or likelihood of, their occurrence (through range information). The National Biodiversity Data Centre ("NBDC"), which incorporates records from a number of different sources, was interrogated for all records within a 10 km square encompassing the Application Site and surrounds.

I-WeBS summary data is available for the following nearby sites:

- Baldoyle Bay;
- Ireland's Eye; and,
- Dublin Bay (North Bull Island).

This information has been tabulated and can be seen in **Appendix II.**

3.3 Protected areas / designated sites

Shapefiles of designated areas in the Republic of Ireland, namely Special Protection Areas (SPAs), were downloaded from the NPWS website and imported onto ArcGIS. Proximity of the application to designated areas, and potential for connectivity with the application was assessed using ArcGIS, ortho-photographs and Ordnance Survey maps.

3.4 Field Study

3.4.1 Breeding Bird Surveys

Three visits (6th May, 27th May and 17th June in 2019) were undertaken to record breeding birds in the environs of Howth Harbour, with the survey area being extended up to 500 m from the proposed works.

Breeding bird surveys followed the common bird census (CBS) methodology, as described in Gilbert *et al.* (1998) - summarising Marchant (1983) and Marchant *et al.* (1990). This approach, which employs territory mapping, is appropriate where there is a requirement to map the distribution of breeding birds across an entire site. These surveys were also used to identify sites used by coastal breeding waders (such as ringed plover and oystercatchers) and any breeding seabirds (gulls and black guillemots).

Surveys commenced from sunrise and were undertaken over the early morning period for a duration of up to four hours. It was advised that surveyors avoid the hour before sunrise (i.e. the dawn to sunrise period) to avoid the peak dawn chorus which would bias the result. Surveys were undertaken in favourable weather conditions, avoiding periods of moderate to strong winds (greater than Beaufort F5), and persistent rain and/or in poor visibility.

The whole site was covered at a slow pace in a single visit, and the route adopted took surveyors within 50 m of all parts of the Application Site, with this interval decreasing on a discretionary basis for areas where closer inspections were required, e.g. dense scrub. All woody vegetation within the walkover survey area was walked and the direction of the survey route was varied between visits to remove bias in timings of coverage.

Surveyors identified and recorded the activity of birds on a map of the site. Locations of bird breeding that was identified across the site are shown on a map in **Appendix III**. On this basis the number of territories for each species within the site could be estimated, recording breeding distribution of species and

providing greater detail on habitat-bird relationships. The aim of this survey was to provide a species list for breeding birds and breeding distribution – numbers of territories are indicative only.

Bird records were divided (based on behaviour in combination with location and other factors) into breeding / territorial behaviours, and non-breeding behaviours. The map in **Appendix III** highlights the location of any important breeding sites, as well as species abundance and distribution.

3.4.2 High Tide/ Low Tide Bird Usage Mapping

There are no I-WeBS count sections covering Howth Harbour and as such new sections have been delineated – see **Figure 4** below. The new count sections incorporated a section utilised during low tide counts conducted over winter 2015-16 that covered the west wall (rock armour) of the harbour and the area of sand flats to the west (see **Appendix I**). The aim was to map bird usage of Howth Harbour and environs by employing 'snap-shot' counts conducted at low tide and at high tide. High tide and high tide (HT/LT) surveys were conducted during the summer of 2019 (May to August) on the following dates:

Month	**Low tide**	**High tide**
May 2019	6th	6th
	27th	27th
June 2019	17th	17th
August 2019	19th	-
Total	**4**	**3**

This was repeated over the non-breeding season with 12 visits conducted between October and March inclusive, as follows:

Month	**Low tide**	**High tide**
October 2019	1st	1st (unfinished[7])
	-	2nd
	23rd	23rd
November 2019	6th	3rd
	17th	17th
	26th	26th
December 2019	9th	9th
January 2020	6th	7th
	21st	21st
February 2020	6th	6th
	17th	20th
March 2020[8]	10th	10th
	23rd	23rd
Total	**12**	**13**

[7] Survey on 1st October was postponed for completion due to bad weather.
[8] During the March 2020 surveys the surveyor also checked for signs of breeding black guillemots returning to the Harbour – none noted on 10th March 2020.

Methodology is based on the approach outlined in Lewis & Tierney (2014). Summary counts were undertaken over a three-hour period, with low tide (LT) or high tide (HT) in the middle and the following information was recorded:

- Survey type LT or HT and tide time.
- Survey start and end times for each count section.
- Weather conditions (wind force/ direction, rainfall, cloud cover, temperature, visibility).
- Sea state.
- Any disturbance factors occurring within the count section – area impacted shown on field maps, noting:
    - Type of disturbance (e.g. dog walker, kite surfer);
    - Duration of disturbance event – occurring at start of count, occurring throughout count, occurring periodically throughout count, single event; and,
    - Level to which birds were affected – no visible impact, vigilant, localised displacement, displaced to beyond count section.
- Location of birds – marked on map or recorded on Eco-log.
- Species and number of birds (*distinguish if counts are duplications recording multiple/additional areas utilised during count period).
- Behaviour of birds (feeding, roosting or loafing and flight).
- Tidal habitat usage of birds (sea, exposed intertidal, salt marsh, terrestrial).

**Note: The aim was to generate single (snap-shot) counts for each of the count sections, which avoids double counting of birds; however, if required duplicate records were taken (e.g. when an interesting alternative feeding record occurred after the initial count). Counts were independent for each of the count sections, meaning the same birds could be recorded in different count sections if moving between sections during the count period.*

Significant winter roost sites are highlighted on **Figure V-I** in **Appendix V**.

Figure 4 **Howth Harbour bird usage mapping count sections**

3.4.3 Breeding Seabird Surveys

Breeding Seabird Surveys targeted two specific Special Protection Areas (SPAs), Howth Head SPA and Ireland's Eye SPA. The coastline was divided into count sections and the sections employed in Seabird 2000 (Mitchell *et al.* 2004) were utilised to allow for comparison with counts conducted in previous years.

The breeding seabird surveys covered the following Seabird 2000 counts sections:

Howth Head (see **Figure 5**).

- HH A1 – north coast beyond SPA
- HH 1 – north coast west of Howth Head to end of SPA
- HH 2 – Howth Head and section of east coast

Ireland's Eye (see **Figure 5**).

- IE 1 – north coast
- IE 2 – east coast
- IE 3 – Thulla (island was not accessed by foot)
- IE 4 – interior

All breeding seabirds were counted within the selected count sections where appropriate and a range of censusing techniques were employed, including land and boat-based counts, as described in Walsh *et al.* (1995). **Table 1** below summaries the census techniques that were employed for seabird species breeding within the study area.

The optimal survey window recommended for black guillemots (April) was missed for 2019 (see Survey Limitations in **Section 3.5** below), however an early May count of adult birds associated with potential breeding sites was undertaken, which is considered acceptable (Walsh *et al.* 1995). In addition, repeated visits during 2019 were used to pin down breeding sites (AOS) in the environs of the harbour. Black guillemots were last surveyed in this area as part of the national census conducted in 2017/18 (results are pending and not documented here). Furthermore, it was decided that the cormorant colony breeding on the rocky islet off Ireland's Eye (Thulla) would not be counted by accessing the island, as this would have caused unnecessary disturbance to breeding birds. Estimates from boat-based counts were undertaken instead, which was also the approach employed in 2017/18.

3.4.4 Black Guillemot Surveys

Typically, large scale (national) black guillemot surveys rely on breeding population estimates derived from counts of individuals in April that are recorded adjacent to suitable breeding habitat. These counts are conducted prior to the nesting period when birds are more conspicuous. Counts later in the breeding season, once birds are incubating, are likely to underestimate the numbers of birds. The black guillemot counts reported in Seabird 2000 were undertaken in 1988-89 as part of a national census. The count sections surveyed for black guillemots are different for those employed for other seabird species and the area of interest is encompassed by three count sections including: Howth Harbour, Ireland's Eye and all the rocky shore of the Howth Head peninsula from Sutton to Howth Harbour.

In 2019, only the section covering Howth Harbour and part of the Howth Head peninsula section (to the Nose of Howth) were covered employing pre-breeding season counts of individuals. For potential breeding sites in the environs of Howth Harbour, ongoing monitoring of nesting activity continued over the 2019 breeding season surveys. This was required to identify nesting locations in relation to the proposed works. Additional checks for breeding activity were made in March 2020.

Figure 5 Breeding Seabird Survey Count Sections

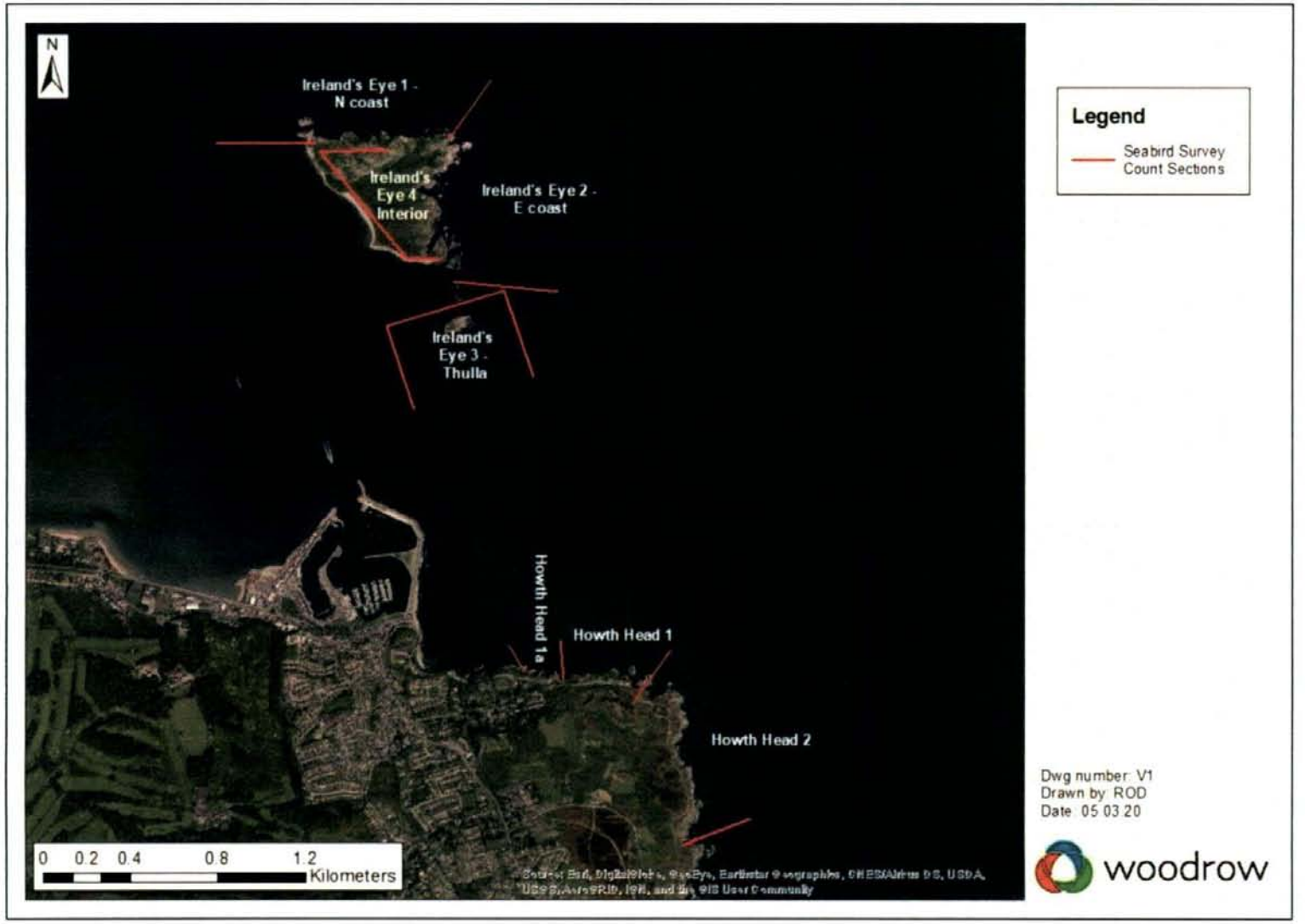


Table 1. Methodological approaches for species of breeding seabirds know to occur on Howth Head and Howth Head

BTO code	Species	Methods (see Walsh *et al.* 1995)	Count unit[9]	Howth Harbour	Howth Head	Ireland's Eye
F.	**Fulmar** *Fulmarus glacialis*	*Whole-colony census method* - Land-based VP counts (x1), validated with boat-based counts (x2)	AOS	na	Breed on sea cliffs	Breed on sea cliffs
GX	**Gannet** *Morus bassana*	*Census method 1* - Land-based VP counts (x1), validated with boat-based counts (x2)	AOS/AON	na	na	Breed on cliffs of stack & NE cliff of main island
CA	**Cormorant** *Phalacrocorax carbo*	*Census method 1* - Land-based VP counts (x1), validated with boat-based counts (x2)	AON	na	na	**QI of SPA** - Main colony on Thulla & also on north coast in some years
SA	**Shag** *Phalacrocorax aristotelis*	*Census method* - Land-based VP counts (x1), validated with boat-based counts (x2)	AON	na	Breed is small numbers on sea cliffs & in caves	Breed is small numbers on sea cliffs & in caves
LB	**Lesser black-backed gull** *Larus fuscus*	*Method 1 (Larus gulls)* - Land-based VP counts (x1) for interior of Ireland's Eye,	AOT/AON	na	na	Colony in middle of island
HG	**Herring gull** *Larus argentatus*	*Method 1 (Larus gulls)* - Land-based VP counts (x1), for interior of Ireland's Eye, with cliff nesters surveyed using boat-based counts (x2)	AOT/AON	Nesting on buildings	Small numbers breed on sea cliffs	**QI of SPA** - Core colony on eastern slope, also on Thulla & sea cliffs
GB	**Great black-backed gull** *Larus marinus*	*Method 1 (Larus gulls)* - Land-based VP counts (x1) for interior of Ireland's Eye, with cliff nesters surveyed using boat-based counts (x2)	AOT/AON	na	Small numbers breed on sea cliffs	Main colony spead from NW to NE, also on Thulla
KI	**Kittiwake** *Rissa tridactyla*	*Census method* - Land-based VP counts (x1), validated with boat-based counts (x2)	AON (also counts of trace nests)	na	**QI of SPA** - Sub-colonies spread round Howth Head	**QI of SPA** - Sub-colonies spread from NE cliffs to stack & around north coast

[9] AOS = Apparently occupied site AON = Apparently occupied nest AOT = Apparently occupied territory Ind.= Individuals

GU	**Guillemot** *Uria aalge*	*Whole-colony census method* - Land-based VP counts (x1), validated with boat-based counts (x2)	Ind.	na	Sub-colonies breed on sea cliff	**QI of SPA** - breeding from NE cliffs to stack & around north coast
RA	**Razorbill** *Alca torda*	*Whole-colony census method* - Land-based VP counts (x1), validated with boat-based counts (x2)	Ind.	na	Sub-colonies breed on sea cliff	**QI of SPA** - breeding from NE cliffs to stack & around north coast
TY	**Black guillemot** *Cepphus grylle*	a) Pre-breeding season counts of adults associating with a colony b) Repeated visits to map AOS in Howth Hrb - Land based monitoring (x4 visits minimum)	a) Adults associated with colony b) AOS for small colonies (Howth Hrb)	Nest in crevices of harbour	Small number nesting in crevices of seas cliffs on north coast, with more distributed around the headland	Small number nesting in crevices of seas cliffs
PU	**Puffin** *Fratercula arctica*	No strict methods to be followed, counts of individuals on land & at sea undertaken while surveying for other species. Note: Accurate surveying requires multiple dusk counts.	Ind./AOB	na	na	Breeding on the northern cliffs