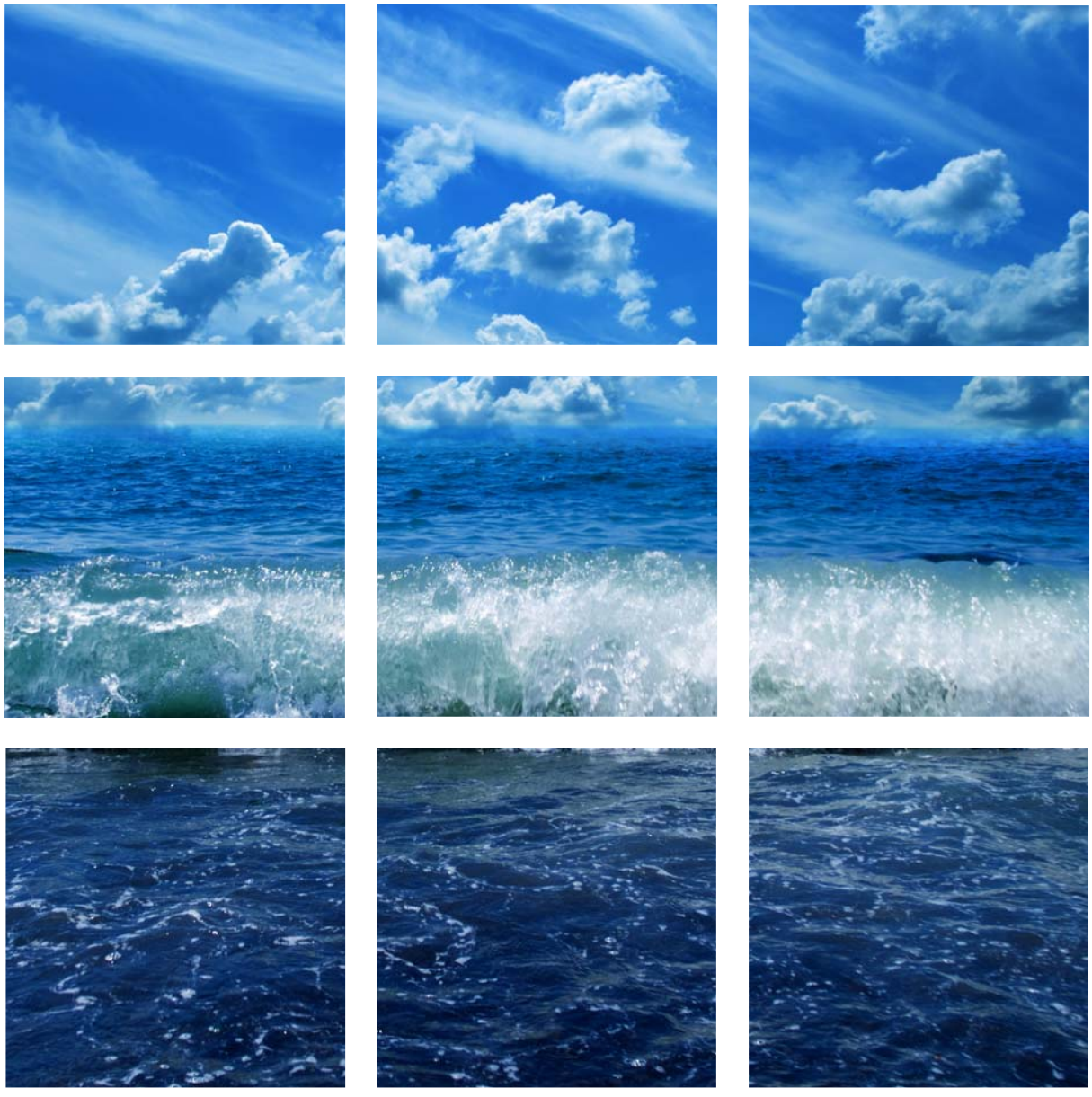
Irish Coastal Protection Strategy Study Phase 2 - South East Coast

Work Packages 2, 3 & 4A - Technical Report Appendices 1-6, 9

IBE0104/June 2010



Appendices

Appendix 1: Storm Track Figures

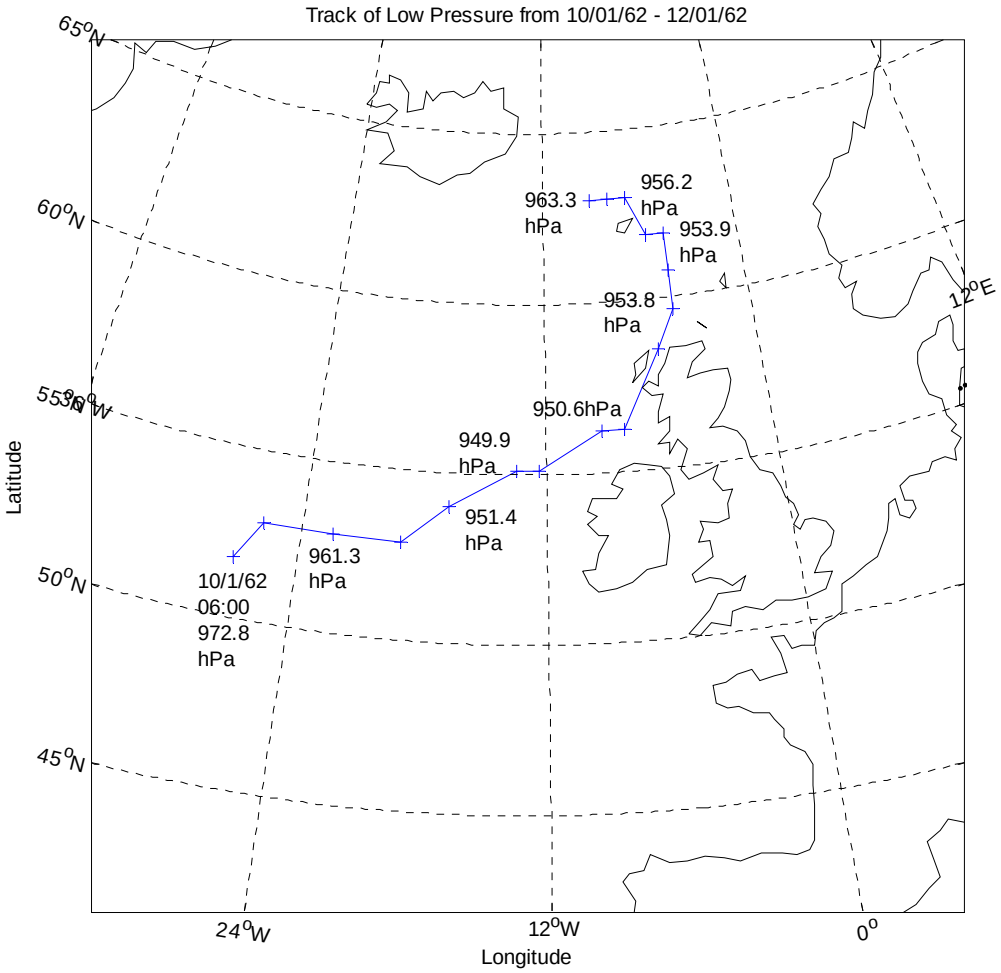


Figure 1: Centre of storm from 10/01/62 - 12/01/62 plotted at 3 hourly intervals, resulting in maximum surge level of 0.764m. in Dublin Bay and 0.637m. at Rosslare

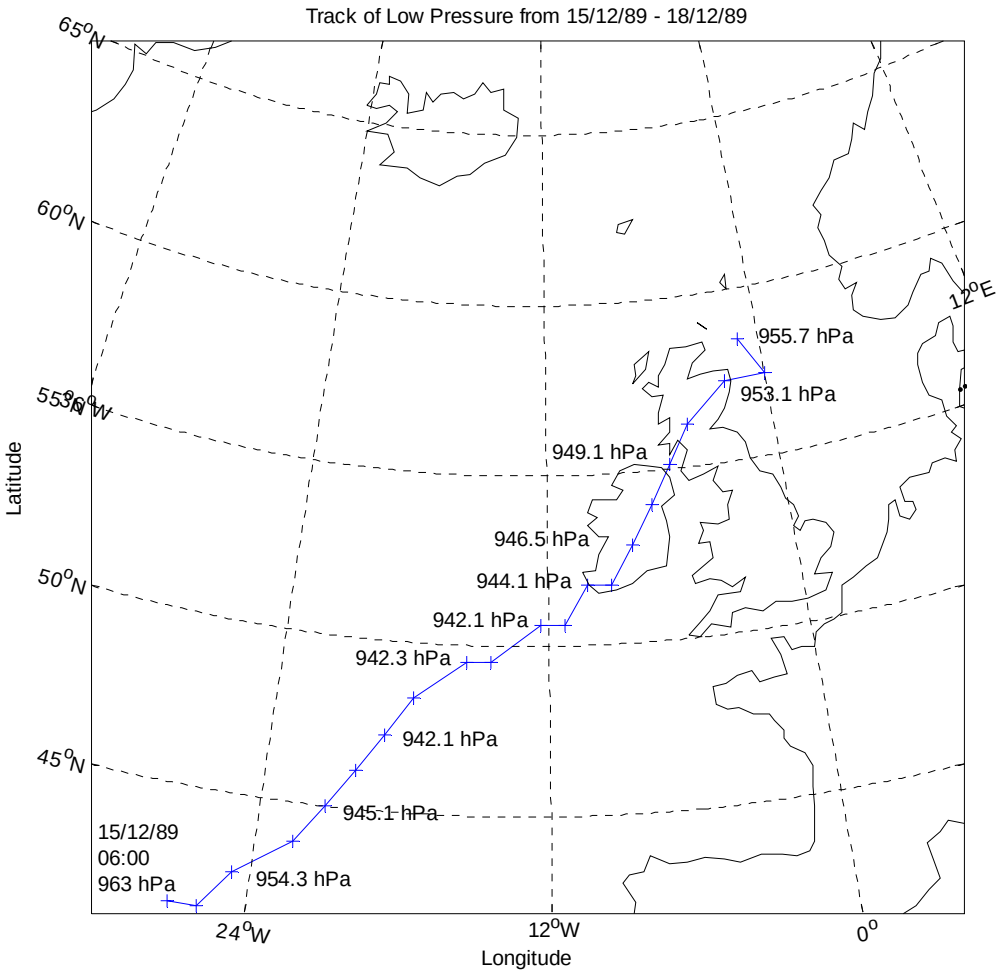


Figure 2: Centre of storm from 15/12/89 - 18/12/89 plotted at 3 hourly intervals, resulting in maximum surge level of 0.937m. in Dublin Bay and 0.869m. at Rosslare

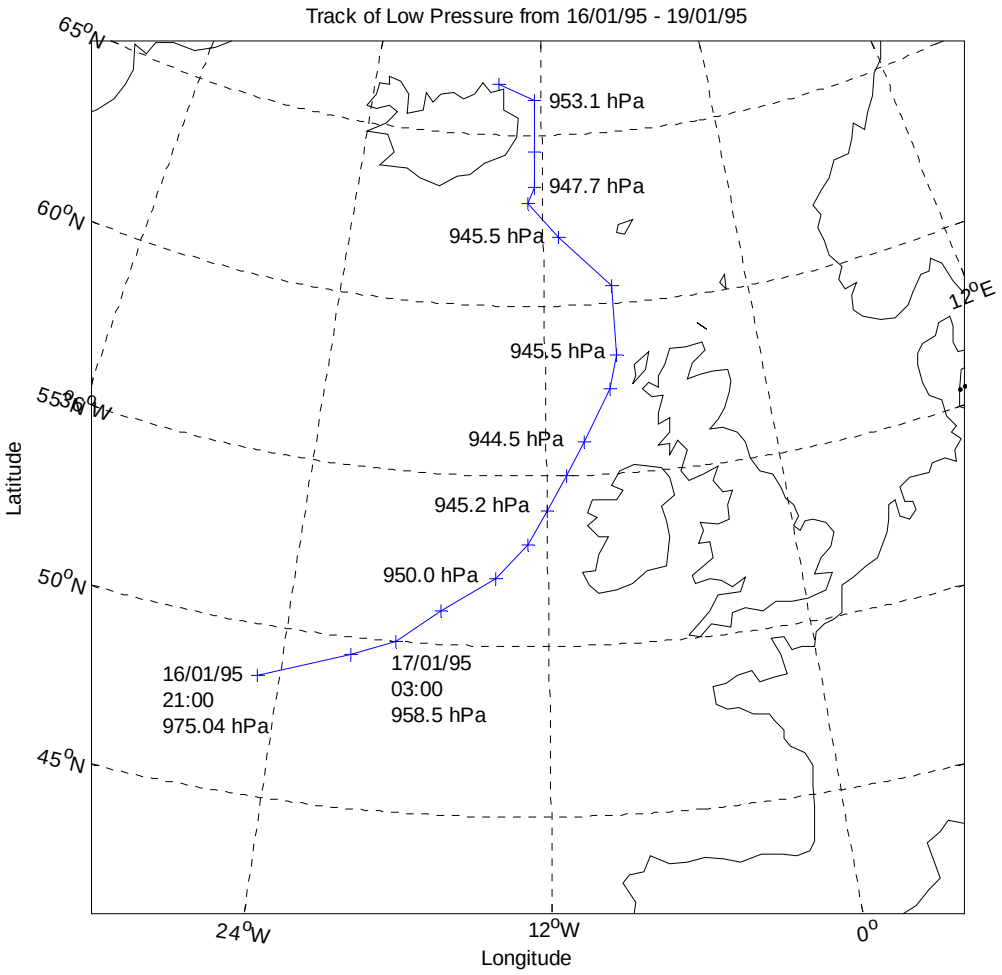


Figure 3: Centre of storm from 16/01/95 - 19/01/95 plotted at 3 hourly intervals, resulting in maximum surge level of 0.752m. in Dublin Bay and 0.654m. at Rosslare

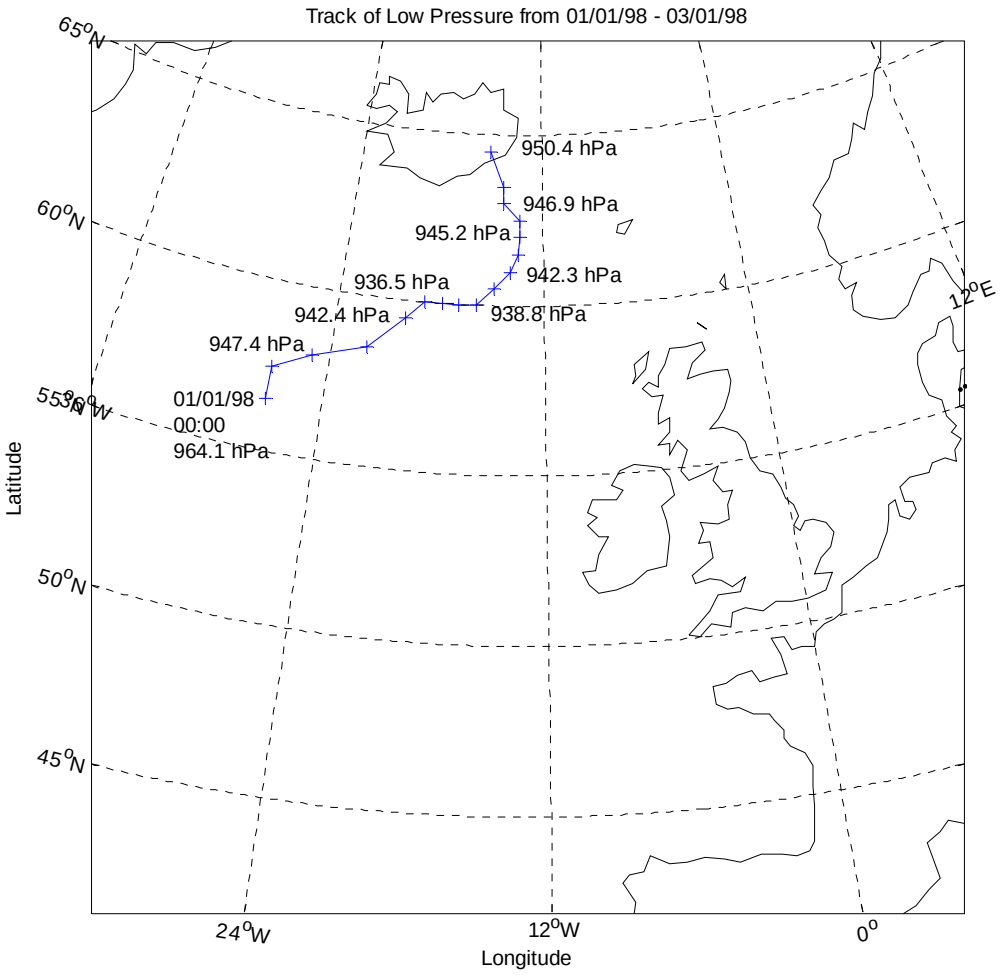


Figure 4 : Centre of storm from 01/01/98 - 03/01/98 plotted at 3 hourly intervals, resulting in maximum surge level of 0.867m. in Dublin Bay and 0.621m. at Rosslare

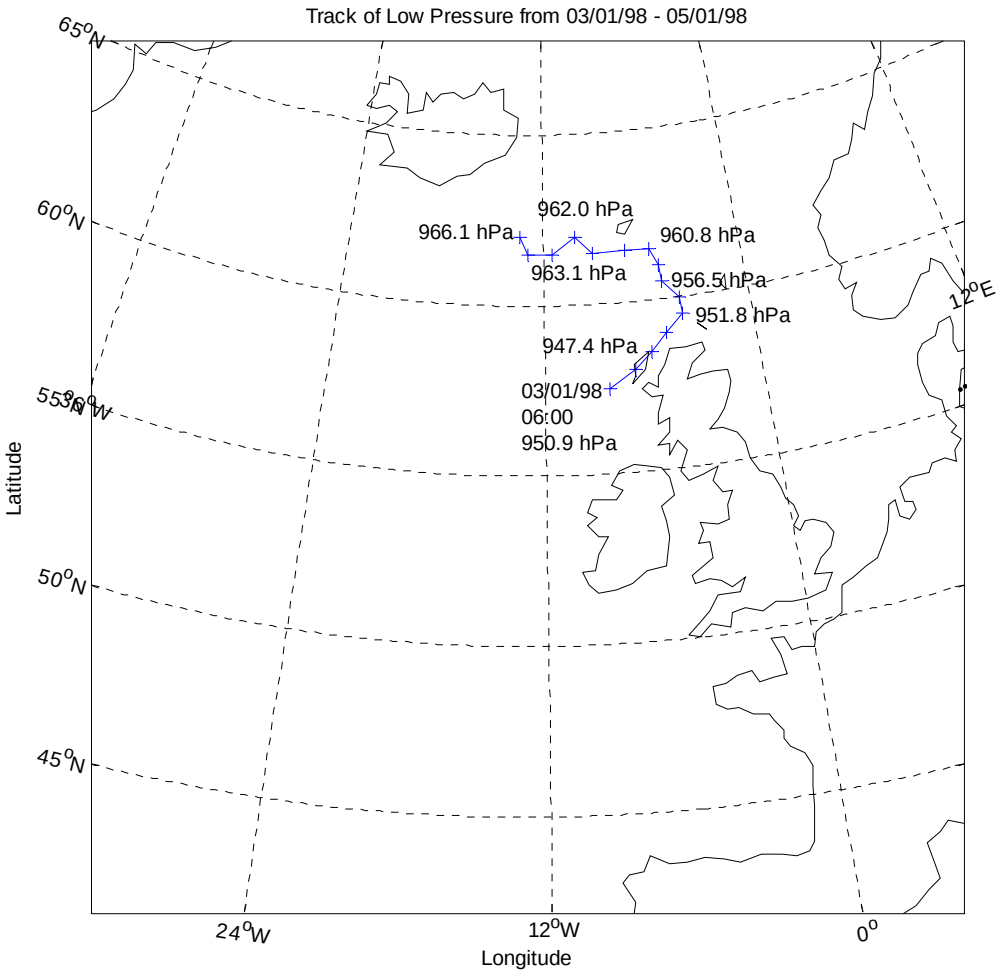


Figure 5: Centre of storm from 03/01/98 - 05/01/98 plotted at 3 hourly intervals, resulting in maximum surge level of 0.867m. in Dublin Bay and 0.621m. at Rosslare

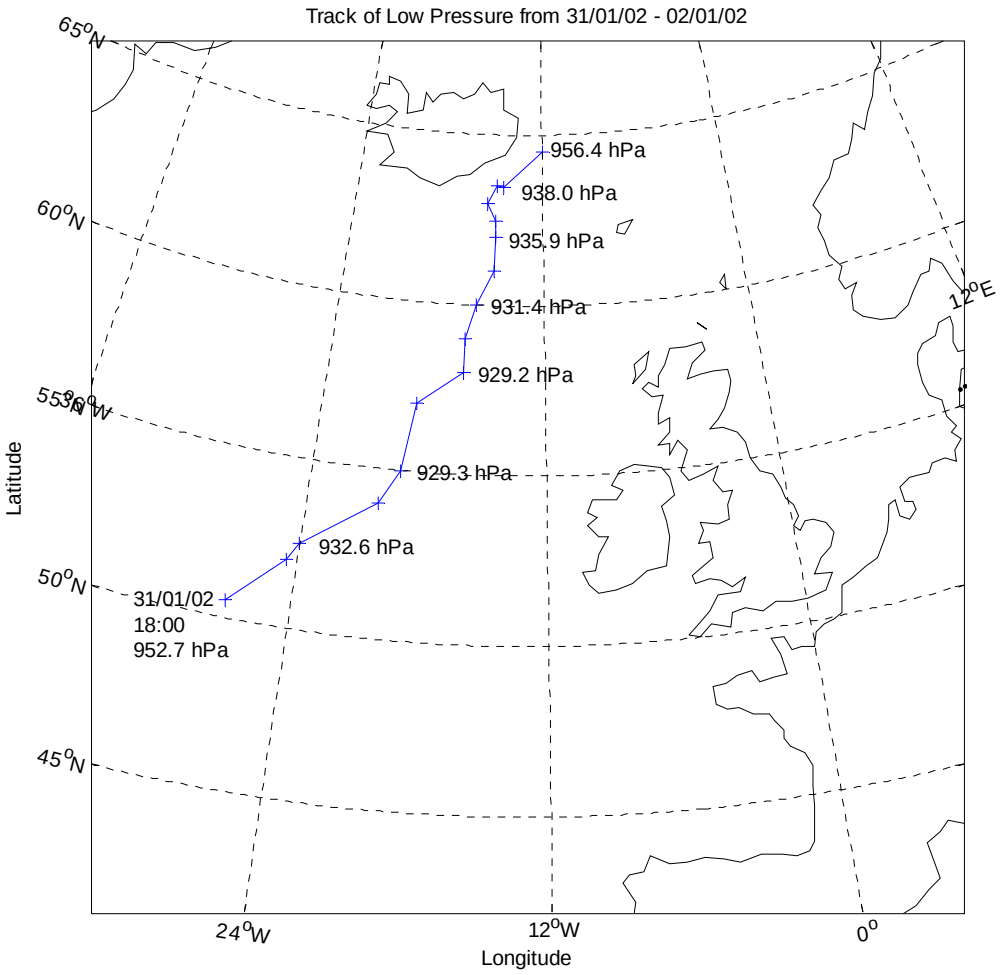
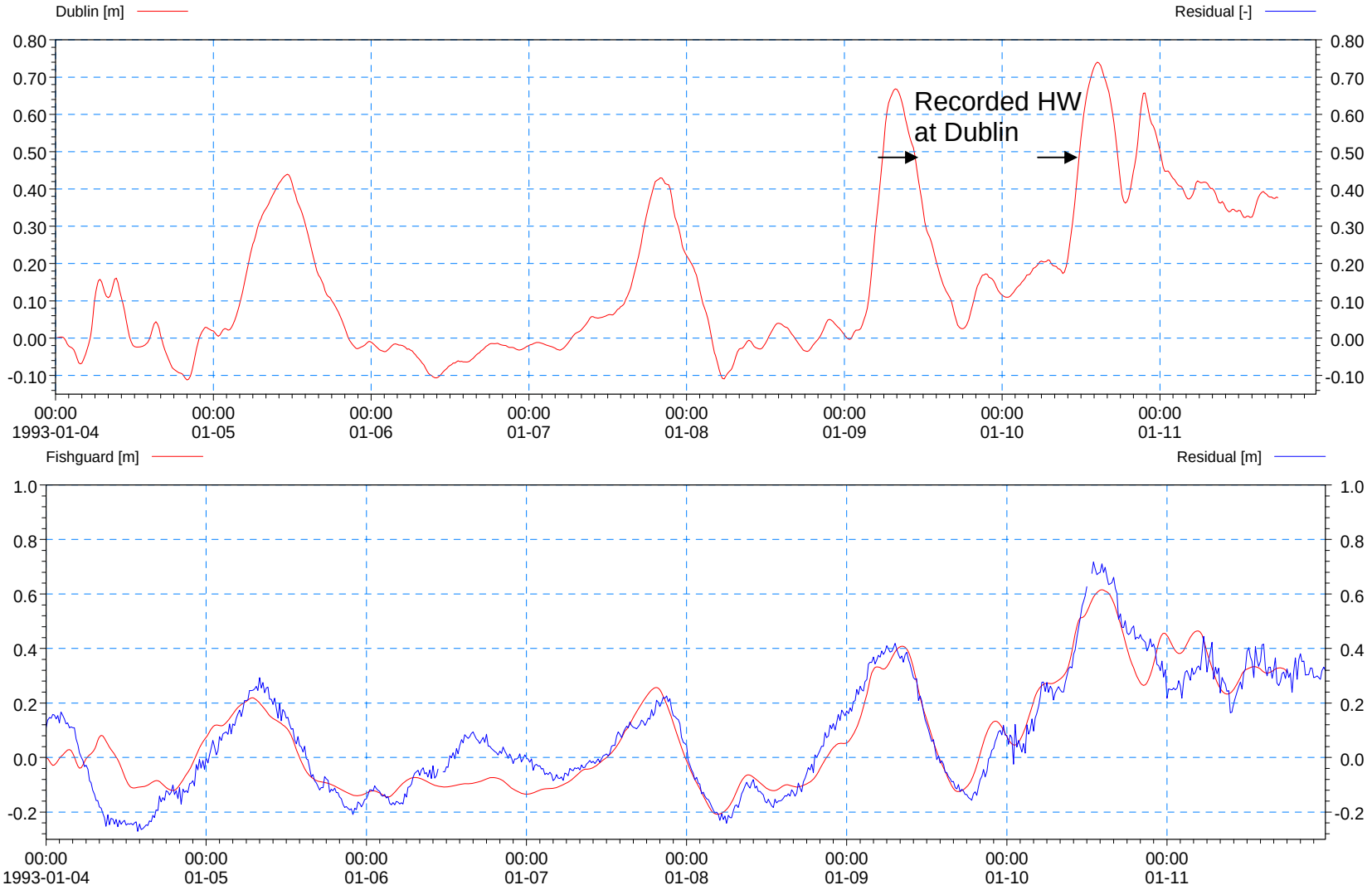


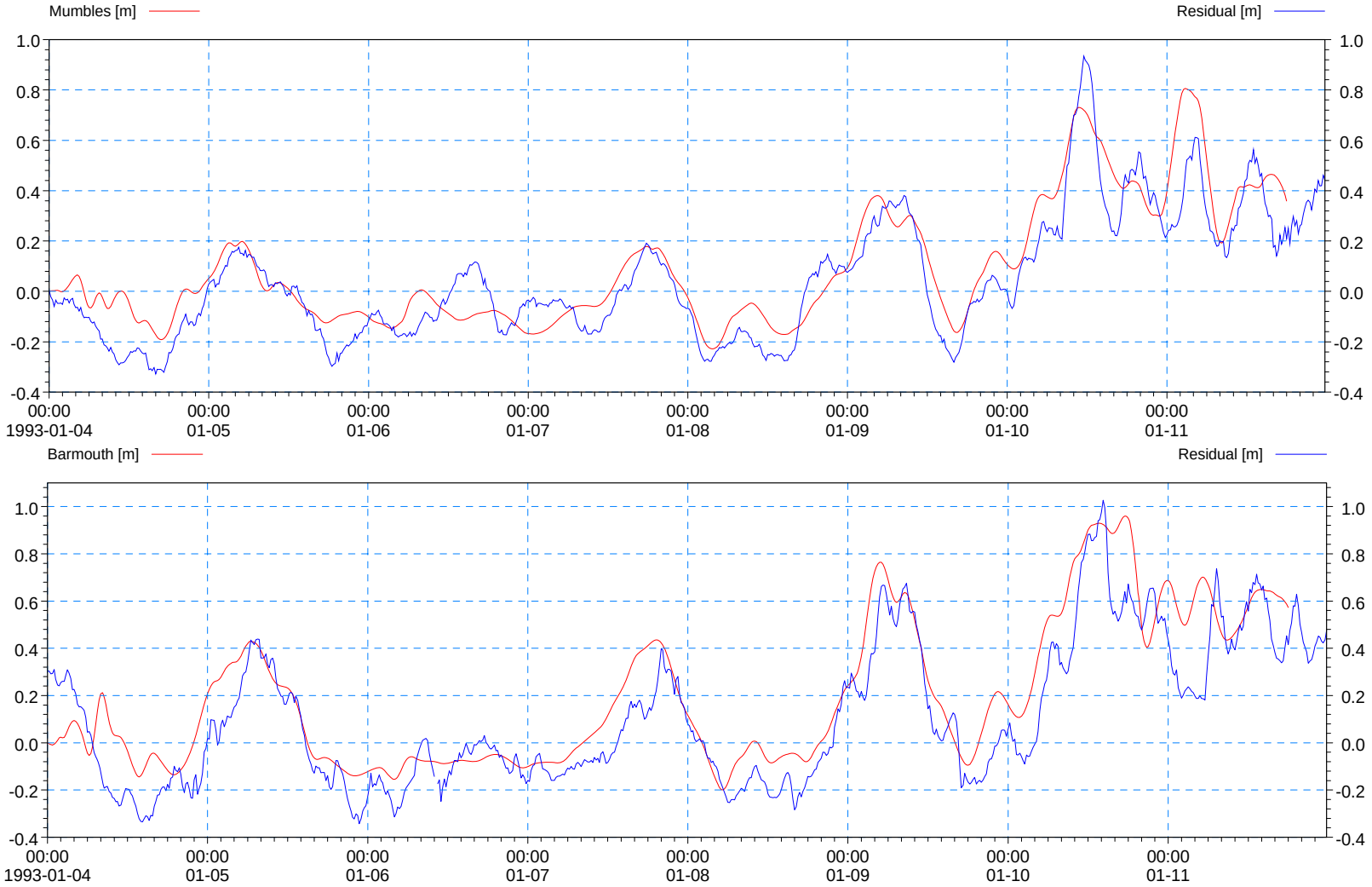
Figure 6 : Centre of storm from 31/01/02 - 02/02/02 plotted at 3 hourly intervals, resulting in maximum surge level of 0.912m. in Dublin Bay and 0.623m. at Rosslare

Appendix 2: Validation Figures of Storm Surge Simulation

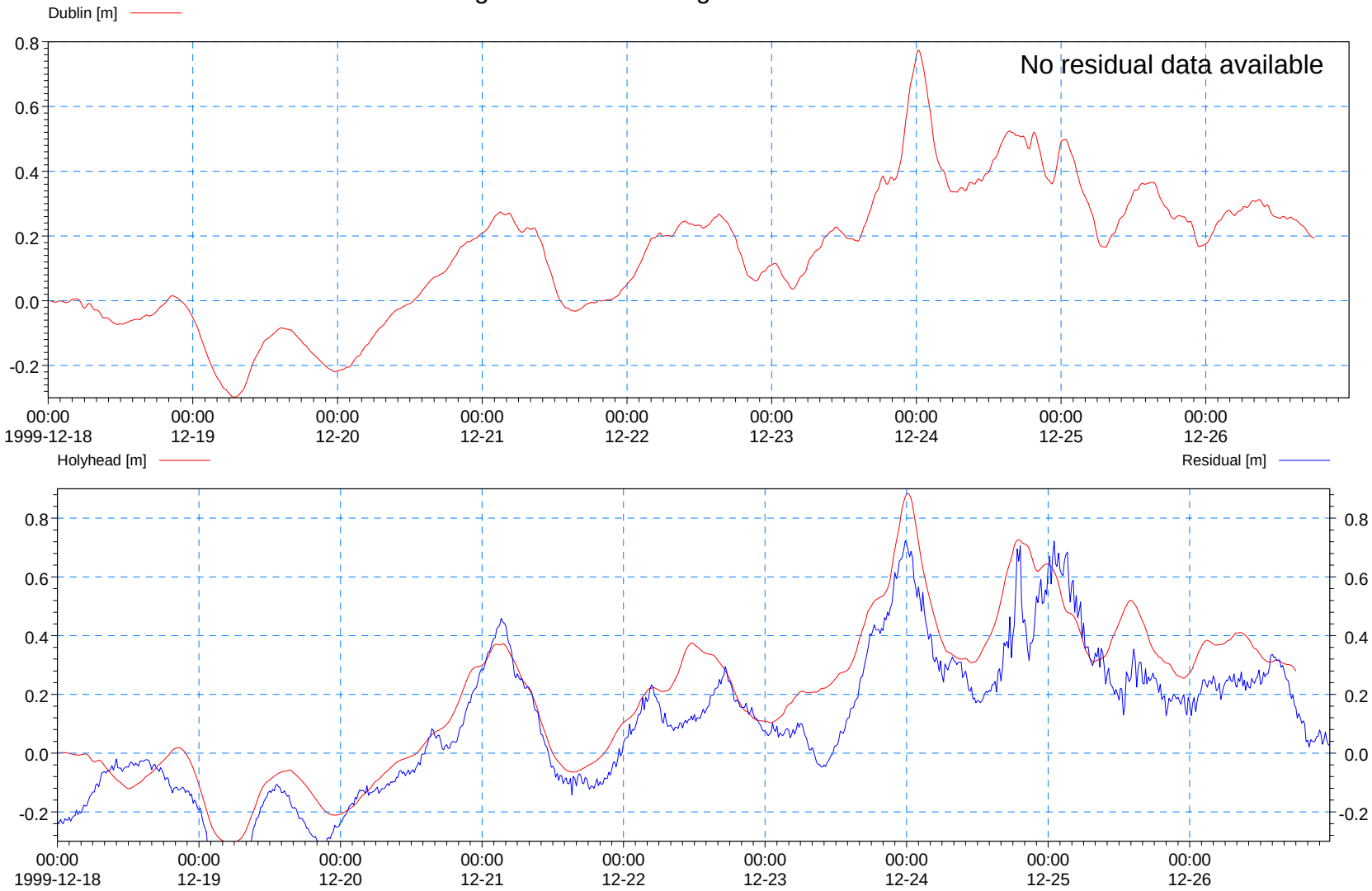
Validation Figures of Storm Surge Simulation: January 1993



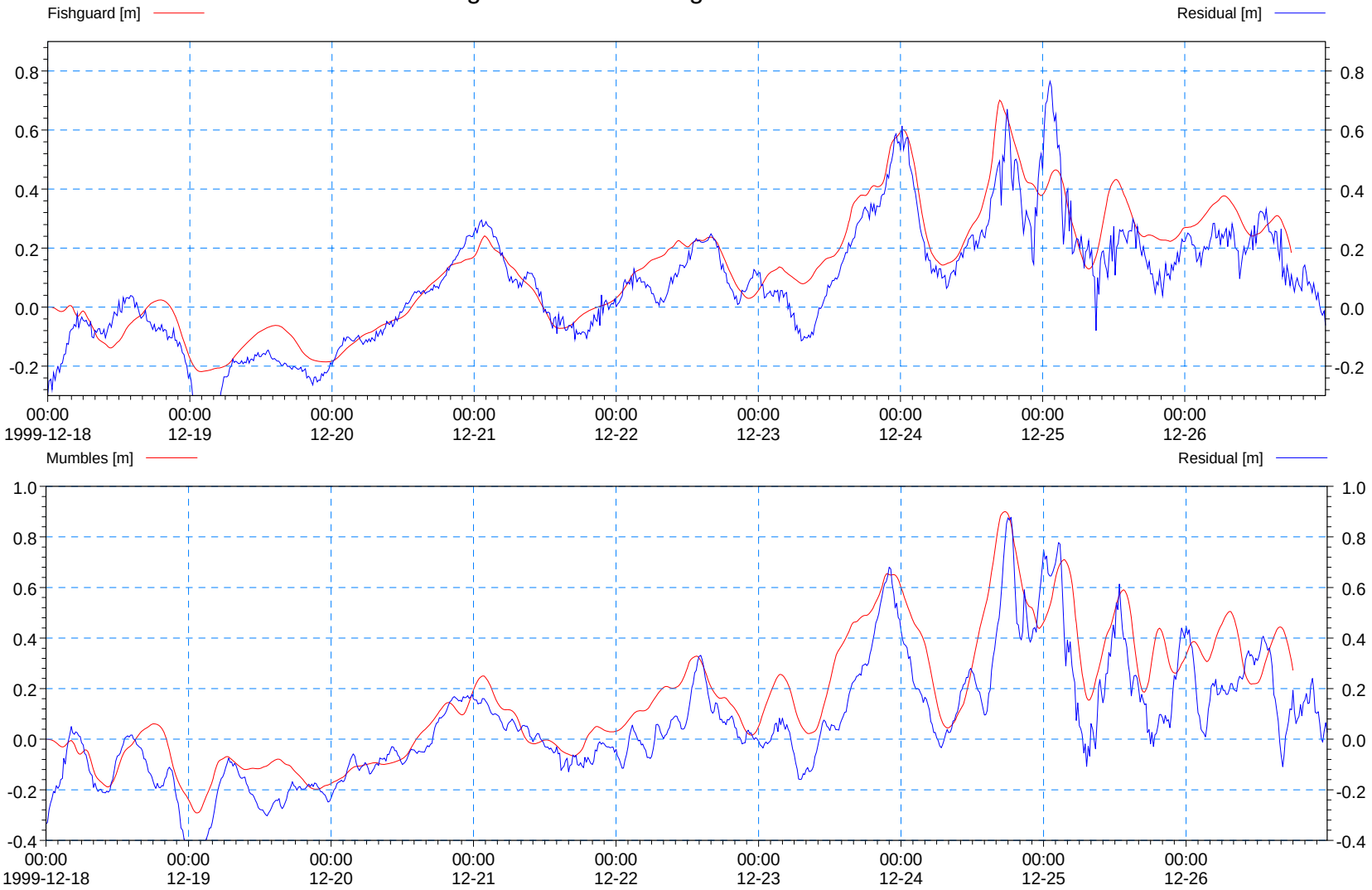
Validation Figures of Storm Surge Simulation: January 1993

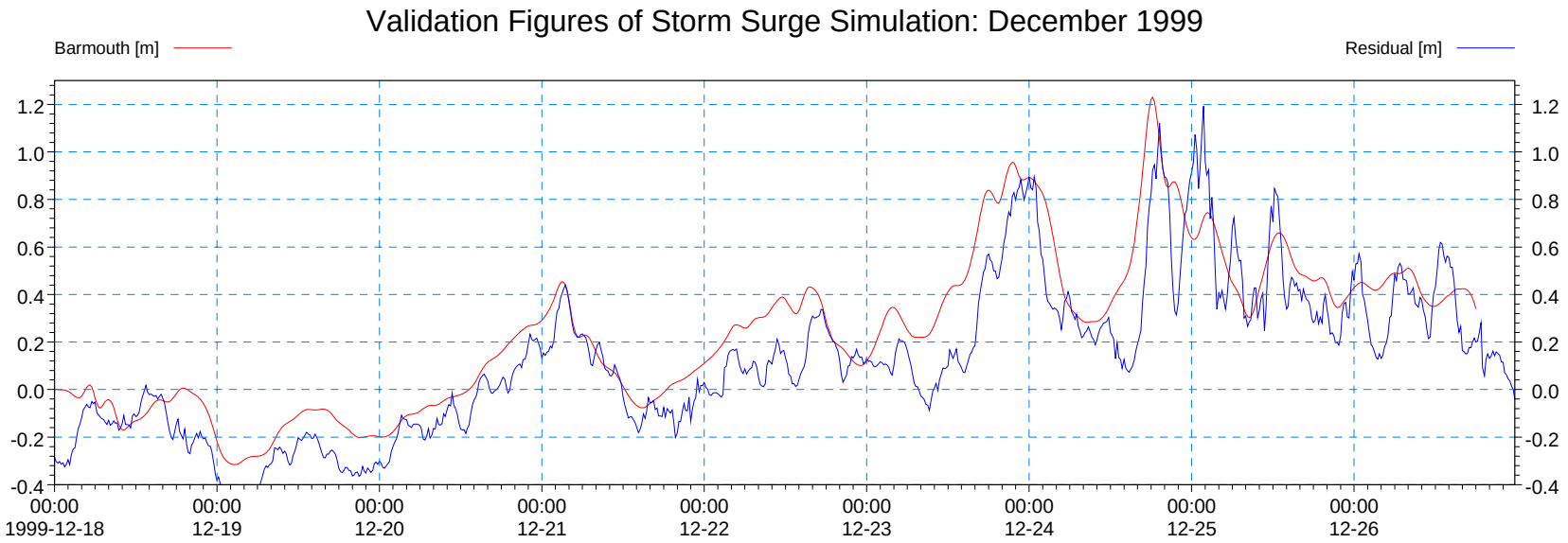


Validation Figures of Storm Surge Simulation: December 1999



Validation Figures of Storm Surge Simulation: December 1999




Validation Figures of Storm Surge Simulation: December 1999
Barmouth [m]
Residual [m]
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0.6
0.4
0.2
0.0
-0.2
-0.4
00:00
1999-12-18
00:00
12-19
00:00
12-20
00:00
12-21
00:00
12-22
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12-25
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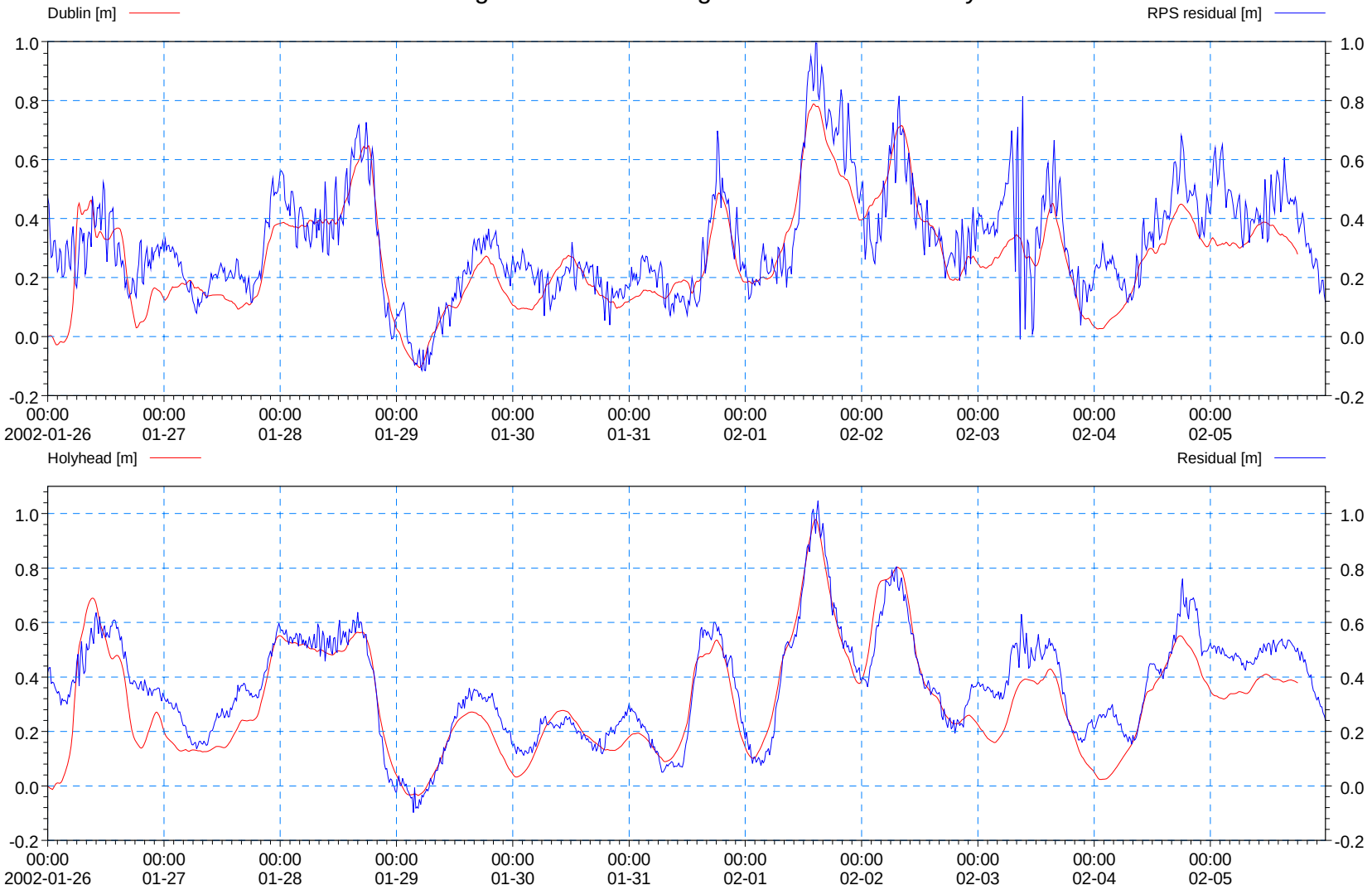
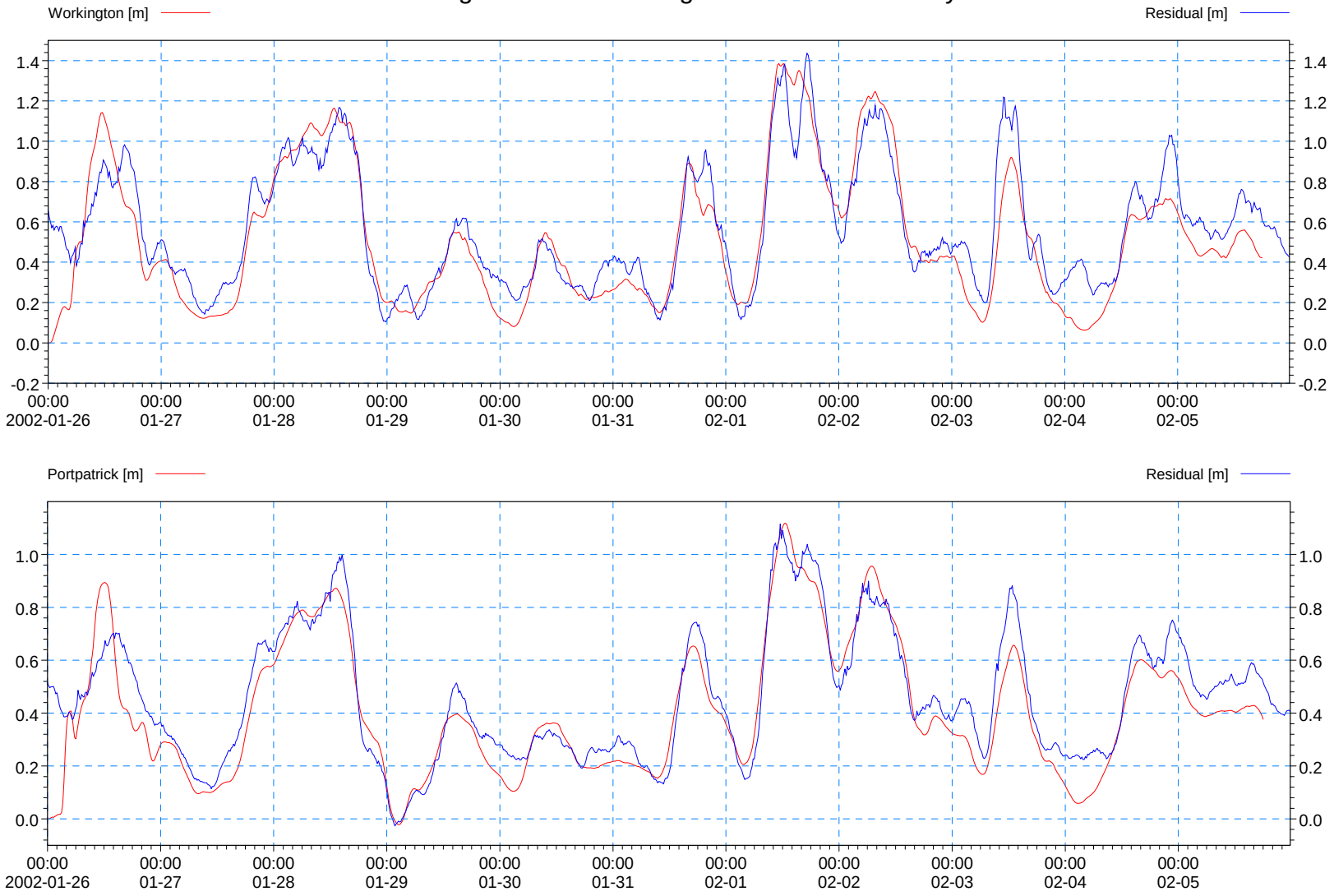
12-26

Validation Figures of Storm Surge Simulation: February 2002

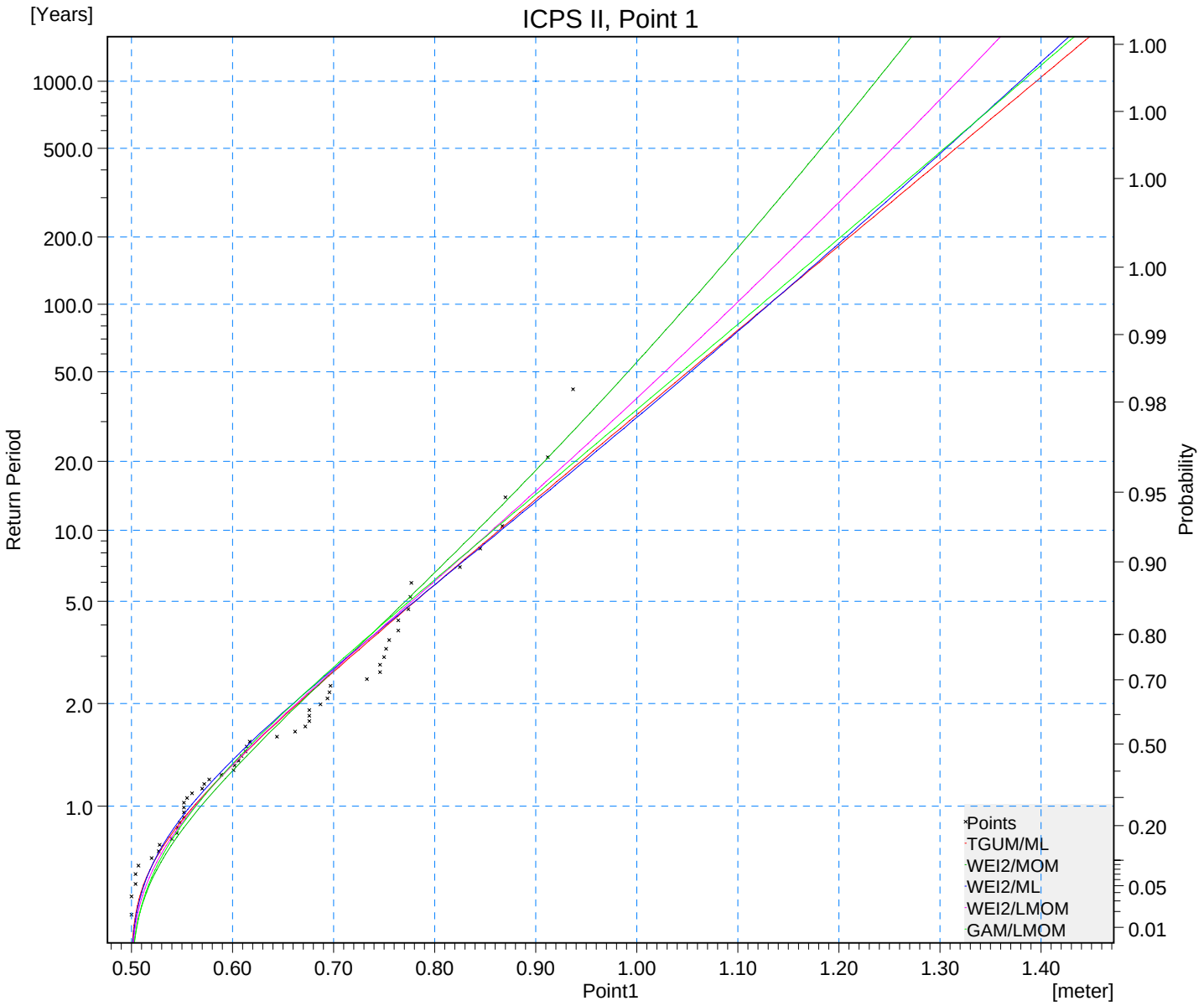


Validation Figures of Storm Surge Simulation: February 2002



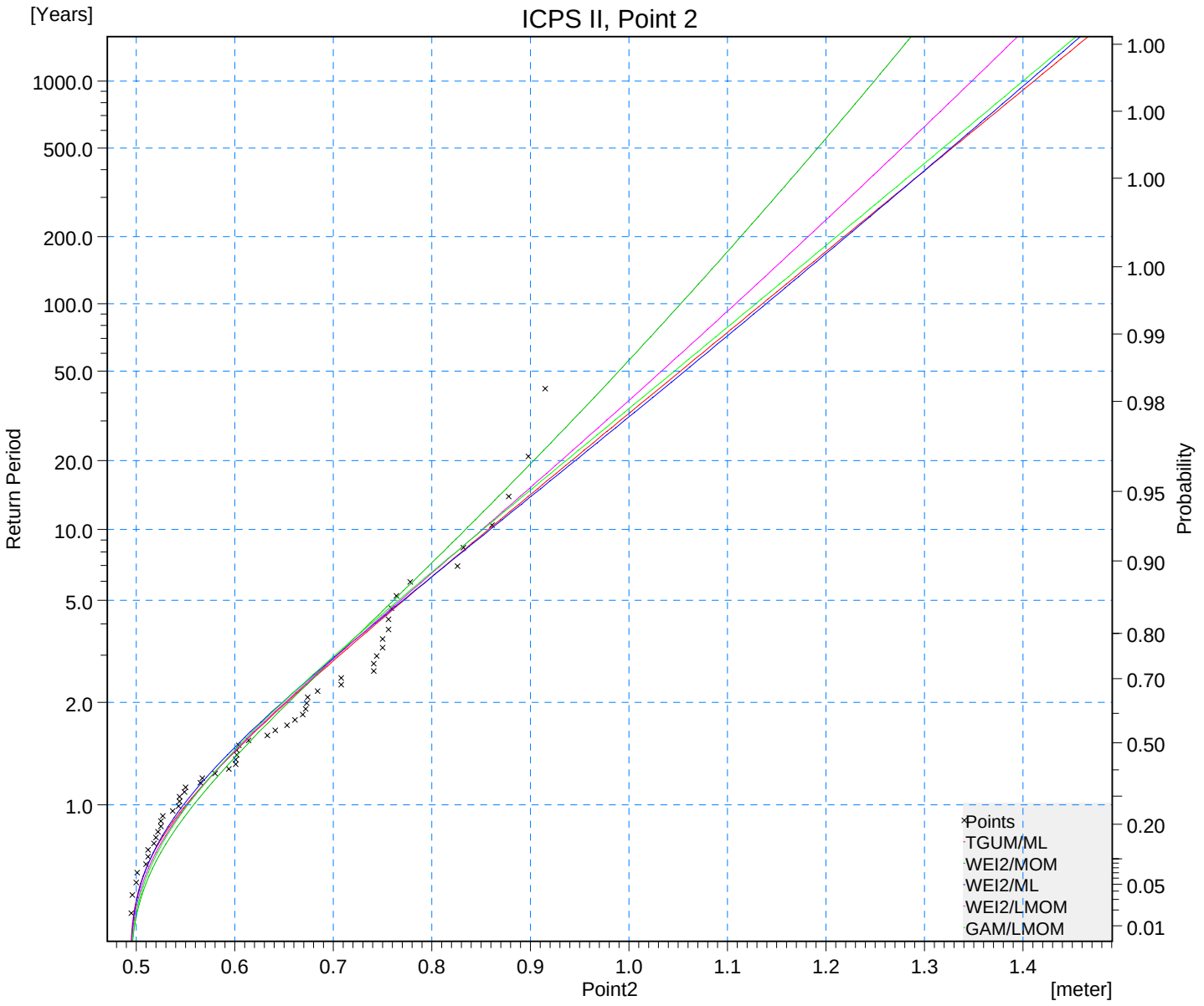
Appendix 3: Extreme Value Analysis of surge residual: points 1-30 & 35-40

ICPS II						
Point 1						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.768	0.760	0.767	0.765	0.762
	10.00	0.858	0.837	0.860	0.851	0.852
	25.00	0.969	0.928	0.972	0.954	0.963
	50.00	1.050	0.991	1.053	1.027	1.044
	100.00	1.130	1.051	1.131	1.097	1.123
	200.00	1.210	1.109	1.207	1.165	1.202
	1000.00	1.395	1.237	1.379	1.318	1.382
Average quantile	5.00	0.770	0.760	0.768	0.765	0.762
	10.00	0.860	0.838	0.862	0.851	0.852
	25.00	0.972	0.929	0.976	0.952	0.962
	50.00	1.054	0.992	1.057	1.024	1.042
	100.00	1.135	1.052	1.136	1.093	1.120
	200.00	1.216	1.109	1.212	1.159	1.198
	1000.00	1.402	1.236	1.384	1.307	1.376
Standard deviation	5.00	0.025	0.023	0.024	0.023	0.023
	10.00	0.031	0.027	0.033	0.029	0.029
	25.00	0.042	0.034	0.049	0.039	0.038
	50.00	0.050	0.040	0.063	0.048	0.046
	100.00	0.059	0.047	0.079	0.059	0.055
	200.00	0.068	0.055	0.096	0.070	0.064
	1000.00	0.089	0.074	0.138	0.099	0.087
Goodness -of-fit statistics	CHISQ	11.857	12.929	11.857	10.429	10.786
	KS	0.099	0.101	0.110	0.103	0.111
	SLSC	0.037	0.036	0.041	0.037	0.040
	PPCC1	0.983	0.988	0.981	0.984	0.980
	PPCC2	0.983	0.986	0.979	0.982	0.980
	LLM	49.579	49.861	49.335	49.741	49.053



RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 2						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.758	0.749	0.757	0.755	0.753
	10.00	0.851	0.829	0.853	0.845	0.846
	25.00	0.967	0.923	0.971	0.954	0.961
	50.00	1.051	0.989	1.056	1.032	1.045
	100.00	1.135	1.052	1.139	1.108	1.128
	200.00	1.218	1.113	1.221	1.182	1.211
	1000.00	1.411	1.249	1.406	1.348	1.400
Average quantile	5.00	0.760	0.750	0.759	0.755	0.753
	10.00	0.854	0.830	0.858	0.845	0.845
	25.00	0.970	0.924	0.980	0.953	0.960
	50.00	1.056	0.990	1.068	1.029	1.043
	100.00	1.140	1.053	1.153	1.103	1.126
	200.00	1.224	1.114	1.238	1.175	1.207
	1000.00	1.418	1.249	1.429	1.336	1.394
Standard deviation	5.00	0.025	0.023	0.024	0.024	0.023
	10.00	0.031	0.027	0.033	0.028	0.029
	25.00	0.041	0.033	0.050	0.038	0.038
	50.00	0.049	0.039	0.065	0.048	0.046
	100.00	0.058	0.046	0.082	0.059	0.055
	200.00	0.067	0.054	0.100	0.072	0.064
	1000.00	0.088	0.074	0.146	0.103	0.087
Goodness -of-fit statistics	CHISQ	9.000	11.857	10.429	9.357	9.714
	KS	0.099	0.110	0.102	0.103	0.107
	SLSC	0.041	0.040	0.044	0.041	0.043
	PPCC1	0.979	0.985	0.977	0.980	0.976
	PPCC2	0.979	0.982	0.974	0.977	0.976
	LLM	51.535	50.374	51.195	51.097	50.130



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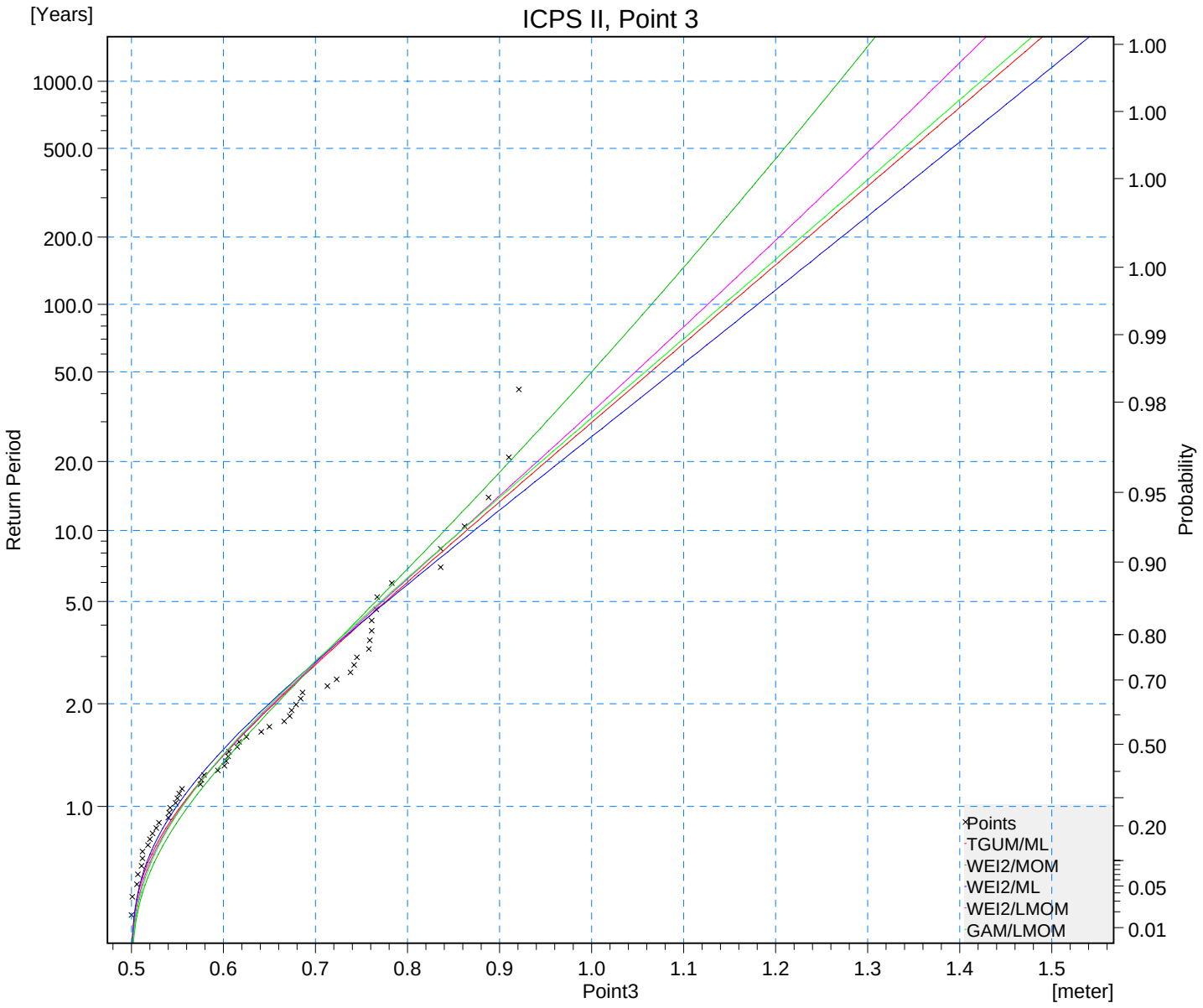
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 3						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.762	0.754	0.763	0.759	0.757
	10.00	0.858	0.835	0.866	0.852	0.852
	25.00	0.976	0.931	0.994	0.965	0.971
	50.00	1.063	0.999	1.087	1.047	1.057
	100.00	1.149	1.065	1.180	1.126	1.143
	200.00	1.235	1.128	1.271	1.204	1.228
	1000.00	1.434	1.269	1.482	1.380	1.423
Average quantile	5.00	0.764	0.754	0.766	0.760	0.758
	10.00	0.861	0.836	0.875	0.852	0.852
	25.00	0.980	0.933	1.012	0.964	0.970
	50.00	1.068	1.001	1.113	1.044	1.056
	100.00	1.155	1.066	1.212	1.122	1.141
	200.00	1.241	1.129	1.310	1.197	1.225
	1000.00	1.441	1.269	1.535	1.368	1.418
Standard deviation	5.00	0.026	0.023	0.025	0.024	0.023
	10.00	0.032	0.027	0.036	0.029	0.029
	25.00	0.042	0.034	0.059	0.039	0.039
	50.00	0.050	0.040	0.080	0.050	0.047
	100.00	0.059	0.047	0.103	0.062	0.056
	200.00	0.068	0.055	0.127	0.075	0.066
	1000.00	0.090	0.076	0.189	0.110	0.090
Goodness -of-fit statistics	CHISQ	7.571	11.857	7.214	8.286	8.286
	KS	0.090	0.103	0.102	0.094	0.099
	SLSC	0.041	0.040	0.047	0.042	0.043
	PPCC1	0.978	0.985	0.973	0.979	0.976
	PPCC2	0.978	0.982	0.971	0.976	0.976
	LLM	51.236	50.569	50.830	51.022	50.407



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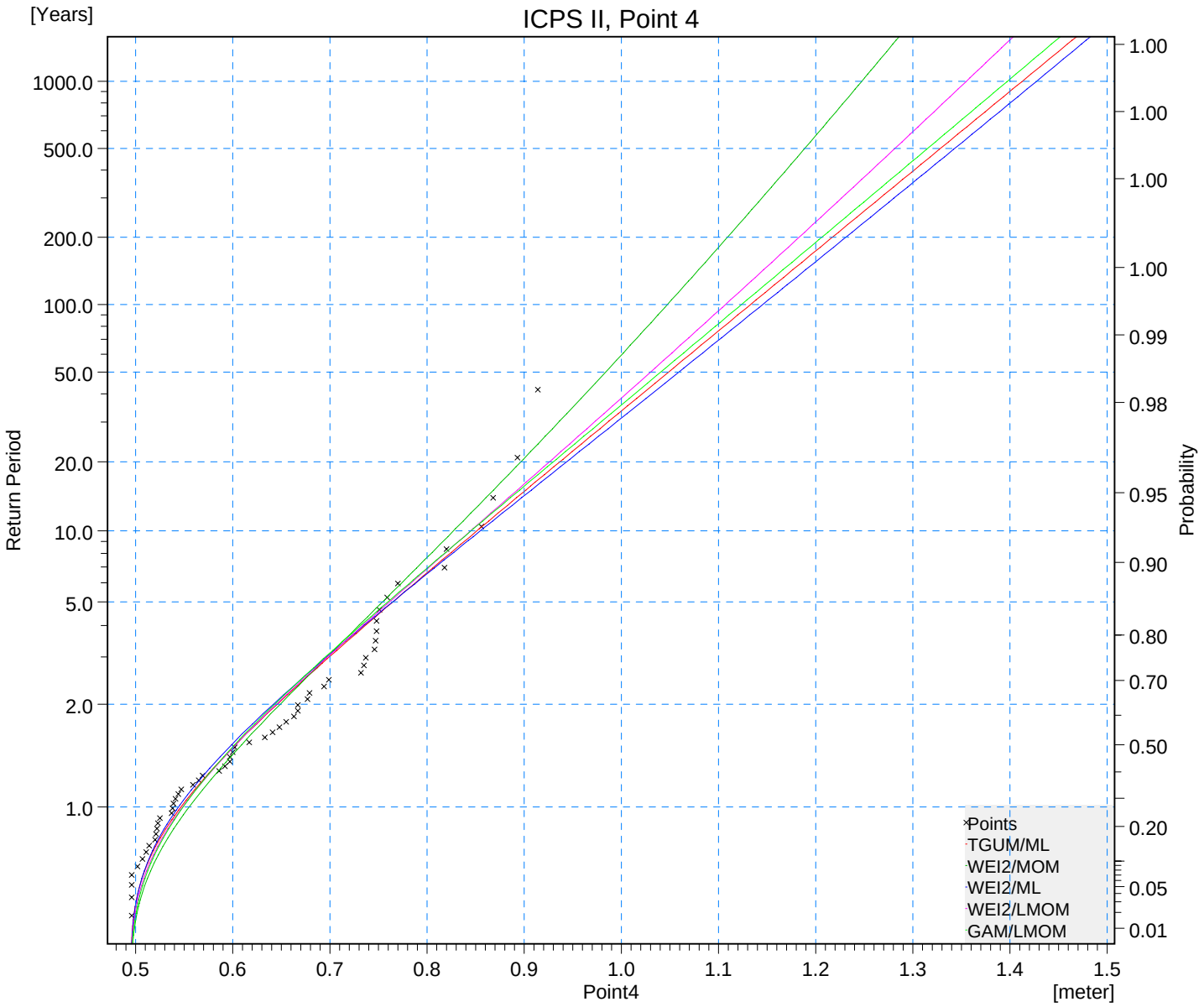
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 4						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.751	0.742	0.750	0.748	0.746
	10.00	0.845	0.822	0.848	0.839	0.839
	25.00	0.962	0.916	0.970	0.949	0.955
	50.00	1.048	0.983	1.058	1.029	1.039
	100.00	1.132	1.047	1.145	1.107	1.123
	200.00	1.217	1.109	1.231	1.183	1.206
	1000.00	1.413	1.248	1.427	1.355	1.397
Average quantile	5.00	0.753	0.743	0.754	0.749	0.746
	10.00	0.848	0.823	0.858	0.839	0.839
	25.00	0.966	0.918	0.987	0.949	0.954
	50.00	1.052	0.985	1.082	1.028	1.039
	100.00	1.138	1.049	1.175	1.104	1.122
	200.00	1.223	1.111	1.268	1.179	1.205
	1000.00	1.420	1.249	1.480	1.347	1.395
Standard deviation	5.00	0.025	0.023	0.024	0.024	0.023
	10.00	0.031	0.027	0.033	0.028	0.028
	25.00	0.040	0.033	0.051	0.039	0.038
	50.00	0.049	0.039	0.068	0.049	0.046
	100.00	0.057	0.047	0.087	0.061	0.056
	200.00	0.066	0.055	0.107	0.074	0.065
	1000.00	0.088	0.076	0.158	0.109	0.089
Goodness -of-fit statistics	CHISQ	7.929	11.500	7.571	8.643	10.429
	KS	0.096	0.110	0.098	0.100	0.103
	SLSC	0.041	0.039	0.045	0.041	0.043
	PPCC1	0.978	0.985	0.975	0.979	0.976
	PPCC2	0.978	0.983	0.974	0.977	0.976
	LLM	53.376	51.014	52.801	52.386	51.143



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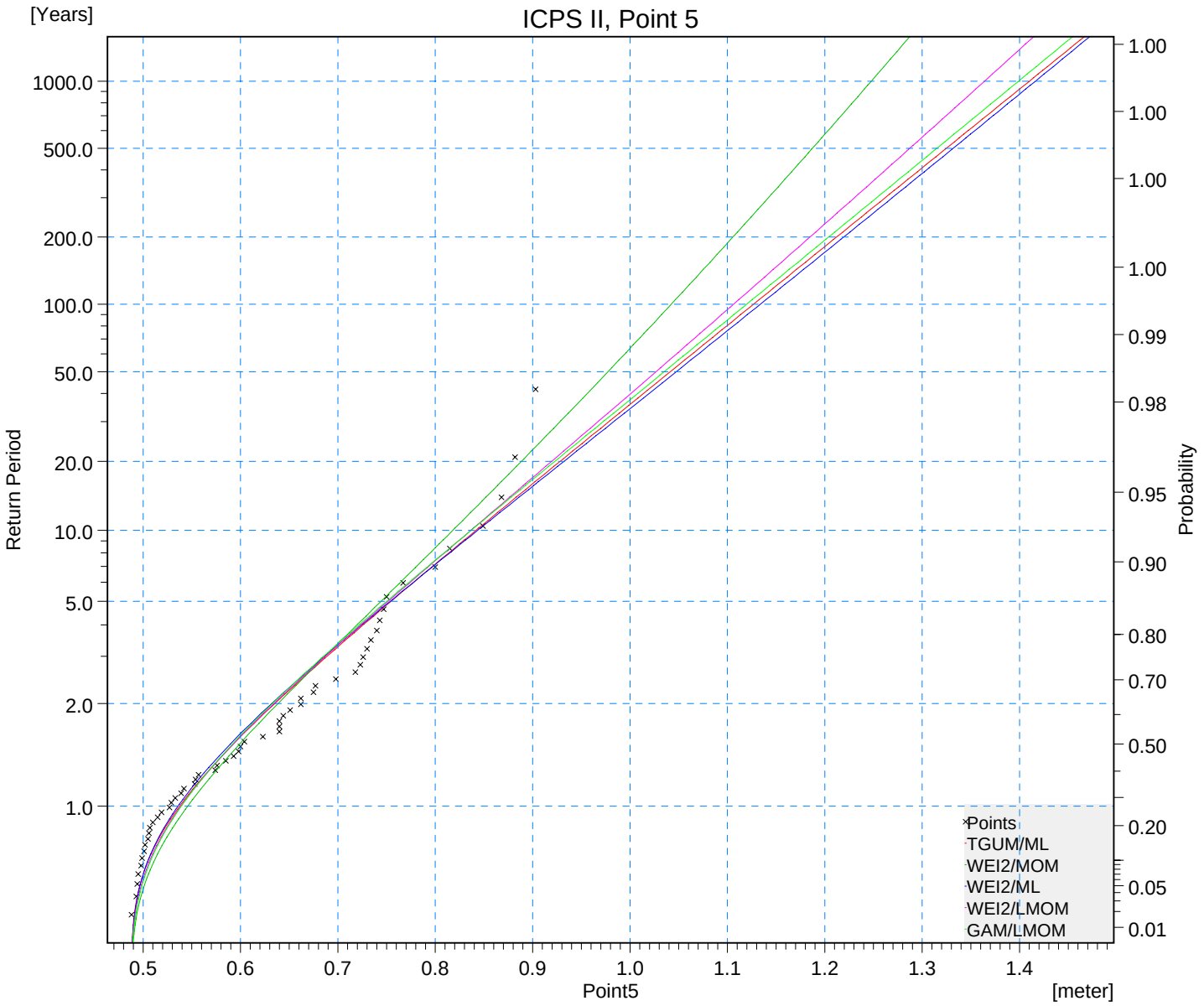
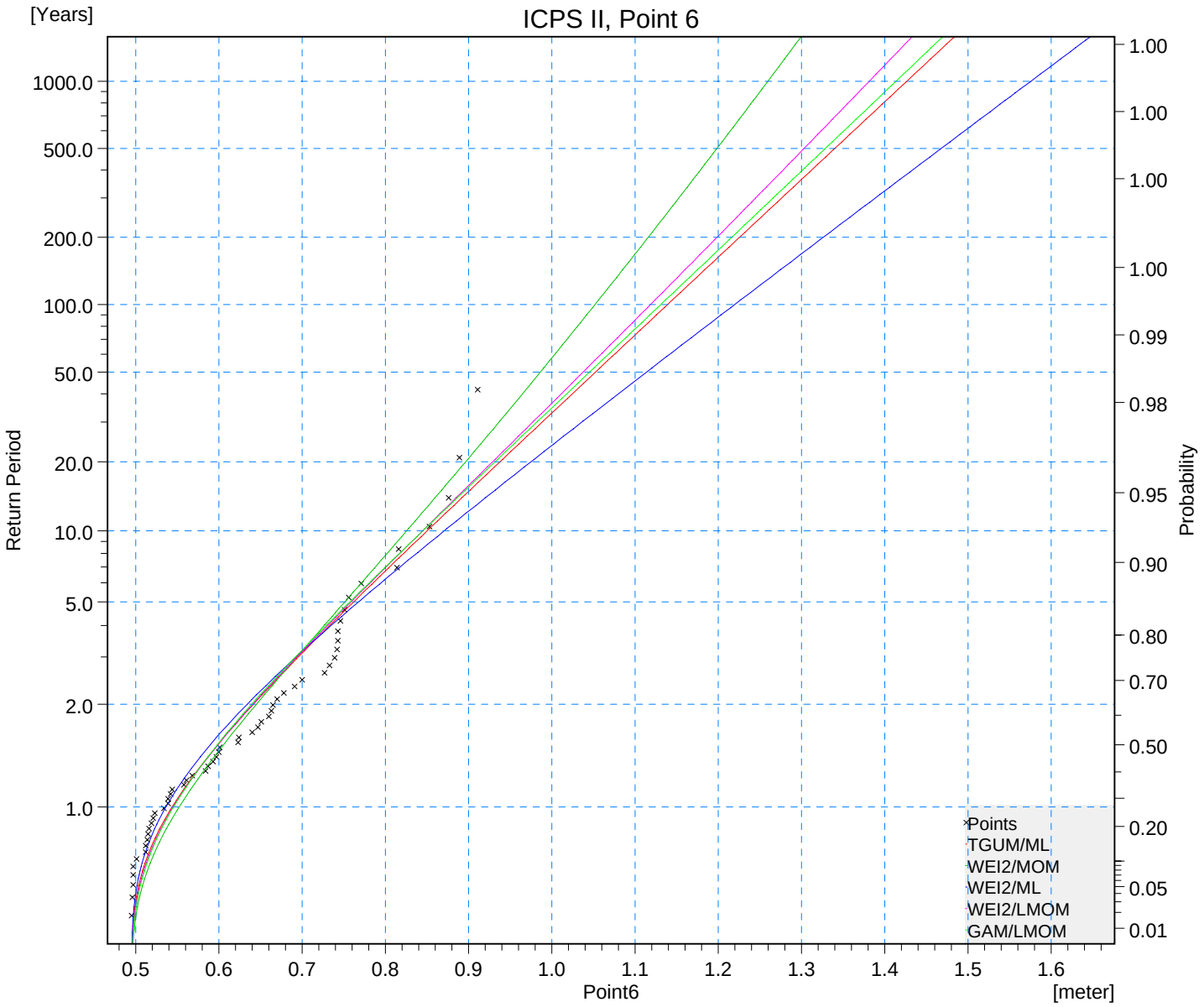
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 5						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.741	0.732	0.740	0.738	0.737
	10.00	0.836	0.813	0.837	0.830	0.831
	25.00	0.953	0.909	0.958	0.944	0.948
	50.00	1.040	0.977	1.046	1.026	1.034
	100.00	1.126	1.042	1.133	1.106	1.119
	200.00	1.212	1.106	1.219	1.185	1.204
	1000.00	1.410	1.248	1.416	1.364	1.399
Average quantile	5.00	0.743	0.733	0.741	0.739	0.737
	10.00	0.839	0.814	0.841	0.830	0.830
	25.00	0.958	0.910	0.964	0.942	0.946
	50.00	1.045	0.978	1.055	1.022	1.032
	100.00	1.132	1.043	1.143	1.100	1.116
	200.00	1.218	1.106	1.231	1.177	1.200
	1000.00	1.418	1.247	1.431	1.350	1.392
Standard deviation	5.00	0.026	0.023	0.025	0.024	0.023
	10.00	0.031	0.027	0.032	0.029	0.029
	25.00	0.040	0.033	0.047	0.039	0.038
	50.00	0.049	0.040	0.060	0.049	0.047
	100.00	0.057	0.047	0.076	0.062	0.056
	200.00	0.066	0.055	0.092	0.075	0.066
	1000.00	0.088	0.077	0.134	0.111	0.090
Goodness -of-fit statistics	CHISQ	11.500	16.143	10.429	10.429	12.929
	KS	0.110	0.123	0.119	0.113	0.117
	SLSC	0.042	0.040	0.045	0.042	0.043
	PPCC1	0.978	0.985	0.975	0.979	0.976
	PPCC2	0.978	0.983	0.974	0.977	0.976
	LLM	53.311	52.868	53.170	53.256	52.897



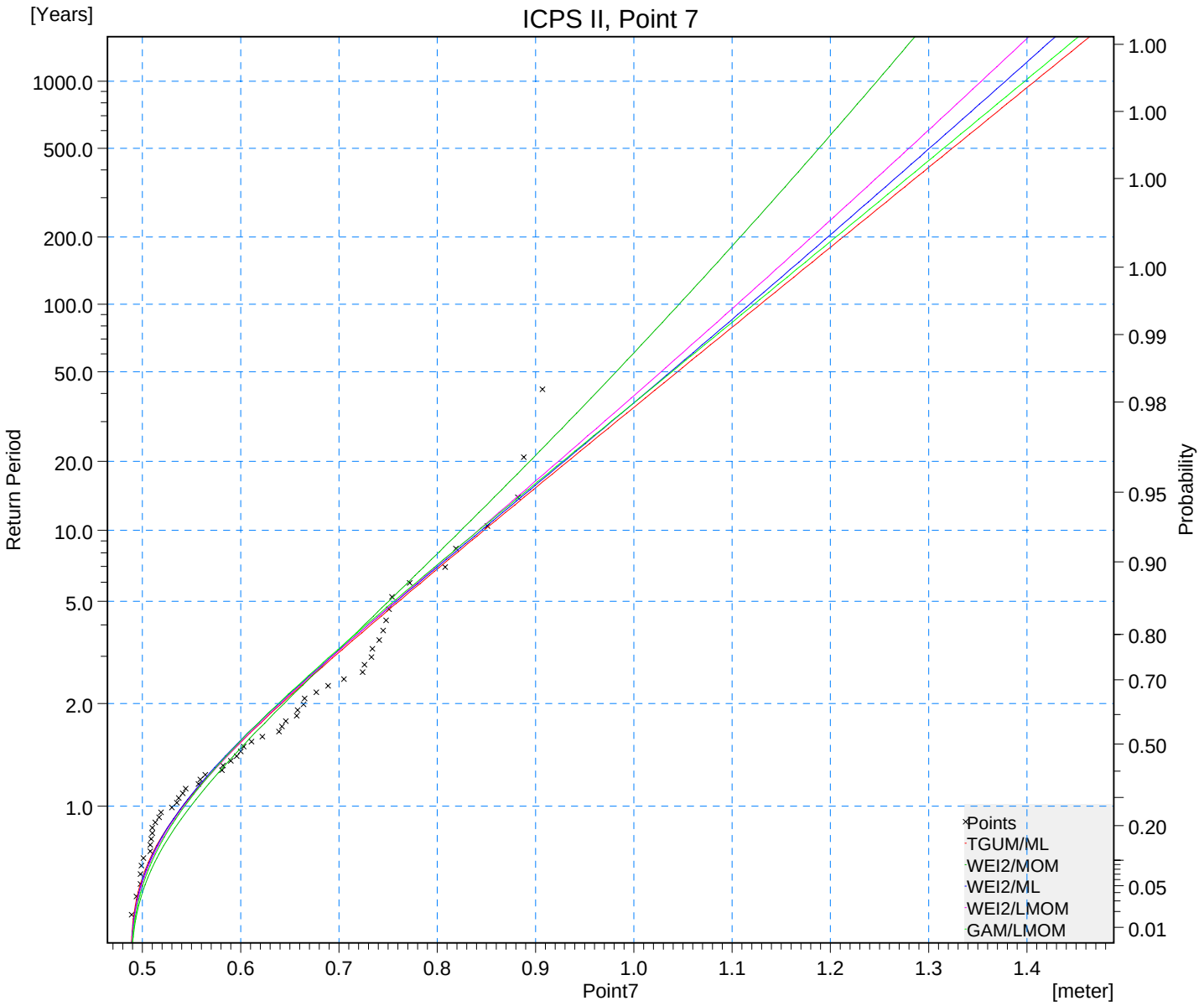
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 6						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.748	0.739	0.752	0.745	0.744
	10.00	0.844	0.820	0.863	0.839	0.839
	25.00	0.963	0.917	1.006	0.953	0.957
	50.00	1.051	0.985	1.112	1.037	1.044
	100.00	1.139	1.051	1.219	1.118	1.131
	200.00	1.225	1.116	1.326	1.198	1.216
	1000.00	1.426	1.260	1.576	1.381	1.414
Average quantile	5.00	0.750	0.740	0.754	0.746	0.744
	10.00	0.847	0.821	0.868	0.838	0.838
	25.00	0.968	0.918	1.014	0.951	0.956
	50.00	1.057	0.986	1.124	1.033	1.042
	100.00	1.145	1.052	1.232	1.112	1.127
	200.00	1.232	1.116	1.341	1.190	1.211
	1000.00	1.435	1.259	1.593	1.366	1.406
Standard deviation	5.00	0.026	0.023	0.025	0.024	0.023
	10.00	0.031	0.027	0.037	0.028	0.029
	25.00	0.040	0.033	0.061	0.039	0.038
	50.00	0.048	0.040	0.084	0.050	0.047
	100.00	0.057	0.047	0.110	0.063	0.056
	200.00	0.066	0.056	0.138	0.077	0.066
	1000.00	0.088	0.077	0.211	0.115	0.091
Goodness -of-fit statistics	CHISQ	7.214	14.357	12.214	7.214	8.286
	KS	0.094	0.127	0.113	0.097	0.102
	SLSC	0.043	0.041	0.053	0.044	0.045
	PPCC1	0.976	0.983	0.965	0.977	0.974
	PPCC2	0.976	0.981	0.965	0.975	0.974
	LLM	53.305	51.734	52.782	52.772	52.067



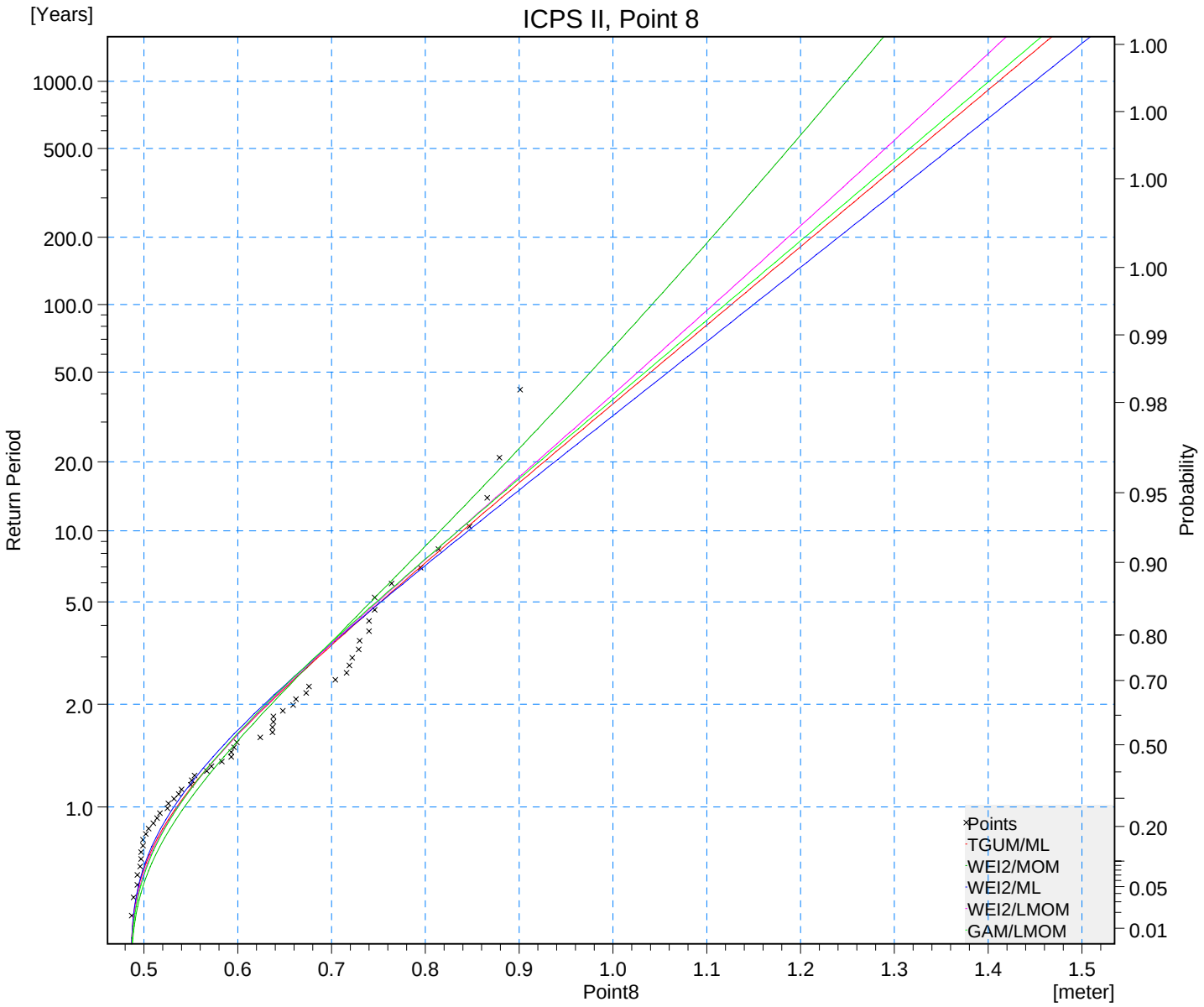
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 7						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.747	0.739	0.745	0.744	0.742
	10.00	0.841	0.819	0.839	0.836	0.836
	25.00	0.958	0.914	0.953	0.947	0.952
	50.00	1.044	0.981	1.037	1.027	1.038
	100.00	1.128	1.046	1.118	1.105	1.122
	200.00	1.213	1.108	1.197	1.181	1.205
	1000.00	1.408	1.247	1.378	1.354	1.398
Average quantile	5.00	0.749	0.739	0.747	0.745	0.743
	10.00	0.844	0.820	0.843	0.836	0.836
	25.00	0.962	0.915	0.962	0.945	0.951
	50.00	1.048	0.982	1.047	1.024	1.036
	100.00	1.133	1.047	1.131	1.100	1.119
	200.00	1.218	1.109	1.213	1.174	1.202
	1000.00	1.415	1.247	1.399	1.341	1.392
Standard deviation	5.00	0.026	0.023	0.025	0.024	0.023
	10.00	0.031	0.027	0.032	0.029	0.029
	25.00	0.041	0.034	0.046	0.039	0.038
	50.00	0.049	0.040	0.058	0.049	0.047
	100.00	0.058	0.047	0.072	0.061	0.056
	200.00	0.067	0.055	0.087	0.074	0.065
	1000.00	0.089	0.076	0.125	0.107	0.089
Goodness -of-fit statistics	CHISQ	10.071	17.571	8.286	8.286	12.571
	KS	0.091	0.125	0.098	0.098	0.104
	SLSC	0.040	0.039	0.042	0.041	0.043
	PPCC1	0.979	0.985	0.979	0.980	0.977
	PPCC2	0.979	0.983	0.977	0.978	0.977
	LLM	52.642	51.764	52.459	52.418	51.786



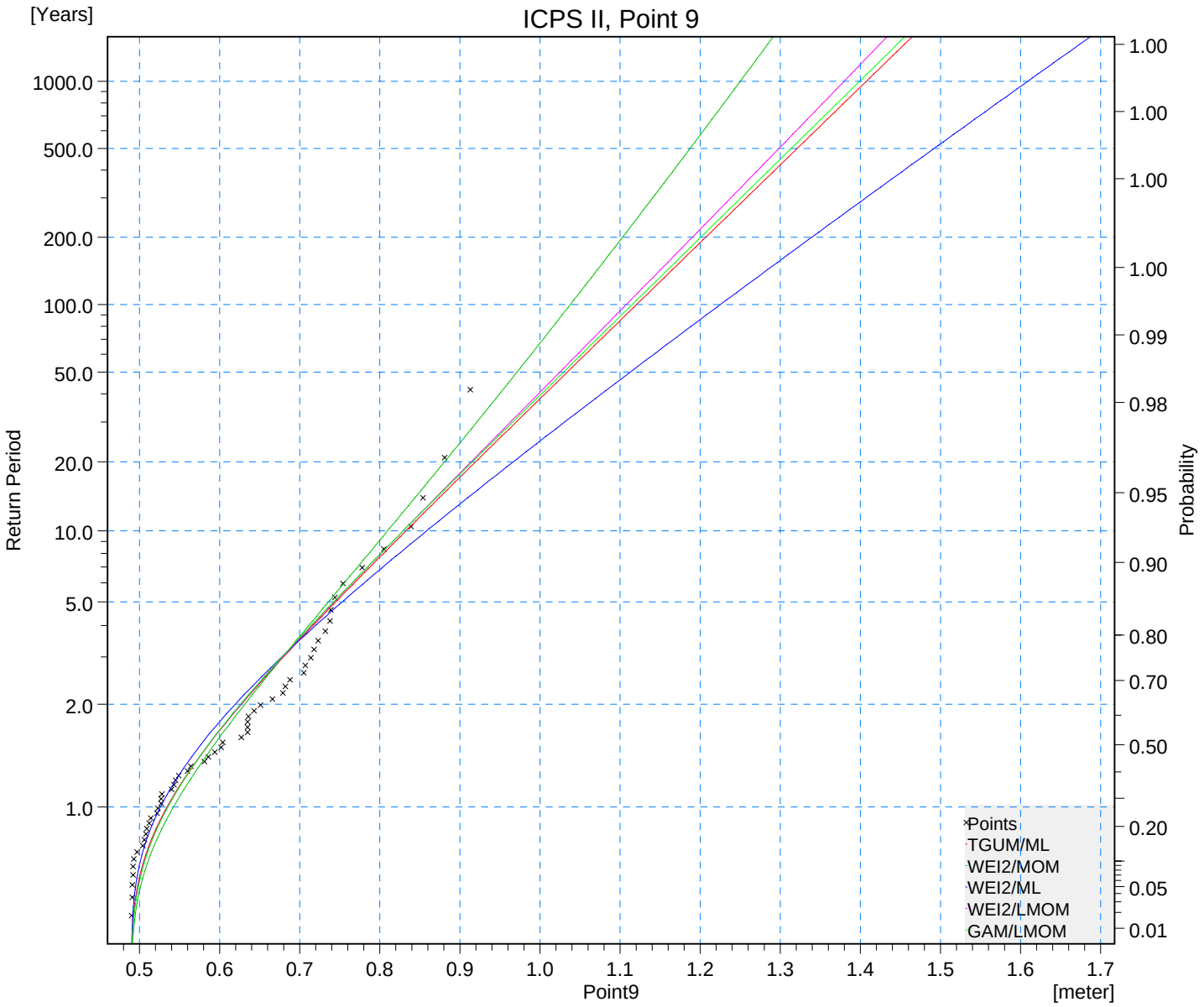
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 8						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.738	0.730	0.738	0.736	0.734
	10.00	0.833	0.811	0.839	0.829	0.829
	25.00	0.952	0.907	0.965	0.943	0.947
	50.00	1.039	0.975	1.058	1.026	1.033
	100.00	1.126	1.041	1.149	1.107	1.119
	200.00	1.212	1.105	1.240	1.187	1.204
	1000.00	1.411	1.249	1.450	1.368	1.401
Average quantile	5.00	0.740	0.731	0.741	0.736	0.734
	10.00	0.837	0.812	0.845	0.829	0.828
	25.00	0.956	0.908	0.976	0.941	0.945
	50.00	1.045	0.977	1.073	1.022	1.031
	100.00	1.132	1.042	1.168	1.101	1.116
	200.00	1.218	1.106	1.262	1.179	1.200
	1000.00	1.419	1.248	1.480	1.354	1.395
Standard deviation	5.00	0.026	0.023	0.025	0.024	0.023
	10.00	0.031	0.027	0.034	0.029	0.029
	25.00	0.040	0.033	0.051	0.039	0.038
	50.00	0.048	0.040	0.067	0.050	0.047
	100.00	0.057	0.047	0.085	0.062	0.056
	200.00	0.066	0.055	0.105	0.076	0.066
	1000.00	0.088	0.077	0.156	0.113	0.090
Goodness -of-fit statistics	CHISQ	12.929	13.286	10.071	12.214	14.714
	KS	0.110	0.118	0.120	0.113	0.116
	SLSC	0.042	0.040	0.046	0.043	0.044
	PPCC1	0.977	0.984	0.973	0.978	0.975
	PPCC2	0.977	0.982	0.972	0.976	0.975
	LLM	54.283	52.942	54.069	53.922	53.368



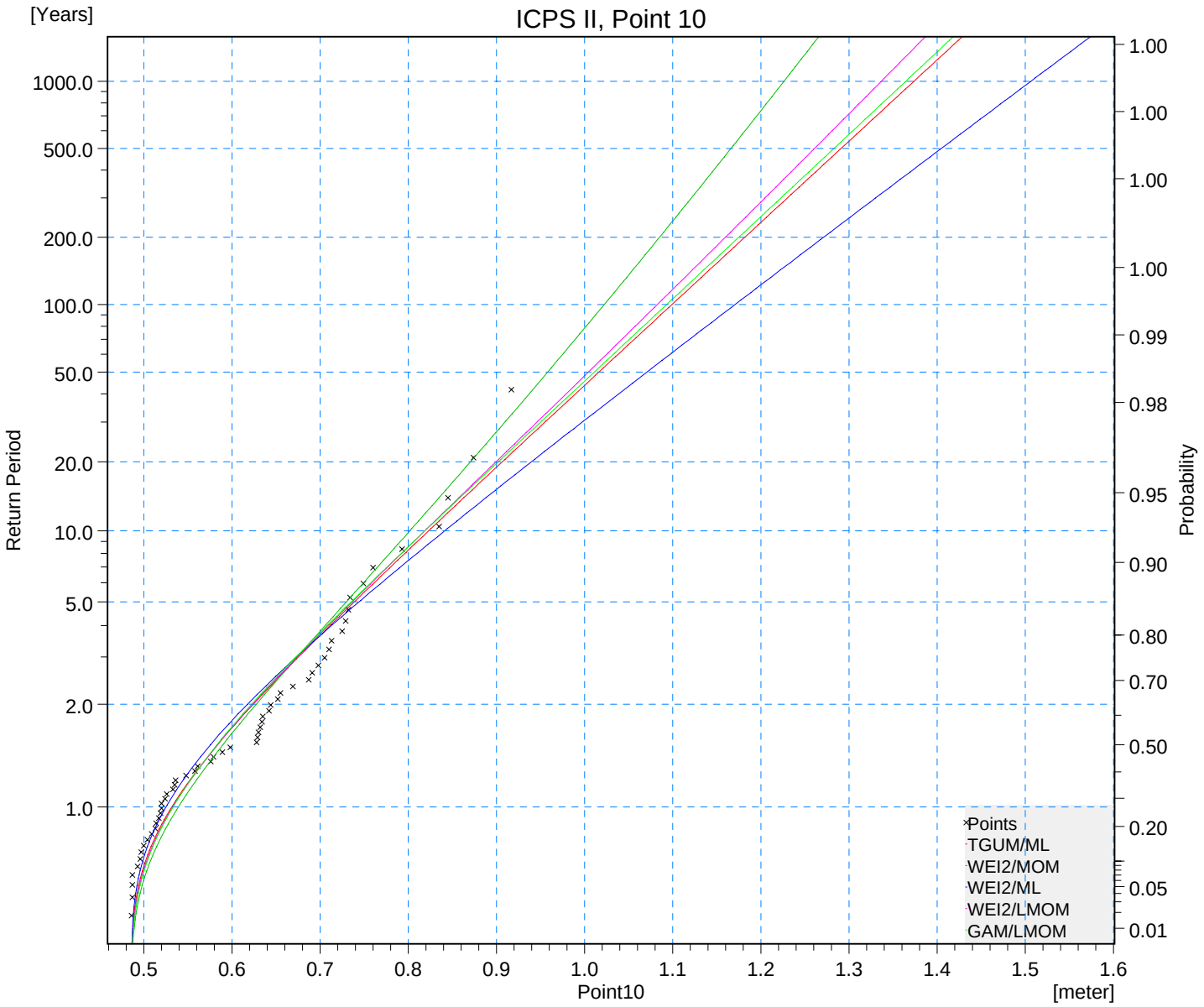
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 9						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.731	0.724	0.737	0.730	0.729
	10.00	0.826	0.804	0.851	0.823	0.823
	25.00	0.945	0.901	0.999	0.939	0.941
	50.00	1.033	0.970	1.111	1.024	1.028
	100.00	1.120	1.038	1.225	1.107	1.115
	200.00	1.207	1.103	1.339	1.190	1.201
	1000.00	1.408	1.250	1.609	1.380	1.399
Average quantile	5.00	0.734	0.725	0.739	0.730	0.729
	10.00	0.830	0.806	0.854	0.823	0.822
	25.00	0.950	0.903	1.004	0.937	0.939
	50.00	1.039	0.972	1.117	1.020	1.026
	100.00	1.127	1.038	1.231	1.101	1.111
	200.00	1.214	1.104	1.345	1.181	1.195
	1000.00	1.416	1.249	1.613	1.363	1.391
Standard deviation	5.00	0.026	0.023	0.026	0.024	0.023
	10.00	0.031	0.027	0.037	0.029	0.029
	25.00	0.040	0.034	0.062	0.040	0.039
	50.00	0.048	0.041	0.085	0.052	0.048
	100.00	0.057	0.049	0.112	0.066	0.058
	200.00	0.066	0.058	0.142	0.081	0.069
	1000.00	0.088	0.082	0.220	0.122	0.095
Goodness-of-fit statistics	CHISQ	7.929	15.786	9.000	11.143	11.857
	KS	0.119	0.128	0.136	0.120	0.123
	SLSC	0.041	0.038	0.052	0.041	0.042
	PPCC1	0.978	0.985	0.965	0.979	0.977
	PPCC2	0.978	0.985	0.966	0.978	0.977
	LLM	55.919	54.237	55.656	55.515	55.074



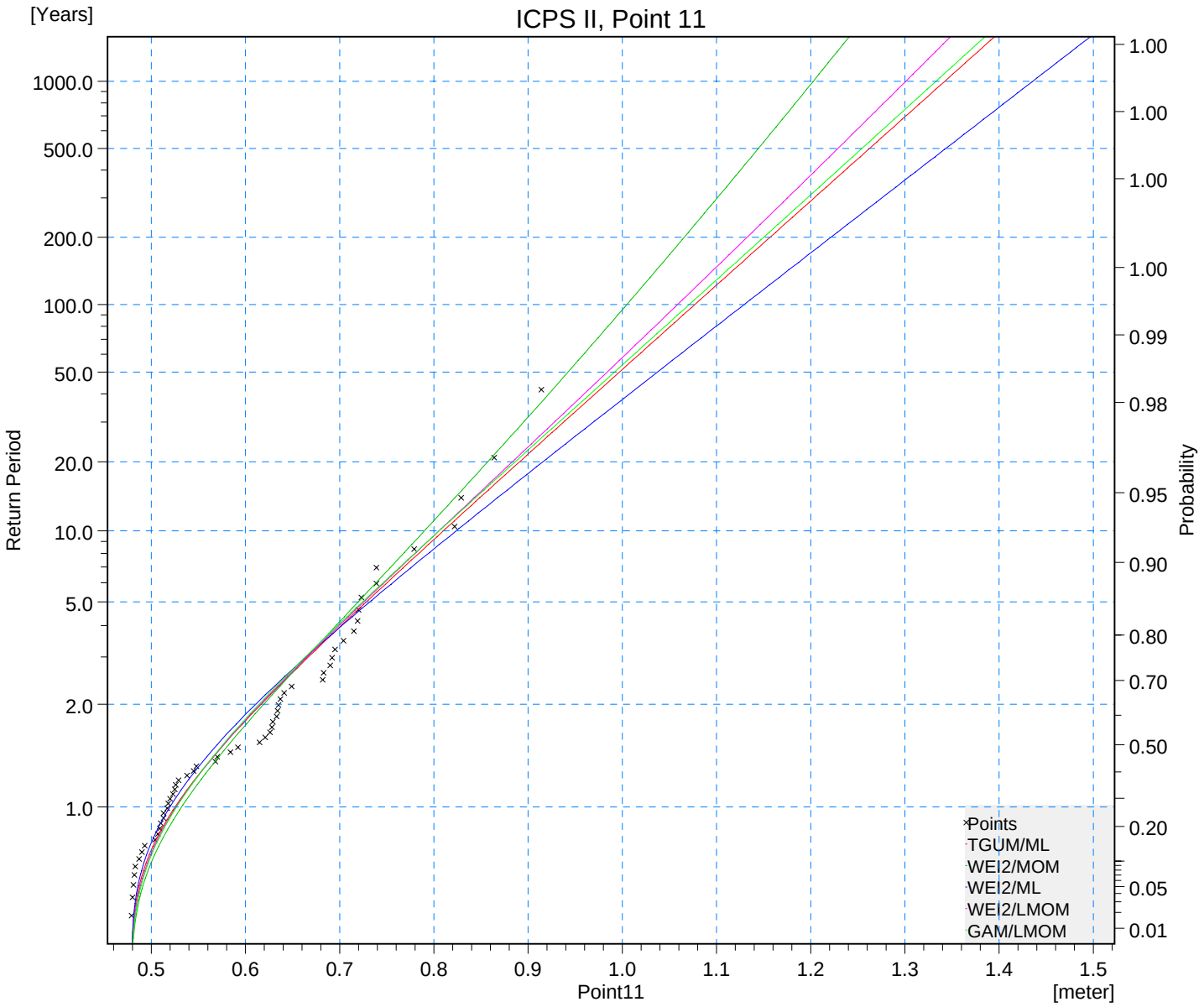
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 10						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.726	0.718	0.729	0.723	0.722
	10.00	0.817	0.797	0.834	0.813	0.813
	25.00	0.931	0.890	0.969	0.923	0.926
	50.00	1.015	0.957	1.070	1.003	1.010
	100.00	1.099	1.022	1.170	1.082	1.093
	200.00	1.182	1.085	1.271	1.160	1.175
	1000.00	1.374	1.226	1.506	1.337	1.364
Average quantile	5.00	0.728	0.719	0.733	0.724	0.722
	10.00	0.820	0.798	0.845	0.813	0.813
	25.00	0.935	0.892	0.990	0.922	0.925
	50.00	1.020	0.959	1.099	1.001	1.008
	100.00	1.104	1.024	1.207	1.078	1.090
	200.00	1.188	1.087	1.316	1.153	1.172
	1000.00	1.381	1.227	1.571	1.325	1.360
Standard deviation	5.00	0.025	0.023	0.025	0.024	0.023
	10.00	0.031	0.027	0.038	0.029	0.029
	25.00	0.040	0.035	0.065	0.041	0.040
	50.00	0.048	0.043	0.090	0.053	0.049
	100.00	0.057	0.051	0.119	0.066	0.059
	200.00	0.066	0.060	0.149	0.081	0.070
	1000.00	0.089	0.084	0.227	0.119	0.096
Goodness -of-fit statistics	CHISQ	10.429	16.143	9.357	11.143	12.571
	KS	0.144	0.135	0.160	0.146	0.150
	SLSC	0.038	0.035	0.047	0.038	0.039
	PPCC1	0.982	0.987	0.973	0.982	0.981
	PPCC2	0.982	0.987	0.973	0.982	0.981
	LLM	56.327	55.028	55.868	55.896	55.326



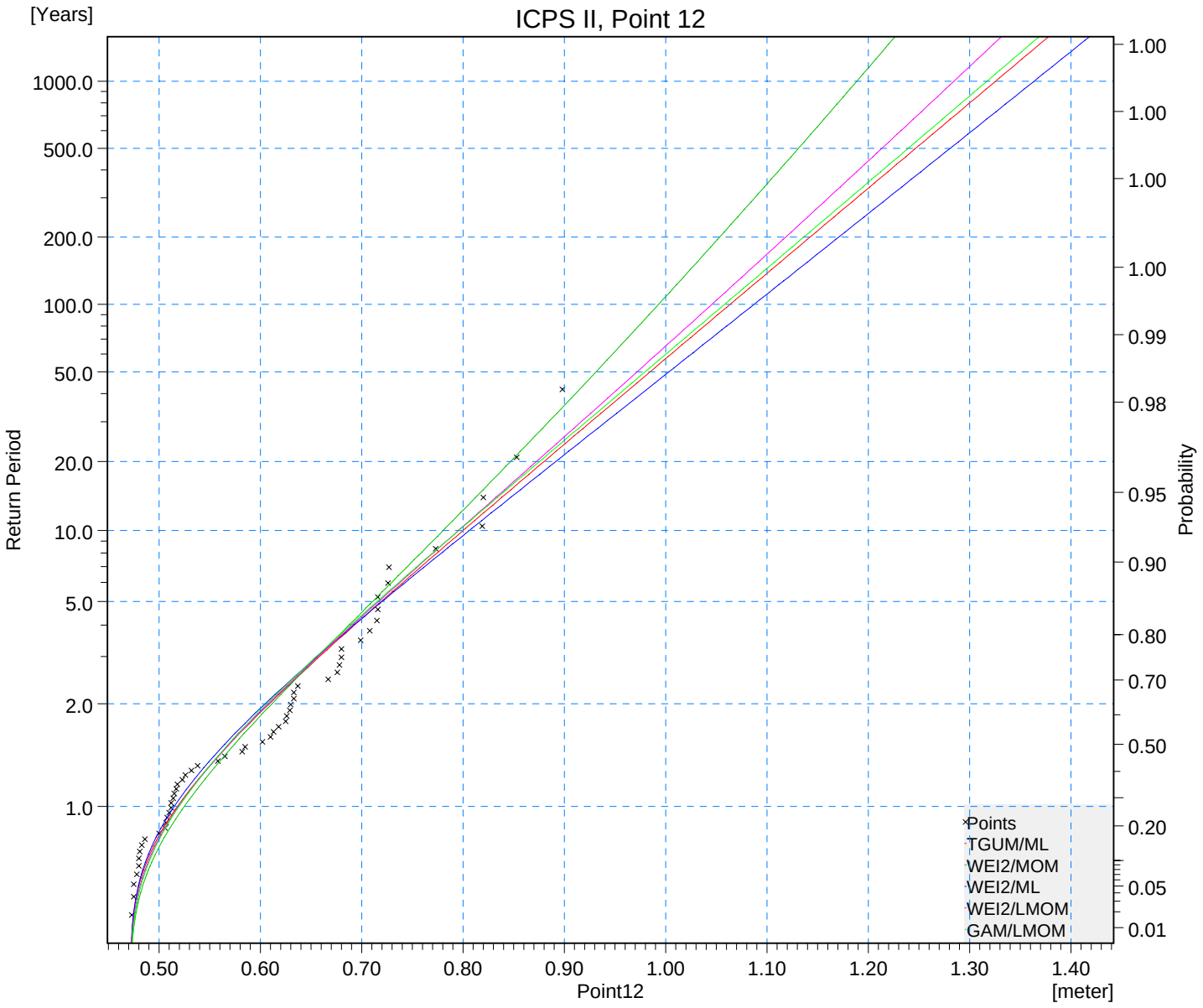
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 11						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.715	0.708	0.718	0.713	0.712
	10.00	0.804	0.785	0.817	0.800	0.800
	25.00	0.915	0.876	0.943	0.906	0.910
	50.00	0.996	0.942	1.036	0.983	0.991
	100.00	1.077	1.005	1.129	1.058	1.071
	200.00	1.157	1.066	1.221	1.132	1.150
	1000.00	1.342	1.203	1.436	1.301	1.333
Average quantile	5.00	0.717	0.709	0.720	0.714	0.712
	10.00	0.807	0.786	0.822	0.800	0.799
	25.00	0.918	0.878	0.951	0.904	0.908
	50.00	1.000	0.943	1.046	0.980	0.988
	100.00	1.081	1.006	1.141	1.053	1.067
	200.00	1.162	1.067	1.235	1.125	1.146
	1000.00	1.349	1.203	1.452	1.287	1.326
Standard deviation	5.00	0.024	0.023	0.024	0.023	0.022
	10.00	0.030	0.028	0.035	0.029	0.029
	25.00	0.040	0.036	0.056	0.041	0.040
	50.00	0.048	0.044	0.075	0.052	0.049
	100.00	0.057	0.052	0.097	0.065	0.059
	200.00	0.066	0.061	0.120	0.080	0.070
	1000.00	0.089	0.085	0.180	0.116	0.095
Goodness -of-fit statistics	CHISQ	15.429	17.214	13.643	13.286	13.286
	KS	0.129	0.123	0.145	0.131	0.135
	SLSC	0.036	0.035	0.043	0.036	0.038
	PPCC1	0.983	0.988	0.977	0.984	0.982
	PPCC2	0.983	0.988	0.977	0.983	0.982
	LLM	57.029	56.026	56.547	56.655	56.068



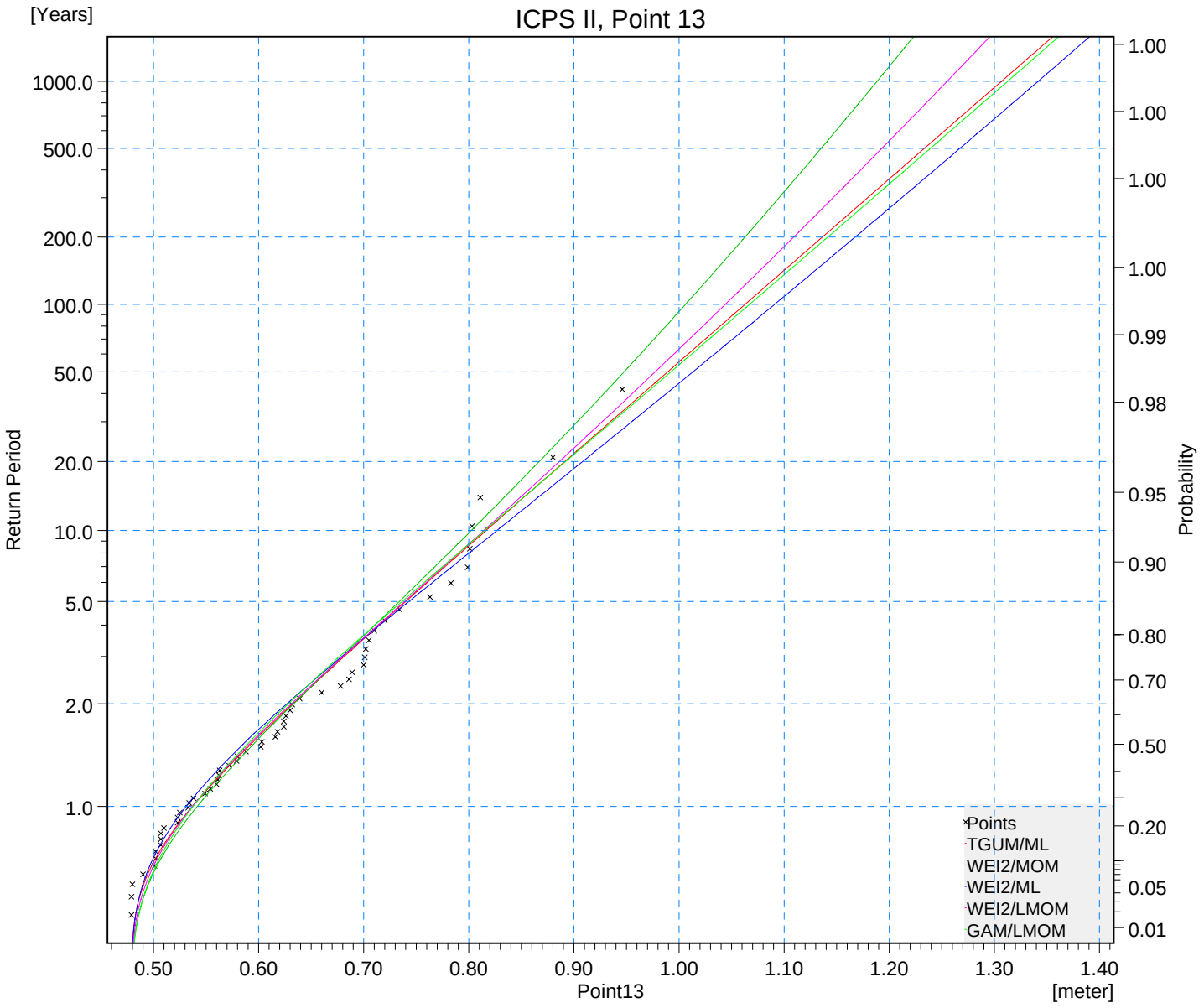
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 12						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.707	0.700	0.707	0.704	0.703
	10.00	0.794	0.775	0.800	0.790	0.790
	25.00	0.903	0.866	0.917	0.895	0.899
	50.00	0.984	0.930	1.002	0.971	0.979
	100.00	1.063	0.993	1.087	1.045	1.058
	200.00	1.142	1.053	1.171	1.118	1.136
	1000.00	1.326	1.189	1.364	1.285	1.317
Average quantile	5.00	0.708	0.700	0.708	0.705	0.703
	10.00	0.797	0.777	0.803	0.790	0.790
	25.00	0.907	0.867	0.921	0.893	0.897
	50.00	0.988	0.932	1.008	0.967	0.976
	100.00	1.068	0.994	1.094	1.040	1.055
	200.00	1.148	1.054	1.178	1.111	1.132
	1000.00	1.332	1.189	1.372	1.271	1.310
Standard deviation	5.00	0.024	0.022	0.024	0.023	0.022
	10.00	0.030	0.027	0.032	0.029	0.029
	25.00	0.040	0.035	0.049	0.040	0.040
	50.00	0.048	0.043	0.064	0.052	0.049
	100.00	0.057	0.051	0.081	0.064	0.058
	200.00	0.066	0.060	0.099	0.078	0.069
	1000.00	0.088	0.083	0.145	0.114	0.093
Goodness -of-fit statistics	CHISQ	20.786	15.429	17.214	16.143	14.357
	KS	0.119	0.125	0.130	0.122	0.126
	SLSC	0.037	0.035	0.040	0.036	0.038
	PPCC1	0.983	0.987	0.979	0.983	0.982
	PPCC2	0.983	0.988	0.979	0.983	0.982
	LLM	58.291	57.050	58.041	57.875	57.260



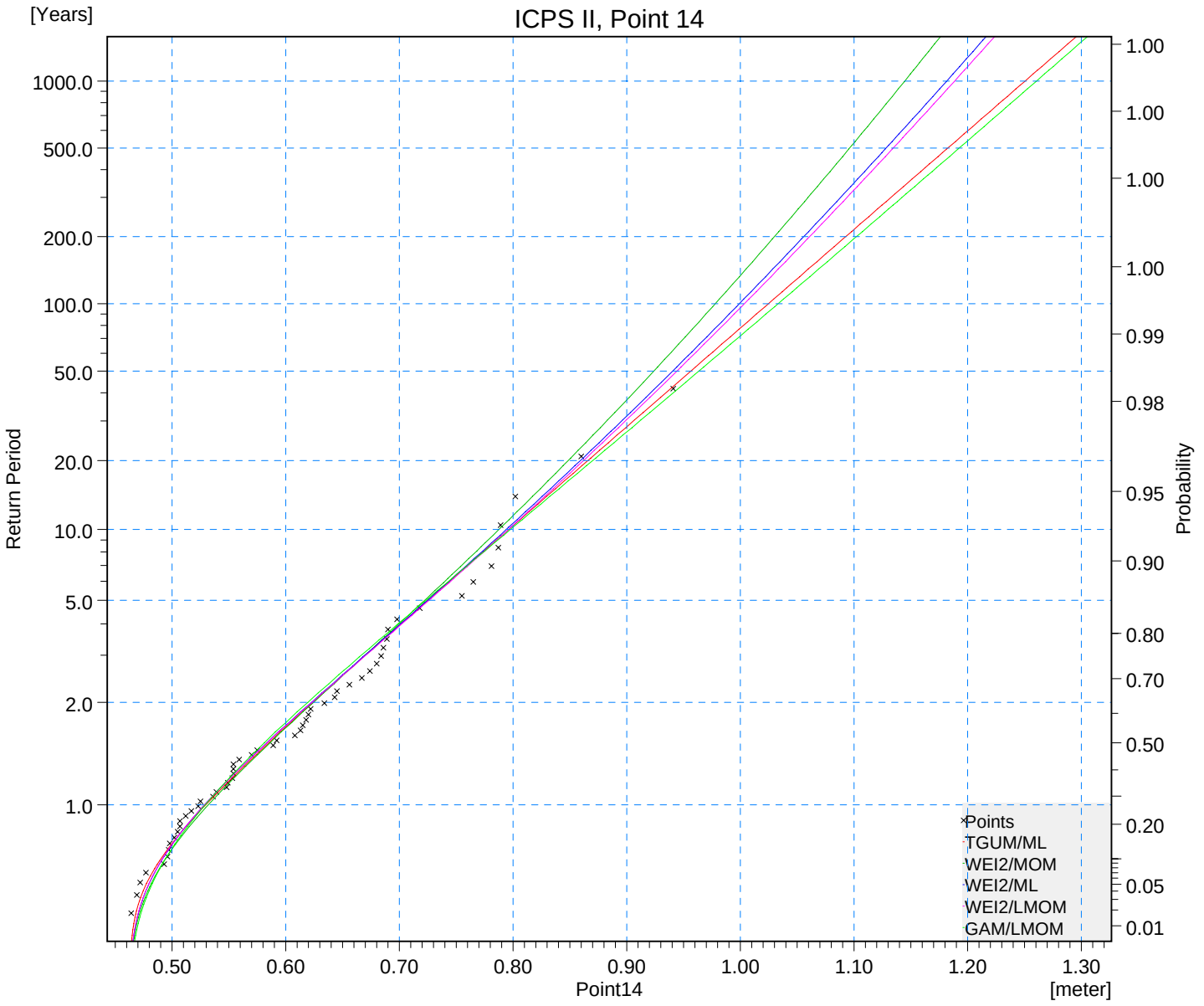
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 13						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.728	0.723	0.730	0.727	0.724
	10.00	0.811	0.798	0.821	0.809	0.809
	25.00	0.913	0.885	0.932	0.907	0.915
	50.00	0.988	0.947	1.012	0.977	0.991
	100.00	1.062	1.006	1.091	1.044	1.067
	200.00	1.136	1.063	1.167	1.109	1.141
	1000.00	1.307	1.189	1.342	1.255	1.313
Average quantile	5.00	0.729	0.723	0.734	0.727	0.724
	10.00	0.813	0.799	0.833	0.809	0.810
	25.00	0.916	0.888	0.956	0.907	0.915
	50.00	0.992	0.950	1.045	0.976	0.991
	100.00	1.066	1.009	1.132	1.042	1.066
	200.00	1.140	1.066	1.217	1.106	1.141
	1000.00	1.312	1.192	1.412	1.249	1.311
Standard deviation	5.00	0.024	0.023	0.024	0.023	0.023
	10.00	0.032	0.029	0.038	0.031	0.031
	25.00	0.043	0.038	0.064	0.043	0.042
	50.00	0.052	0.046	0.087	0.054	0.052
	100.00	0.062	0.055	0.111	0.065	0.061
	200.00	0.071	0.064	0.136	0.078	0.072
	1000.00	0.093	0.087	0.199	0.109	0.096
Goodness -of-fit statistics	CHISQ	2.571	3.286	5.071	2.571	3.643
	KS	0.070	0.078	0.084	0.072	0.079
	SLSC	0.024	0.027	0.031	0.025	0.028
	PPCC1	0.993	0.995	0.990	0.993	0.991
	PPCC2	0.993	0.994	0.989	0.992	0.991
	LLM	53.503	53.777	52.858	53.573	53.105



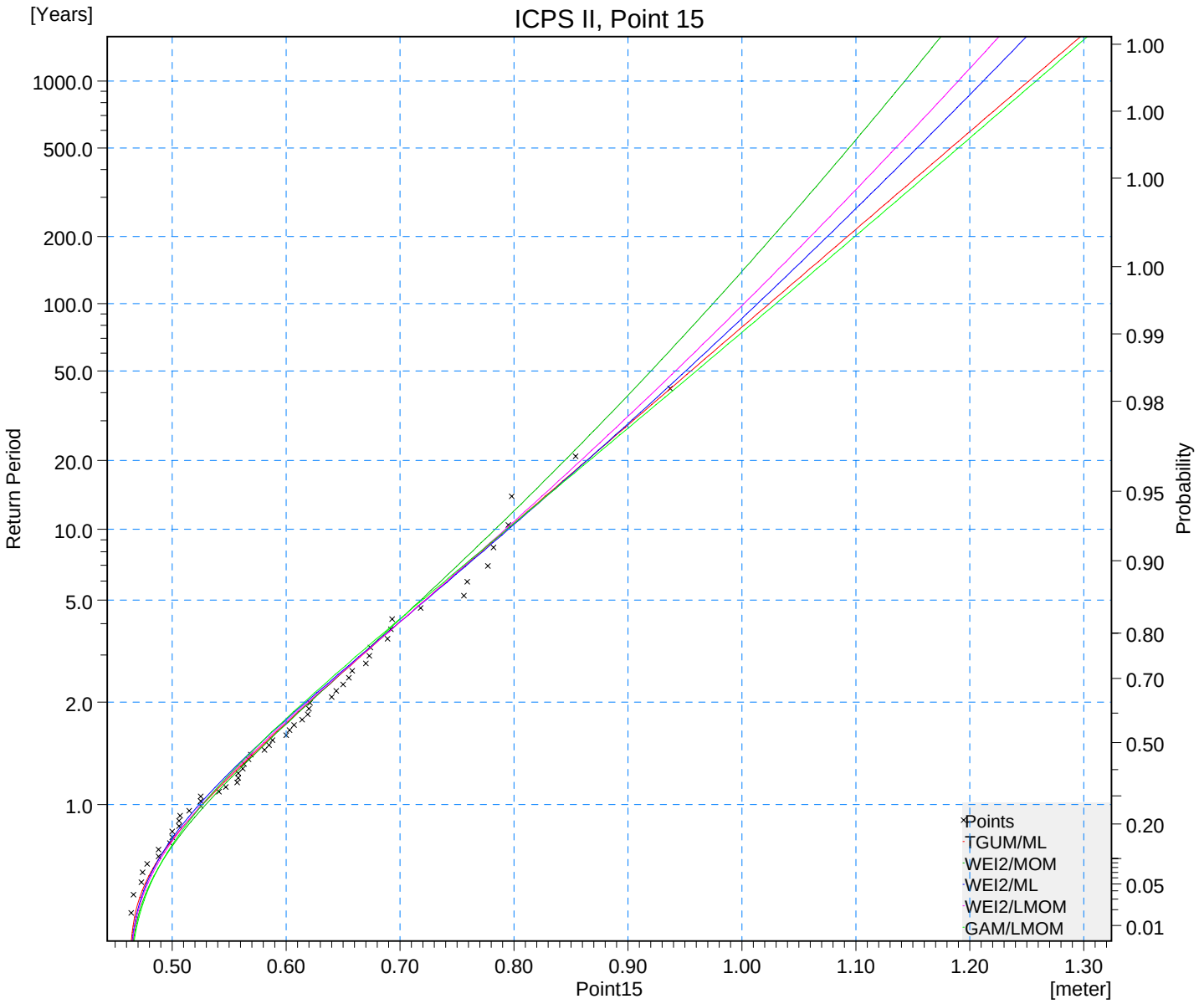
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 14						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.714	0.712	0.713	0.715	0.712
	10.00	0.791	0.783	0.789	0.791	0.792
	25.00	0.886	0.866	0.878	0.881	0.891
	50.00	0.956	0.923	0.940	0.943	0.963
	100.00	1.024	0.978	0.999	1.003	1.033
	200.00	1.093	1.030	1.056	1.061	1.102
	1000.00	1.251	1.145	1.182	1.189	1.261
Average quantile	5.00	0.715	0.712	0.715	0.715	0.712
	10.00	0.793	0.784	0.793	0.791	0.792
	25.00	0.888	0.867	0.883	0.880	0.890
	50.00	0.958	0.925	0.947	0.941	0.961
	100.00	1.027	0.980	1.007	1.000	1.031
	200.00	1.096	1.032	1.066	1.056	1.100
	1000.00	1.255	1.146	1.195	1.181	1.257
Standard deviation	5.00	0.024	0.023	0.023	0.023	0.023
	10.00	0.032	0.029	0.031	0.031	0.030
	25.00	0.043	0.039	0.044	0.042	0.042
	50.00	0.051	0.047	0.054	0.052	0.051
	100.00	0.060	0.056	0.066	0.063	0.060
	200.00	0.068	0.065	0.077	0.074	0.070
	1000.00	0.089	0.086	0.105	0.100	0.093
Goodness -of-fit statistics	CHISQ	9.714	8.286	10.786	9.714	7.929
	KS	0.064	0.062	0.069	0.068	0.079
	SLSC	0.020	0.025	0.022	0.021	0.024
	PPCC1	0.995	0.996	0.996	0.996	0.994
	PPCC2	0.995	0.996	0.995	0.995	0.994
	LLM	54.020	53.641	53.779	53.783	52.661



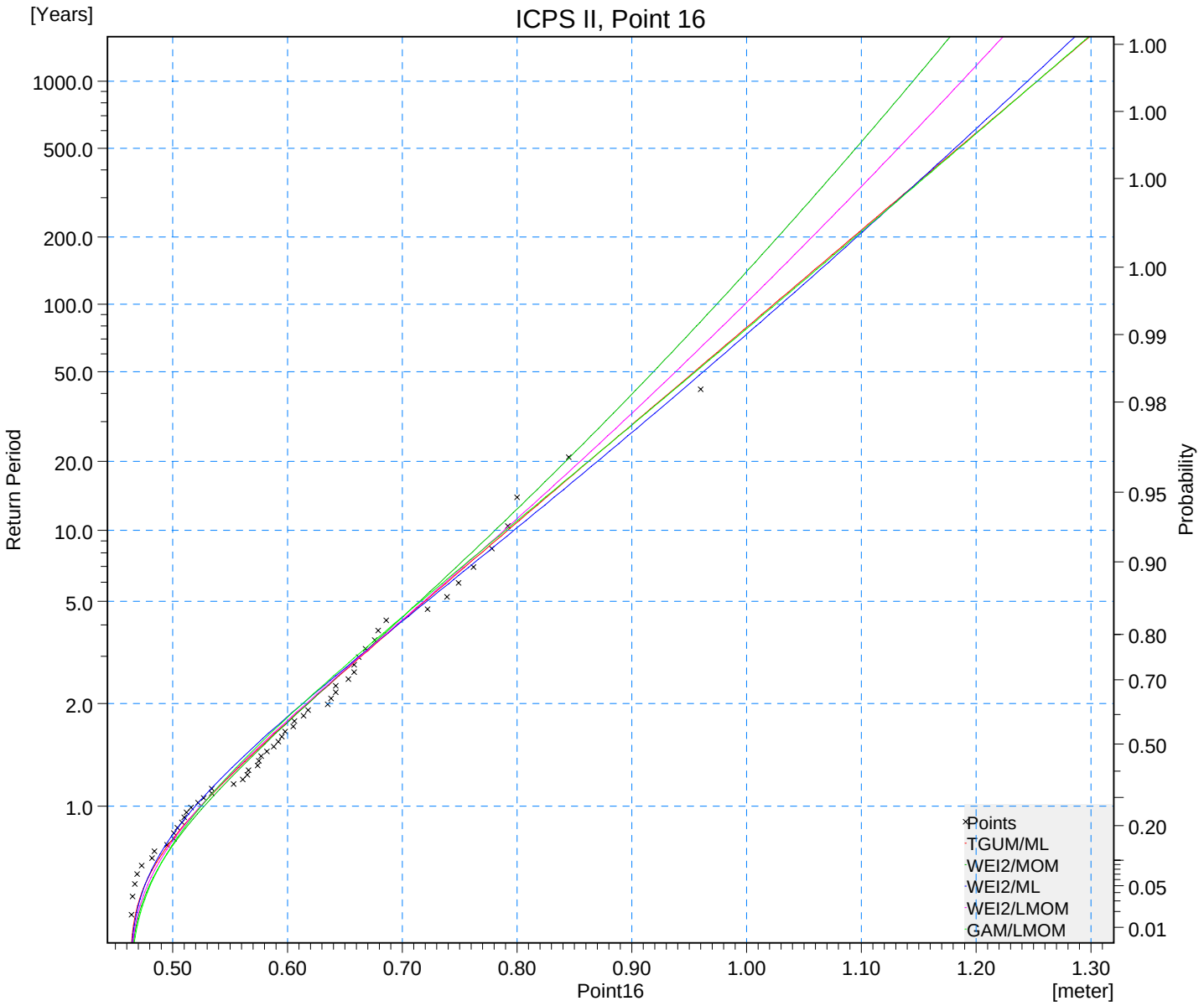
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 15						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.711	0.707	0.711	0.711	0.708
	10.00	0.789	0.779	0.790	0.787	0.788
	25.00	0.884	0.862	0.884	0.878	0.887
	50.00	0.954	0.919	0.950	0.941	0.959
	100.00	1.024	0.974	1.013	1.002	1.029
	200.00	1.093	1.027	1.075	1.060	1.099
	1000.00	1.252	1.143	1.212	1.190	1.258
Average quantile	5.00	0.712	0.708	0.713	0.711	0.708
	10.00	0.790	0.780	0.796	0.787	0.788
	25.00	0.887	0.864	0.894	0.877	0.887
	50.00	0.957	0.922	0.963	0.939	0.958
	100.00	1.027	0.977	1.030	0.999	1.028
	200.00	1.096	1.029	1.095	1.056	1.097
	1000.00	1.256	1.145	1.238	1.182	1.255
Standard deviation	5.00	0.023	0.023	0.023	0.023	0.023
	10.00	0.031	0.029	0.032	0.031	0.031
	25.00	0.042	0.039	0.048	0.043	0.042
	50.00	0.051	0.048	0.062	0.054	0.052
	100.00	0.060	0.057	0.076	0.065	0.062
	200.00	0.069	0.066	0.091	0.076	0.072
	1000.00	0.089	0.088	0.127	0.105	0.096
Goodness -of-fit statistics	CHISQ	4.714	2.929	4.000	4.000	4.714
	KS	0.061	0.069	0.077	0.068	0.072
	SLSC	0.018	0.024	0.020	0.019	0.023
	PPCC1	0.996	0.997	0.996	0.996	0.994
	PPCC2	0.996	0.996	0.995	0.996	0.994
	LLM	54.777	54.028	54.292	54.262	52.924



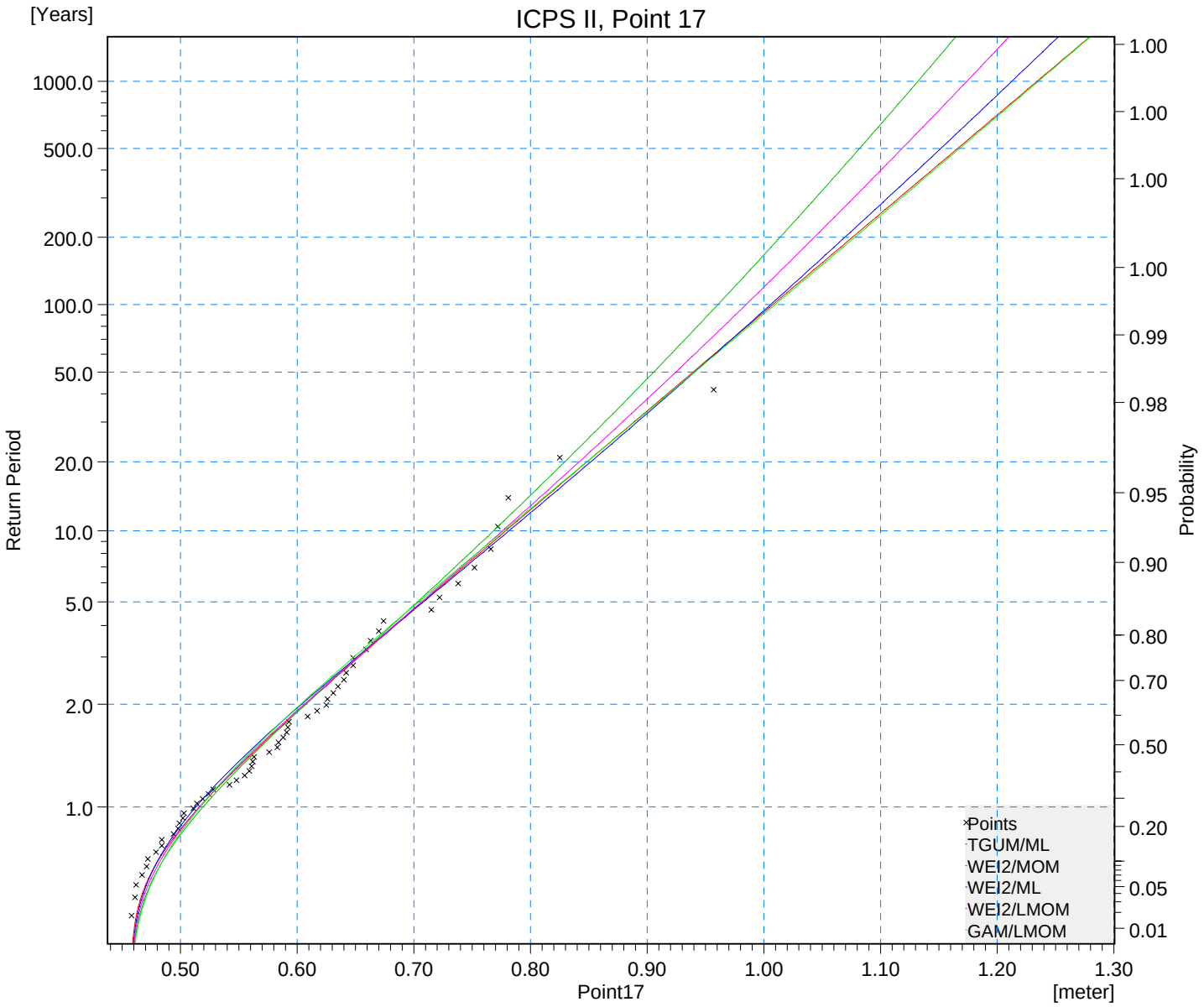
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 16						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.708	0.704	0.709	0.707	0.704
	10.00	0.787	0.776	0.792	0.784	0.785
	25.00	0.883	0.860	0.891	0.874	0.883
	50.00	0.954	0.918	0.961	0.937	0.955
	100.00	1.023	0.974	1.030	0.998	1.025
	200.00	1.093	1.027	1.096	1.057	1.094
	1000.00	1.253	1.145	1.245	1.187	1.253
Average quantile	5.00	0.710	0.705	0.711	0.708	0.705
	10.00	0.789	0.778	0.795	0.784	0.784
	25.00	0.885	0.862	0.896	0.872	0.882
	50.00	0.956	0.920	0.968	0.934	0.953
	100.00	1.026	0.976	1.037	0.994	1.022
	200.00	1.095	1.030	1.104	1.051	1.091
	1000.00	1.256	1.147	1.254	1.177	1.248
Standard deviation	5.00	0.023	0.023	0.023	0.023	0.023
	10.00	0.031	0.031	0.034	0.032	0.031
	25.00	0.042	0.043	0.051	0.045	0.044
	50.00	0.051	0.053	0.066	0.057	0.055
	100.00	0.060	0.063	0.082	0.069	0.065
	200.00	0.069	0.073	0.099	0.082	0.076
	1000.00	0.091	0.099	0.139	0.113	0.102
Goodness -of-fit statistics	CHISQ	7.214	7.929	9.357	4.714	7.214
	KS	0.071	0.064	0.095	0.076	0.083
	SLSC	0.020	0.027	0.023	0.022	0.024
	PPCC1	0.995	0.996	0.994	0.995	0.994
	PPCC2	0.995	0.995	0.994	0.995	0.994
	LLM	55.410	54.036	54.532	54.374	52.605



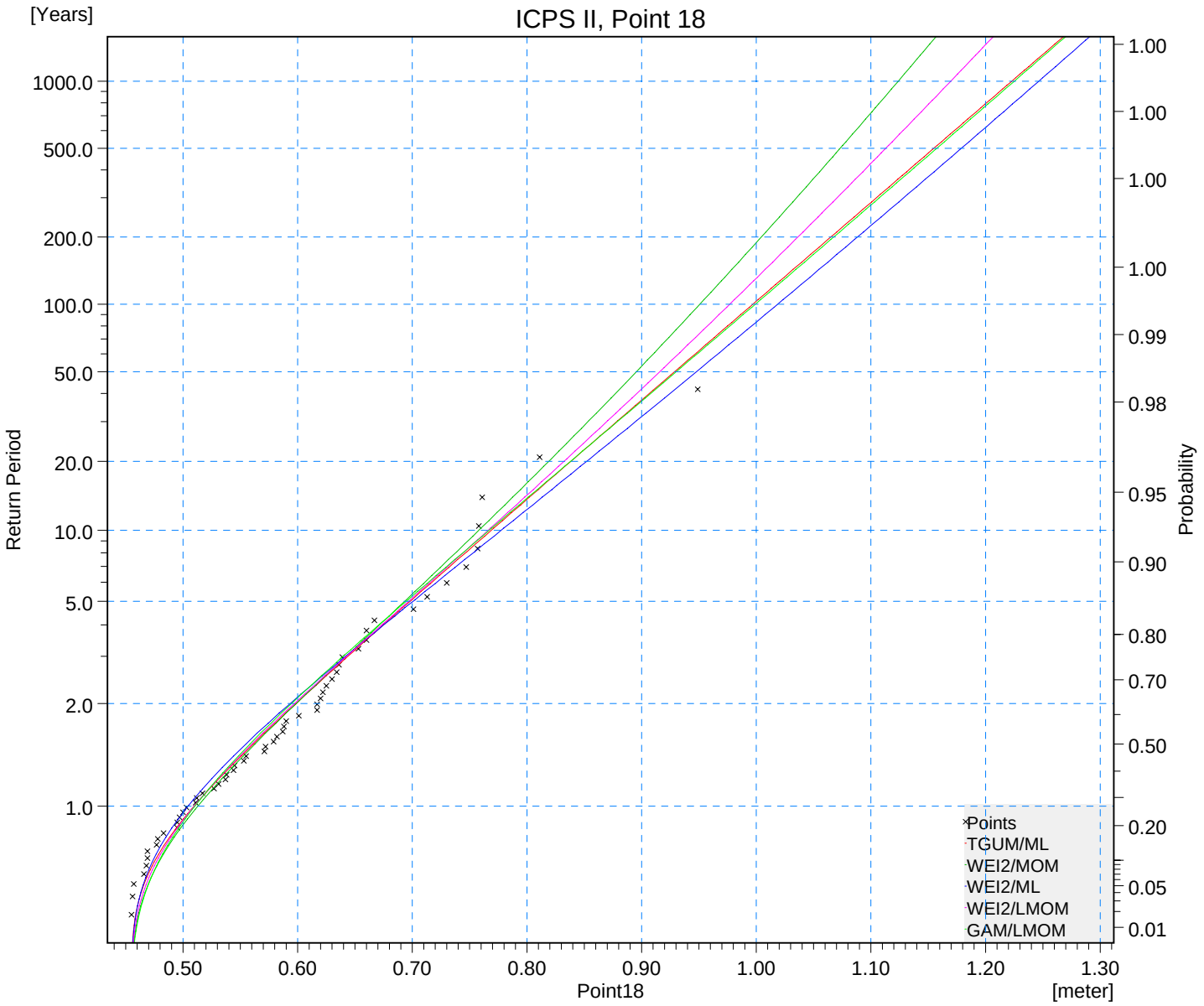
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 17						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.696	0.693	0.696	0.695	0.693
	10.00	0.774	0.764	0.776	0.771	0.772
	25.00	0.869	0.847	0.872	0.860	0.869
	50.00	0.938	0.905	0.940	0.924	0.940
	100.00	1.007	0.960	1.005	0.984	1.009
	200.00	1.076	1.014	1.069	1.043	1.078
	1000.00	1.234	1.132	1.213	1.174	1.235
Average quantile	5.00	0.698	0.694	0.698	0.696	0.693
	10.00	0.775	0.765	0.780	0.771	0.771
	25.00	0.871	0.849	0.877	0.859	0.868
	50.00	0.941	0.907	0.946	0.921	0.938
	100.00	1.010	0.963	1.013	0.980	1.007
	200.00	1.078	1.017	1.078	1.037	1.074
	1000.00	1.237	1.134	1.222	1.163	1.230
Standard deviation	5.00	0.023	0.023	0.023	0.023	0.023
	10.00	0.030	0.031	0.033	0.031	0.031
	25.00	0.042	0.044	0.049	0.045	0.044
	50.00	0.051	0.054	0.063	0.057	0.054
	100.00	0.060	0.065	0.077	0.069	0.065
	200.00	0.069	0.076	0.092	0.082	0.076
	1000.00	0.090	0.103	0.129	0.114	0.102
Goodness -of-fit statistics	CHISQ	7.214	8.286	8.643	5.429	9.000
	KS	0.069	0.066	0.085	0.074	0.083
	SLSC	0.023	0.031	0.026	0.026	0.026
	PPCC1	0.994	0.994	0.993	0.994	0.993
	PPCC2	0.994	0.992	0.992	0.992	0.993
	LLM	56.565	56.349	56.236	56.375	55.575



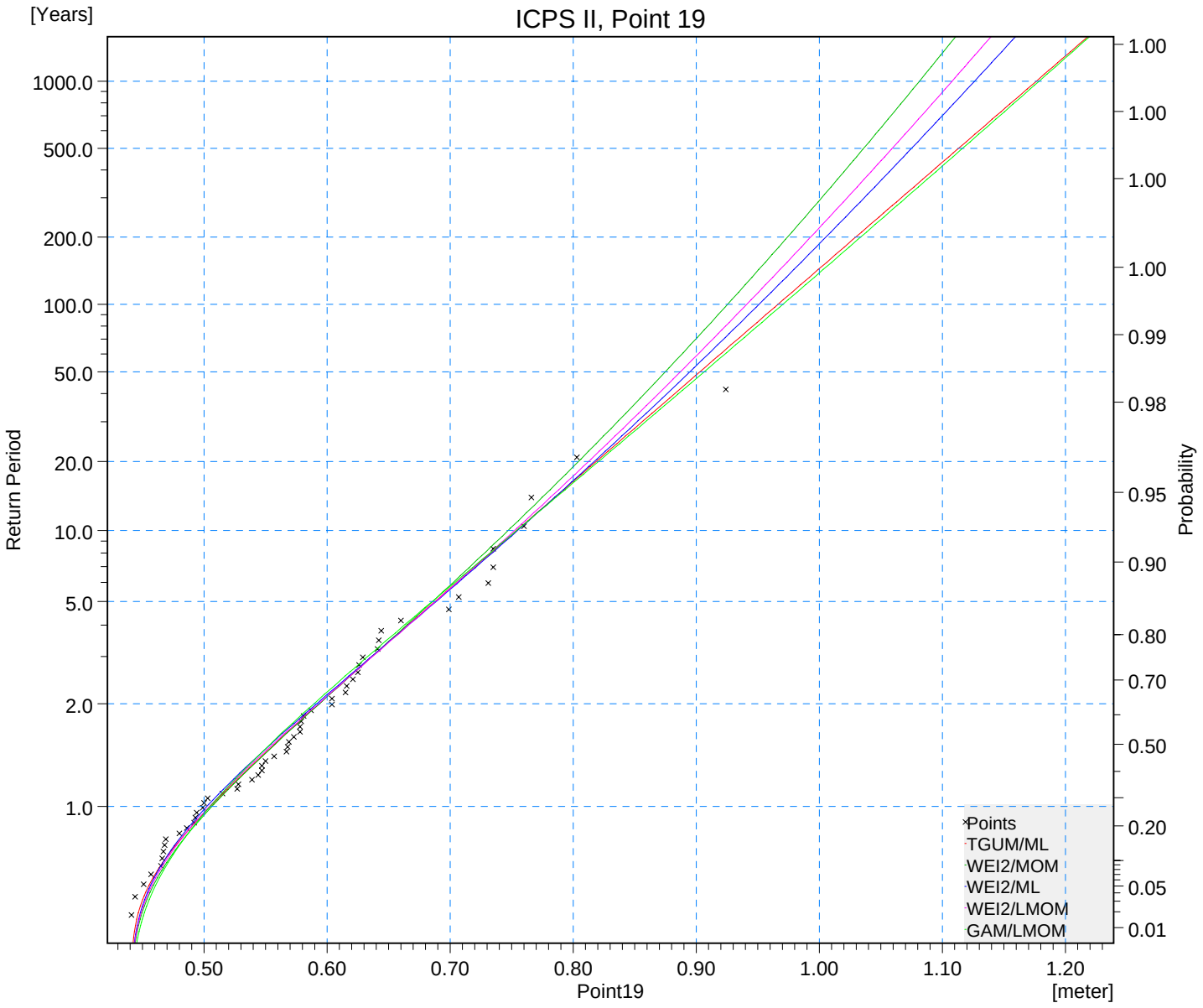
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 18						
		D/E Combination				
	Return Period [years]	**TGUM/ML**	**WEI2/MOM**	**WEI2/ML**	**WEI2/LMOM**	**GAM/LMOM**
Estimated quantile	5.00	0.687	0.683	0.688	0.686	0.683
	10.00	0.764	0.753	0.772	0.761	0.762
	25.00	0.858	0.836	0.874	0.851	0.859
	50.00	0.928	0.895	0.947	0.915	0.929
	100.00	0.997	0.951	1.018	0.977	0.999
	200.00	1.065	1.004	1.088	1.036	1.067
	1000.00	1.223	1.124	1.247	1.170	1.225
Average quantile	5.00	0.688	0.684	0.690	0.686	0.683
	10.00	0.766	0.755	0.776	0.761	0.762
	25.00	0.861	0.839	0.880	0.850	0.857
	50.00	0.930	0.897	0.955	0.912	0.927
	100.00	0.999	0.953	1.027	0.972	0.996
	200.00	1.068	1.007	1.098	1.030	1.064
	1000.00	1.226	1.126	1.259	1.159	1.220
Standard deviation	5.00	0.022	0.023	0.023	0.023	0.022
	10.00	0.030	0.031	0.034	0.031	0.031
	25.00	0.041	0.044	0.053	0.045	0.044
	50.00	0.050	0.054	0.070	0.057	0.054
	100.00	0.059	0.065	0.088	0.069	0.065
	200.00	0.069	0.077	0.107	0.082	0.076
	1000.00	0.090	0.104	0.153	0.114	0.102
Goodness -of-fit statistics	CHISQ	3.643	7.214	5.786	5.429	8.643
	KS	0.081	0.082	0.096	0.085	0.093
	SLSC	0.025	0.033	0.029	0.029	0.028
	PPCC1	0.993	0.993	0.990	0.992	0.991
	PPCC2	0.993	0.990	0.990	0.991	0.991
	LLM	58.047	57.415	57.329	57.545	56.545



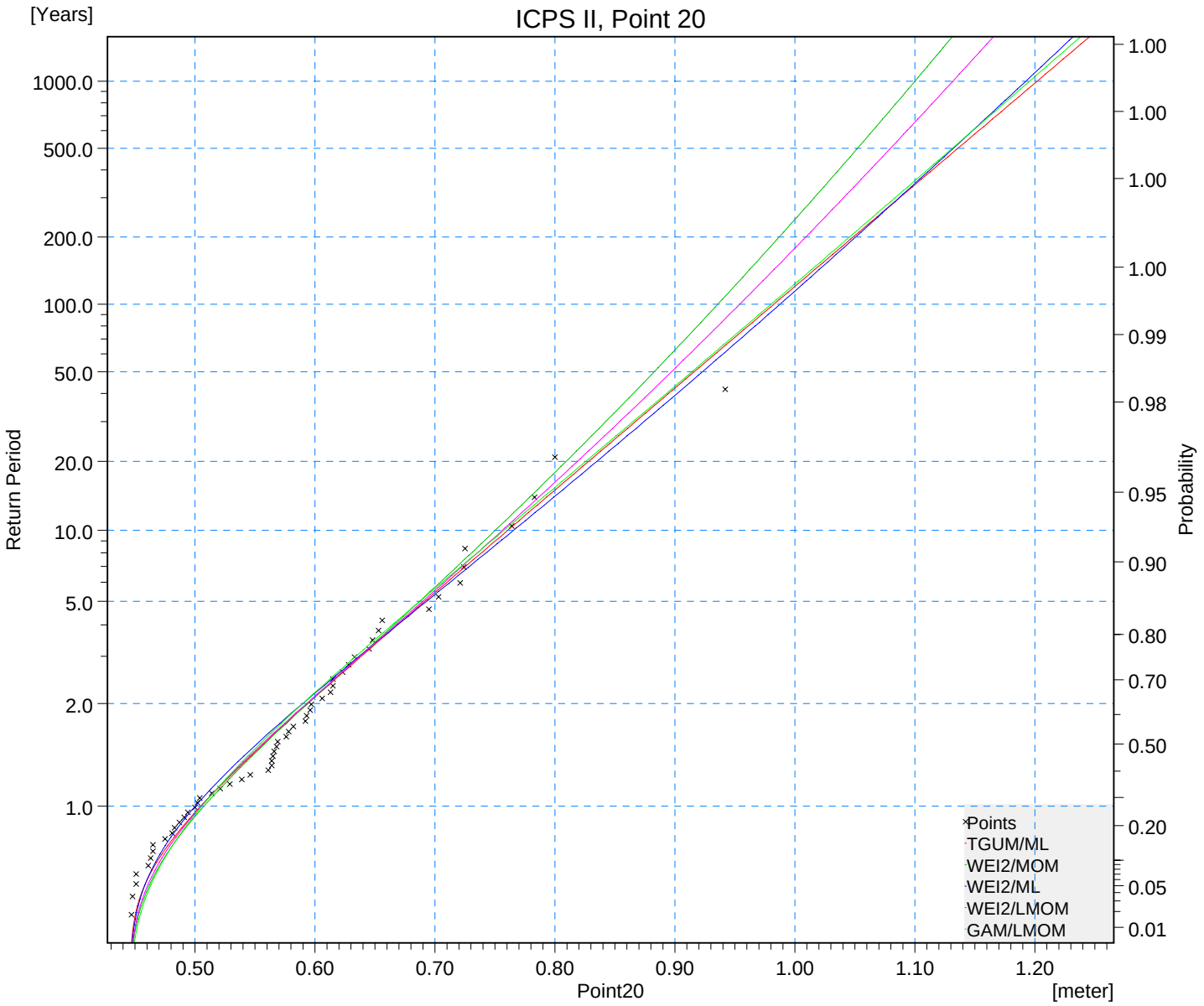
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 19						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.677	0.676	0.678	0.678	0.675
	10.00	0.749	0.743	0.750	0.748	0.749
	25.00	0.838	0.820	0.835	0.830	0.840
	50.00	0.902	0.874	0.894	0.887	0.906
	100.00	0.966	0.925	0.951	0.941	0.970
	200.00	1.030	0.974	1.005	0.993	1.034
	1000.00	1.176	1.081	1.126	1.108	1.179
Average quantile	5.00	0.678	0.677	0.680	0.678	0.675
	10.00	0.751	0.745	0.755	0.748	0.749
	25.00	0.839	0.823	0.843	0.829	0.839
	50.00	0.904	0.877	0.905	0.885	0.905
	100.00	0.968	0.928	0.964	0.938	0.968
	200.00	1.032	0.977	1.022	0.989	1.031
	1000.00	1.179	1.084	1.148	1.101	1.175
Standard deviation	5.00	0.022	0.022	0.022	0.022	0.022
	10.00	0.029	0.030	0.031	0.031	0.030
	25.00	0.040	0.042	0.046	0.043	0.043
	50.00	0.048	0.051	0.058	0.054	0.052
	100.00	0.056	0.061	0.071	0.065	0.062
	200.00	0.065	0.071	0.084	0.076	0.073
	1000.00	0.084	0.094	0.116	0.103	0.097
Goodness -of-fit statistics	CHISQ	6.143	8.643	9.000	10.786	10.786
	KS	0.074	0.072	0.085	0.078	0.089
	SLSC	0.022	0.032	0.026	0.027	0.025
	PPCC1	0.995	0.994	0.994	0.994	0.993
	PPCC2	0.995	0.992	0.993	0.992	0.993
	LLM	57.298	57.452	57.277	57.391	56.770



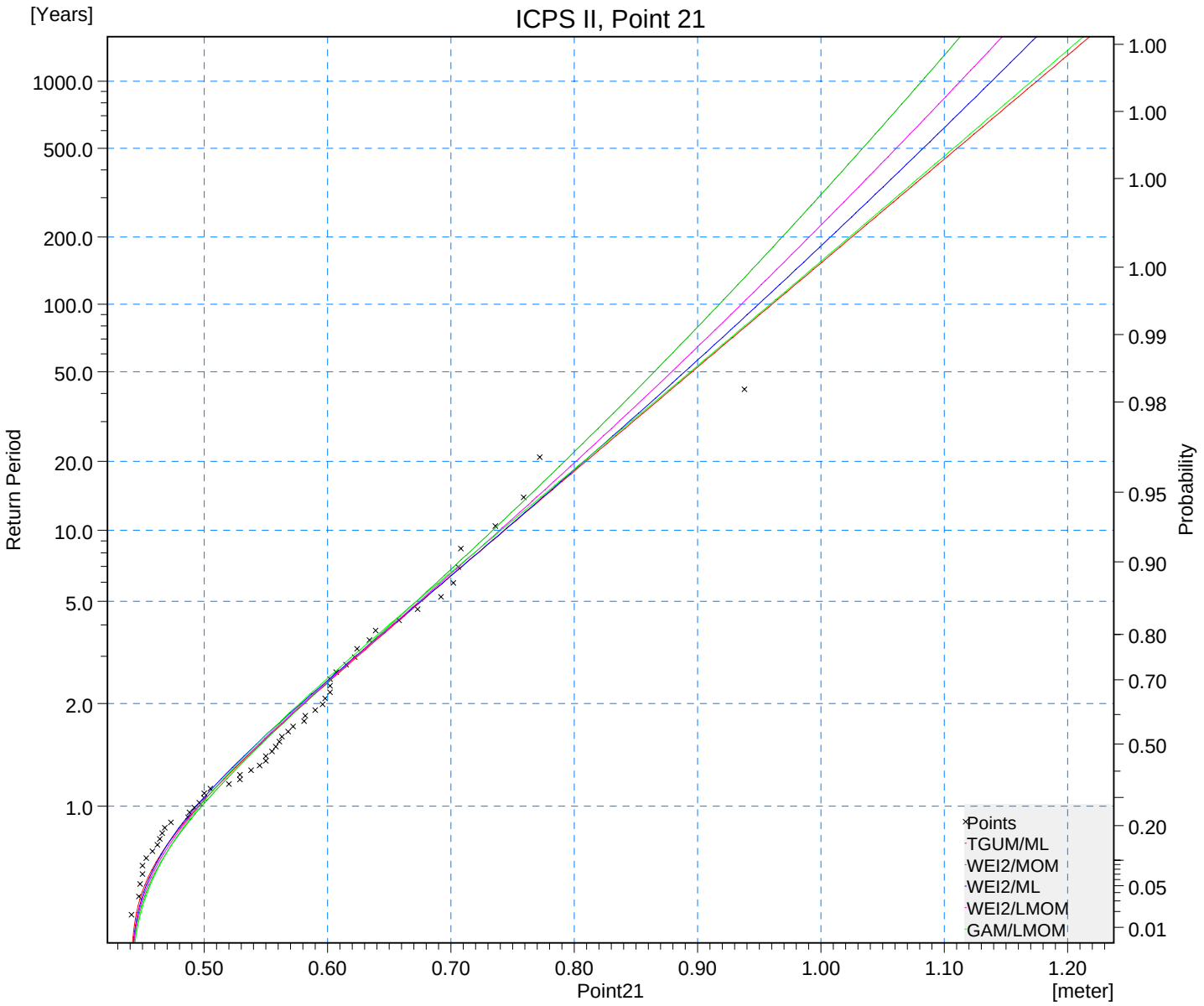
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 20						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.681	0.677	0.681	0.679	0.676
	10.00	0.756	0.746	0.760	0.751	0.752
	25.00	0.848	0.826	0.855	0.837	0.846
	50.00	0.915	0.882	0.922	0.896	0.913
	100.00	0.982	0.935	0.987	0.954	0.980
	200.00	1.048	0.987	1.051	1.009	1.045
	1000.00	1.202	1.100	1.192	1.132	1.196
Average quantile	5.00	0.682	0.678	0.683	0.680	0.677
	10.00	0.757	0.748	0.764	0.751	0.752
	25.00	0.850	0.829	0.861	0.835	0.844
	50.00	0.917	0.885	0.930	0.894	0.912
	100.00	0.984	0.938	0.997	0.949	0.977
	200.00	1.051	0.990	1.061	1.003	1.042
	1000.00	1.204	1.103	1.206	1.121	1.190
Standard deviation	5.00	0.022	0.023	0.023	0.022	0.022
	10.00	0.029	0.031	0.033	0.031	0.031
	25.00	0.040	0.044	0.050	0.045	0.044
	50.00	0.049	0.055	0.065	0.057	0.054
	100.00	0.057	0.066	0.081	0.069	0.065
	200.00	0.066	0.077	0.097	0.082	0.076
	1000.00	0.087	0.104	0.137	0.113	0.103
Goodness -of-fit statistics	CHISQ	10.429	11.143	10.786	10.429	9.714
	KS	0.123	0.119	0.143	0.127	0.136
	SLSC	0.025	0.034	0.028	0.029	0.029
	PPCC1	0.993	0.992	0.991	0.992	0.991
	PPCC2	0.993	0.990	0.991	0.991	0.991
	LLM	57.941	56.594	57.058	56.864	55.031



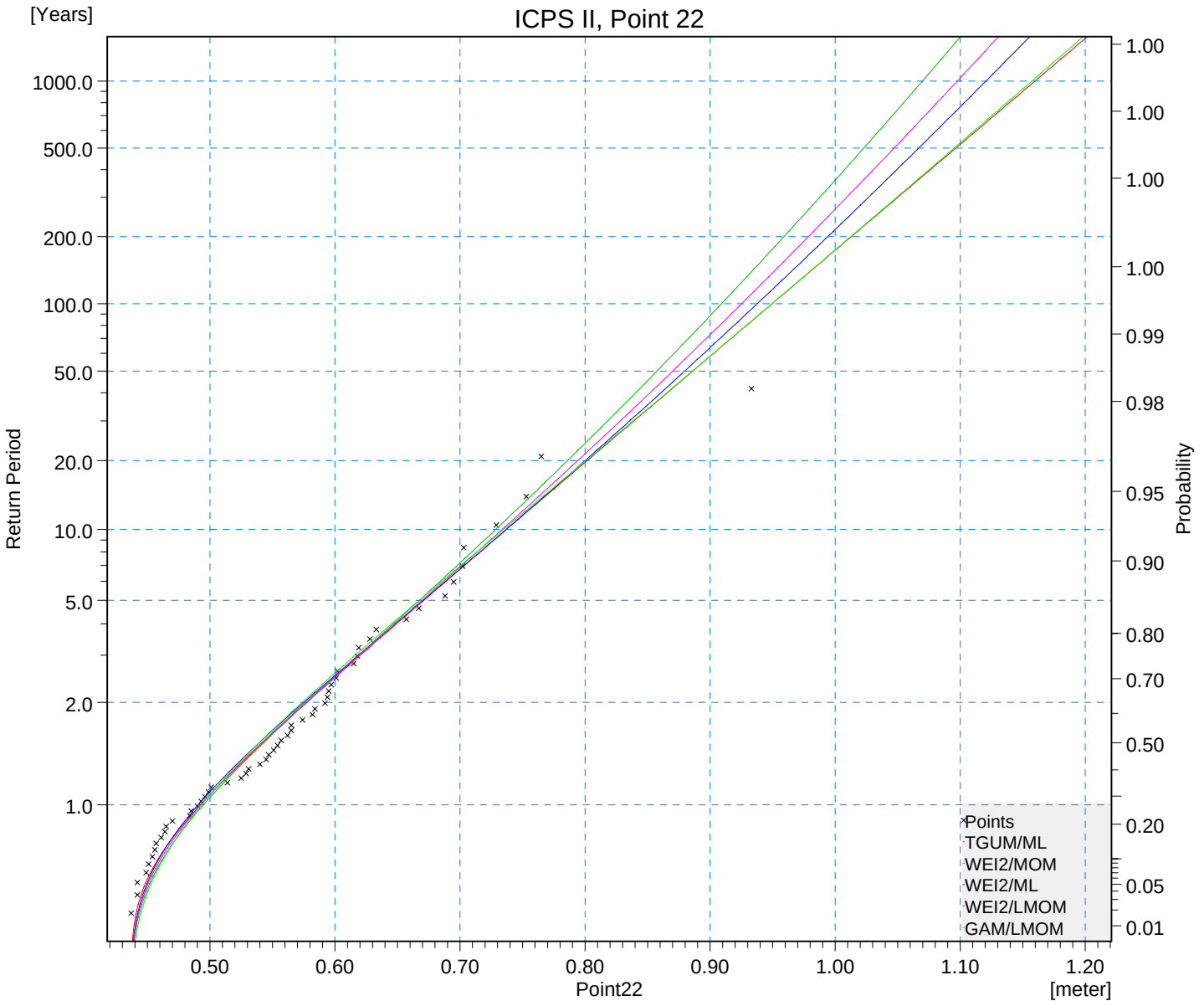
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 21						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.665	0.662	0.665	0.664	0.661
	10.00	0.739	0.730	0.738	0.735	0.736
	25.00	0.829	0.809	0.826	0.819	0.827
	50.00	0.895	0.864	0.889	0.878	0.893
	100.00	0.960	0.917	0.949	0.935	0.959
	200.00	1.025	0.968	1.008	0.990	1.023
	1000.00	1.175	1.082	1.138	1.113	1.171
Average quantile	5.00	0.667	0.663	0.666	0.664	0.662
	10.00	0.740	0.732	0.742	0.735	0.735
	25.00	0.830	0.811	0.831	0.817	0.826
	50.00	0.896	0.867	0.895	0.875	0.891
	100.00	0.962	0.921	0.956	0.931	0.956
	200.00	1.027	0.972	1.016	0.984	1.020
	1000.00	1.177	1.085	1.149	1.102	1.165
Standard deviation	5.00	0.021	0.023	0.022	0.022	0.022
	10.00	0.029	0.032	0.032	0.031	0.030
	25.00	0.039	0.046	0.046	0.045	0.043
	50.00	0.048	0.057	0.059	0.056	0.054
	100.00	0.056	0.069	0.072	0.069	0.065
	200.00	0.065	0.081	0.085	0.082	0.076
	1000.00	0.086	0.110	0.118	0.113	0.102
Goodness -of-fit statistics	CHISQ	6.143	8.643	7.214	10.429	12.571
	KS	0.090	0.087	0.102	0.094	0.102
	SLSC	0.029	0.039	0.033	0.035	0.032
	PPCC1	0.990	0.990	0.989	0.989	0.989
	PPCC2	0.990	0.986	0.987	0.987	0.989
	LLM	59.959	59.910	59.826	59.913	59.252



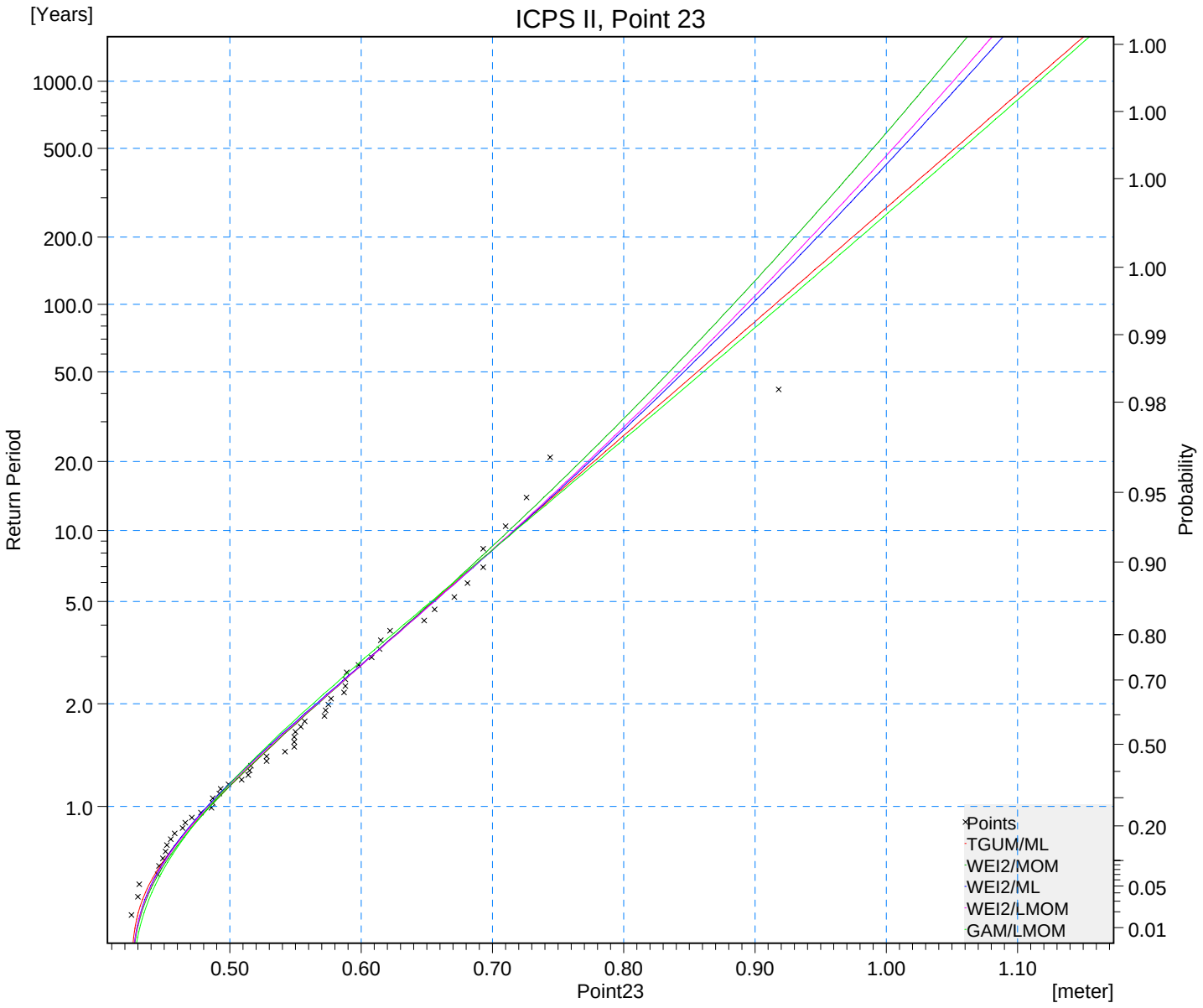
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 22						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.660	0.658	0.660	0.659	0.657
	10.00	0.732	0.724	0.732	0.729	0.730
	25.00	0.821	0.802	0.818	0.811	0.820
	50.00	0.885	0.857	0.879	0.869	0.885
	100.00	0.949	0.909	0.937	0.925	0.949
	200.00	1.013	0.959	0.994	0.978	1.012
	1000.00	1.160	1.070	1.121	1.098	1.157
Average quantile	5.00	0.662	0.659	0.662	0.660	0.657
	10.00	0.734	0.726	0.735	0.729	0.730
	25.00	0.822	0.805	0.822	0.810	0.819
	50.00	0.887	0.860	0.884	0.866	0.883
	100.00	0.951	0.912	0.943	0.920	0.946
	200.00	1.014	0.962	1.001	0.972	1.009
	1000.00	1.161	1.073	1.128	1.087	1.152
Standard deviation	5.00	0.021	0.023	0.022	0.022	0.022
	10.00	0.028	0.032	0.031	0.030	0.030
	25.00	0.039	0.046	0.046	0.044	0.043
	50.00	0.047	0.057	0.058	0.056	0.053
	100.00	0.056	0.069	0.071	0.068	0.064
	200.00	0.064	0.081	0.084	0.080	0.075
	1000.00	0.084	0.109	0.116	0.110	0.100
Goodness -of-fit statistics	CHISQ	5.429	8.286	7.214	5.429	10.071
	KS	0.083	0.083	0.095	0.087	0.095
	SLSC	0.029	0.040	0.034	0.036	0.032
	PPCC1	0.990	0.990	0.989	0.989	0.989
	PPCC2	0.990	0.985	0.986	0.986	0.989
	LLM	60.214	60.228	60.118	60.212	59.575



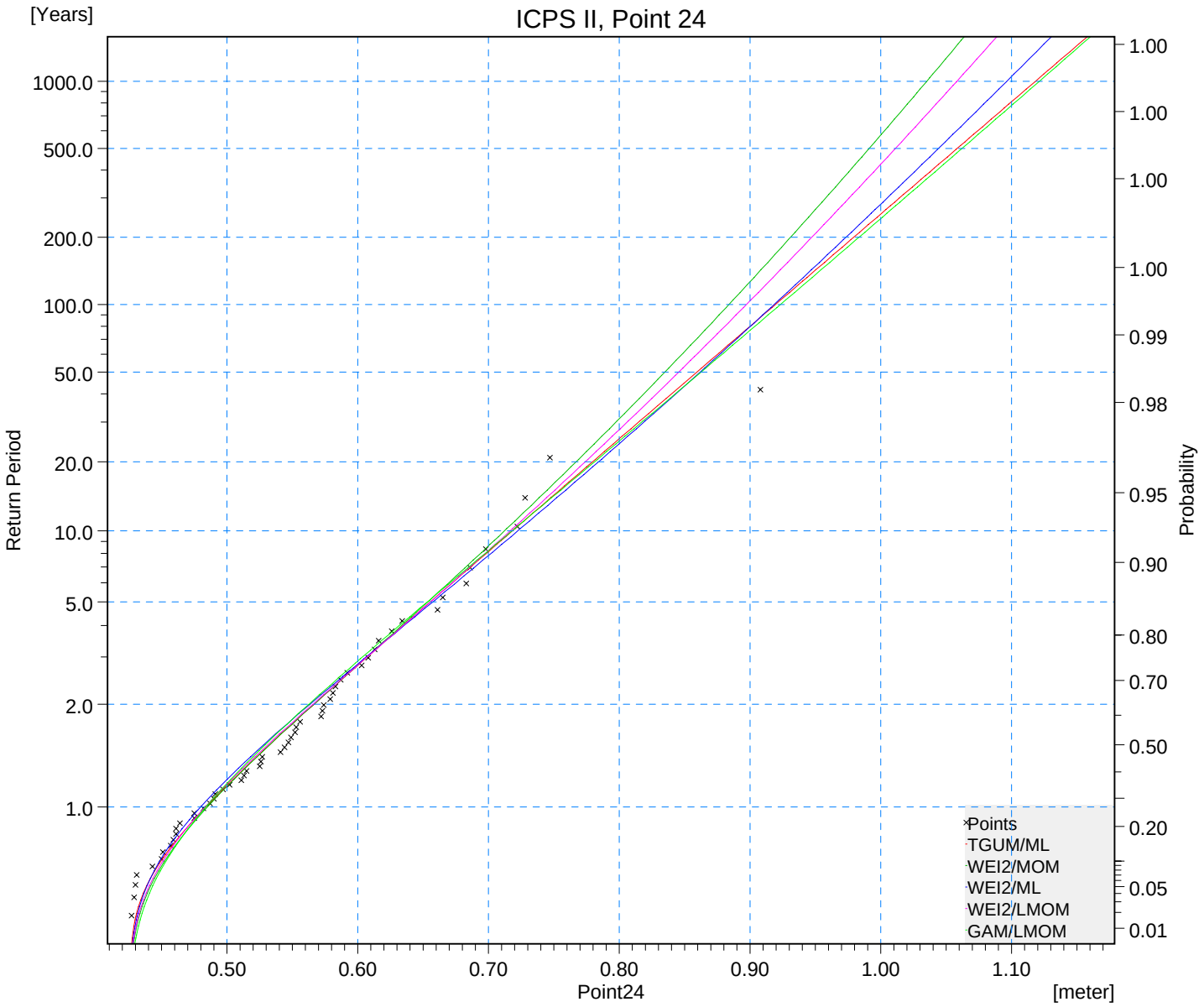
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 23						
		D/E Combination				
	Return Period [years]	**TGUM/ML**	**WEI2/MOM**	**WEI2/ML**	**WEI2/LMOM**	**GAM/LMOM**
Estimated quantile	5.00	0.645	0.645	0.646	0.646	0.643
	10.00	0.712	0.709	0.713	0.712	0.713
	25.00	0.795	0.783	0.791	0.789	0.798
	50.00	0.855	0.834	0.845	0.842	0.860
	100.00	0.915	0.883	0.897	0.893	0.920
	200.00	0.974	0.930	0.947	0.942	0.980
	1000.00	1.111	1.034	1.058	1.051	1.116
Average quantile	5.00	0.646	0.646	0.647	0.646	0.643
	10.00	0.714	0.711	0.716	0.712	0.713
	25.00	0.796	0.785	0.795	0.787	0.797
	50.00	0.857	0.837	0.851	0.840	0.858
	100.00	0.916	0.886	0.904	0.890	0.918
	200.00	0.976	0.934	0.955	0.937	0.977
	1000.00	1.113	1.037	1.068	1.042	1.112
Standard deviation	5.00	0.021	0.022	0.022	0.021	0.021
	10.00	0.028	0.032	0.031	0.030	0.030
	25.00	0.038	0.046	0.045	0.043	0.042
	50.00	0.046	0.057	0.056	0.053	0.051
	100.00	0.054	0.068	0.067	0.064	0.061
	200.00	0.062	0.079	0.079	0.075	0.071
	1000.00	0.080	0.106	0.106	0.102	0.095
Goodness -of-fit statistics	CHISQ	2.571	3.286	3.286	2.571	4.714
	KS	0.083	0.083	0.090	0.087	0.098
	SLSC	0.030	0.045	0.040	0.041	0.032
	PPCC1	0.990	0.989	0.989	0.989	0.989
	PPCC2	0.990	0.981	0.983	0.982	0.989
	LLM	61.155	61.374	61.263	61.316	60.908



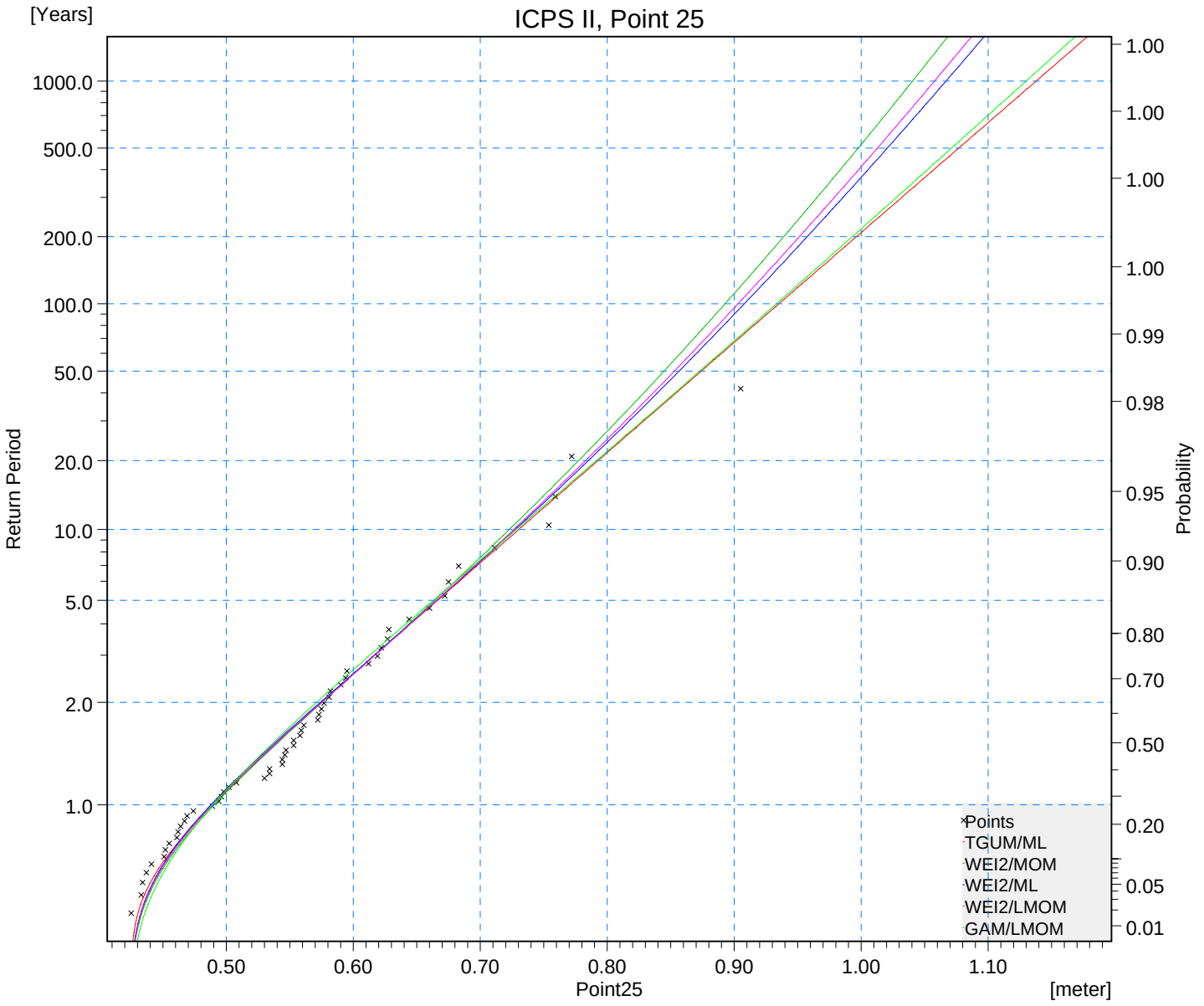
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 24						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.646	0.644	0.647	0.646	0.643
	10.00	0.714	0.708	0.718	0.712	0.713
	25.00	0.797	0.783	0.802	0.790	0.799
	50.00	0.859	0.834	0.861	0.845	0.862
	100.00	0.919	0.884	0.918	0.897	0.923
	200.00	0.979	0.931	0.973	0.947	0.983
	1000.00	1.118	1.035	1.096	1.058	1.121
Average quantile	5.00	0.647	0.645	0.649	0.646	0.643
	10.00	0.715	0.710	0.721	0.712	0.713
	25.00	0.799	0.785	0.807	0.789	0.798
	50.00	0.860	0.837	0.867	0.842	0.860
	100.00	0.921	0.887	0.925	0.893	0.921
	200.00	0.981	0.934	0.981	0.942	0.980
	1000.00	1.120	1.038	1.106	1.049	1.117
Standard deviation	5.00	0.021	0.022	0.022	0.021	0.021
	10.00	0.028	0.031	0.031	0.030	0.029
	25.00	0.038	0.044	0.047	0.042	0.042
	50.00	0.046	0.055	0.059	0.053	0.051
	100.00	0.054	0.065	0.073	0.064	0.061
	200.00	0.062	0.076	0.087	0.076	0.071
	1000.00	0.081	0.103	0.121	0.103	0.095
Goodness-of-fit statistics	CHISQ	2.571	2.214	2.571	1.857	1.857
	KS	0.071	0.071	0.088	0.076	0.086
	SLSC	0.026	0.039	0.031	0.035	0.029
	PPCC1	0.992	0.991	0.991	0.991	0.991
	PPCC2	0.992	0.986	0.988	0.987	0.991
	LLM	61.529	60.422	60.686	60.582	58.900



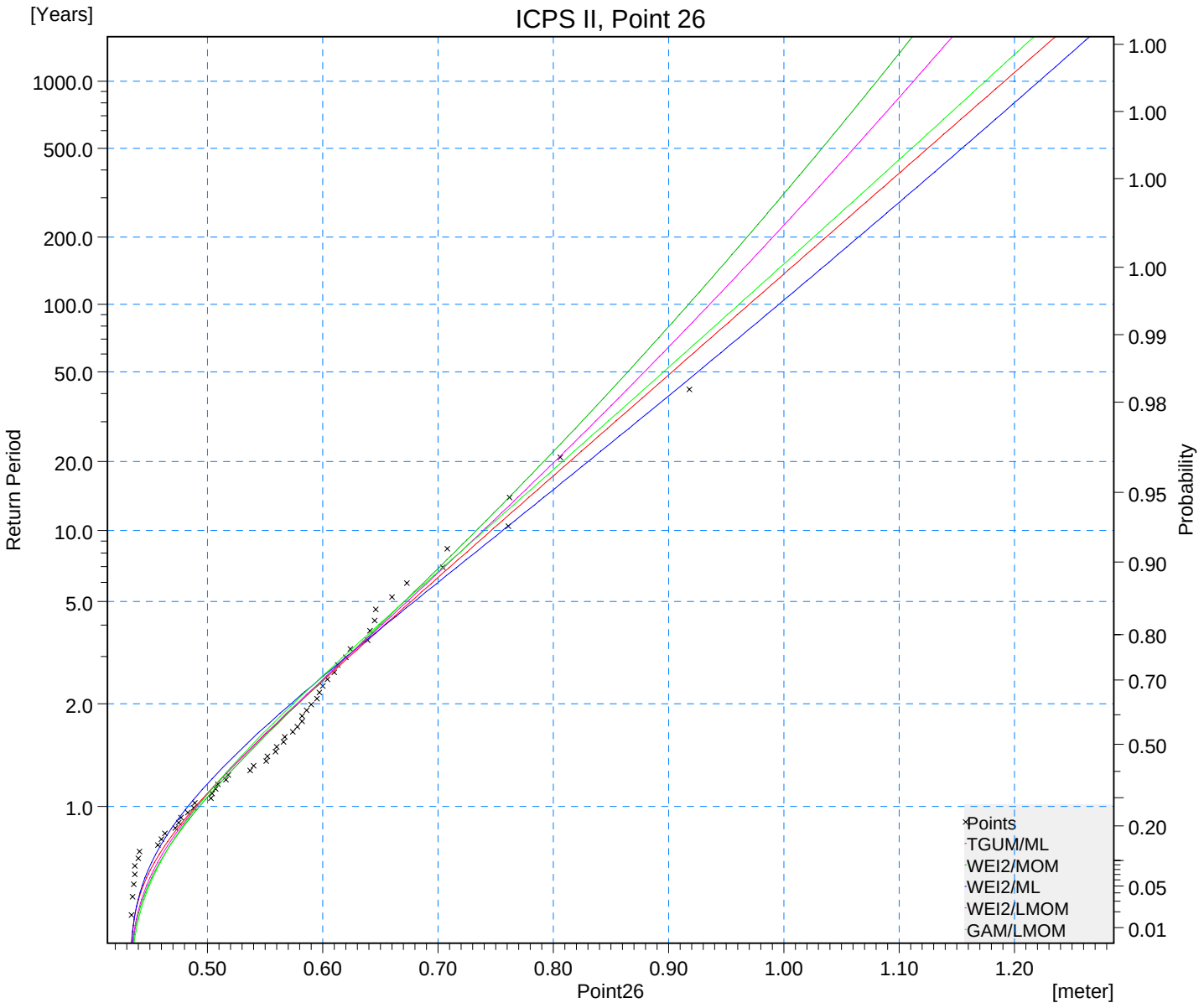
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 25						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.656	0.654	0.656	0.656	0.653
	10.00	0.726	0.719	0.723	0.722	0.724
	25.00	0.811	0.793	0.801	0.799	0.810
	50.00	0.873	0.844	0.856	0.852	0.872
	100.00	0.935	0.893	0.908	0.903	0.933
	200.00	0.996	0.939	0.957	0.951	0.993
	1000.00	1.138	1.041	1.067	1.058	1.130
Average quantile	5.00	0.657	0.656	0.657	0.656	0.653
	10.00	0.727	0.721	0.726	0.722	0.723
	25.00	0.812	0.795	0.806	0.797	0.809
	50.00	0.875	0.847	0.861	0.850	0.870
	100.00	0.937	0.895	0.914	0.899	0.931
	200.00	0.998	0.942	0.965	0.946	0.990
	1000.00	1.140	1.043	1.076	1.049	1.125
Standard deviation	5.00	0.021	0.022	0.022	0.022	0.021
	10.00	0.028	0.030	0.030	0.030	0.030
	25.00	0.038	0.043	0.043	0.043	0.042
	50.00	0.045	0.052	0.053	0.053	0.052
	100.00	0.053	0.062	0.064	0.064	0.062
	200.00	0.061	0.072	0.075	0.075	0.072
	1000.00	0.079	0.096	0.101	0.102	0.096
Goodness -of-fit statistics	CHISQ	9.000	9.000	7.571	9.000	7.929
	KS	0.105	0.104	0.112	0.108	0.120
	SLSC	0.024	0.036	0.031	0.033	0.028
	PPCC1	0.993	0.992	0.992	0.992	0.992
	PPCC2	0.993	0.989	0.990	0.989	0.992
	LLM	58.768	59.042	58.942	58.997	58.381



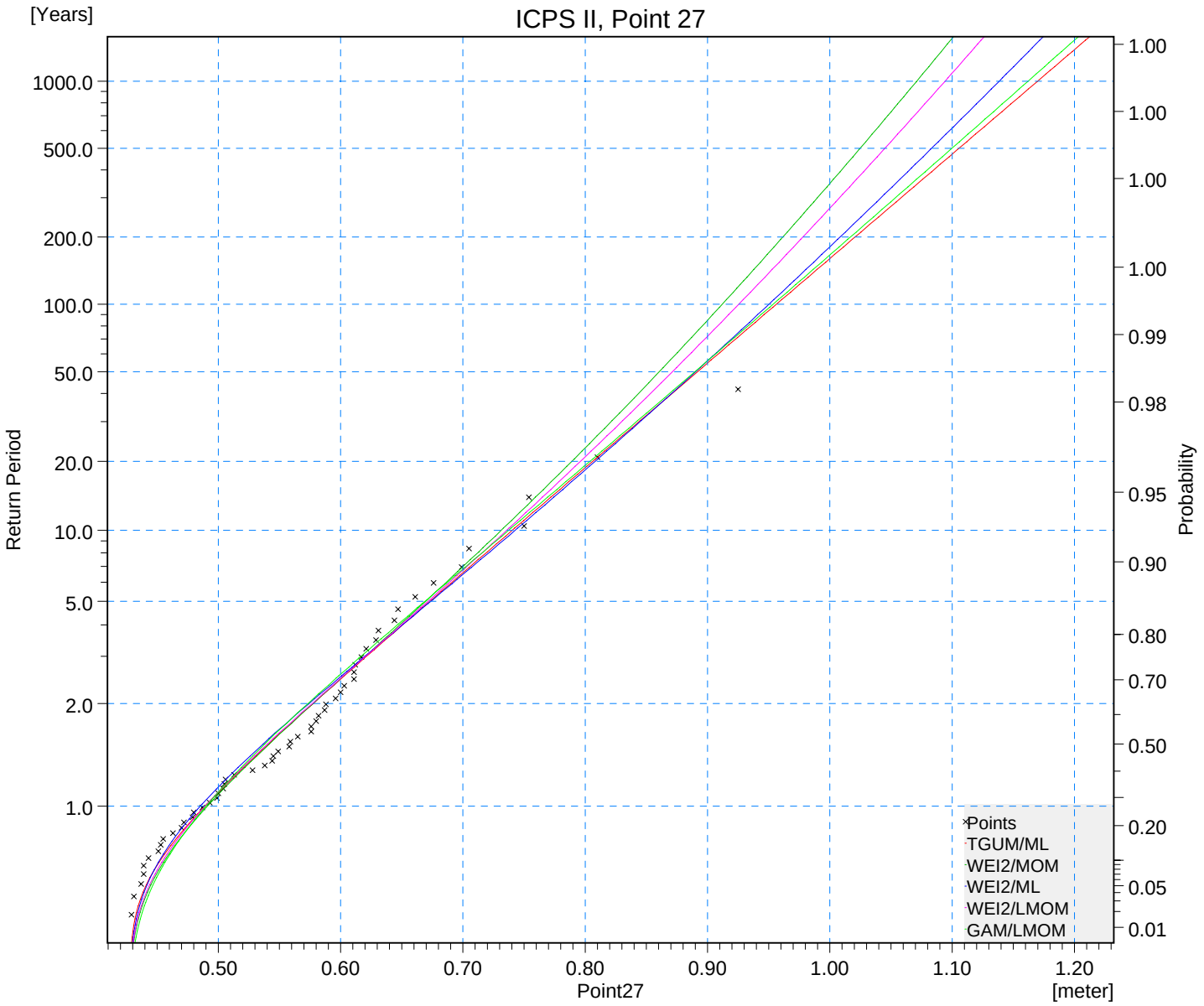
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 26						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.666	0.661	0.667	0.663	0.660
	10.00	0.741	0.729	0.751	0.734	0.735
	25.00	0.834	0.808	0.852	0.819	0.828
	50.00	0.902	0.864	0.924	0.878	0.895
	100.00	0.970	0.917	0.995	0.935	0.961
	200.00	1.037	0.968	1.065	0.990	1.026
	1000.00	1.191	1.081	1.221	1.113	1.175
Average quantile	5.00	0.667	0.662	0.669	0.663	0.660
	10.00	0.743	0.731	0.753	0.734	0.735
	25.00	0.836	0.811	0.855	0.817	0.826
	50.00	0.904	0.867	0.928	0.875	0.893
	100.00	0.972	0.920	0.999	0.930	0.958
	200.00	1.039	0.971	1.068	0.983	1.022
	1000.00	1.194	1.083	1.223	1.100	1.168
Standard deviation	5.00	0.021	0.022	0.022	0.022	0.022
	10.00	0.028	0.031	0.033	0.031	0.031
	25.00	0.039	0.044	0.052	0.045	0.044
	50.00	0.048	0.055	0.069	0.057	0.054
	100.00	0.056	0.066	0.087	0.070	0.066
	200.00	0.065	0.077	0.106	0.083	0.077
	1000.00	0.086	0.104	0.153	0.116	0.104
Goodness -of-fit statistics	CHISQ	5.071	7.214	9.000	7.214	8.643
	KS	0.108	0.104	0.135	0.111	0.120
	SLSC	0.027	0.034	0.032	0.030	0.031
	PPCC1	0.991	0.990	0.987	0.990	0.989
	PPCC2	0.991	0.989	0.988	0.990	0.989
	LLM	58.587	56.401	57.354	56.820	54.313



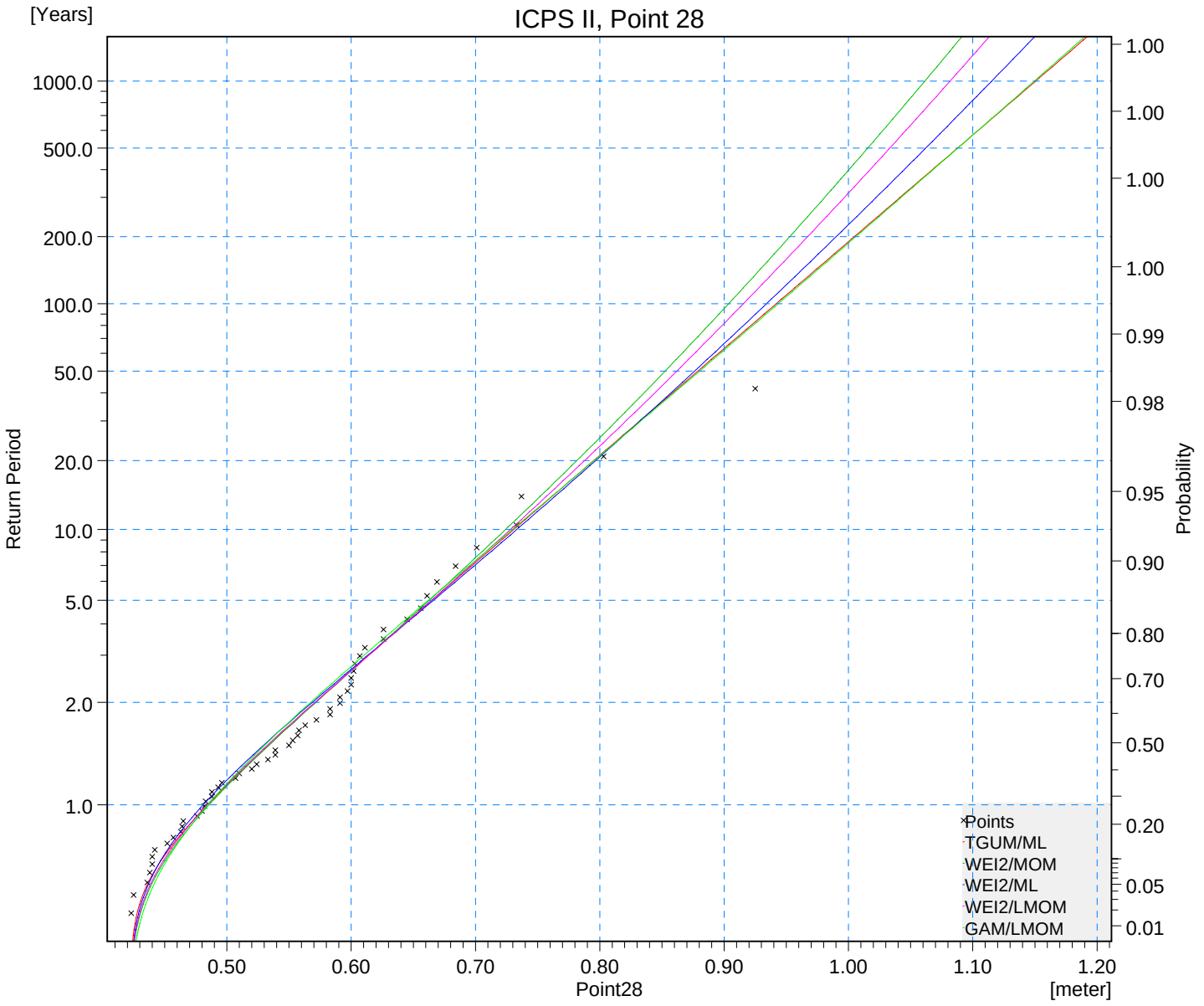
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 27						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.662	0.659	0.663	0.661	0.658
	10.00	0.736	0.727	0.738	0.731	0.732
	25.00	0.825	0.805	0.827	0.813	0.823
	50.00	0.891	0.860	0.890	0.871	0.889
	100.00	0.956	0.912	0.950	0.925	0.953
	200.00	1.021	0.962	1.008	0.978	1.017
	1000.00	1.170	1.071	1.139	1.094	1.162
Average quantile	5.00	0.663	0.661	0.665	0.662	0.658
	10.00	0.737	0.729	0.743	0.731	0.732
	25.00	0.827	0.808	0.836	0.812	0.822
	50.00	0.893	0.863	0.902	0.868	0.887
	100.00	0.958	0.915	0.965	0.921	0.951
	200.00	1.022	0.965	1.025	0.972	1.014
	1000.00	1.172	1.074	1.161	1.085	1.157
Standard deviation	5.00	0.021	0.023	0.023	0.022	0.022
	10.00	0.029	0.032	0.033	0.031	0.031
	25.00	0.039	0.045	0.049	0.045	0.044
	50.00	0.047	0.056	0.063	0.057	0.054
	100.00	0.056	0.067	0.078	0.069	0.065
	200.00	0.064	0.079	0.093	0.081	0.076
	1000.00	0.084	0.106	0.130	0.111	0.102
Goodness -of-fit statistics	CHISQ	6.143	8.643	9.000	7.214	10.429
	KS	0.092	0.093	0.103	0.095	0.107
	SLSC	0.026	0.037	0.030	0.033	0.030
	PPCC1	0.992	0.991	0.990	0.990	0.990
	PPCC2	0.992	0.987	0.989	0.988	0.990
	LLM	58.036	57.010	57.295	57.172	55.428



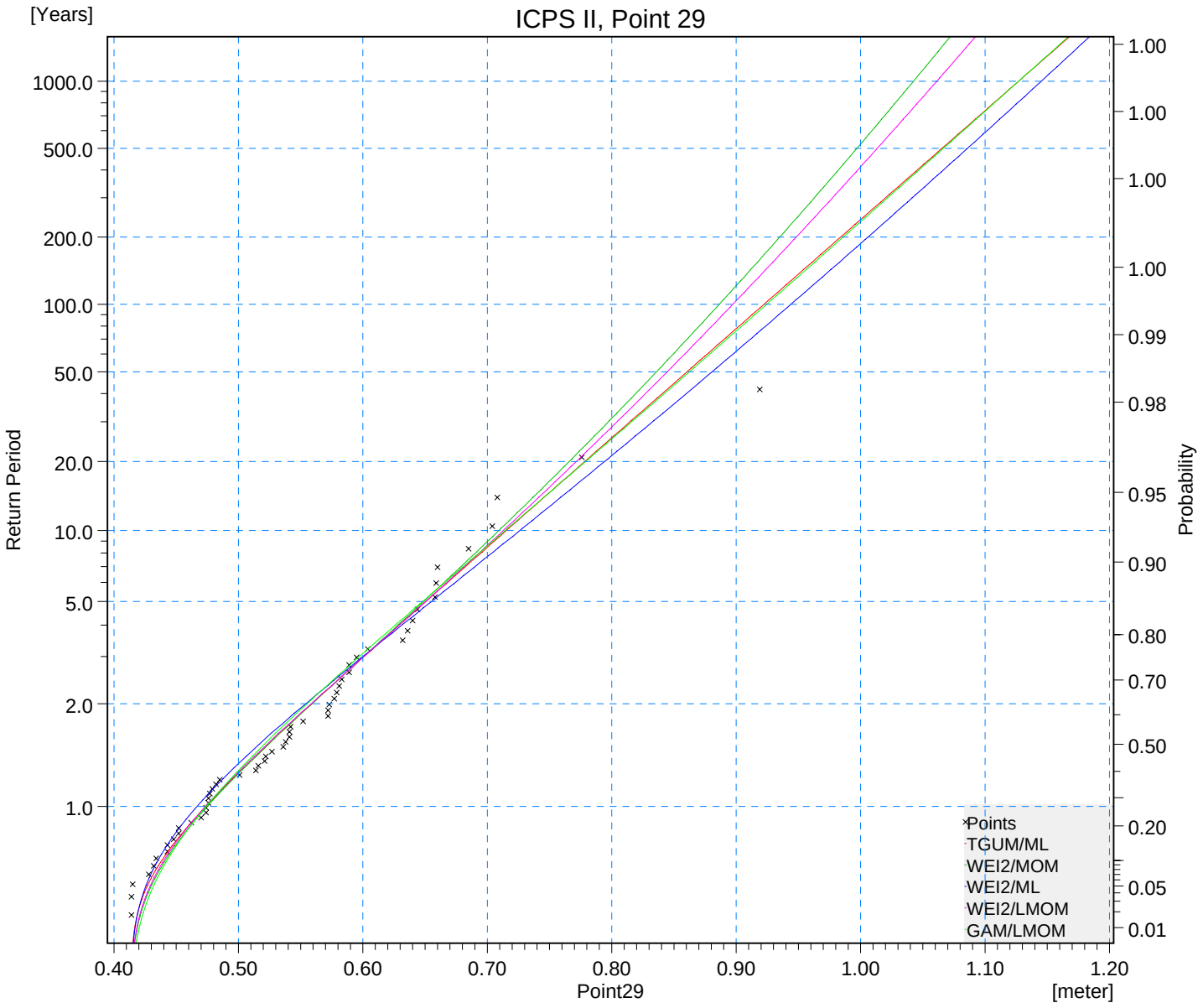
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 28						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.654	0.653	0.655	0.654	0.651
	10.00	0.726	0.720	0.728	0.724	0.725
	25.00	0.814	0.798	0.815	0.805	0.814
	50.00	0.878	0.852	0.876	0.861	0.879
	100.00	0.942	0.903	0.934	0.915	0.943
	200.00	1.005	0.953	0.990	0.967	1.006
	1000.00	1.151	1.062	1.115	1.082	1.150
Average quantile	5.00	0.656	0.654	0.658	0.655	0.652
	10.00	0.727	0.722	0.736	0.724	0.725
	25.00	0.815	0.801	0.829	0.804	0.814
	50.00	0.880	0.856	0.895	0.860	0.879
	100.00	0.943	0.908	0.958	0.913	0.942
	200.00	1.006	0.957	1.019	0.964	1.005
	1000.00	1.152	1.067	1.154	1.075	1.147
Standard deviation	5.00	0.022	0.023	0.023	0.022	0.022
	10.00	0.029	0.032	0.033	0.031	0.031
	25.00	0.039	0.046	0.051	0.045	0.044
	50.00	0.048	0.058	0.065	0.056	0.054
	100.00	0.056	0.069	0.081	0.068	0.065
	200.00	0.064	0.081	0.096	0.080	0.076
	1000.00	0.084	0.108	0.134	0.109	0.101
Goodness -of-fit statistics	CHISQ	4.714	4.357	5.071	4.357	9.714
	KS	0.081	0.081	0.088	0.082	0.094
	SLSC	0.027	0.040	0.032	0.036	0.030
	PPCC1	0.992	0.990	0.990	0.990	0.991
	PPCC2	0.992	0.986	0.988	0.987	0.991
	LLM	58.384	58.357	58.157	58.330	57.600



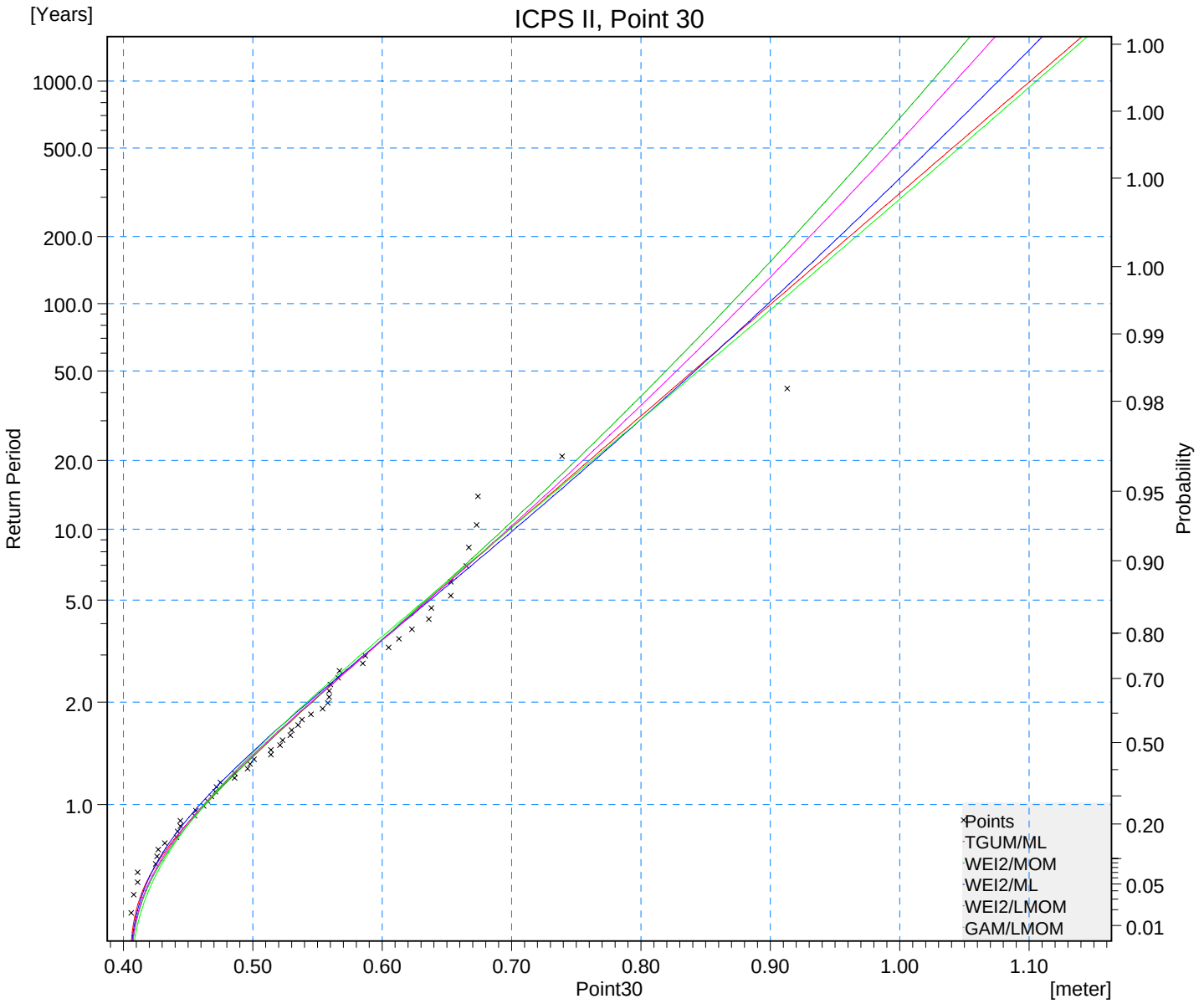
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 29						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.640	0.639	0.644	0.640	0.637
	10.00	0.711	0.705	0.721	0.709	0.710
	25.00	0.797	0.782	0.814	0.788	0.798
	50.00	0.860	0.835	0.880	0.844	0.862
	100.00	0.922	0.886	0.944	0.897	0.924
	200.00	0.984	0.935	1.006	0.948	0.986
	1000.00	1.127	1.043	1.145	1.061	1.127
Average quantile	5.00	0.642	0.640	0.648	0.641	0.638
	10.00	0.712	0.708	0.733	0.709	0.710
	25.00	0.798	0.785	0.836	0.788	0.798
	50.00	0.861	0.840	0.910	0.843	0.862
	100.00	0.924	0.891	0.981	0.896	0.924
	200.00	0.986	0.940	1.051	0.946	0.986
	1000.00	1.129	1.049	1.208	1.057	1.126
Standard deviation	5.00	0.021	0.023	0.023	0.022	0.022
	10.00	0.029	0.033	0.037	0.031	0.031
	25.00	0.039	0.047	0.061	0.044	0.043
	50.00	0.047	0.059	0.082	0.056	0.054
	100.00	0.056	0.071	0.103	0.067	0.064
	200.00	0.064	0.083	0.125	0.079	0.075
	1000.00	0.084	0.111	0.179	0.108	0.100
Goodness -of-fit statistics	CHISQ	4.357	3.286	7.571	5.071	7.571
	KS	0.086	0.086	0.097	0.087	0.098
	SLSC	0.030	0.045	0.034	0.041	0.033
	PPCC1	0.990	0.988	0.987	0.988	0.989
	PPCC2	0.990	0.981	0.985	0.982	0.989
	LLM	59.330	59.235	58.270	59.146	58.485



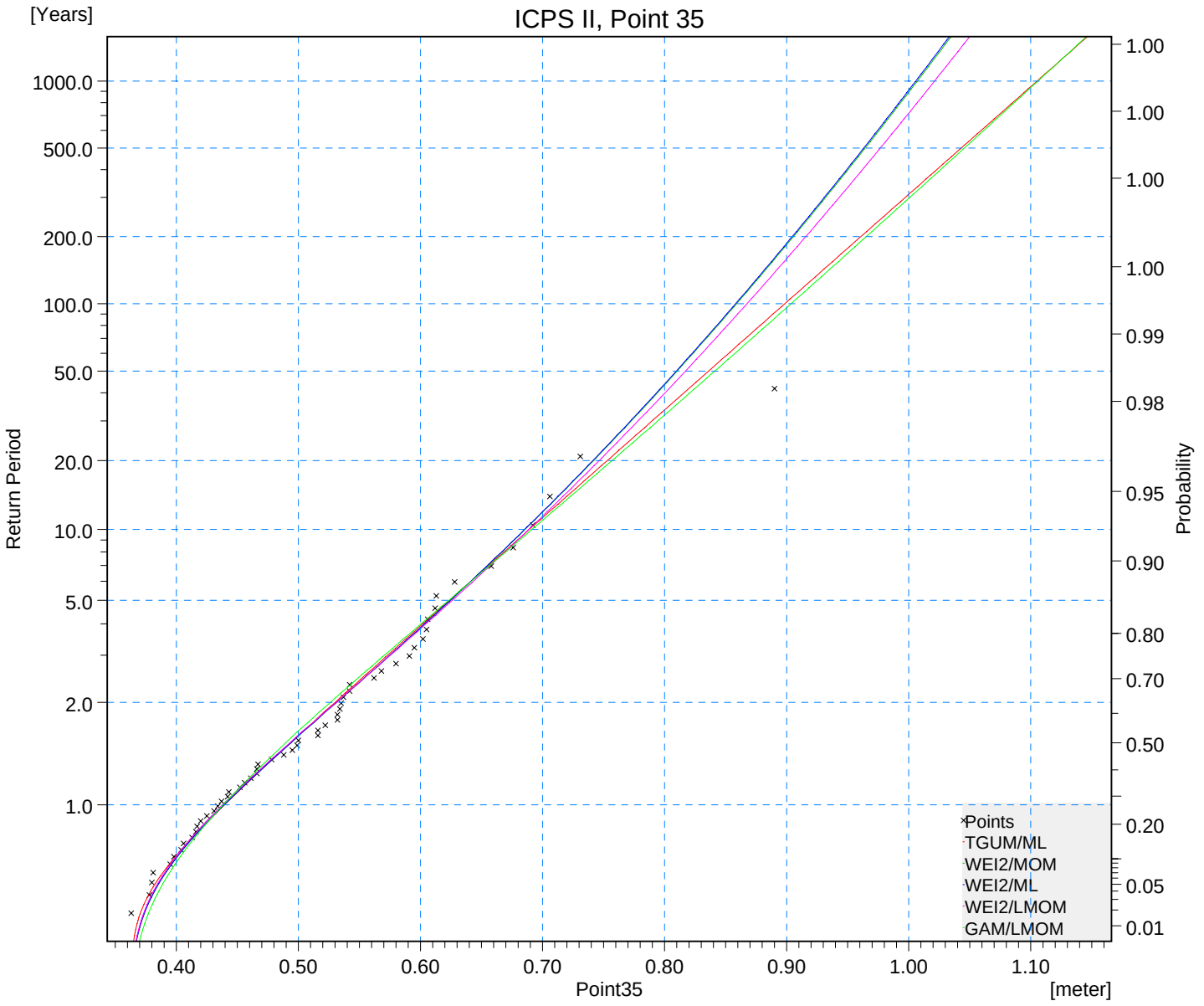
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 30						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.625	0.624	0.627	0.626	0.623
	10.00	0.694	0.690	0.698	0.693	0.694
	25.00	0.778	0.766	0.782	0.772	0.781
	50.00	0.840	0.819	0.841	0.827	0.844
	100.00	0.900	0.869	0.898	0.880	0.905
	200.00	0.961	0.918	0.953	0.930	0.966
	1000.00	1.101	1.025	1.076	1.043	1.106
Average quantile	5.00	0.626	0.626	0.629	0.626	0.623
	10.00	0.695	0.692	0.702	0.693	0.694
	25.00	0.779	0.769	0.789	0.770	0.780
	50.00	0.841	0.822	0.850	0.824	0.842
	100.00	0.902	0.873	0.909	0.876	0.903
	200.00	0.963	0.922	0.966	0.925	0.963
	1000.00	1.103	1.029	1.093	1.034	1.101
Standard deviation	5.00	0.021	0.023	0.022	0.022	0.022
	10.00	0.028	0.033	0.033	0.030	0.030
	25.00	0.039	0.049	0.049	0.044	0.043
	50.00	0.047	0.061	0.062	0.055	0.053
	100.00	0.055	0.073	0.076	0.066	0.063
	200.00	0.063	0.086	0.090	0.078	0.074
	1000.00	0.083	0.115	0.125	0.106	0.098
Goodness -of-fit statistics	CHISQ	5.071	5.071	5.786	5.071	6.857
	KS	0.063	0.064	0.080	0.069	0.078
	SLSC	0.035	0.050	0.042	0.047	0.037
	PPCC1	0.986	0.985	0.984	0.985	0.985
	PPCC2	0.986	0.975	0.978	0.976	0.985
	LLM	61.294	60.395	60.578	60.498	59.046



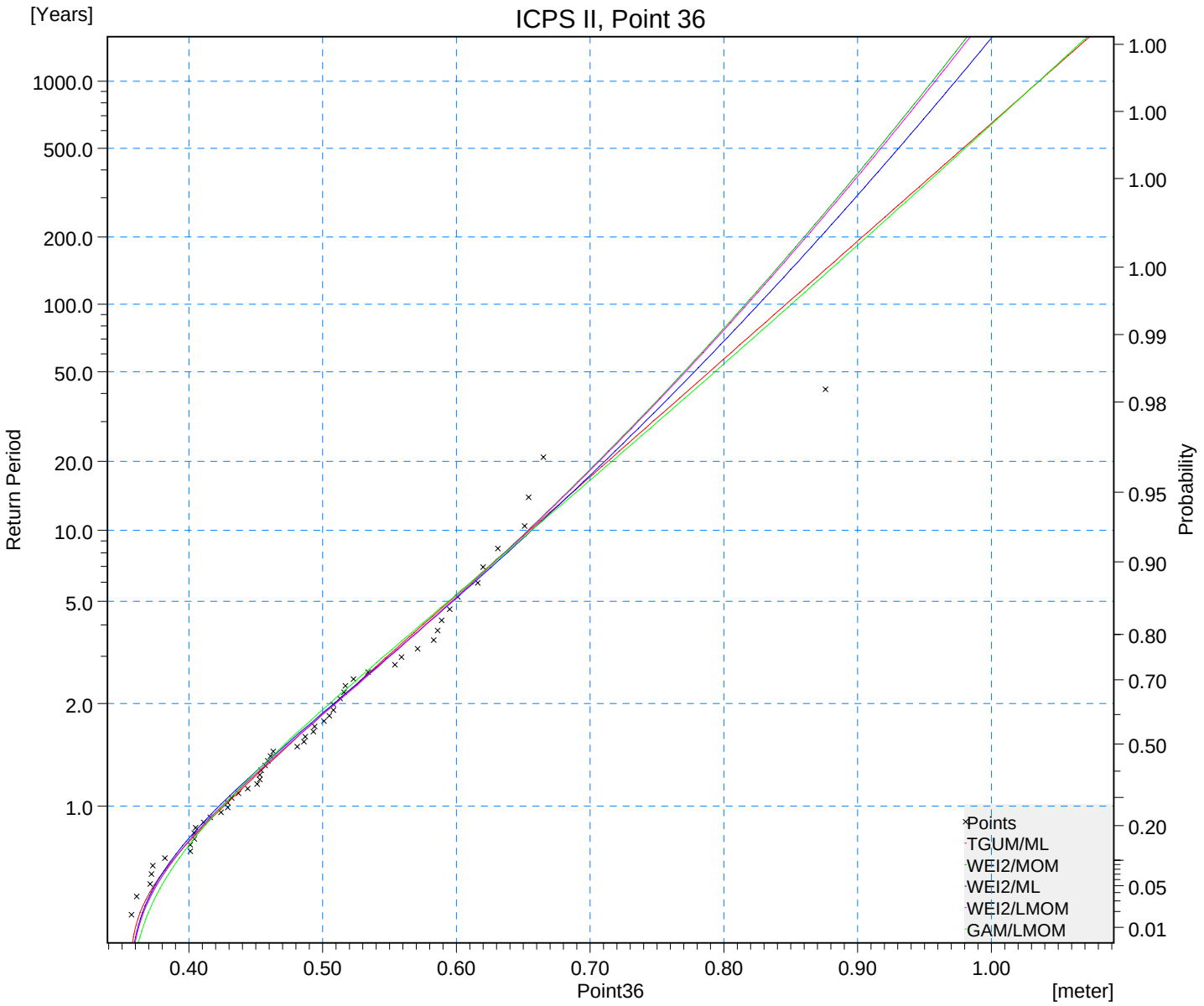
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 35						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.613	0.615	0.614	0.616	0.612
	10.00	0.685	0.681	0.681	0.684	0.686
	25.00	0.772	0.758	0.757	0.763	0.776
	50.00	0.835	0.810	0.809	0.816	0.840
	100.00	0.898	0.859	0.858	0.867	0.903
	200.00	0.961	0.905	0.905	0.916	0.965
	1000.00	1.105	1.007	1.006	1.021	1.106
Average quantile	5.00	0.614	0.616	0.616	0.616	0.612
	10.00	0.686	0.683	0.684	0.684	0.686
	25.00	0.773	0.760	0.762	0.761	0.775
	50.00	0.837	0.812	0.815	0.814	0.839
	100.00	0.900	0.862	0.865	0.864	0.901
	200.00	0.963	0.908	0.913	0.911	0.963
	1000.00	1.108	1.010	1.017	1.014	1.102
Standard deviation	5.00	0.022	0.024	0.023	0.023	0.023
	10.00	0.030	0.033	0.032	0.031	0.031
	25.00	0.040	0.046	0.044	0.043	0.043
	50.00	0.048	0.056	0.053	0.053	0.052
	100.00	0.055	0.066	0.063	0.063	0.062
	200.00	0.063	0.076	0.073	0.073	0.072
	1000.00	0.081	0.101	0.095	0.097	0.095
Goodness -of-fit statistics	CHISQ	5.429	4.000	5.071	4.000	4.000
	KS	0.068	0.064	0.064	0.066	0.081
	SLSC	0.025	0.042	0.042	0.039	0.028
	PPCC1	0.993	0.992	0.992	0.992	0.992
	PPCC2	0.993	0.984	0.984	0.985	0.992
	LLM	54.762	55.401	55.405	55.318	55.289



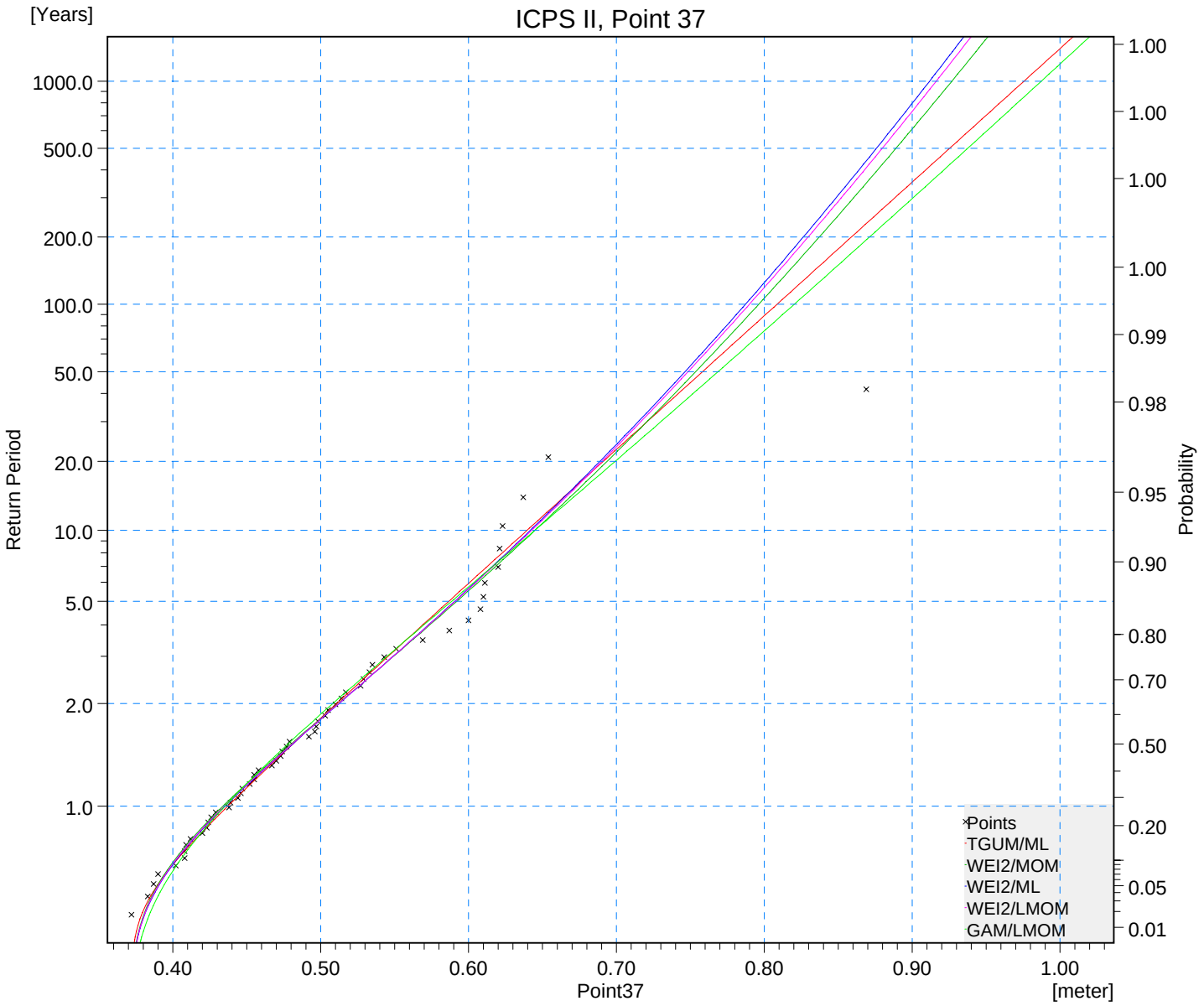
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 36						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.585	0.587	0.588	0.587	0.584
	10.00	0.650	0.650	0.652	0.650	0.652
	25.00	0.730	0.721	0.726	0.722	0.734
	50.00	0.789	0.770	0.777	0.771	0.793
	100.00	0.846	0.816	0.826	0.817	0.850
	200.00	0.903	0.860	0.872	0.861	0.907
	1000.00	1.036	0.956	0.973	0.958	1.036
Average quantile	5.00	0.586	0.589	0.590	0.588	0.584
	10.00	0.652	0.652	0.657	0.650	0.652
	25.00	0.732	0.724	0.735	0.721	0.733
	50.00	0.790	0.774	0.789	0.769	0.792
	100.00	0.848	0.820	0.839	0.815	0.849
	200.00	0.905	0.864	0.888	0.858	0.905
	1000.00	1.038	0.960	0.994	0.952	1.033
Standard deviation	5.00	0.021	0.023	0.022	0.022	0.021
	10.00	0.028	0.034	0.032	0.030	0.030
	25.00	0.038	0.049	0.047	0.043	0.042
	50.00	0.045	0.060	0.059	0.052	0.051
	100.00	0.052	0.072	0.070	0.062	0.061
	200.00	0.060	0.083	0.082	0.072	0.071
	1000.00	0.077	0.110	0.110	0.096	0.094
Goodness-of-fit statistics	CHISQ	3.643	4.357	5.786	4.357	6.143
	KS	0.048	0.054	0.063	0.055	0.063
	SLSC	0.037	0.058	0.054	0.058	0.039
	PPCC1	0.985	0.983	0.983	0.983	0.984
	PPCC2	0.985	0.967	0.969	0.967	0.984
	LLM	59.527	58.608	58.668	58.617	56.836



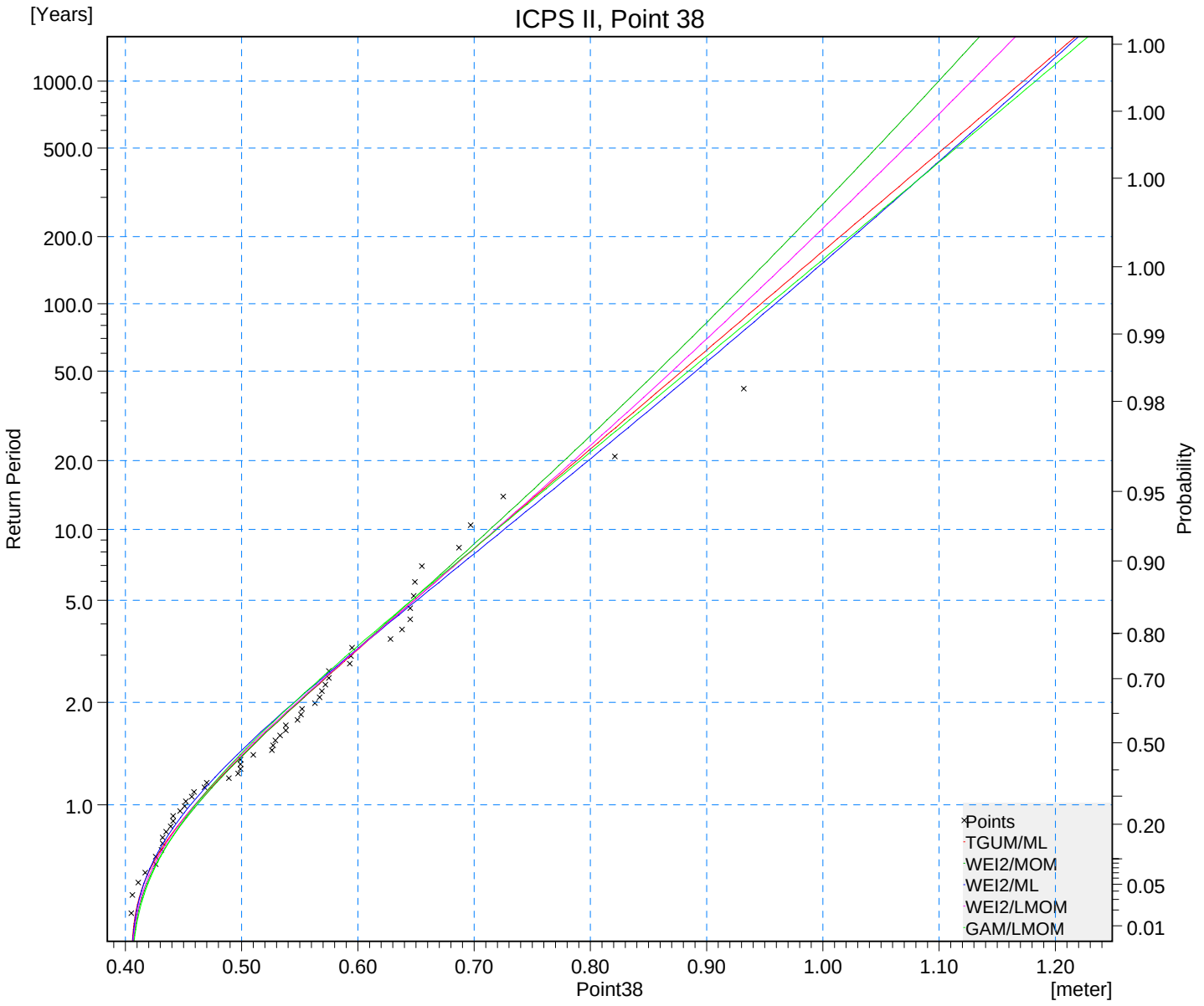
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 37						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.578	0.583	0.582	0.582	0.580
	10.00	0.636	0.641	0.638	0.639	0.641
	25.00	0.706	0.707	0.702	0.704	0.715
	50.00	0.758	0.753	0.746	0.748	0.768
	100.00	0.808	0.796	0.787	0.790	0.820
	200.00	0.859	0.837	0.826	0.830	0.871
	1000.00	0.976	0.927	0.912	0.916	0.987
Average quantile	5.00	0.579	0.585	0.584	0.583	0.580
	10.00	0.637	0.644	0.642	0.639	0.641
	25.00	0.707	0.711	0.708	0.703	0.714
	50.00	0.759	0.757	0.754	0.746	0.767
	100.00	0.810	0.800	0.796	0.787	0.819
	200.00	0.860	0.842	0.837	0.826	0.869
	1000.00	0.977	0.932	0.925	0.910	0.984
Standard deviation	5.00	0.020	0.023	0.022	0.021	0.020
	10.00	0.027	0.034	0.031	0.029	0.029
	25.00	0.036	0.049	0.044	0.041	0.041
	50.00	0.043	0.061	0.054	0.050	0.049
	100.00	0.050	0.073	0.064	0.059	0.059
	200.00	0.056	0.085	0.073	0.069	0.068
	1000.00	0.073	0.113	0.096	0.090	0.089
Goodness -of-fit statistics	CHISQ	1.857	2.929	1.143	1.857	0.786
	KS	0.055	0.047	0.049	0.048	0.051
	SLSC	0.047	0.069	0.075	0.073	0.046
	PPCC1	0.979	0.976	0.976	0.976	0.979
	PPCC2	0.979	0.954	0.951	0.952	0.979
	LLM	65.527	65.558	65.674	65.642	66.027



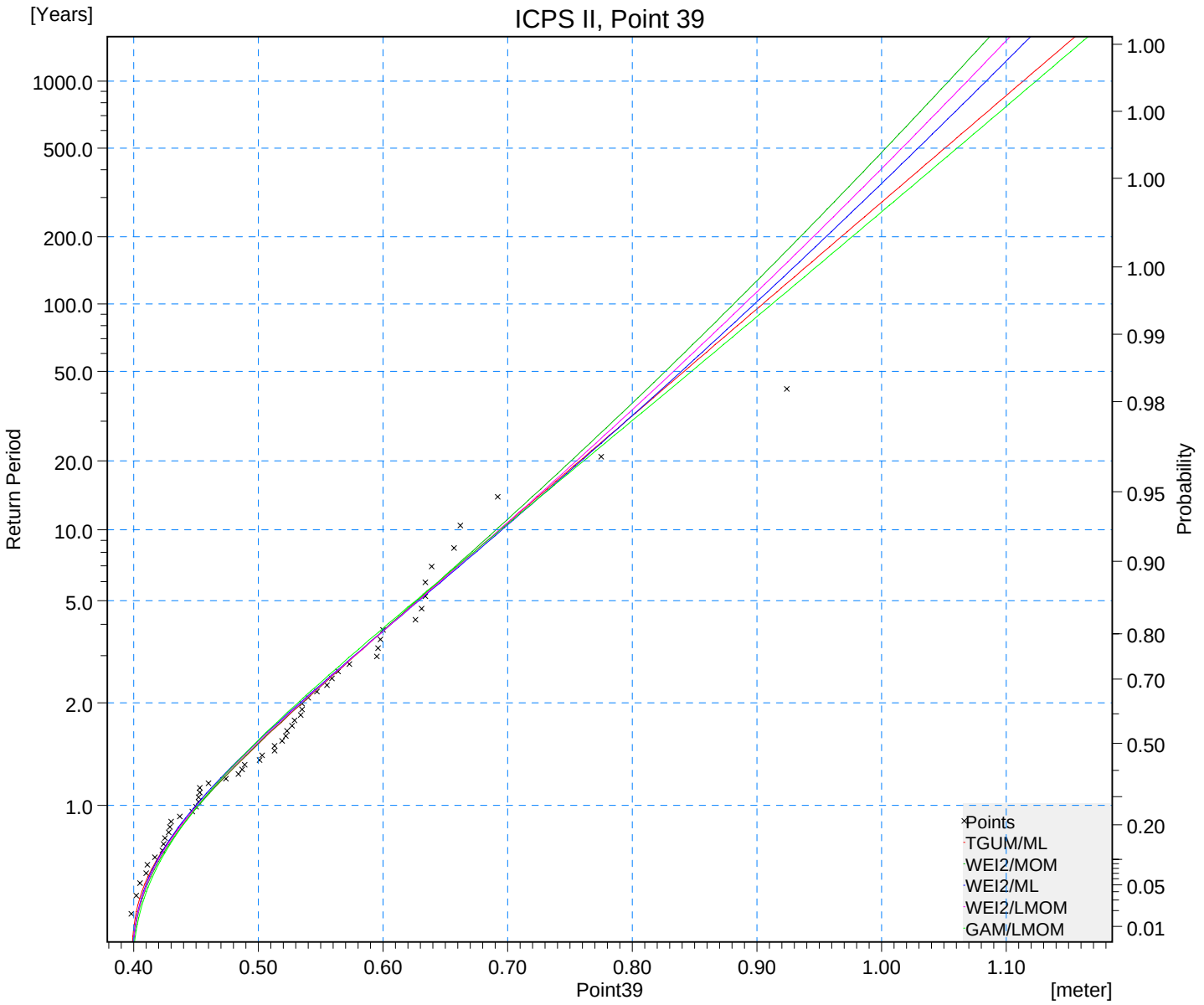
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 38						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.637	0.635	0.639	0.637	0.635
	10.00	0.714	0.709	0.720	0.714	0.714
	25.00	0.809	0.796	0.819	0.805	0.812
	50.00	0.878	0.857	0.890	0.870	0.884
	100.00	0.947	0.916	0.959	0.932	0.954
	200.00	1.015	0.973	1.026	0.993	1.023
	1000.00	1.172	1.100	1.178	1.128	1.183
Average quantile	5.00	0.638	0.637	0.641	0.638	0.635
	10.00	0.715	0.711	0.728	0.714	0.714
	25.00	0.810	0.799	0.833	0.804	0.811
	50.00	0.879	0.861	0.909	0.867	0.882
	100.00	0.948	0.920	0.983	0.928	0.952
	200.00	1.016	0.978	1.055	0.987	1.021
	1000.00	1.173	1.105	1.217	1.118	1.178
Standard deviation	5.00	0.023	0.025	0.024	0.024	0.024
	10.00	0.032	0.036	0.037	0.034	0.034
	25.00	0.044	0.052	0.057	0.050	0.049
	50.00	0.054	0.065	0.075	0.063	0.060
	100.00	0.064	0.078	0.093	0.077	0.072
	200.00	0.074	0.092	0.113	0.091	0.084
	1000.00	0.097	0.125	0.160	0.126	0.113
Goodness -of-fit statistics	CHISQ	6.500	4.357	7.571	5.786	5.071
	KS	0.090	0.090	0.107	0.095	0.103
	SLSC	0.030	0.040	0.032	0.036	0.032
	PPCC1	0.990	0.989	0.989	0.989	0.990
	PPCC2	0.990	0.985	0.987	0.986	0.990
	LLM	57.762	57.625	57.412	57.612	57.103



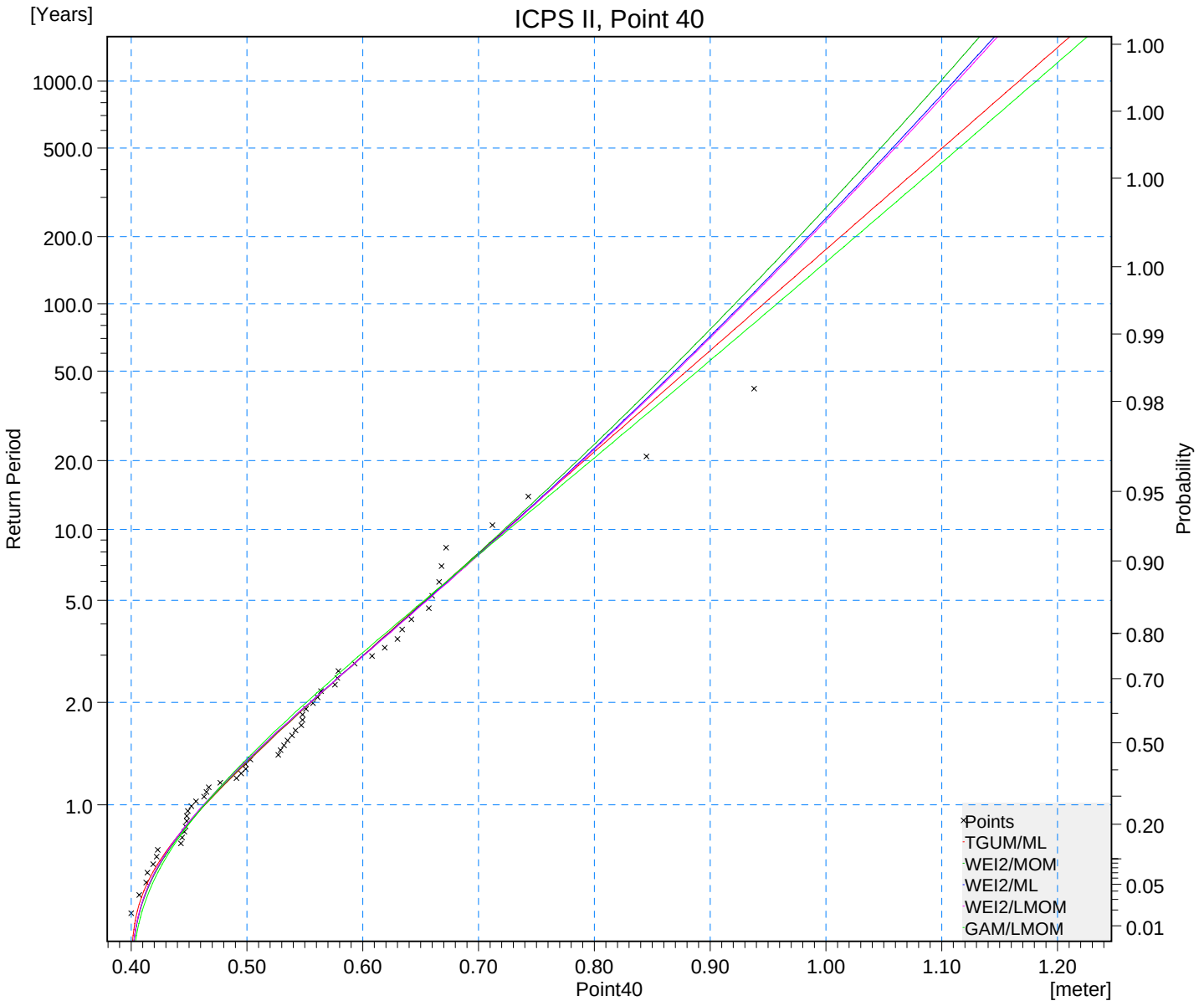
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II						
Point 39						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.618	0.617	0.618	0.618	0.615
	10.00	0.689	0.686	0.691	0.689	0.689
	25.00	0.777	0.768	0.777	0.773	0.780
	50.00	0.841	0.826	0.839	0.832	0.847
	100.00	0.904	0.881	0.898	0.890	0.912
	200.00	0.968	0.935	0.955	0.945	0.976
	1000.00	1.114	1.054	1.084	1.069	1.124
Average quantile	5.00	0.619	0.618	0.620	0.618	0.616
	10.00	0.690	0.689	0.695	0.689	0.689
	25.00	0.778	0.772	0.784	0.771	0.779
	50.00	0.842	0.830	0.847	0.830	0.845
	100.00	0.905	0.886	0.908	0.885	0.909
	200.00	0.968	0.940	0.967	0.939	0.973
	1000.00	1.114	1.059	1.100	1.058	1.119
Standard deviation	5.00	0.022	0.024	0.024	0.023	0.023
	10.00	0.030	0.036	0.034	0.033	0.033
	25.00	0.042	0.053	0.050	0.049	0.047
	50.00	0.051	0.067	0.063	0.061	0.058
	100.00	0.060	0.082	0.077	0.074	0.070
	200.00	0.070	0.096	0.092	0.088	0.082
	1000.00	0.092	0.131	0.126	0.121	0.110
Goodness -of-fit statistics	CHISQ	8.643	8.643	8.643	8.643	11.857
	KS	0.087	0.089	0.096	0.092	0.100
	SLSC	0.036	0.048	0.043	0.045	0.037
	PPCC1	0.986	0.985	0.985	0.985	0.986
	PPCC2	0.986	0.978	0.980	0.979	0.986
	LLM	60.920	61.029	60.922	60.993	60.724



RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

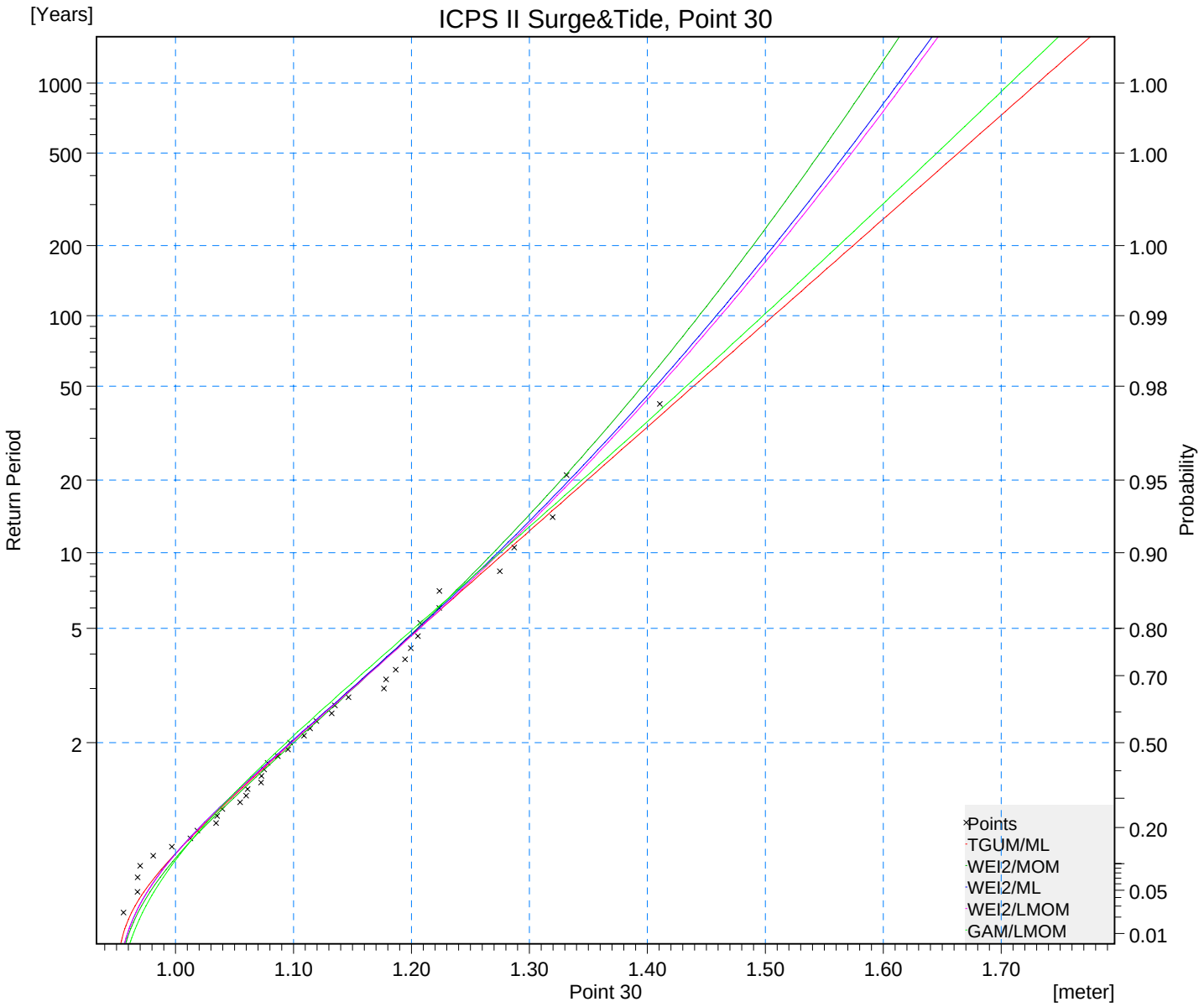
ICPS II						
Point 40						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	0.643	0.644	0.644	0.645	0.642
	10.00	0.718	0.717	0.719	0.720	0.721
	25.00	0.811	0.803	0.807	0.808	0.818
	50.00	0.879	0.864	0.869	0.870	0.888
	100.00	0.946	0.921	0.928	0.929	0.957
	200.00	1.013	0.977	0.985	0.987	1.026
	1000.00	1.167	1.099	1.111	1.113	1.182
Average quantile	5.00	0.644	0.645	0.646	0.645	0.642
	10.00	0.720	0.720	0.723	0.720	0.721
	25.00	0.812	0.807	0.814	0.807	0.817
	50.00	0.880	0.868	0.878	0.868	0.887
	100.00	0.947	0.926	0.939	0.926	0.955
	200.00	1.014	0.981	0.998	0.981	1.023
	1000.00	1.168	1.104	1.128	1.104	1.177
Standard deviation	5.00	0.024	0.026	0.025	0.025	0.025
	10.00	0.033	0.036	0.035	0.035	0.035
	25.00	0.045	0.052	0.051	0.051	0.050
	50.00	0.055	0.065	0.063	0.063	0.061
	100.00	0.064	0.078	0.076	0.077	0.073
	200.00	0.074	0.091	0.089	0.090	0.085
	1000.00	0.096	0.123	0.120	0.122	0.114
Goodness -of-fit statistics	CHISQ	7.214	7.571	5.786	7.214	7.214
	KS	0.089	0.091	0.095	0.094	0.104
	SLSC	0.030	0.041	0.039	0.039	0.030
	PPCC1	0.991	0.990	0.990	0.990	0.991
	PPCC2	0.991	0.985	0.986	0.986	0.991
	LLM	55.332	55.660	55.607	55.604	55.509



RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

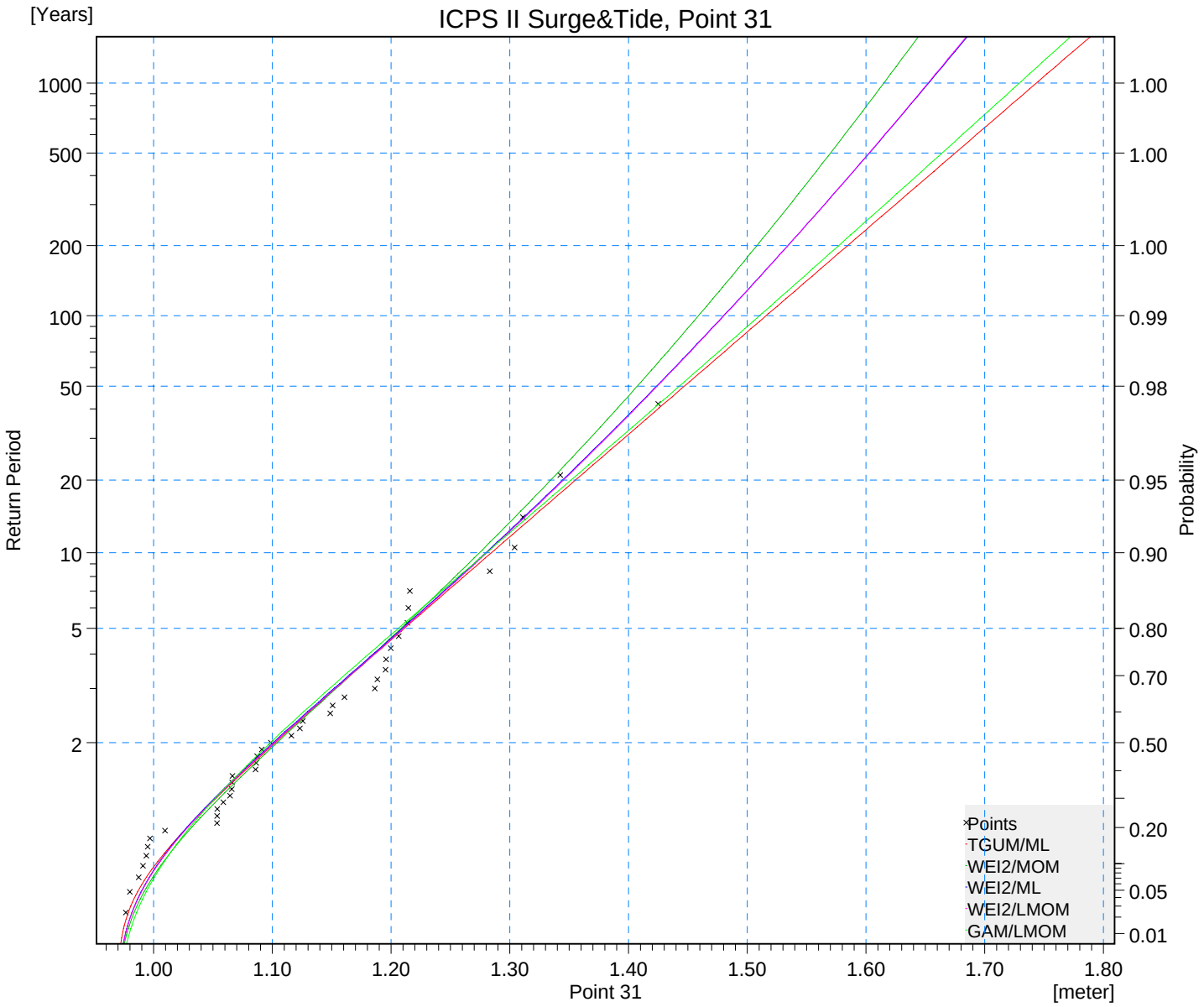
Appendix 4: Extreme Value Analysis of combined tide and surge: Points 31-34

ICPS II Surge&Tide						
Point 30						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	1.195	1.194	1.194	1.196	1.190
	10.00	1.274	1.265	1.268	1.270	1.270
	25.00	1.369	1.343	1.351	1.353	1.365
	50.00	1.438	1.395	1.406	1.409	1.432
	100.00	1.507	1.444	1.458	1.462	1.498
	200.00	1.574	1.489	1.507	1.511	1.562
	1000.00	1.731	1.587	1.613	1.618	1.708
Average quantile	5.00	1.196	1.195	1.196	1.196	1.191
	10.00	1.276	1.266	1.271	1.270	1.270
	25.00	1.372	1.344	1.355	1.352	1.364
	50.00	1.442	1.397	1.412	1.407	1.431
	100.00	1.511	1.445	1.464	1.458	1.495
	200.00	1.579	1.491	1.514	1.506	1.559
	1000.00	1.737	1.588	1.621	1.609	1.702
Standard deviation	5.00	0.023	0.023	0.023	0.023	0.022
	10.00	0.031	0.029	0.030	0.030	0.030
	25.00	0.041	0.038	0.042	0.042	0.041
	50.00	0.050	0.046	0.052	0.052	0.051
	100.00	0.059	0.054	0.062	0.062	0.061
	200.00	0.067	0.063	0.073	0.073	0.072
	1000.00	0.088	0.083	0.099	0.098	0.097
Goodness -of-fit statistics	CHISQ	3.293	2.902	4.073	4.463	4.073
	KS	0.078	0.078	0.079	0.076	0.090
	SLSC	0.020	0.024	0.021	0.019	0.026
	PPCC1	0.995	0.996	0.996	0.996	0.993
	PPCC2	0.995	0.996	0.996	0.996	0.993
	LLM	36.291	36.293	36.344	36.343	34.876



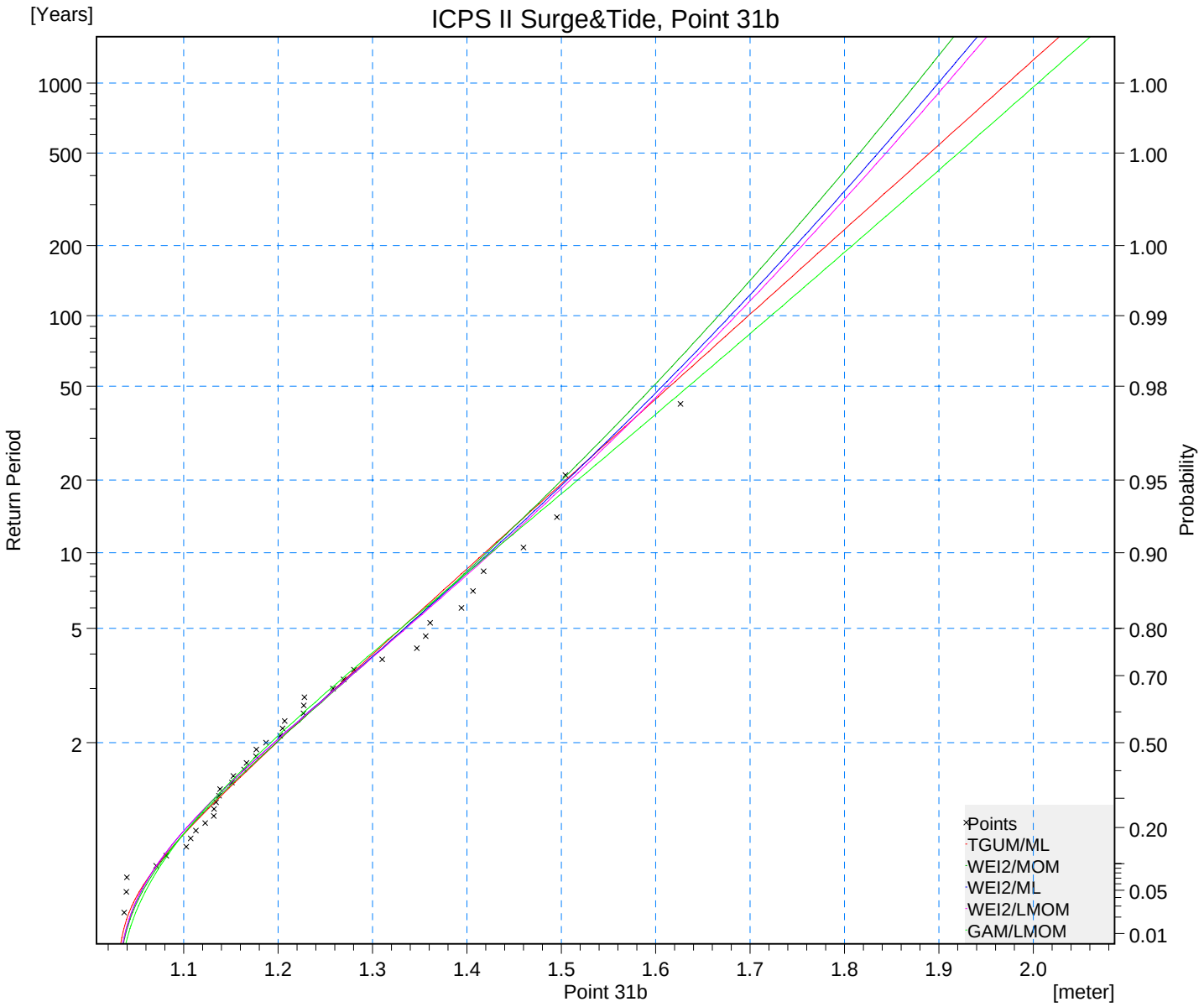
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II Surge&Tide						
Point 31						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	1.199	1.197	1.198	1.199	1.194
	10.00	1.279	1.270	1.275	1.276	1.275
	25.00	1.376	1.351	1.363	1.363	1.372
	50.00	1.446	1.407	1.423	1.423	1.442
	100.00	1.516	1.459	1.480	1.480	1.510
	200.00	1.584	1.508	1.534	1.534	1.577
	1000.00	1.743	1.615	1.653	1.652	1.729
Average quantile	5.00	1.201	1.198	1.199	1.199	1.195
	10.00	1.281	1.271	1.278	1.276	1.275
	25.00	1.379	1.353	1.367	1.362	1.371
	50.00	1.449	1.409	1.429	1.420	1.440
	100.00	1.519	1.460	1.487	1.476	1.507
	200.00	1.588	1.510	1.542	1.528	1.573
	1000.00	1.749	1.616	1.662	1.641	1.723
Standard deviation	5.00	0.023	0.023	0.023	0.023	0.023
	10.00	0.031	0.029	0.030	0.030	0.030
	25.00	0.042	0.039	0.043	0.043	0.042
	50.00	0.051	0.048	0.054	0.054	0.053
	100.00	0.060	0.057	0.066	0.066	0.063
	200.00	0.069	0.067	0.078	0.078	0.075
	1000.00	0.091	0.089	0.108	0.107	0.101
Goodness-of-fit statistics	CHISQ	8.366	13.049	13.049	13.049	12.659
	KS	0.109	0.107	0.115	0.111	0.112
	SLSC	0.026	0.030	0.026	0.026	0.031
	PPCC1	0.991	0.992	0.992	0.992	0.989
	PPCC2	0.991	0.993	0.992	0.992	0.989
	LLM	38.017	37.977	38.060	38.059	36.975



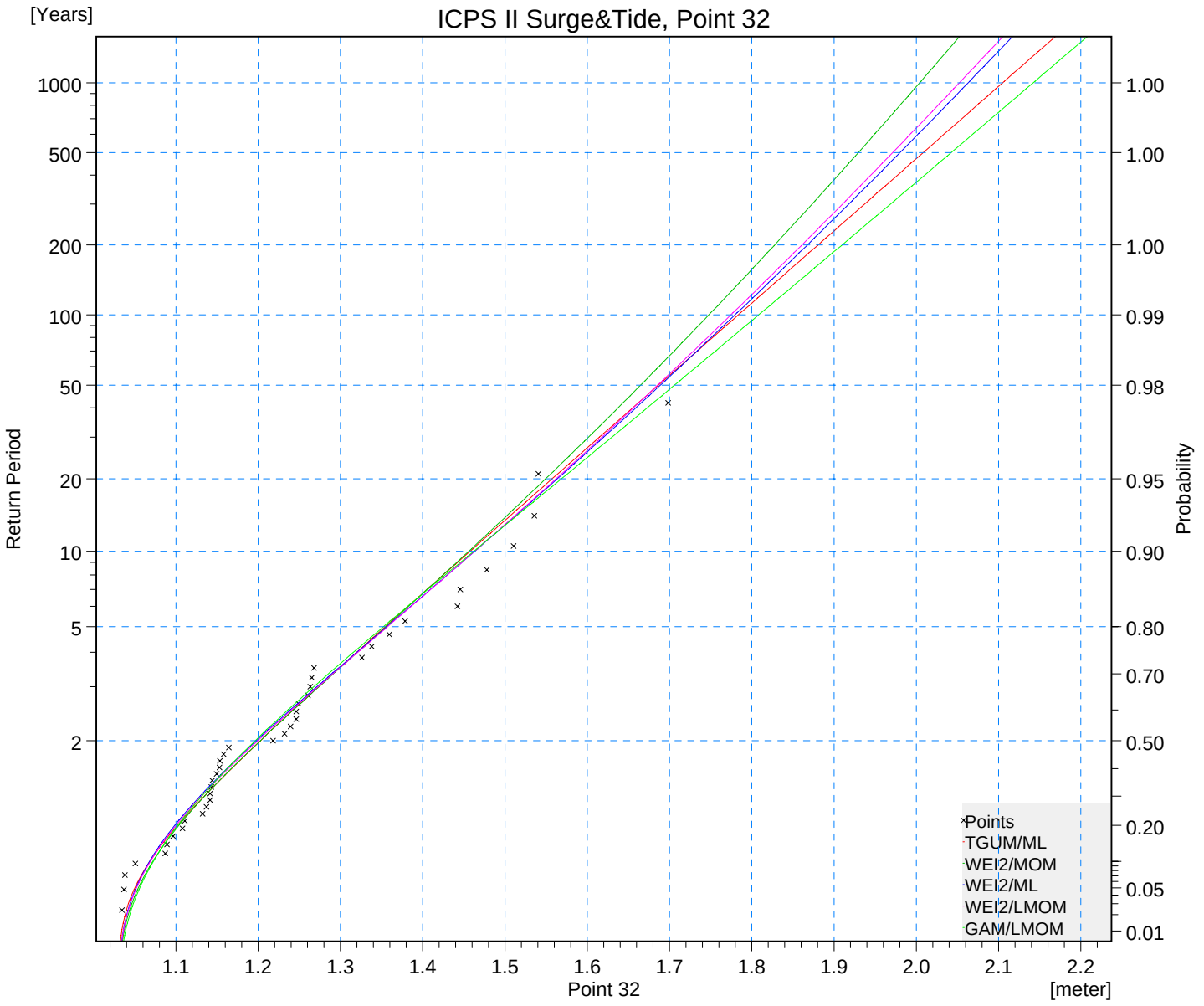
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II Surge&Tide						
Point 31b						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	1.316	1.319	1.319	1.321	1.315
	10.00	1.413	1.415	1.418	1.420	1.419
	25.00	1.529	1.523	1.529	1.533	1.544
	50.00	1.614	1.597	1.606	1.611	1.634
	100.00	1.698	1.666	1.679	1.685	1.722
	200.00	1.781	1.732	1.748	1.755	1.808
	1000.00	1.973	1.876	1.899	1.909	2.005
Average quantile	5.00	1.318	1.320	1.321	1.321	1.315
	10.00	1.416	1.417	1.421	1.420	1.419
	25.00	1.533	1.525	1.535	1.532	1.543
	50.00	1.619	1.600	1.613	1.608	1.632
	100.00	1.703	1.669	1.686	1.680	1.719
	200.00	1.787	1.736	1.756	1.749	1.804
	1000.00	1.980	1.880	1.909	1.898	1.999
Standard deviation	5.00	0.032	0.031	0.031	0.032	0.031
	10.00	0.045	0.040	0.042	0.043	0.043
	25.00	0.062	0.055	0.060	0.061	0.061
	50.00	0.076	0.066	0.074	0.076	0.075
	100.00	0.089	0.078	0.090	0.091	0.089
	200.00	0.103	0.090	0.105	0.106	0.104
	1000.00	0.135	0.120	0.142	0.143	0.139
Goodness -of-fit statistics	CHISQ	4.463	4.463	3.293	3.293	3.683
	KS	0.074	0.076	0.077	0.078	0.077
	SLSC	0.027	0.030	0.027	0.025	0.024
	PPCC1	0.994	0.995	0.995	0.995	0.995
	PPCC2	0.994	0.995	0.995	0.995	0.995
	LLM	28.635	28.371	28.392	28.390	27.641



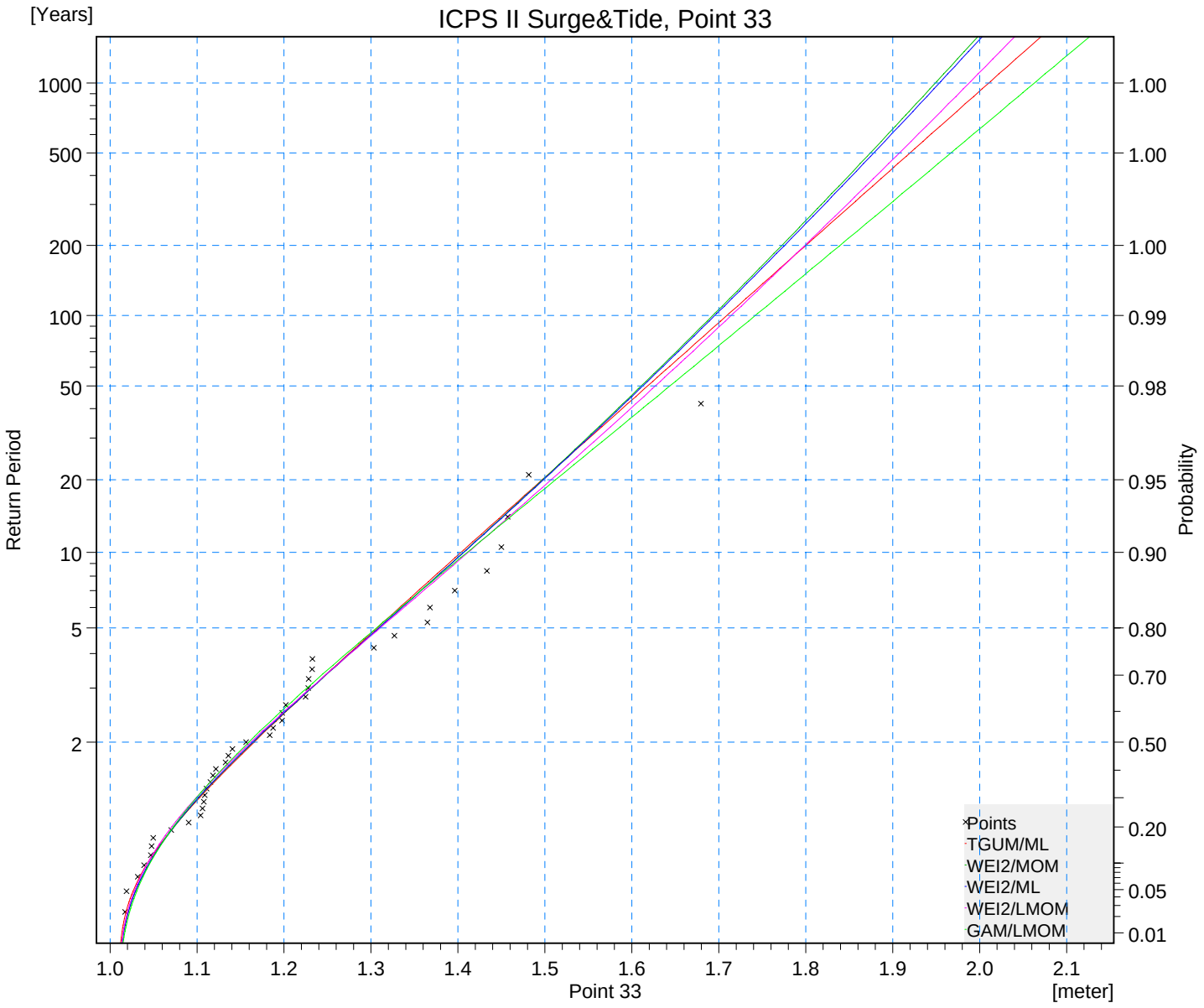
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II Surge&Tide						
Point 32						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	1.338	1.339	1.339	1.340	1.335
	10.00	1.450	1.449	1.456	1.456	1.454
	25.00	1.586	1.576	1.592	1.590	1.600
	50.00	1.685	1.664	1.688	1.684	1.705
	100.00	1.783	1.747	1.779	1.774	1.808
	200.00	1.880	1.828	1.867	1.861	1.909
	1000.00	2.105	2.004	2.063	2.052	2.142
Average quantile	5.00	1.340	1.340	1.340	1.341	1.335
	10.00	1.454	1.451	1.459	1.456	1.454
	25.00	1.591	1.579	1.598	1.589	1.598
	50.00	1.691	1.668	1.695	1.681	1.702
	100.00	1.789	1.752	1.787	1.768	1.804
	200.00	1.887	1.832	1.876	1.852	1.905
	1000.00	2.113	2.008	2.073	2.037	2.134
Standard deviation	5.00	0.036	0.035	0.036	0.036	0.035
	10.00	0.051	0.046	0.049	0.050	0.049
	25.00	0.072	0.063	0.072	0.071	0.070
	50.00	0.088	0.077	0.091	0.089	0.087
	100.00	0.104	0.092	0.112	0.108	0.105
	200.00	0.121	0.107	0.133	0.128	0.122
	1000.00	0.160	0.144	0.185	0.175	0.165
Goodness -of-fit statistics	CHISQ	9.537	9.537	6.415	6.415	6.024
	KS	0.097	0.096	0.091	0.086	0.084
	SLSC	0.030	0.034	0.028	0.028	0.028
	PPCC1	0.992	0.993	0.993	0.993	0.992
	PPCC2	0.992	0.992	0.993	0.993	0.992
	LLM	25.037	24.617	24.696	24.692	23.948



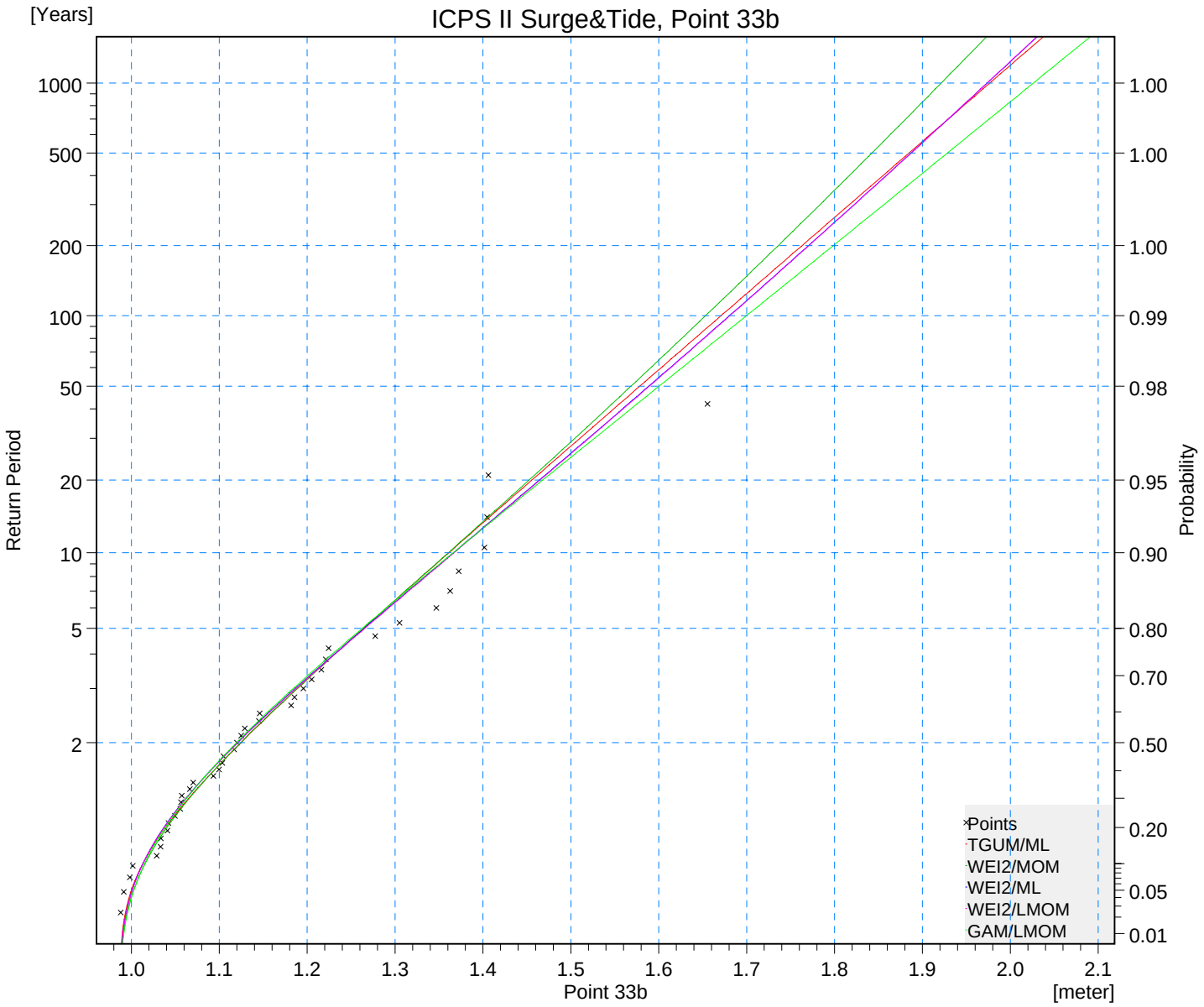
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II Surge&Tide						
Point 33						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	1.291	1.293	1.293	1.294	1.290
	10.00	1.397	1.399	1.400	1.405	1.403
	25.00	1.524	1.523	1.524	1.534	1.542
	50.00	1.617	1.610	1.612	1.626	1.643
	100.00	1.709	1.693	1.695	1.714	1.741
	200.00	1.800	1.772	1.775	1.799	1.839
	1000.00	2.010	1.949	1.954	1.988	2.063
Average quantile	5.00	1.293	1.295	1.295	1.295	1.290
	10.00	1.400	1.402	1.404	1.405	1.403
	25.00	1.528	1.527	1.531	1.533	1.541
	50.00	1.621	1.615	1.621	1.622	1.640
	100.00	1.713	1.698	1.706	1.708	1.738
	200.00	1.805	1.778	1.788	1.791	1.834
	1000.00	2.016	1.955	1.969	1.973	2.055
Standard deviation	5.00	0.035	0.034	0.034	0.035	0.034
	10.00	0.050	0.047	0.048	0.049	0.049
	25.00	0.071	0.067	0.069	0.072	0.071
	50.00	0.087	0.083	0.087	0.091	0.088
	100.00	0.104	0.100	0.105	0.110	0.106
	200.00	0.120	0.118	0.123	0.131	0.124
	1000.00	0.159	0.160	0.168	0.180	0.168
Goodness -of-fit statistics	CHISQ	7.585	7.585	7.585	6.024	6.024
	KS	0.087	0.088	0.090	0.098	0.098
	SLSC	0.034	0.038	0.038	0.033	0.030
	PPCC1	0.991	0.991	0.991	0.992	0.992
	PPCC2	0.991	0.990	0.990	0.990	0.992
	LLM	28.401	28.514	28.515	28.491	28.334



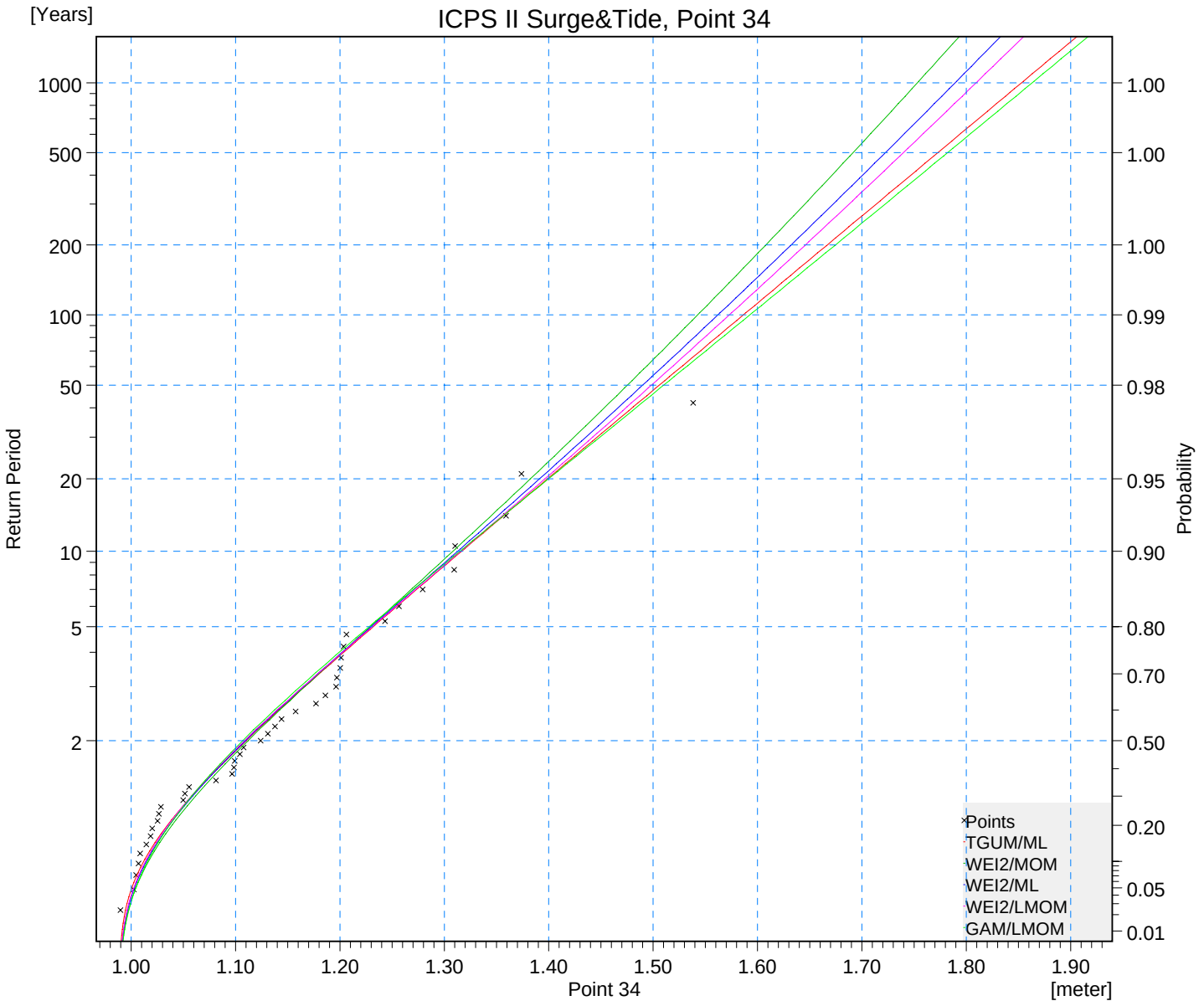
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
Date: 06/19/06	Probability plot	Drawing no. BE544810	
Init: B.Elsaesser			

ICPS II Surge&Tide						
Point 33b						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	1.249	1.249	1.249	1.249	1.246
	10.00	1.354	1.354	1.359	1.360	1.359
	25.00	1.483	1.479	1.492	1.493	1.498
	50.00	1.577	1.567	1.588	1.588	1.599
	100.00	1.670	1.653	1.680	1.680	1.699
	200.00	1.763	1.736	1.770	1.770	1.798
	1000.00	1.977	1.921	1.974	1.974	2.026
Average quantile	5.00	1.251	1.250	1.250	1.250	1.247
	10.00	1.358	1.357	1.365	1.360	1.359
	25.00	1.487	1.484	1.505	1.492	1.497
	50.00	1.582	1.574	1.605	1.585	1.597
	100.00	1.675	1.660	1.701	1.675	1.696
	200.00	1.768	1.744	1.796	1.763	1.794
	1000.00	1.983	1.931	2.009	1.959	2.019
Standard deviation	5.00	0.034	0.034	0.034	0.034	0.033
	10.00	0.049	0.048	0.049	0.049	0.049
	25.00	0.071	0.070	0.075	0.072	0.071
	50.00	0.088	0.089	0.097	0.092	0.089
	100.00	0.105	0.108	0.121	0.113	0.107
	200.00	0.123	0.128	0.146	0.135	0.126
	1000.00	0.165	0.177	0.208	0.190	0.171
Goodness -of-fit statistics	CHISQ	5.244	4.073	4.073	4.073	3.683
	KS	0.064	0.060	0.069	0.068	0.061
	SLSC	0.036	0.042	0.036	0.036	0.033
	PPCC1	0.989	0.989	0.989	0.989	0.989
	PPCC2	0.989	0.986	0.987	0.987	0.989
	LLM	31.139	30.764	30.853	30.851	30.458



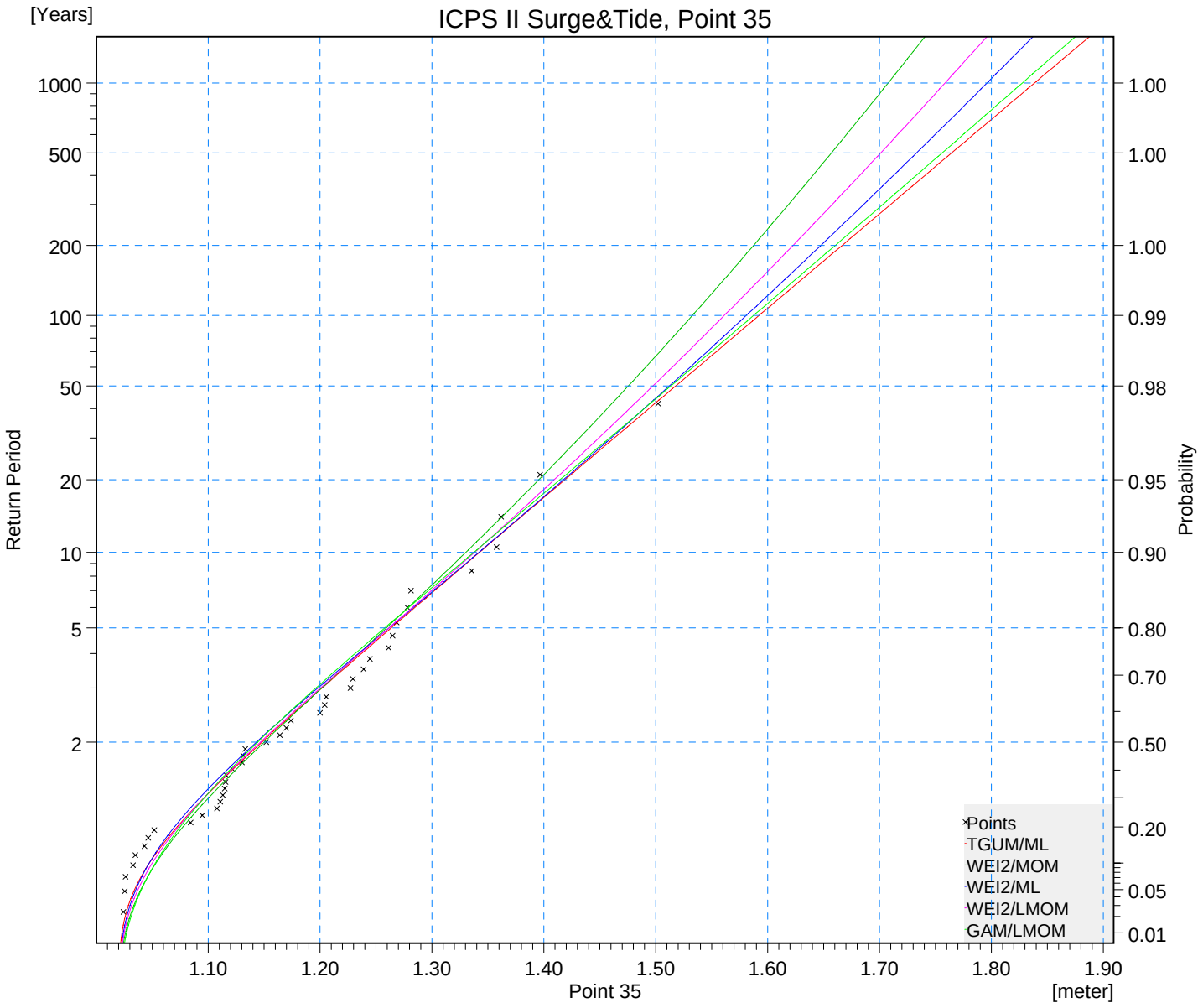
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

ICPS II Surge&Tide						
Point 34						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	1.218	1.216	1.217	1.217	1.214
	10.00	1.311	1.303	1.307	1.310	1.309
	25.00	1.423	1.404	1.414	1.420	1.425
	50.00	1.505	1.475	1.489	1.498	1.509
	100.00	1.586	1.542	1.562	1.573	1.592
	200.00	1.667	1.608	1.632	1.646	1.674
	1000.00	1.853	1.753	1.789	1.809	1.863
Average quantile	5.00	1.220	1.217	1.218	1.218	1.215
	10.00	1.313	1.305	1.311	1.310	1.309
	25.00	1.426	1.407	1.421	1.418	1.423
	50.00	1.508	1.479	1.499	1.494	1.507
	100.00	1.589	1.547	1.574	1.567	1.589
	200.00	1.670	1.613	1.646	1.637	1.669
	1000.00	1.857	1.758	1.808	1.793	1.855
Standard deviation	5.00	0.027	0.028	0.028	0.028	0.027
	10.00	0.037	0.038	0.038	0.038	0.038
	25.00	0.052	0.055	0.055	0.056	0.055
	50.00	0.064	0.069	0.070	0.072	0.069
	100.00	0.076	0.084	0.085	0.089	0.083
	200.00	0.089	0.100	0.102	0.107	0.099
	1000.00	0.118	0.137	0.141	0.152	0.135
Goodness -of-fit statistics	CHISQ	3.293	4.854	2.902	2.902	4.073
	KS	0.096	0.116	0.105	0.100	0.107
	SLSC	0.027	0.036	0.032	0.030	0.030
	PPCC1	0.992	0.992	0.992	0.991	0.991
	PPCC2	0.992	0.990	0.991	0.991	0.991
	LLM	36.865	36.465	36.601	36.636	36.061



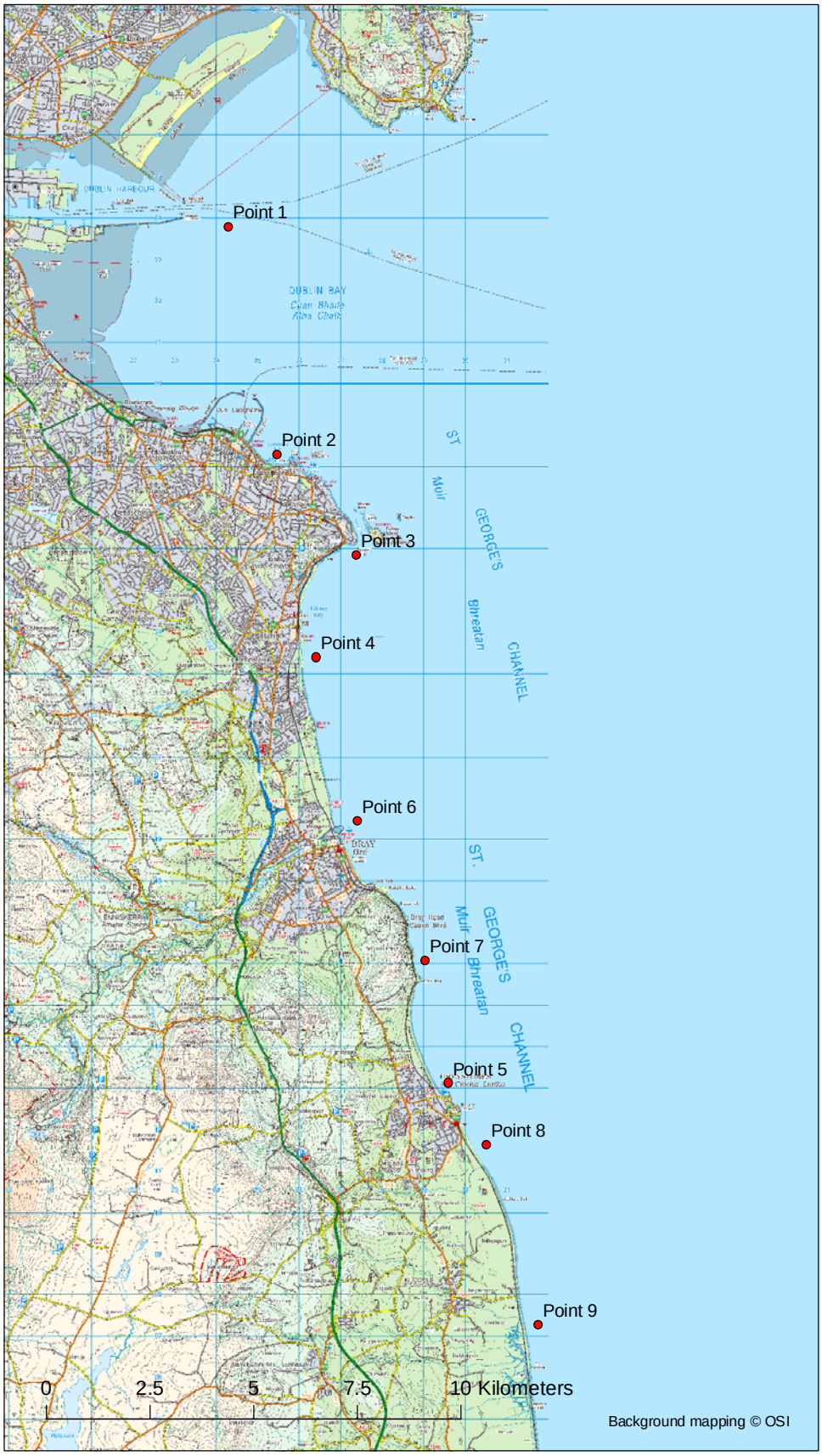
RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

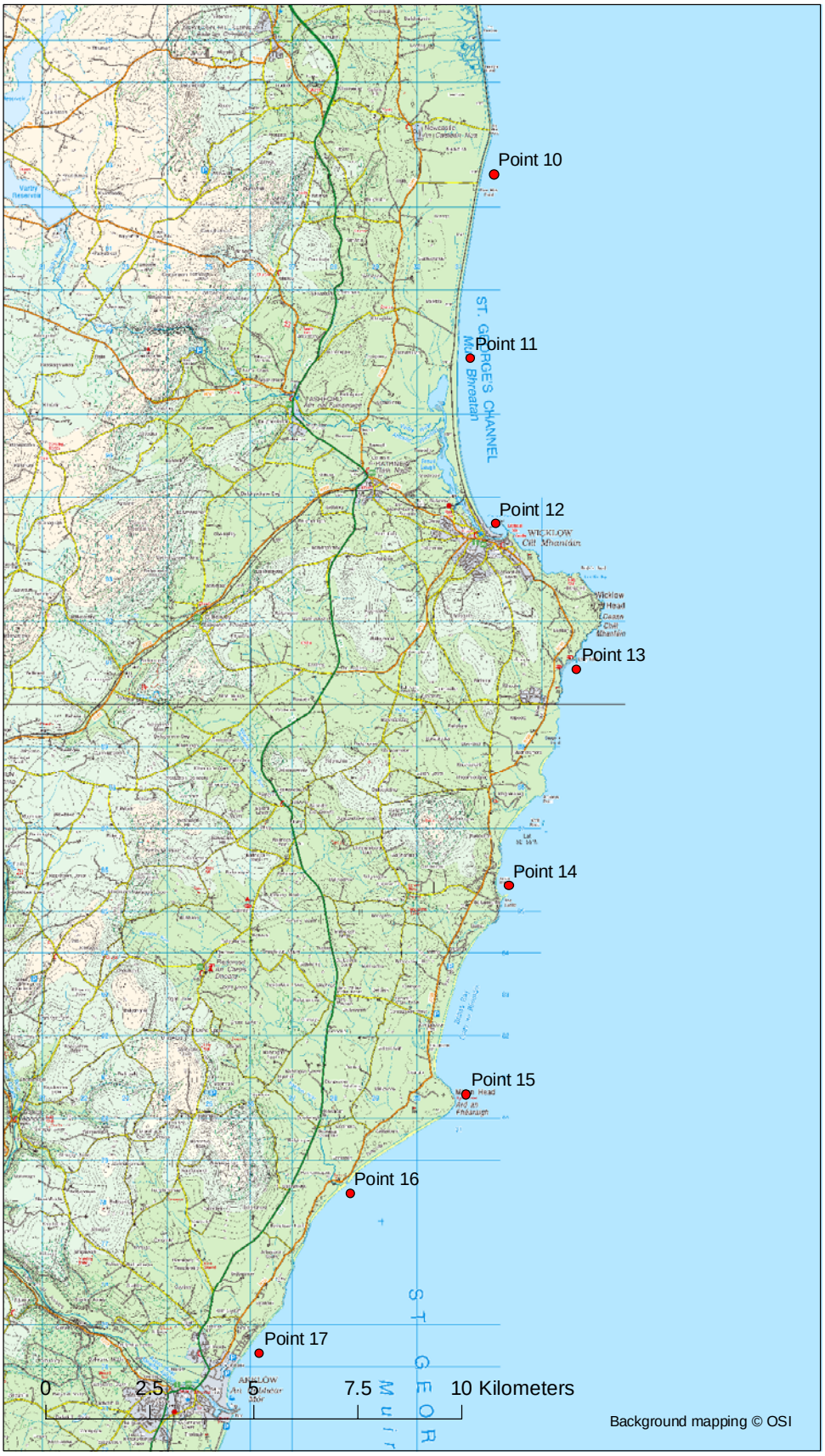
ICPS II Surge&Tide						
Point 35						
		D/E Combination				
	Return Period [years]	TGUM/ML	WEI2/MOM	WEI2/ML	WEI2/LMOM	GAM/LMOM
Estimated quantile	5.00	1.251	1.248	1.249	1.249	1.245
	10.00	1.337	1.325	1.336	1.333	1.332
	25.00	1.441	1.414	1.439	1.429	1.437
	50.00	1.517	1.475	1.511	1.497	1.513
	100.00	1.592	1.532	1.581	1.561	1.587
	200.00	1.666	1.587	1.647	1.623	1.660
	1000.00	1.838	1.708	1.796	1.759	1.828
Average quantile	5.00	1.253	1.249	1.250	1.250	1.246
	10.00	1.340	1.327	1.340	1.333	1.332
	25.00	1.444	1.416	1.444	1.428	1.435
	50.00	1.521	1.477	1.517	1.493	1.510
	100.00	1.596	1.535	1.587	1.555	1.584
	200.00	1.671	1.590	1.655	1.615	1.656
	1000.00	1.844	1.709	1.804	1.745	1.820
Standard deviation	5.00	0.025	0.025	0.025	0.025	0.024
	10.00	0.032	0.032	0.033	0.032	0.032
	25.00	0.045	0.043	0.050	0.047	0.046
	50.00	0.055	0.053	0.065	0.059	0.057
	100.00	0.065	0.064	0.081	0.073	0.069
	200.00	0.076	0.075	0.098	0.087	0.082
	1000.00	0.101	0.101	0.140	0.123	0.112
Goodness -of-fit statistics	CHISQ	7.976	6.805	11.488	6.805	6.805
	KS	0.103	0.101	0.121	0.105	0.107
	SLSC	0.024	0.028	0.025	0.024	0.029
	PPCC1	0.993	0.994	0.991	0.993	0.990
	PPCC2	0.993	0.994	0.992	0.993	0.990
	LLM	37.244	36.460	36.776	36.718	35.390



RPS Consulting Engineers	Client: OPW		MIKEZero
	Project: ICPSS, Phase 2		
	Date: 06/19/06	Probability plot	Drawing no. BE544810
	Init: B.Elsaesser		

Appendix 5: Location of extreme water level points as extracted from ISTSM


Point 1
Point 2
Point 3
Point 4
Point 6
Point 7
Point 5
Point 8
Point 9
DUBLIN HARBOUR
DUBLIN BAY
ST
Muir
GEORGES
Bhreatan
CHANNEL
ST.
Muir
GEORGES
Bhreatan
CHANNEL
0
2.5
5
7.5
10 Kilometers
Background mapping © OSI


Point 10
Point 11
Point 12
Point 13
Point 14
Point 15
Point 16
Point 17
ST. GEORGE'S CHANNEL
0
2.5
5
7.5
10 Kilometers
Background mapping © OSI


Point 18
Point 19
Point 20
Point 21
Point 22
Point 23
Point 24
Point 25
Point 26
Point 27
ST GEORGES CHANNEL
Muir Bhreatan
0
2.5
5
7.5
10 Kilometers
Background mapping © OSI


Point 28
Point 29
Point 30
Point 32
Point 31b
Point 31
Point 33
Point 33b
Point 35
Point 34
Point 36
Point 37
Point 38
Point 39
Point 40
0
2.5
5
7.5
10 Kilometers
Background mapping © OSI

Appendix 6: Quality Control Survey Report

Appendix 6

Quality Control Survey Report

1.0 Introduction

Quality control assessments were undertaken to verify the accuracy of the Digital Terrain Model (DTM) and also to verify the accuracy of the flood extents generated from the combination of the predicted extreme water levels with the DTM. These assessments were focussed on the main urban centres considered to be vulnerable to coastal flooding.

To facilitate these assessments Reencon Development Services Limited (RDS) were commissioned to carry out a Quality Control (QC) survey for five sample areas on the south east coast; namely Bray, Wicklow, Arklow, Wexford and Rosslare, recording the level of hard surfaces in the vicinity of the 0.5% AEP flood extent. The client also conducted a QC survey over extensive areas along the south east coast. It was decided to combine both sets of QC survey points from RDS and the client into one dataset, which was then processed by RPS, comparing the accuracy of the DTM with these points as well as the alignment of the flood extent. This provided an indication of the likely accuracy of the flood extents generated from the DTM.

This report presents the methodology, along with the combined results, and the results of the assessment of both the DTM and flood extent accuracy relative to the QC survey points.

2.0 Methodology

RPS used the 2007 DTM produced by ERA Maptec to generate the flood extents for the south east coast. This DTM was derived using a combination of different data sets, largely based on a first generation, low resolution (5m), topographic LIDAR Survey flown by Infoterra in 2001. Due to insufficient coverage in certain areas and its low resolution this DTM was supplemented by additional higher resolution surveys as detailed in Section 6.4 (Refer main technical report).

RDS and the client each carried out a QC survey on areas along the south east coast, with the results combined to form one dataset from which to assess the accuracy of the DTM. This section outlines the methodologies used by both RDS and the client in carrying out the surveys.

2.1 Survey Methodology

RDS carried out a topographic survey, between October and November 2007, using differential GPS (DGPS) and conventional theodolite techniques. The surveyors were required to record ground levels on hard surfaces in publicly accessible areas such as roads, footpaths and parks. Each road was covered by at least one survey line with a maximum level spacing of 5 metres. The survey coverage area was to extend from 1 metre below to 1.5 metres above the flood extent defined by the 0.5% AEP.

The survey was carried out to a vertical accuracy of +/- 20mm and a horizontal accuracy of +/- 200mm. Quality checks and Quality of Signal records (for DGPS data) were also provided. The survey point data was recorded in latitude, longitude projection and to ellipsoidal height datum in the ETRS 89 co-ordinate system and was subsequently converted to Irish Grid projection and referenced to OD Malin height datum. For each survey point, a descriptive note was also recorded, classifying the nature of the point, i.e. benchmarks, footpaths, road levels, road verge etc.

The client also carried out a QC survey along more extensive areas on the south east coast, using a similar methodology.

2.2 Combined Dataset and Accuracy Statistics

The combined survey data was used to quality control the DTM and flood extents in two ways. Initially, the survey levels were compared to the equivalent DTM elevation at the same location. This enabled a vertical accuracy assessment of the DTM to be made relative to the recorded survey control data. This also facilitated the identification of rogue or inaccurate points in the survey. In a second analysis the survey points were compared against the flood extents derived from the DTM, as detailed in Section 6.3 (Refer main technical report). From this analysis, the horizontal accuracy of these flood extents could be assessed.

The difference between the DTM and the QC survey points is referred to as height difference for the purpose of this report, such that all positive values describe areas where the DTM underestimated elevation and negative values where the DTM overestimated elevation. A number of rogue points discovered during this assessment were discarded, allowing more reliable statistics of height difference to be calculated including the mean, maximum, minimum, standard deviation, 95th percentile, upper and lower 95% confidence limits (estimated using the 2.5% and 97.5% percentile values), upper and lower 99% confidence limits (estimated using the 0.5% and 99.5% percentile values) and the RMSE (Root Mean Squared Error). It was noted that only a limited number of the survey points were required to be discarded, for example those at boundary locations, which have no bearing on the flood extents. The number of points removed, included 83 points that were outside the DTM, and a further 40 points due them being located on for example harbour piers and bridges.

3.0 Comparison of DTM and Survey Data

The extent of the QC Survey data recorded and submitted by RDS and the client was considered after review to be sufficient for its intended purpose i.e. to verify the accuracy of the DTM and flood extents. However, some of the DTM data when compared to the survey data showed minor discrepancies which were due to the terrain model being outdated in very localised areas (Arklow), as man-made infills or changes in road alignment since the date of the original survey had altered the ground levels. Notwithstanding this, the mean height difference and standard deviations calculated from the comparison of the QC data set and the DTM were considered satisfactory, showing smaller differences than expected.

The results of the assessment of DTM vertical accuracy is presented below for each of the twelve areas; Bray, Greystones, The Breaches, Wicklow, Brittas Bay. Arklow, Courtown, Curracloe, Castlebridge, Wexford Harbour, Wexford and Rosslare. The spatial distribution of the recorded survey points in five of the urban centres; (Bray, Wicklow, Arklow, Wexford and Rosslare) is shown in Figures 13 to 17 of Appendix 6A together with the height difference calculated between each survey point and DTM. Each point is colour-coded to show the difference between survey height and DTM height, with green and blue reflecting positive differences and red, orange and yellow showing negative differences. Points meeting the specified tolerance of ±0.2m are displayed in yellow and green.

3.1 Bray

The initial survey data recorded and submitted for Bray by RDS was found to be incorrect with all levels offset by 1 metre as a result of a survey base station error. RDS subsequently corrected the error and re-submitted the data with accuracy statements and record photographs. Following review of the re-submitted data, which was combined with the client's survey points, a number of unreliable points were identified and removed, for example those on the narrow harbour pier and bridge, due to DTM resolution constraints.

The Bray survey data was compared with the DTM elevations at the same locations and height difference statistics were calculated. The results of this analysis for Bray are shown in Table 1.

Table 1: Bray Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	1.039
Minimum	-1.359
Mean	0.167
Standard Deviation	0.230
95th Percentile	0.441
Upper 95% Confidence Limit	0.504
Lower 95% Confidence Limit	-0.276
Upper 99% Confidence Limit	0.714
Lower 99% Confidence Limit	-0.752
RMSE	0.284
Count	1416

The statistics in Table 1 are based on the comparison of 1416 survey points, with a few of the points having been removed from the analysis. Most of the discarded points were located on the harbour pier and bridge, and were considered unreliable due to DTM resolution constraints. Many of the larger height differences were found close to the edges of the DTM as would be expected. The RMSE value of 0.28m is not far outside the specified tolerance value. The accuracy of the DTM at Bray is between -0.28m and 0.50m at the 95% confidence limit and between -0.75m and 0.71m at the 99% confidence limit. The distribution of height difference for Bray is shown in Figure 1.

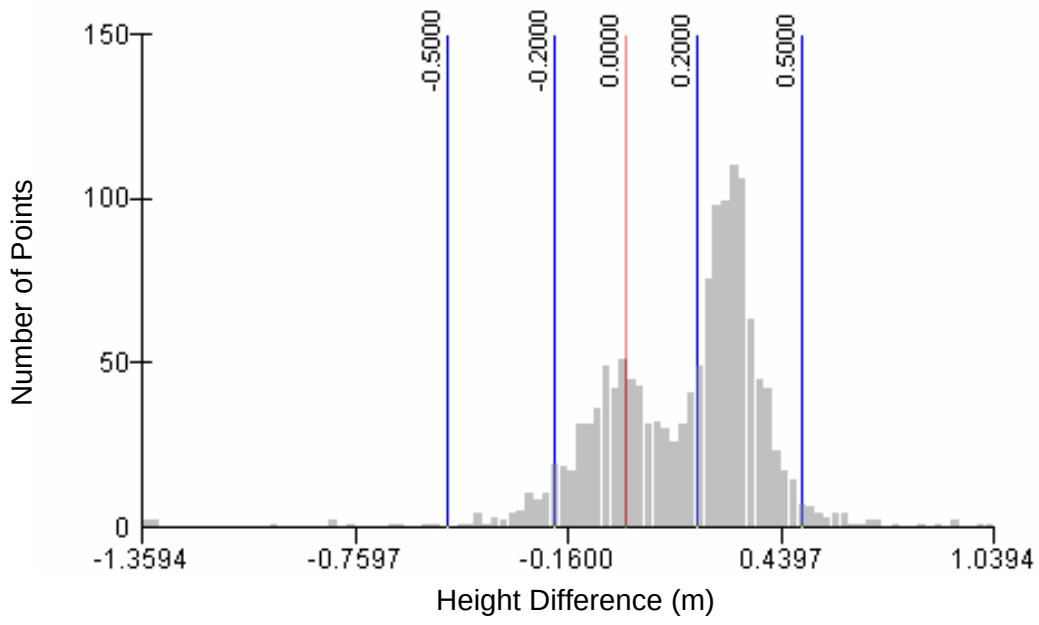


Figure 1: Bray Height Difference Distribution

3.2 Greystones

The Greystones survey data was compared with the DTM elevations at the same locations and height difference statistics were calculated. Only a small number of survey points were taken in the Greystones area, with 13 points remaining for analysis. Therefore, no percentage confidence limits of percentiles were calculated. The results of the analysis are shown in Table 2.

Table 2: Greystones Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	0.078
Minimum	-0.704
Mean	-0.225
Standard Deviation	0.207
95th Percentile	-
Upper 95% Confidence Limit	-
Lower 95% Confidence Limit	-
Upper 99% Confidence Limit	-
Lower 99% Confidence Limit	-
RMSE	0.305
Count	13

The RMSE value of 0.31m is outside the specified tolerance value. The mean height difference is -0.23m, with a standard deviation of 0.21m, also outside the tolerance. However, due to the very minimal number of ground control points in this area, these statistics can not be regarded with confidence as representative of the overall accuracy of the DTM. The distribution of height difference for Greystones is shown in Figure 2 below.

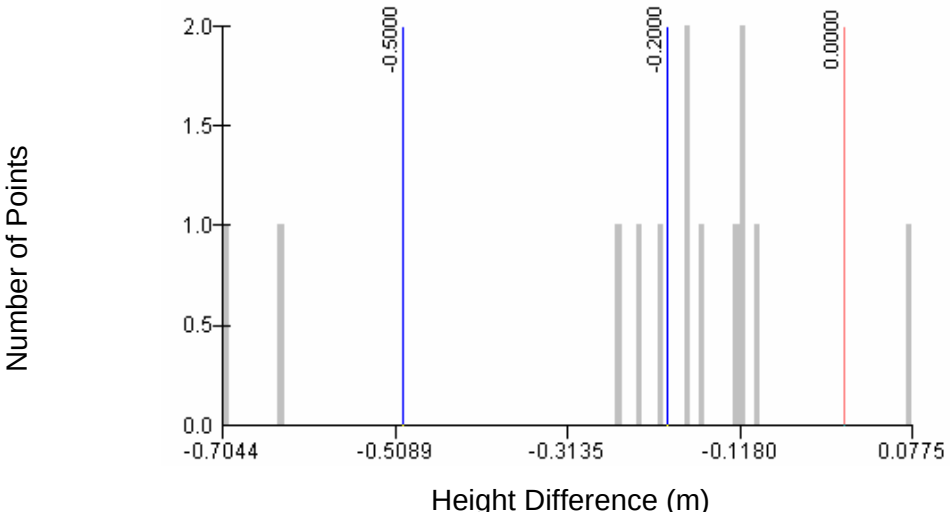


Figure 2: Greystones Height Difference Distribution

3.3 The Breaches

The Breaches survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 3 were calculated.

Table 3: The Breaches Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	0.744
Minimum	-1.862
Mean	-0.027
Standard Deviation	0.279
95th Percentile	0.247
Upper 95% Confidence Limit	0.296
Lower 95% Confidence Limit	-0.891
Upper 99% Confidence Limit	0.712
Lower 99% Confidence Limit	-1.691
RMSE	0.280
Count	308

The statistics in Table 3 are based on the comparison of 308 survey points, with a few of the points having been removed from the analysis. The RMSE value of 0.28m is not far outside the specified tolerance value. The accuracy of the DTM at The Breaches is between -0.891m and 0.30m at the 95% confidence limit and between -1.69m and 0.71m at the 99% confidence limit, showing quite a range in height differences at this location. The distribution of height difference for The Breaches is shown in Figure 3.

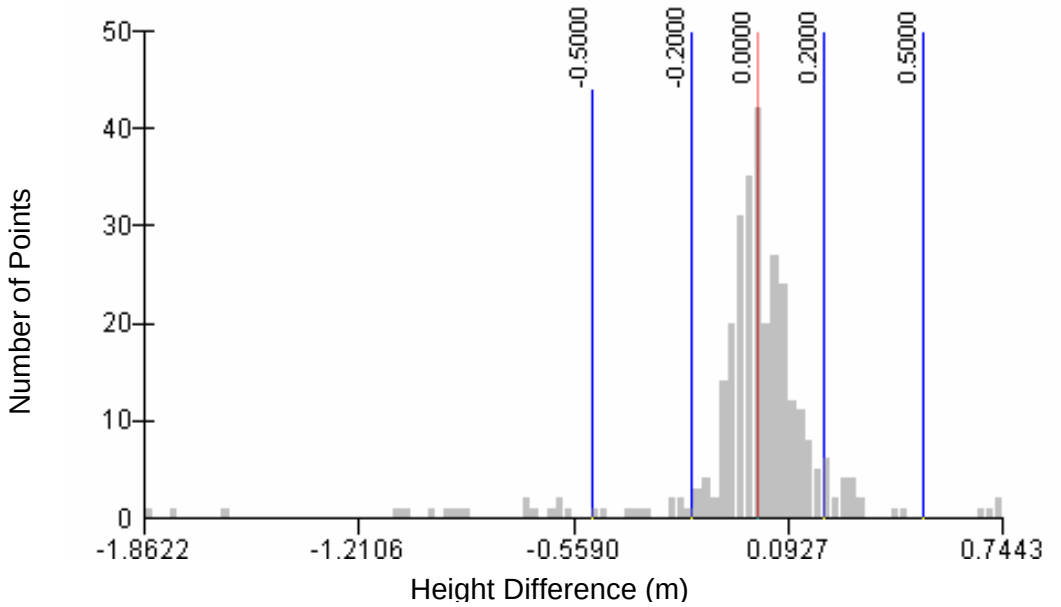


Figure 3: The Breaches Height Difference Distribution

3.4 Wicklow

The Wicklow survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 4 were calculated.

Table 4: Wicklow Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	0.959
Minimum	-1.185
Mean	-0.058
Standard Deviation	0.180
95th Percentile	0.166
Upper 95% Confidence Limit	0.228
Lower 95% Confidence Limit	-0.488
Upper 99% Confidence Limit	0.656
Lower 99% Confidence Limit	-0.820
RMSE	0.189
Count	893

The statistics in Table 4 are based on the comparison of 893 survey points. A number of points were discarded from the analysis as they were outside the DTM or located on a bridge. It is apparent that the standard deviation and the mean height differences are both very low, with the largest differences occurring close to the boundaries of the DTM. The accuracy of the DTM at Wicklow is between -0.49m and 0.23m at the 95% confidence limit and between -0.82m and 0.66m at the 99% confidence limit. This is shown graphically in Figure 4.

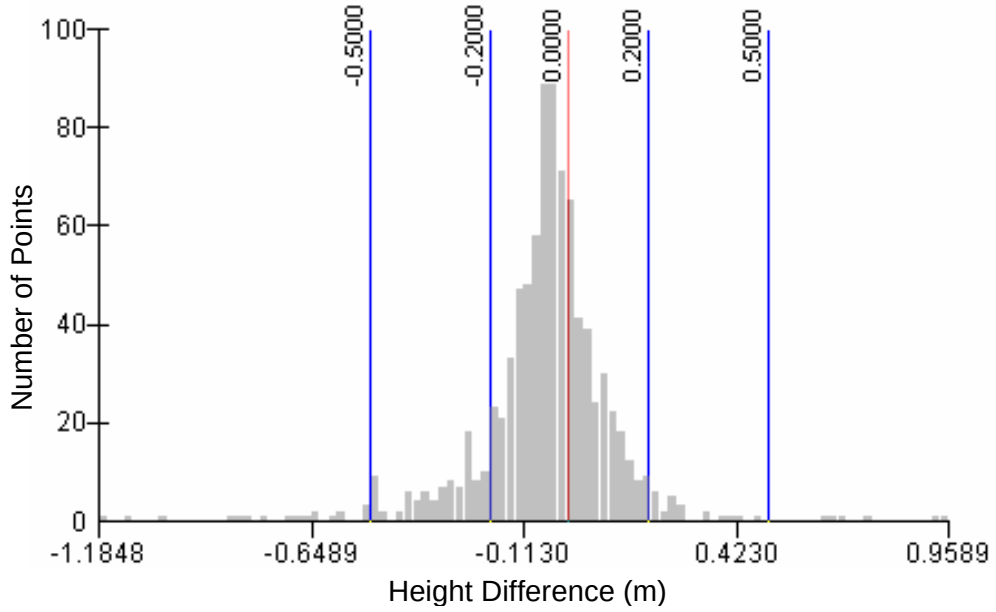


Figure 4: Wicklow Height Difference Distribution

3.5 Brittas Bay

The Brittas Bay survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 5 were calculated.

Table 5: Brittas Bay Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	1.417
Minimum	-1.577
Mean	0.058
Standard Deviation	0.281
95th Percentile	0.630
Upper 95% Confidence Limit	0.743
Lower 95% Confidence Limit	-0.266
Upper 99% Confidence Limit	1.251
Lower 99% Confidence Limit	-0.470
RMSE	0.287
Count	219

The statistics in Table 5 are based on the comparison of 219 survey points. The accuracy of the DTM at Brittas Bay is between -0.27m and 0.74m at the 95% confidence limit and between -0.47m and 1.25m at the 99% confidence limit. The distribution of height difference for Brittas Bay is shown in Figure 5.

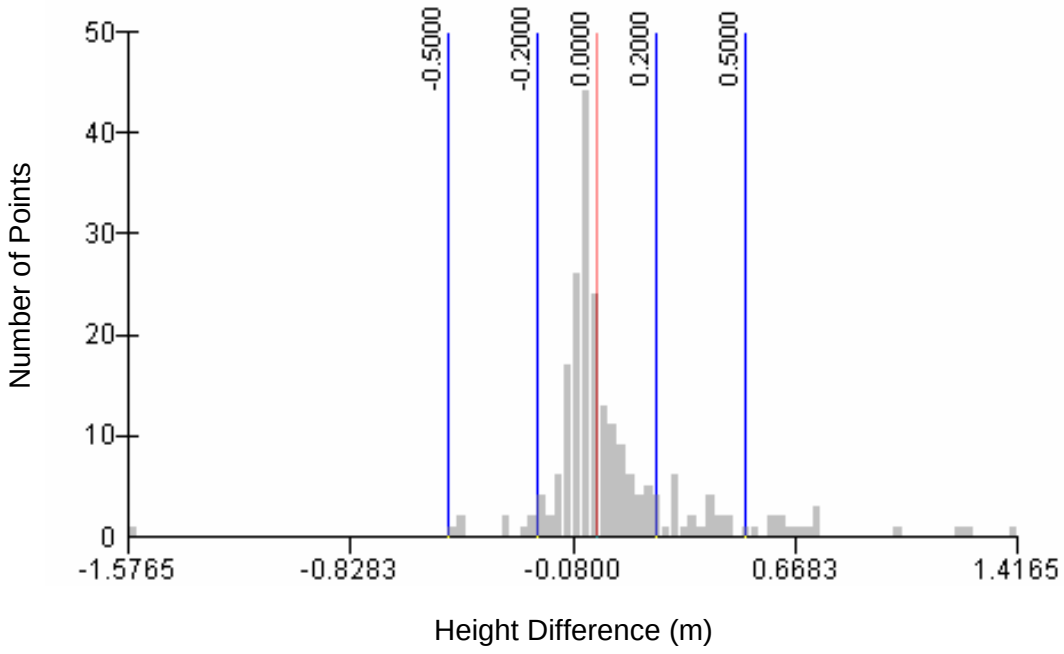


Figure 5: Brittas Bay Height Difference Distribution

3.6 Arklow

The Arklow survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 6 were calculated.

Table 6: Arklow Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	1.209
Minimum	-1.391
Mean	0.180
Standard Deviation	0.204
95th Percentile	0.459
Upper 95% Confidence Limit	0.582
Lower 95% Confidence Limit	-0.214
Upper 99% Confidence Limit	0.895
Lower 99% Confidence Limit	-0.561
RMSE	0.272
Count	2251

The statistics in Table 6 are based on the comparison of 2251 survey points. With regard to the Arklow data set, a difference in the survey data and the DTM was identified due to a change in road alignment and development. The DTM in this area was primarily produced from the 2005 BKS survey which is considered recent. This change in road alignment has resulted in invalid control points being produced, with a number of points having to be removed, and thus not used in the analysis of height difference.

While a very low mean height difference of 0.18m was found, the standard deviation of 0.20m is considered larger than expected. This is possibly due to an error in the datum of the LIDAR survey, though in the overall context this error is acceptable. It can be seen in Figure 15 that the points with the biggest height difference are more evenly distributed in Arklow than in most other locations.

The distribution of height difference for Arklow is shown in Figure 6.

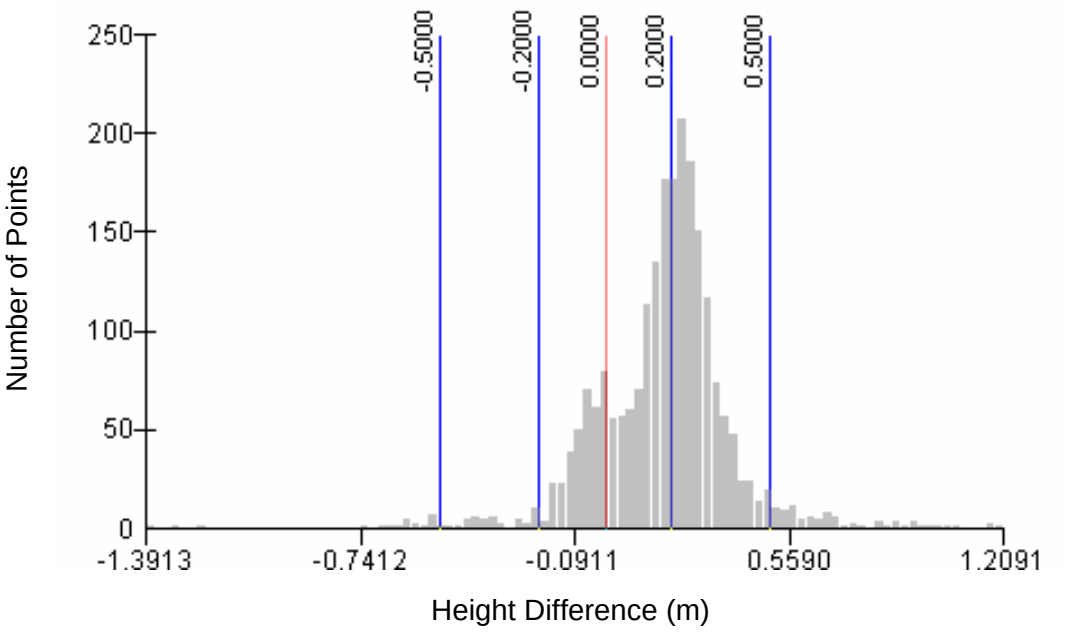


Figure 6: Arklow Height Difference Distribution

3.7 Courtown

The Courtown survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 7 were calculated.

Table 7: Courtown Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	0.664
Minimum	-0.621
Mean	0.060
Standard Deviation	0.151
95th Percentile	0.309
Upper 95% Confidence Limit	0.356
Lower 95% Confidence Limit	-0.235
Upper 99% Confidence Limit	0.534
Lower 99% Confidence Limit	-0.427
RMSE	0.163
Count	284

The statistics in Table 7 are based on the comparison of 284 survey points. The accuracy of the DTM at Courtown is between -0.24m and 0.36m at the 95% confidence limit and between -0.43m and 0.53m at the 99% confidence limit. The distribution of height difference for Courtown is shown in Figure 7.

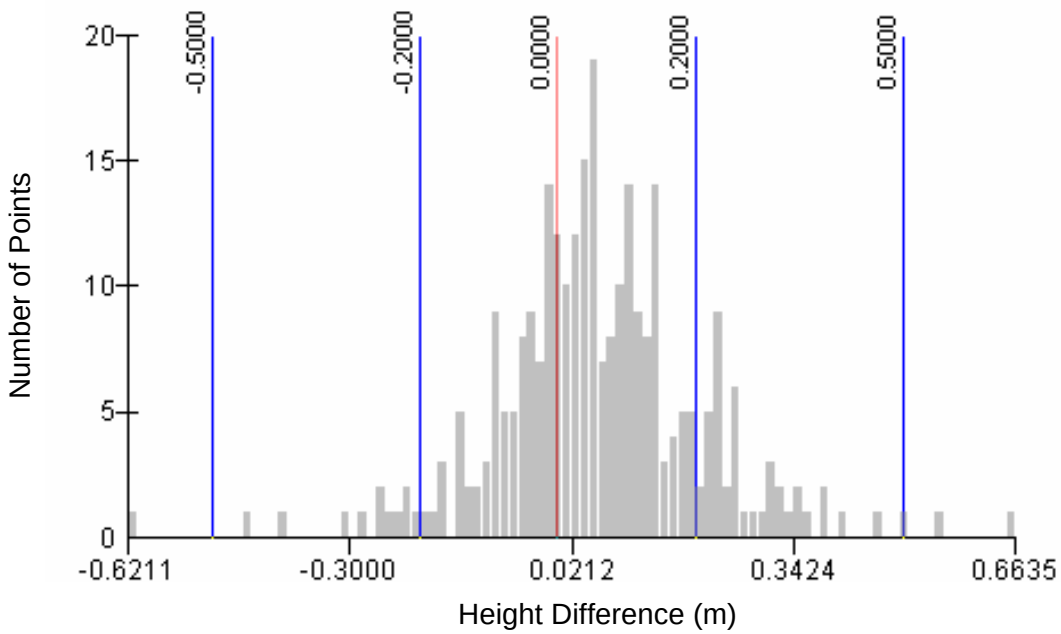


Figure 7: Courtown Height Difference Distribution

3.8 Curracloe

The Curracloe survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 8 were calculated.

Table 8: Curracloe Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	0.651
Minimum	-1.106
Mean	-0.073
Standard Deviation	0.185
95th Percentile	0.203
Upper 95% Confidence Limit	0.278
Lower 95% Confidence Limit	-0.280
Upper 99% Confidence Limit	0.497
Lower 99% Confidence Limit	-0.768
RMSE	0.198
Count	88

The statistics in Table 8 are based on the comparison of 88 survey points. The accuracy of the DTM at Curracloe is between -0.28m and 0.28m at the 95% confidence limit and between -0.77m and 0.50m at the 99% confidence limit. The distribution of height difference for Curracloe is shown in Figure 8.

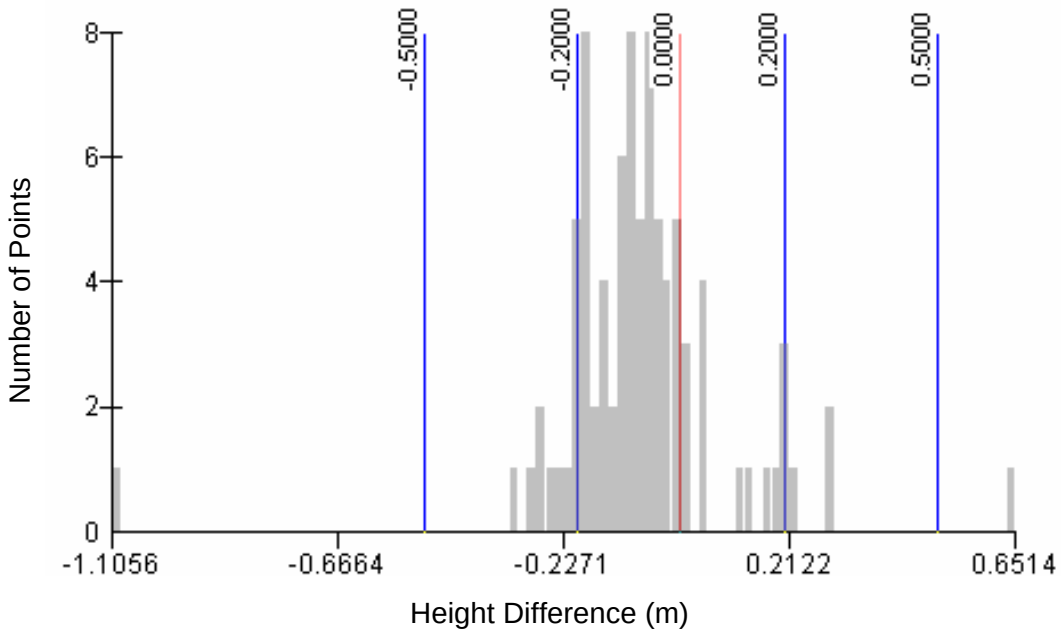


Figure 8: Curracloe Height Difference Distribution

3.9 Castlebridge

The Castlebridge survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 9 were calculated.

Table 9: Castlebridge Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	0.356
Minimum	-0.565
Mean	-0.048
Standard Deviation	0.112
95th Percentile	0.115
Upper 95% Confidence Limit	0.144
Lower 95% Confidence Limit	-0.264
Upper 99% Confidence Limit	0.297
Lower 99% Confidence Limit	-0.544
RMSE	0.121
Count	317

The statistics in Table 9 are based on the comparison of 317 survey points. The accuracy of the DTM at Castlebridge is between -0.26m and 0.14m at the 95% confidence limit and between -0.54m and 0.30m at the 99% confidence limit. The distribution of height difference for Castlebridge is shown in Figure 9.

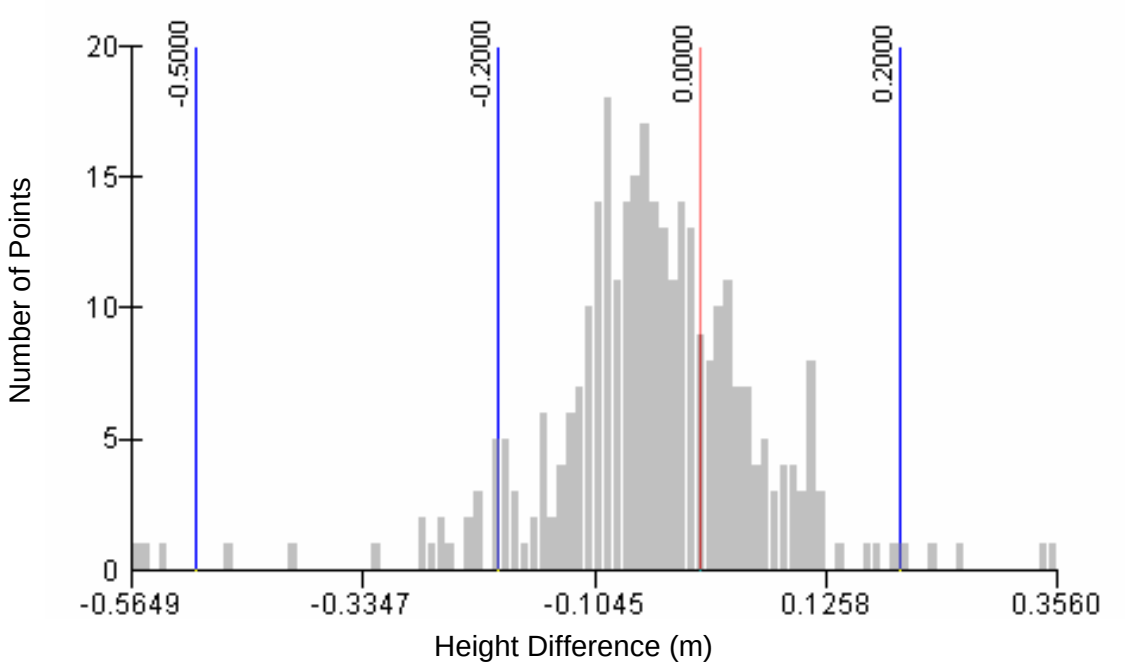


Figure 9: Castlebridge Height Difference Distribution

3.10 Wexford Harbour

The Wexford Harbour survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 10 were calculated.

Table 10: Wexford Harbour Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	1.828
Minimum	-1.852
Mean	-0.197
Standard Deviation	0.429
95th Percentile	0.404
Upper 95% Confidence Limit	0.703
Lower 95% Confidence Limit	-1.074
Upper 99% Confidence Limit	1.451
Lower 99% Confidence Limit	-1.647
RMSE	0.473
Count	283

The statistics in Table 10 are based on the comparison of 283 survey points. The accuracy of the DTM at Wexford Harbour is between -1.07m and 0.70m at the 95% confidence limit and between -1.65m and 1.45m at the 99% confidence limit, revealing quite a low accuracy DTM at this location. The distribution of height difference for Wexford Harbour is shown in Figure 10.

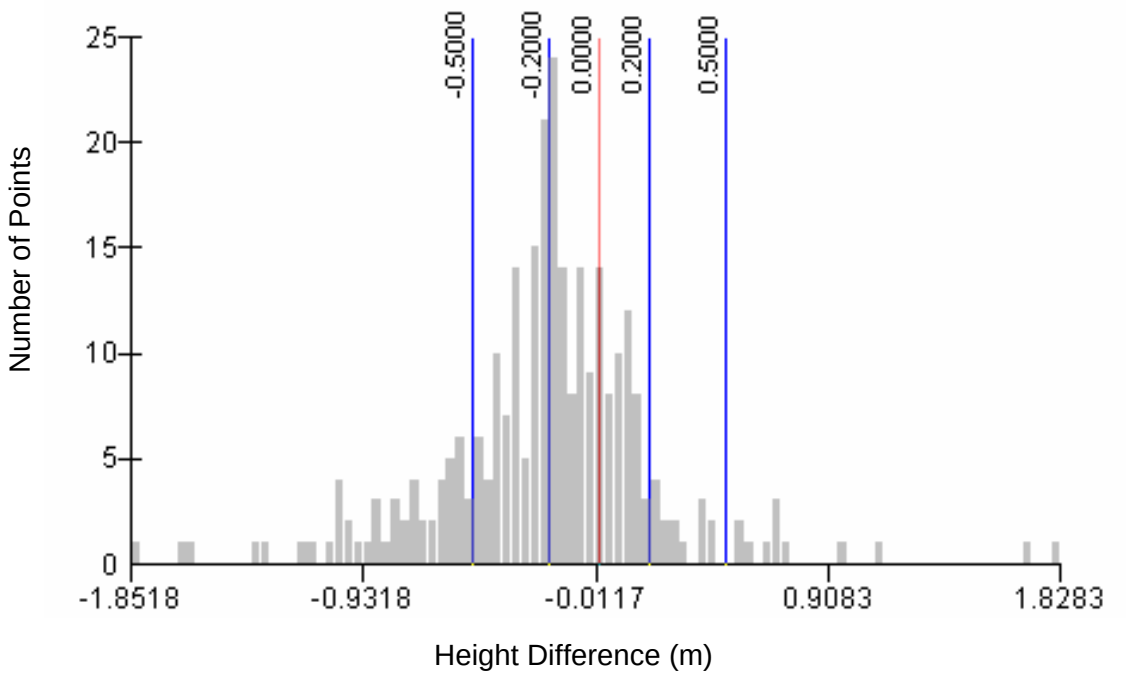


Figure 10: Wexford Harbour Height Difference Distribution

3.11 Wexford

The Wexford survey data was compared with the DTM elevations at the same locations and height difference statistics shown in Table 11 were calculated.

Table 11: Wexford Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	1.549
Minimum	-2.494
Mean	-0.090
Standard Deviation	0.246
95th Percentile	0.159
Upper 95% Confidence Limit	0.241
Lower 95% Confidence Limit	-0.728
Upper 99% Confidence Limit	0.719
Lower 99% Confidence Limit	-1.161
RMSE	0.262
Count	3287

The statistics in Table 11 are based on the comparison of 3287 survey points. A number of points were discarded from the analysis, due to the existence of bridges and some points being outside the DTM. Also, many of these represented temporary benchmarks and base station points which were invalid control points and should not have been included in the survey. The mean of -0.09m is quite small, but the

standard deviation of 0.25m is considered large possibly due to the complex street layout and the likelihood that certain streets are not precisely defined by the DTM survey. There is also a lot of vegetation in a localised area in the north (Crosstown Lane), causing discrepancies in the RDS survey due to poor signal. Hence a large difference exists between the survey and the DTM, as shown in Figure 16. The accuracy of the DTM at Wexford is between -0.73m and 0.24m at the 95% confidence limit and between -1.16m and 0.72m at the 99% confidence limit.

The distribution of height difference for Wexford is shown in Figure 11.

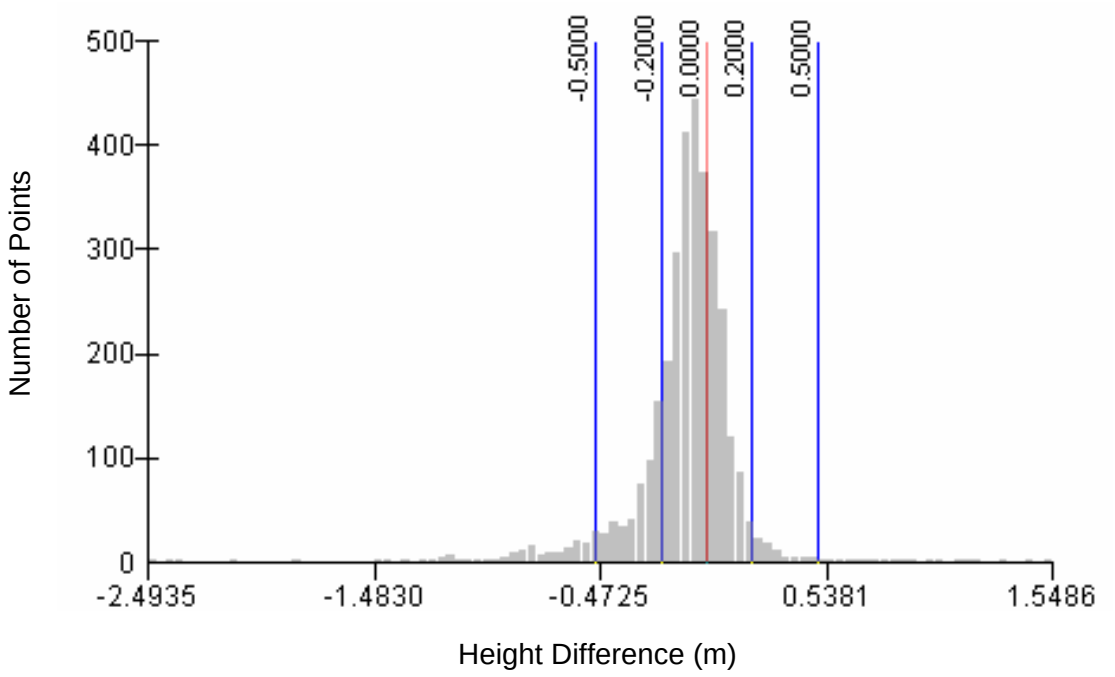


Figure 11: Wexford Height Difference Distribution

3.12 Rosslare

The Rosslare survey data was compared with the DTM elevations at the same locations and height difference statistics are shown in Table 12 were calculated.

Table 12: Rosslare Height Difference Statistics

HEIGHT DIFFERENCE (METRES)	
Maximum	1.073
Minimum	-2.331
Mean	-0.173
Standard Deviation	0.258
95th Percentile	0.101
Upper 95% Confidence Limit	0.210
Lower 95% Confidence Limit	-0.882
Upper 99% Confidence Limit	0.495
Lower 99% Confidence Limit	-1.344
RMSE	0.311
Count	1998

The statistics in Table 12 are based on the comparison of 1998 survey points. A small number of points were discarded from the analysis due to close proximity to DTM boundaries. Given that the Rosslare DTM is mostly based on the Infoterra, first generation LiDAR survey, the mean height difference of -0.17m is considered better than expected., however the standard deviation is 0.26m. The distribution of height difference for Rosslare is shown in Figure 12 below.

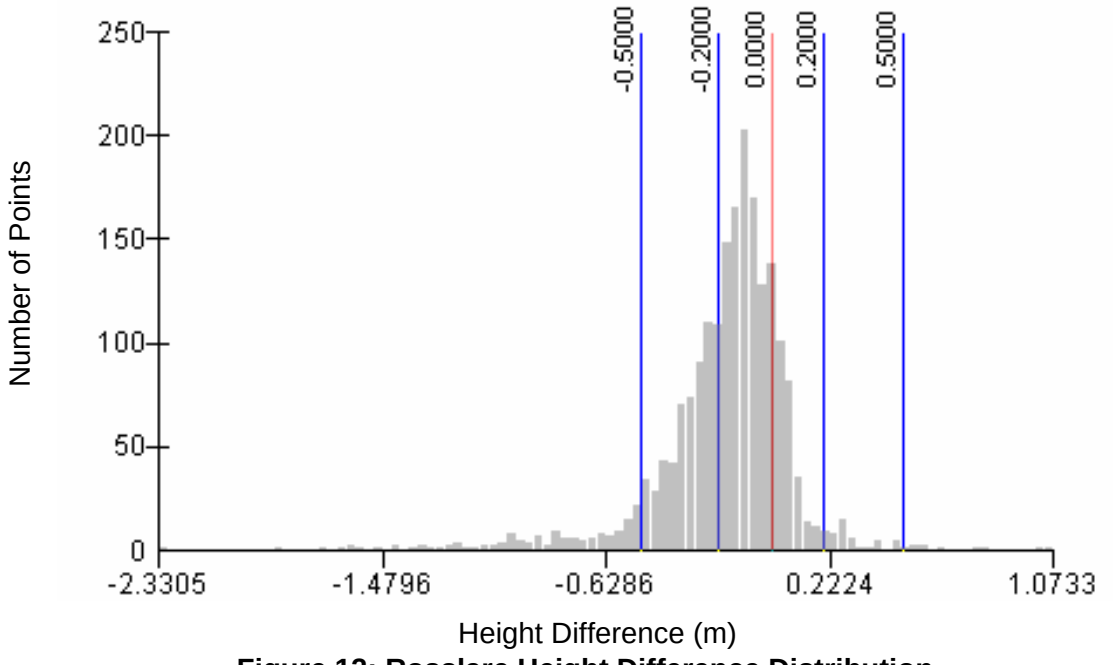


Figure 12: Rosslare Height Difference Distribution

3.13 Summary of Results

The overall results of the assessment of the DTM vertical accuracy in the main urban centres and other surveyed areas along the south east coast, based on comparison with the quality control survey data, are summarised in Table 13.

For all twelve locations mean height difference and standard deviation values range between -0.23m to 0.18m and 0.11m to 0.430m respectively. Maximum height differences range between 0.08m to 1.83m and minimum height differences range between -2.49m to -0.57m. The RMSE of height difference values is in general quite high, ranging from 0.12m at Castlebridge to 0.47m at Wexford Harbour.

The results also indicate that at the 95% confidence limit, the accuracy of the DTM varies from between:

- -0.27m to 0.50m at Bray
- -0.89m to 0.30m at the Breaches
- -0.49m to 0.23m at Wicklow
- -0.27m to 0.74m at Brittas Bay
- -0.21m to 0.58m at Arklow
- -0.24 to 0.36 at Courtown
- -0.28m to 0.28m at Curracloe
- -0.26m to 0.14m at Castlebridge
- -1.07m to 0.70m at Wexford Harbour
- -0.73m to 0.24m at Wexford
- -0.88m to 0.21m at Rosslare

At the 99% confidence limit the accuracy of the DTM varies from between:

- -0.75m to 0.71m at Bray
- -1.69m to 0.71m at the Breaches
- -0.82m to 0.66m at Wicklow
- -0.47m to 1.25m at Brittas Bay
- -0.56m to 0.90m at Arklow
- -0.43m to 0.53m at Courtown
- -0.77m to 0.50m at Curracloe
- -0.54m to 0.30m at Castlebridge
- -1.65m to 1.45m at Wexford Harbour
- -1.16m to 0.72m at Wexford
- -1.34m to 0.50m at Rosslare

Combining all locations, at the 95% confidence limit the accuracy of the DTM varies between -0.61m to 0.45m and between -1.14m to 0.76m at the 99% confidence limit. The overall RMSE is 0.27m.

Table 13: Statistical Results for 12 Urban Areas

	Maximum	Minimum	Mean	Standard Deviation.	95% Percentile	Upper 95% Confidence Limit	Lower 95% Confidence Limit	Upper 99% Confidence Limit	Lower 99% Confidence Limit	RMSE	Count
Bray	1.039	-1.359	0.167	0.230	0.441	0.504	-0.276	0.714	-0.752	0.284	1416
Greystones	0.078	-0.704	-0.225	0.207	-	-	-	-	-	0.305	13
Breaches	0.744	-1.862	-0.027	0.279	0.247	0.296	-0.891	0.712	-1.691	0.280	308
Wicklow	0.959	-1.185	-0.058	0.180	0.166	0.228	-0.488	0.656	-0.820	0.189	893
Brittas Bray	1.417	-1.577	0.058	0.281	0.630	0.743	-0.266	1.251	-0.470	0.287	219
Arklow	1.209	-1.391	0.180	0.204	0.459	0.582	-0.214	0.895	-0.561	0.272	2251
Courtown	0.664	-0.621	0.060	0.151	0.309	0.356	-0.235	0.534	-0.427	0.163	284
Curracloe	0.651	-1.106	-0.073	0.185	0.203	0.278	-0.280	0.497	-0.768	0.198	88
Castlebridge	0.356	-0.565	-0.048	0.112	0.115	0.144	-0.264	0.297	-0.544	0.121	317
Wexford Harbour	1.828	-1.852	-0.197	0.429	0.404	0.703	-1.074	1.451	-1.647	0.473	283
Wexford	1.549	-2.494	-0.090	0.246	0.159	0.241	-0.728	0.719	-1.161	0.262	3287
Rosslare	1.073	-2.331	-0.173	0.258	0.101	0.210	-0.882	0.495	-1.344	0.311	1998
Total	1.828	-2.494	-0.010	0.274	0.360	0.446	-0.609	0.756	-1.142	0.274	11357

4.0 Comparison of Flood Extents and Survey Data

To assess the accuracy of the flood extents generated from the DTM, a level comparison was undertaken between the flood extents and the survey points for five of the urban centres along the coastline. This was done by selecting a sample area (between 1.5 and 18 hectares) from each urban centre and comparing flood extent and survey levels within this area. The results of this assessment are shown in Figures 18-27 of Appendix 6B. The assessment was undertaken for flood extents associated with both the 0.5% and 0.1% AEP. These figures show the spatial distribution of the survey points relative to the flood extents in each sample area. The results for each urban centre are outlined below.

4.1 Bray

The results of the flood extent accuracy assessment for Bray are shown in Figures 18 and 19. These figures show the flood extents produced from the DTM for the 0.5% and 0.1% AEP and the predicted flood levels associated with these events i.e. 3.087m O.D. Malin for 0.1% AEP and 2.846m O.D. Malin for 0.5% AEP in the selected area. Figure 18 highlights those survey points in yellow which should fall within the 0.5% AEP flood extent and Figure 19 shows those survey points in green which should fall within the 0.1% AEP flood extent. In the sample area selected it can be seen that over half of the yellow points lie outside the 0.5% AEP flood extent and almost two thirds of the green points lie outside the 0.1% AEP flood extent.

The maximum horizontal distance between the 0.5% AEP flood extent and those survey points shown outside of this flood extent but below the 0.5% flood level was found to be approximately 75m. The maximum horizontal distance between the 0.1% AEP flood extent and those survey points shown outside of this flood extent but below the 0.1% flood level was found to be approximately 85m, noted as poor horizontal accuracy.

4.2 Wicklow

The results of the flood extent accuracy assessment for Wicklow are shown in Figures 20 and 21. The predicted flood extent levels for this area are 2.475m O.D. Malin for 0.1% AEP and 2.254m O.D. Malin for 0.5% AEP in the selected area. These Figures show that most of the survey points fall within the correct flood extent range.

The maximum horizontal distance between the 0.5% AEP flood extent and those survey points shown outside of this flood extent but below the 0.5% flood level was found to be approximately 2m. The maximum horizontal distance between the 0.1% AEP flood extent and those survey points shown outside of this flood extent but

below the 0.1% flood level was found to be approximately 2m.Thus proving the horizontal accuracy to be around 2 metres, which is the resolution of the DTM.

In general the ground survey and the DTM compare very well in Wicklow, which is reflected in the low mean height difference and 95th percentile and the correlation of the flood extents. In Wicklow there are less higher buildings and narrow streets compared to some parts of Wexford and Arklow. This in general means greater accuracy.

4.3 Arklow

The results of the flood extent accuracy assessment for Arklow are shown in Figures 22 and 23. For Arklow, the predicted flood extent levels are 1.654m O.D. Malin for 0.1% AEP and 1.468m O.D. Malin for 0.5% AEP in the selected area. These Figures show a large percentage of the yellow and green points fall within the respective flood extents. This can be observed for most of Arklow and the sample area is considered, in general, representative of that section of the coast. There appears to be a fixed offset of the higher resolution DTM in this area, though small it is of the order of 0.25m.

The maximum horizontal distance between the 0.5% AEP flood extent and those survey points shown outside of this flood extent but below the 0.5% flood level was found to be approximately 32m. The maximum horizontal distance between the 0.1% AEP flood extent and those survey points shown outside of this flood extent but below the 0.1% flood level was found to be approximately 45m.

4.4 Wexford

The results of the flood extent accuracy assessment for Wexford are shown in Figures 24 and 25. For Wexford, the predicted flood extent levels are 1.952m O.D. Malin for 0.1% AEP and 1.724m O.D. Malin for 0.5% AEP in the selected area. These figures show that the vast majority of the surveyed points which are below the respective flood level are within the flood extents. As mentioned earlier the degree of urbanisation and the combination of high buildings and narrow streets makes the establishment of a good terrain model more difficult. This combined with the recent changes in topography results in some errors in the flood extent.

The maximum horizontal distance between the 0.5% AEP flood extent and those survey points shown outside of this flood extent but below the 0.5% flood level was found to be approximately 19m. The maximum horizontal distance between the 0.1% AEP flood extent and those survey points shown outside of this flood extent but below the 0.1% flood level was found to be approximately 25m.

4.5 Rosslare

The results of the flood extent accuracy assessment for Rosslare are shown in Figures 26 and 27. For Rosslare, the predicted flood extent levels are 1.759m O.D. Malin for 0.1% AEP and 1.608m O.D. Malin for 0.5% AEP in the selected area. These Figures show that almost all of the surveyed points which are below the respective flood level are within the flood extents.

The maximum horizontal distance between the 0.5% AEP flood extent and those survey points shown outside of this flood extent but below the 0.5% flood level was found to be approximately 2m. The maximum horizontal distance between the 0.1% AEP flood extent and those survey points shown outside of this flood extent but below the 0.1% flood level was found to be approximately 2m.

Table 14: Horizontal Accuracy of Flood Extents

LOCATION	0.5% AEP	0.1% AEP
Bray	75m	85m
Wicklow	2m	2m
Arklow	32m	45m
Wexford	19m	25m
Rosslare	2m	2m

It can be seen from Table 14 that Wicklow and Rosslare have high horizontal accuracy of 2 metres for both 0.5% AEP and 0.1% AEP. Wexford is of medium accuracy with 19 metres for 0.5% AEP and 25 metres for 0.1% AEP. Arklow is of lower accuracy with 32 metres for 0.5% AEP and 45 metres for 0.1% AEP, while Bray is least accurate with 75 metres for 0.5% AEP and 85 metres for 0.1% AEP.

5.0 Conclusion

Based on the two combined ground surveys carried out in the twelve areas as part of this study, it can be concluded that the DTM is generally of the accuracy expected and provides a good basis for the generation of flood extents.

For all twelve locations mean height difference and standard deviation values range between -0.23m to 0.18m and 0.11m to 0.43m respectively. Maximum height differences range between 0.08m to 1.83m and minimum height differences range between -2.49m to -0.57m. The RMSE of height difference values is in general quite high, ranging from 0.12m at Castlebridge to 0.47m at Wexford Harbour. The results also indicate that at the 95% confidence limit, the accuracy of the DTM varies from between -1.07m at the Wexford Harbour to 0.74m at Brittas Bay. At the 99% confidence limit the accuracy of the DTM varies from between -1.69m at the Breaches to 1.45m at Wexford Harbour.

Combining all locations, at the 95% confidence limit the accuracy of the DTM varies between -0.61m to 0.45m and between -1.14m to 0.76m at the 99% confidence limit. The overall RMSE is 0.27m.

Horizontal accuracy of the flood extents for 0.5% AEP ranged from as accurate as 2 metres at Wicklow and Rosslare to 75 metres at Bray, showing the vast extents to which horizontal accuracy can differ. For 0.1% AEP, horizontal accuracy ranged from 2 metres at Wicklow and Rosslare to 85 metres at Bray. For both 0.5% and 0.1% AEP's, Wexford and Arklow were found in the middle of the range, with Wexford having higher accuracy than Arklow.

APPENDIX 6A: Figures 13 to 17

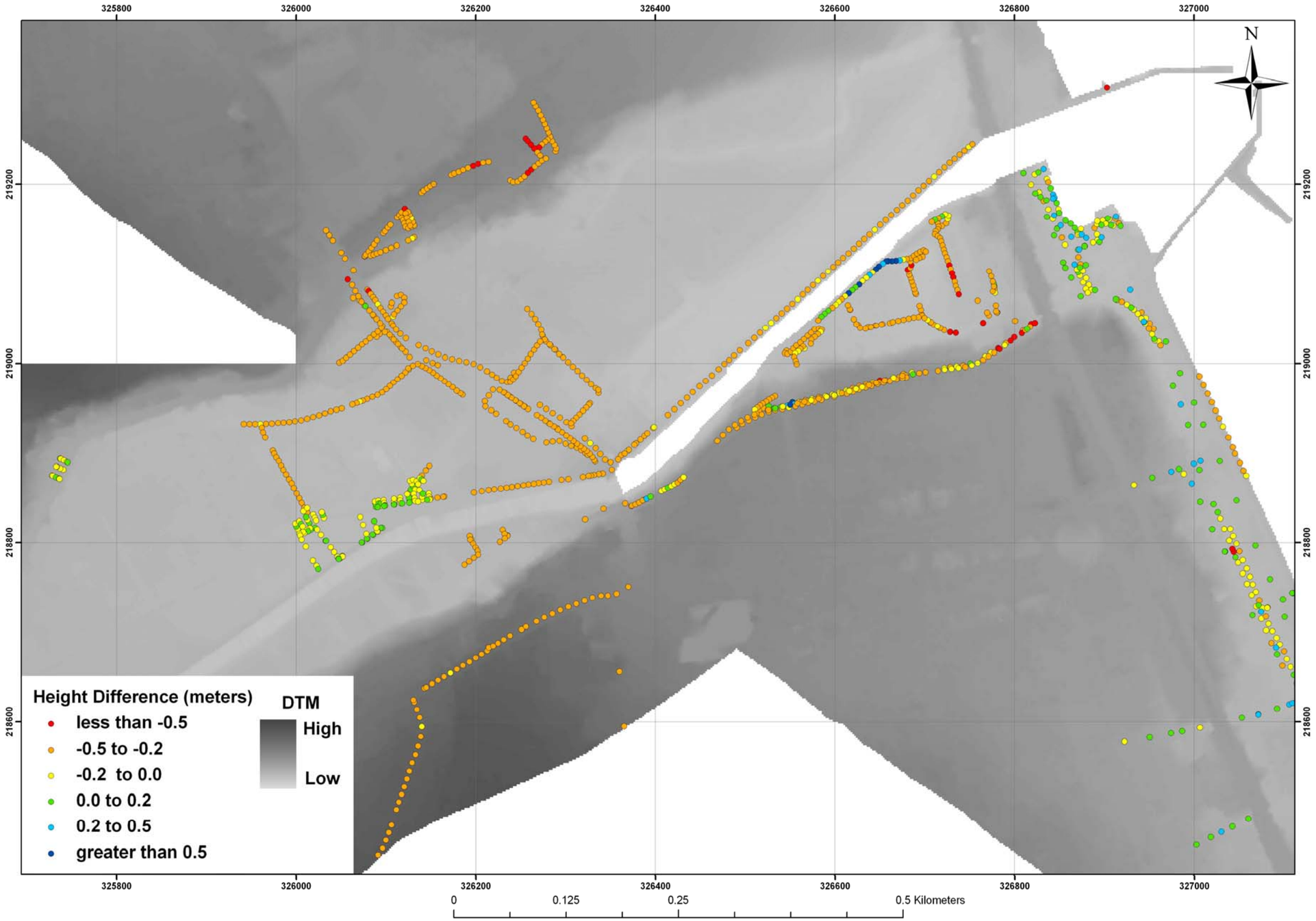


Figure 13: Comparison of DTM and Survey Data - Bray

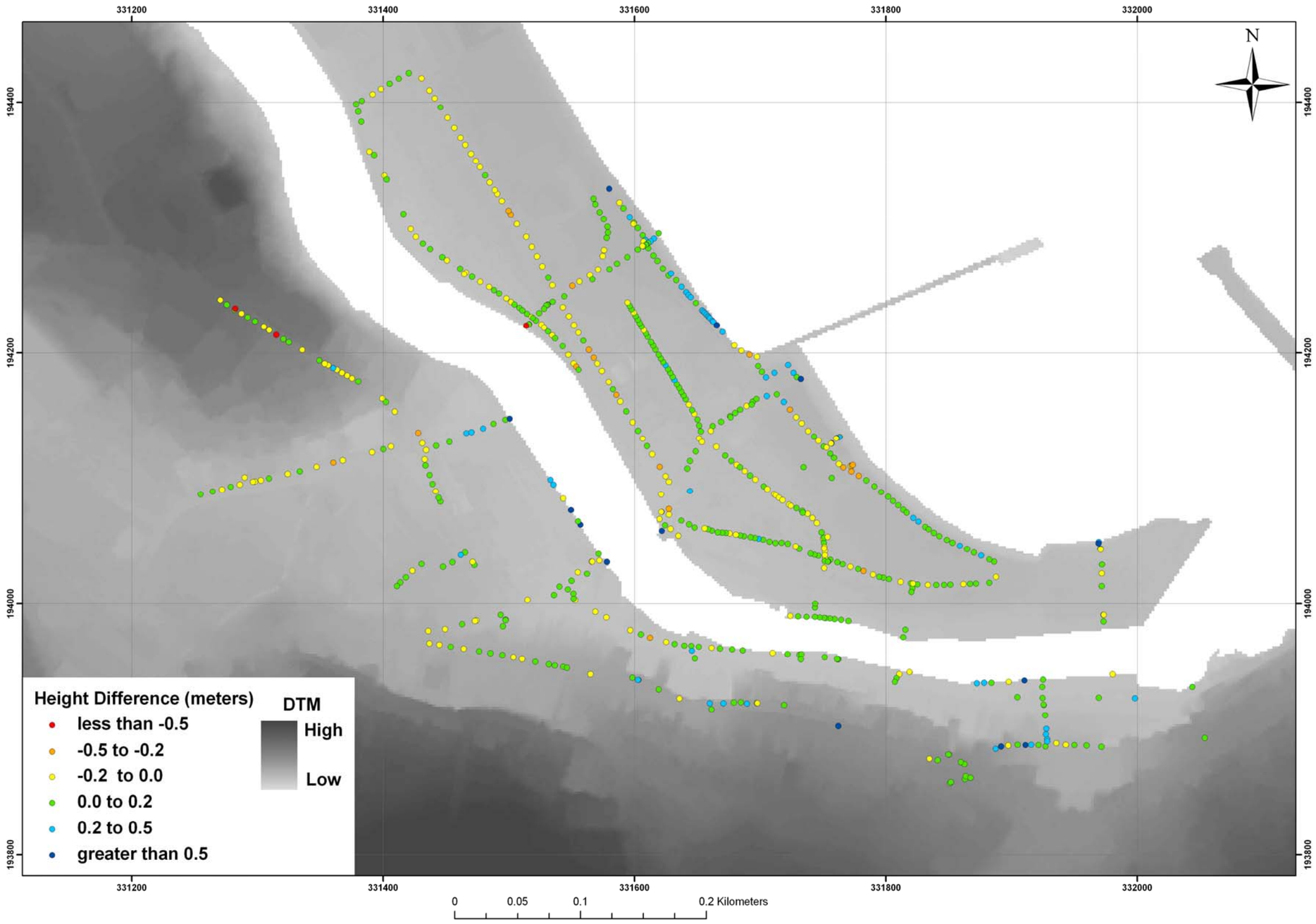


Figure 14: Comparison of DTM and Survey Data - Wicklow

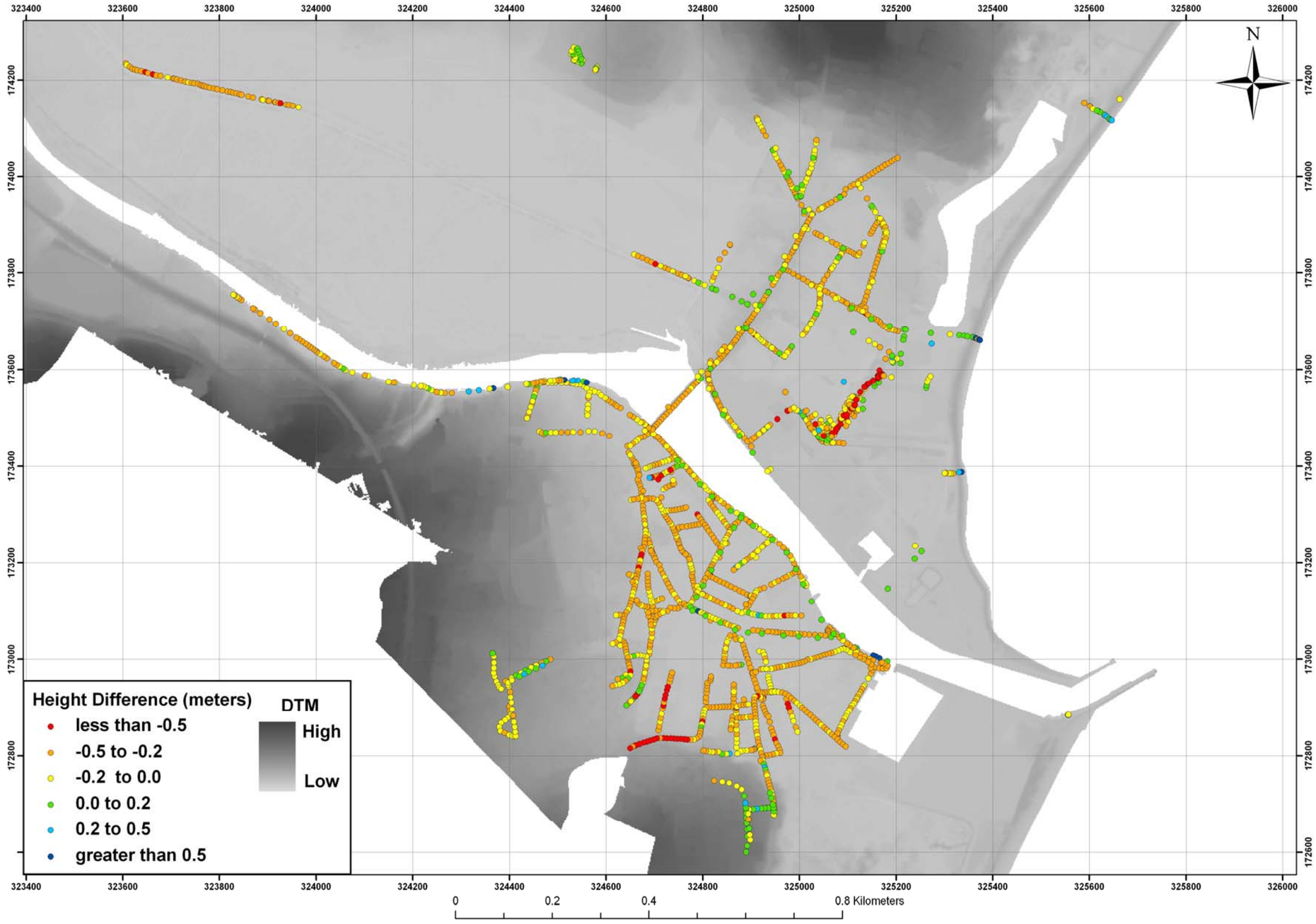


Figure 15: Comparison of DTM and Survey Data - Arklow

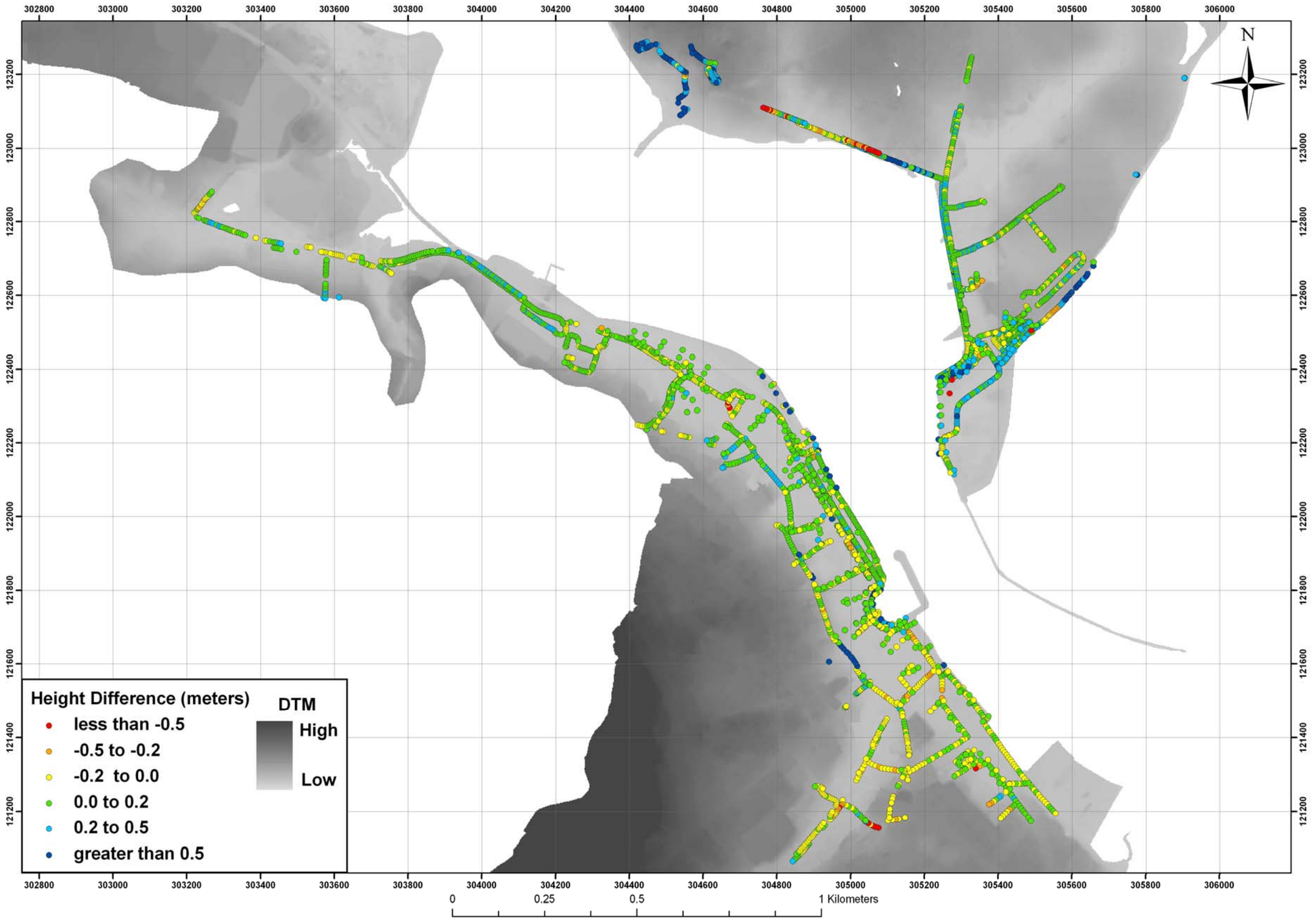


Figure 16: Comparison of DTM and Survey Data - Wexford

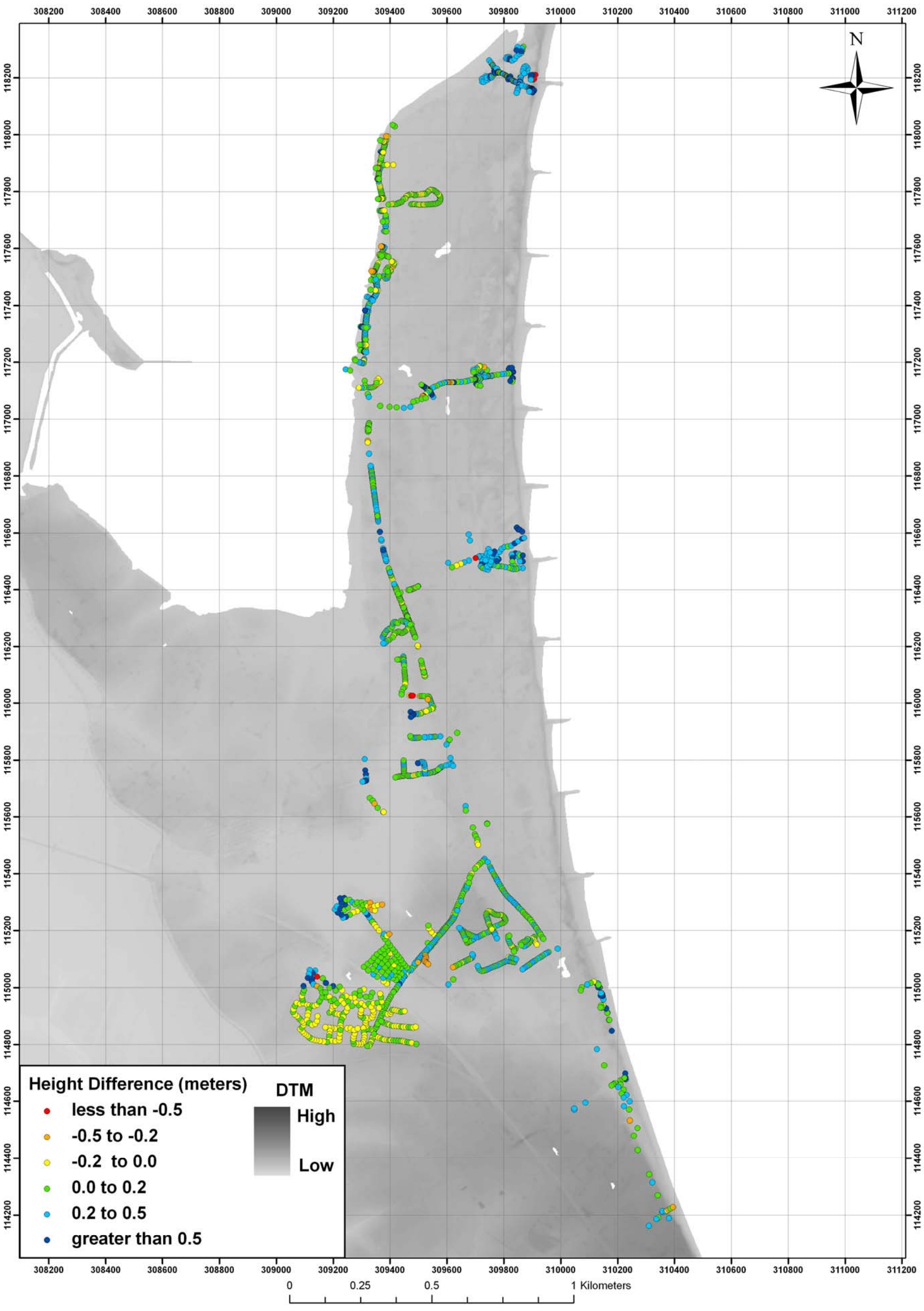


Figure 17: Comparison of DTM and Survey Data - Rosslare

APPENDIX 6B : Figures 18 to 27

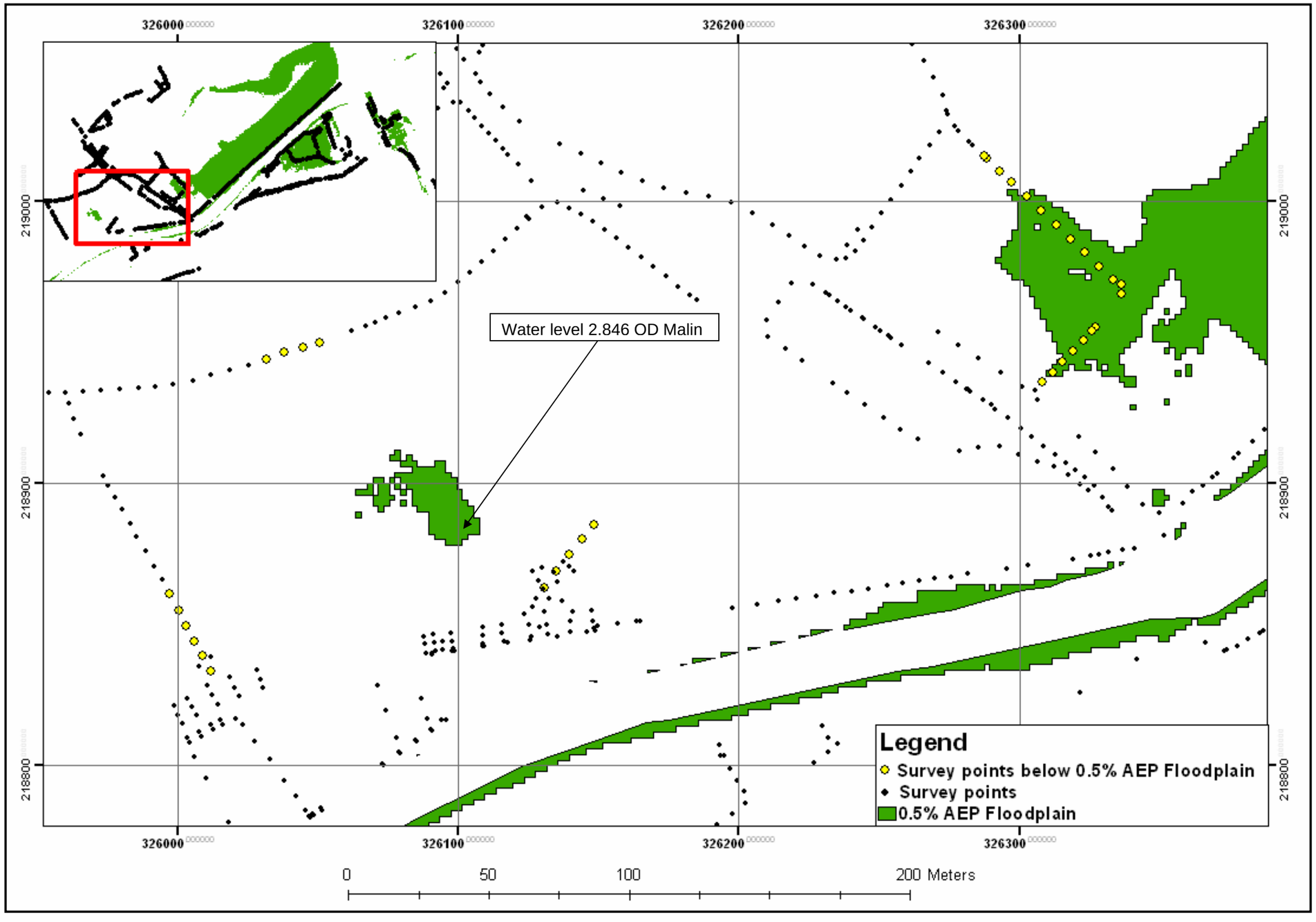


Figure 18: Comparison of 0.5% AEP Floodplain and Survey Data – Bray sub-area

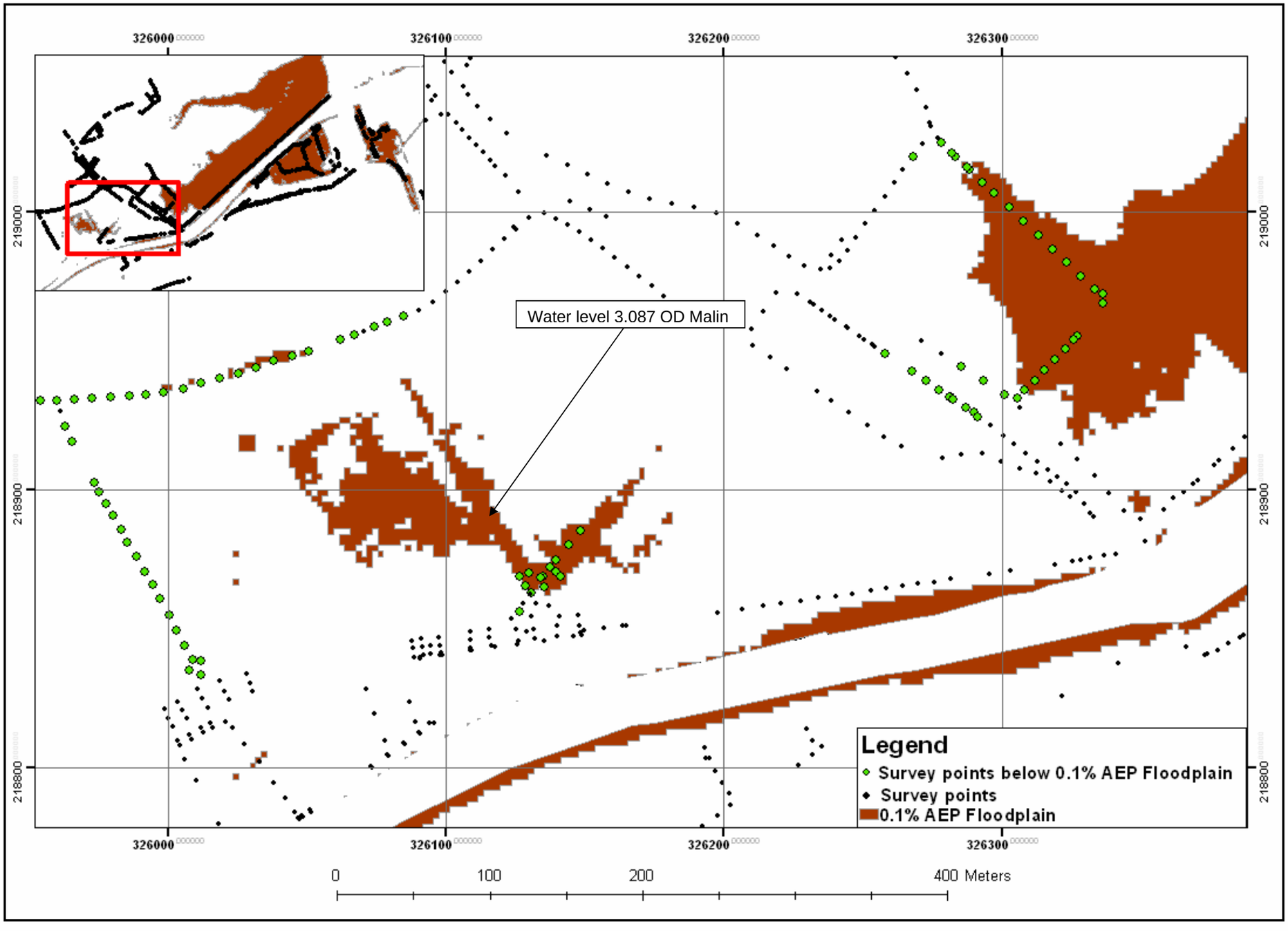


Figure 19: Comparison of 0.1% AEP Floodplain and Survey Data – Bray sub-area

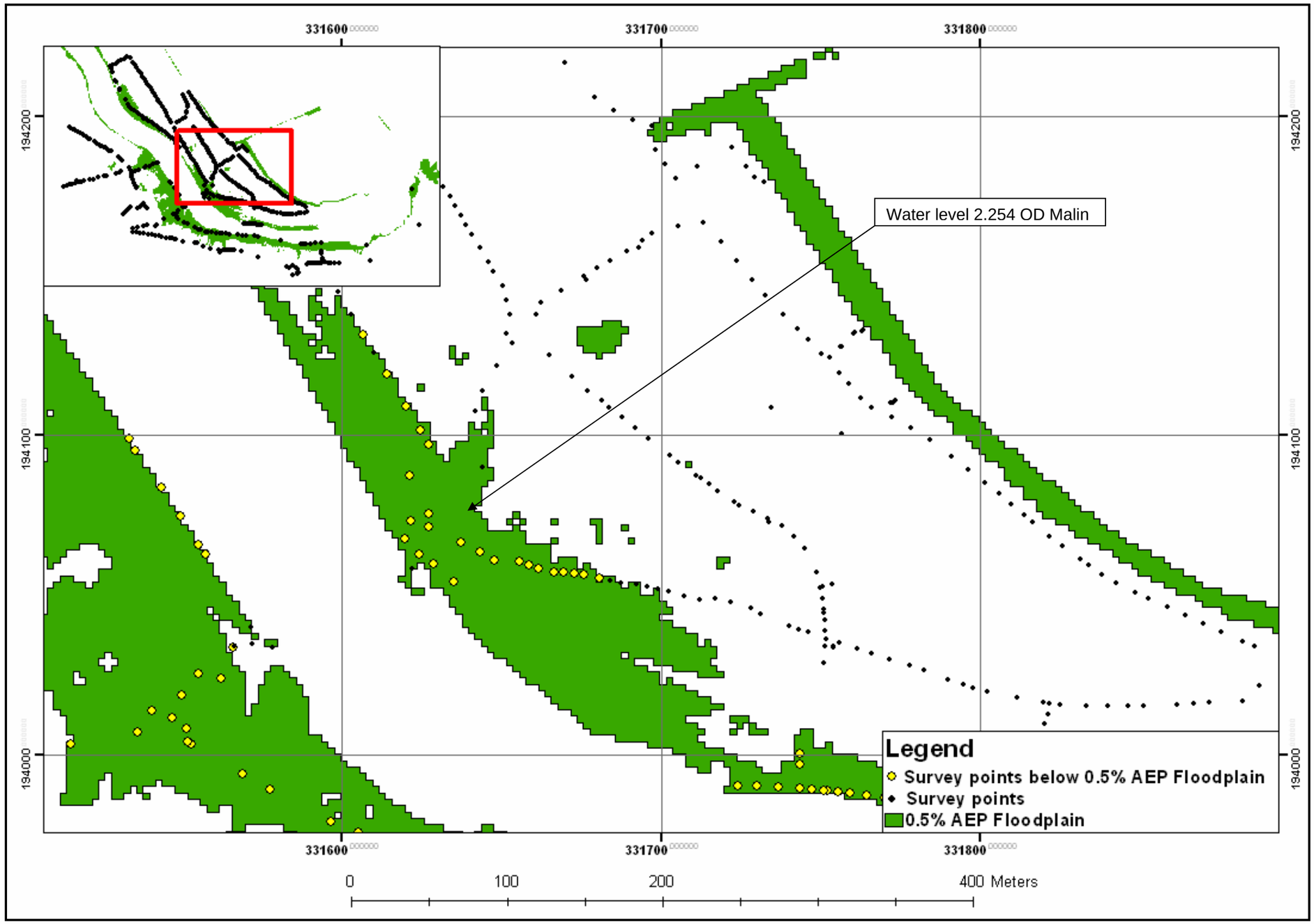


Figure 20: Comparison of 0.5% AEP Floodplain and Survey Data – Wicklow sub-area

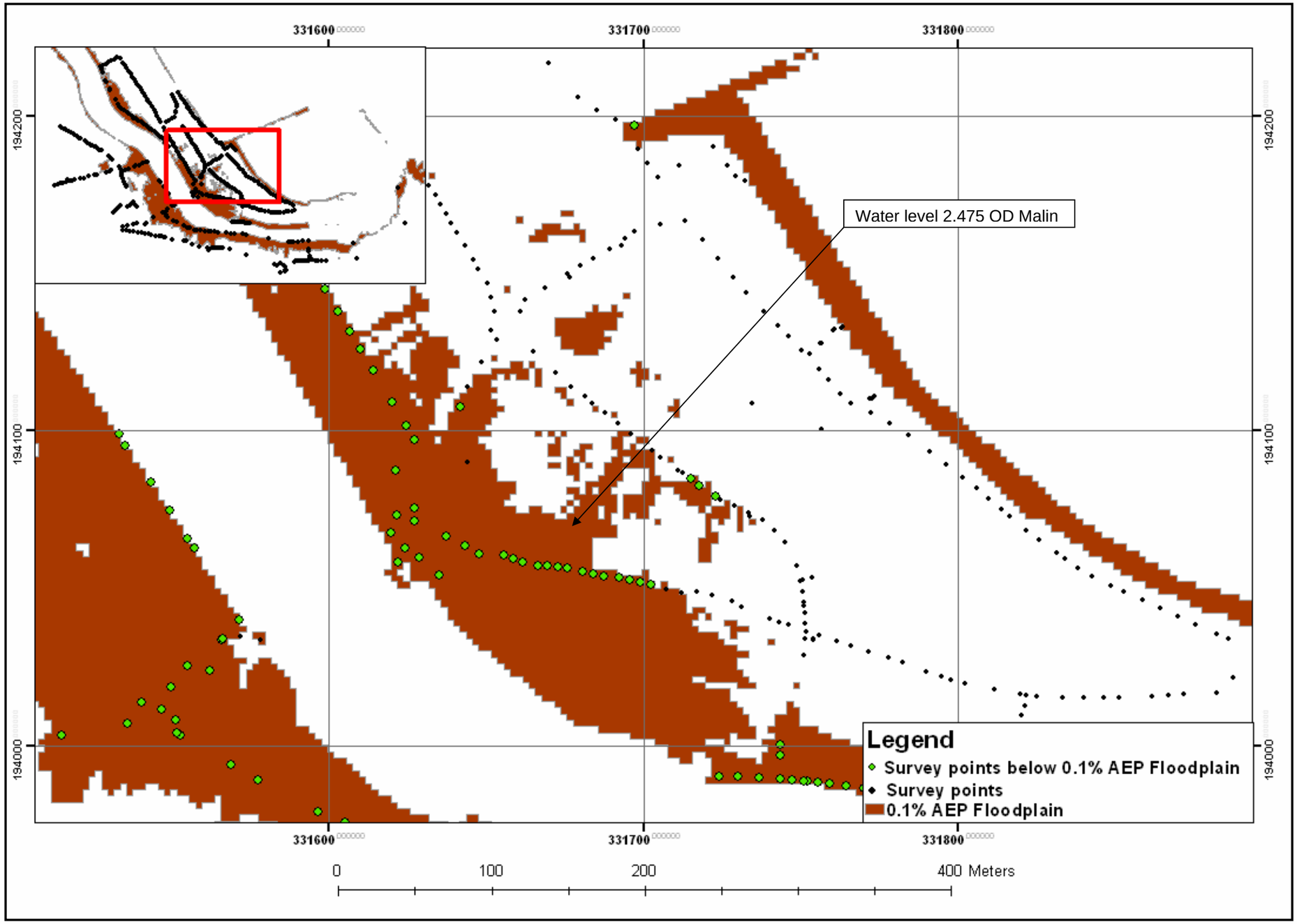


Figure 21: Comparison of 0.1% AEP Floodplain and Survey Data – Wicklow sub-area

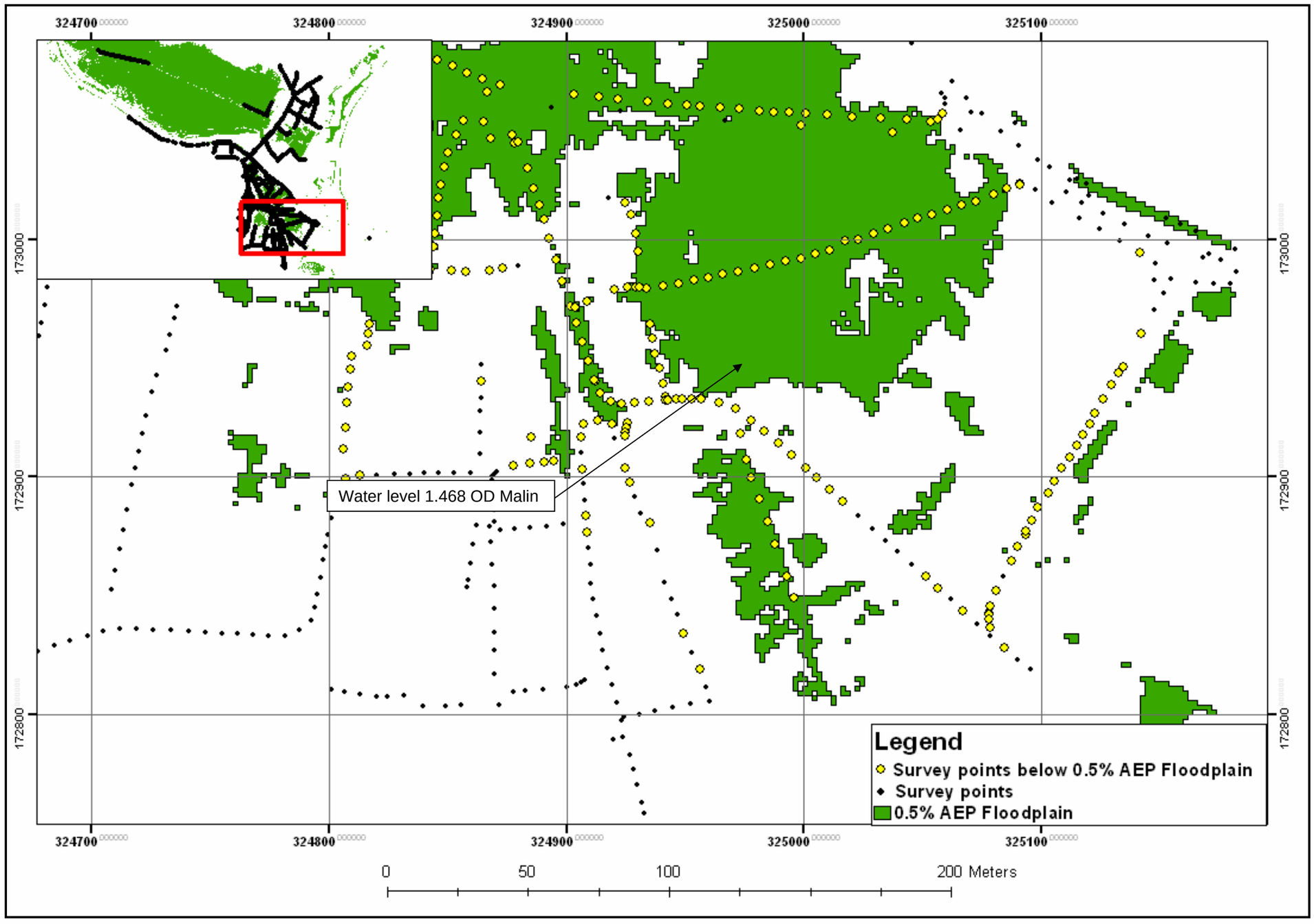


Figure 22: Comparison of 0.5% AEP Floodplain and Survey Data – Arklow sub-area

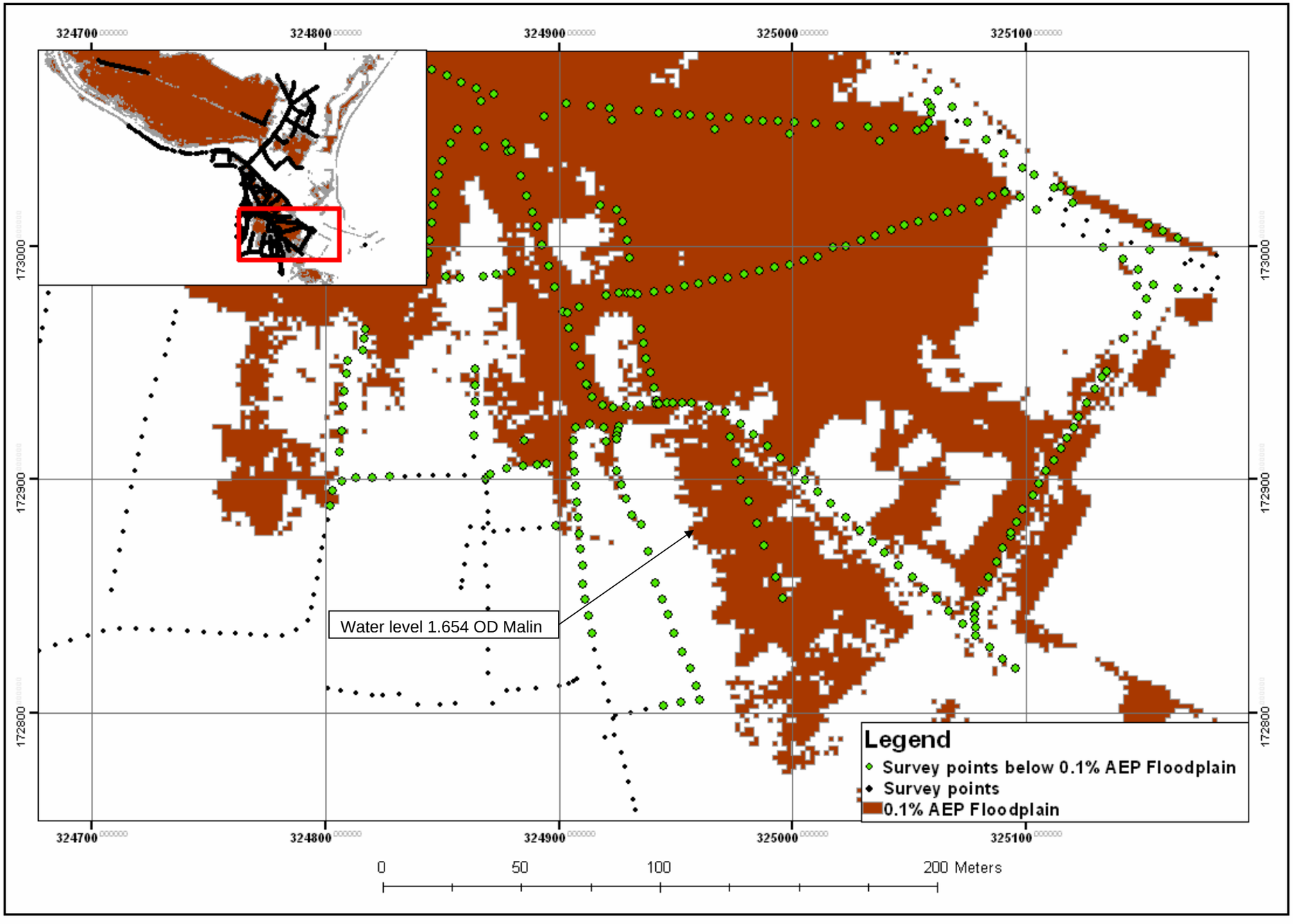


Figure 23: Comparison of 0.1% AEP Floodplain and Survey Data – Arklow sub-area

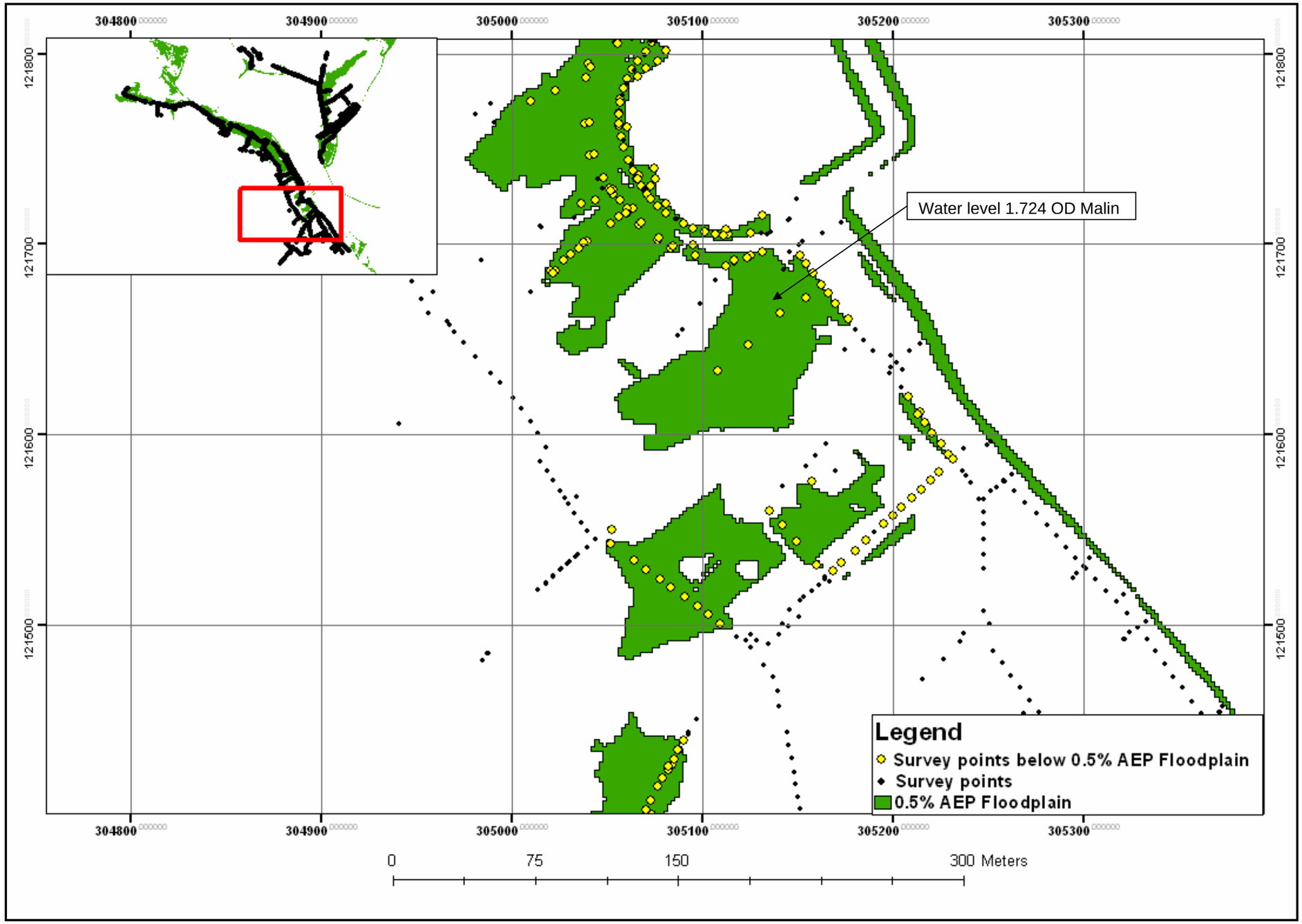


Figure 24: Comparison of 0.5% AEP Floodplain and Survey Data – Wexford sub-area

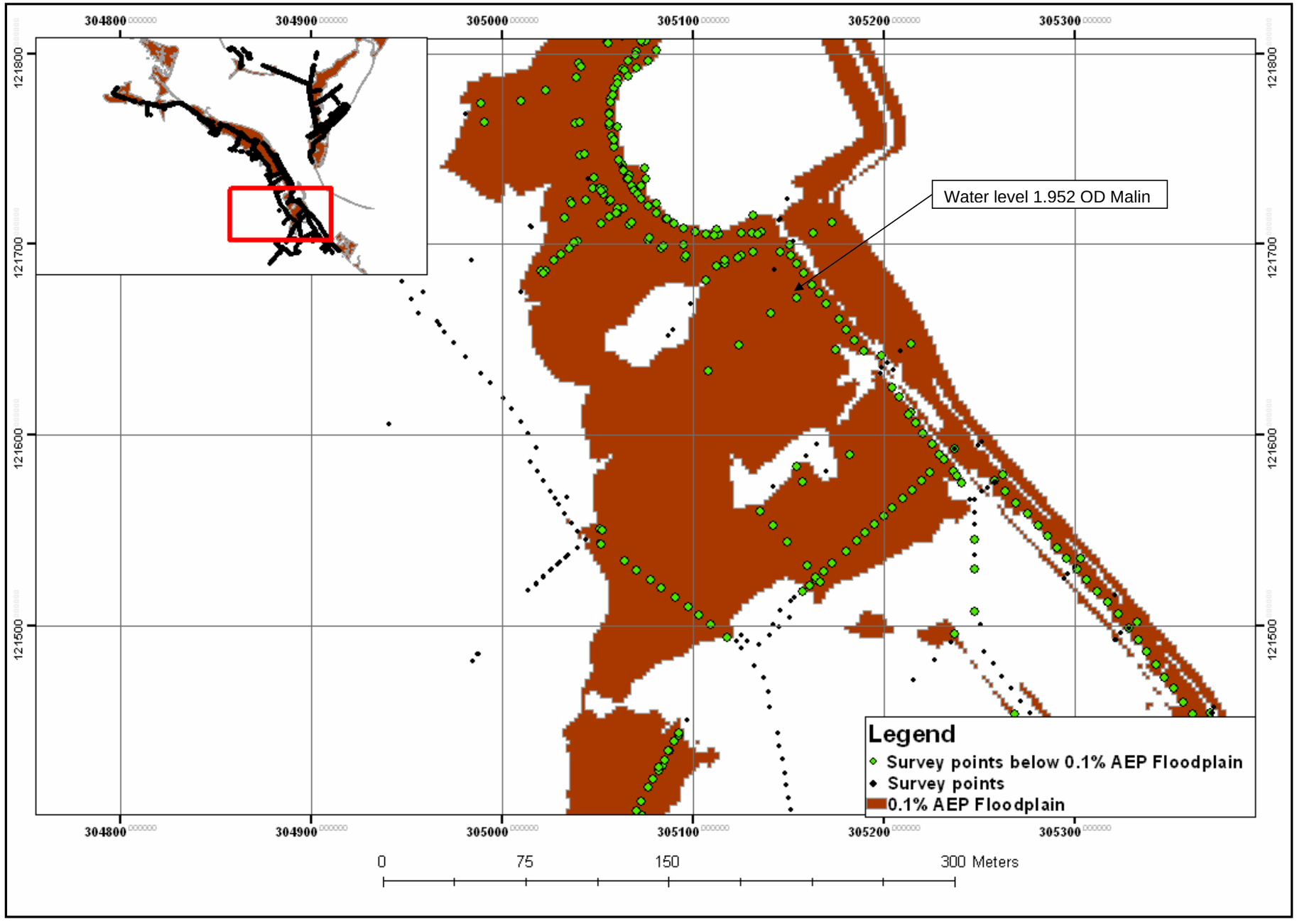


Figure 25: Comparison of 0.1% AEP Floodplain and Survey Data – Wexford sub-area

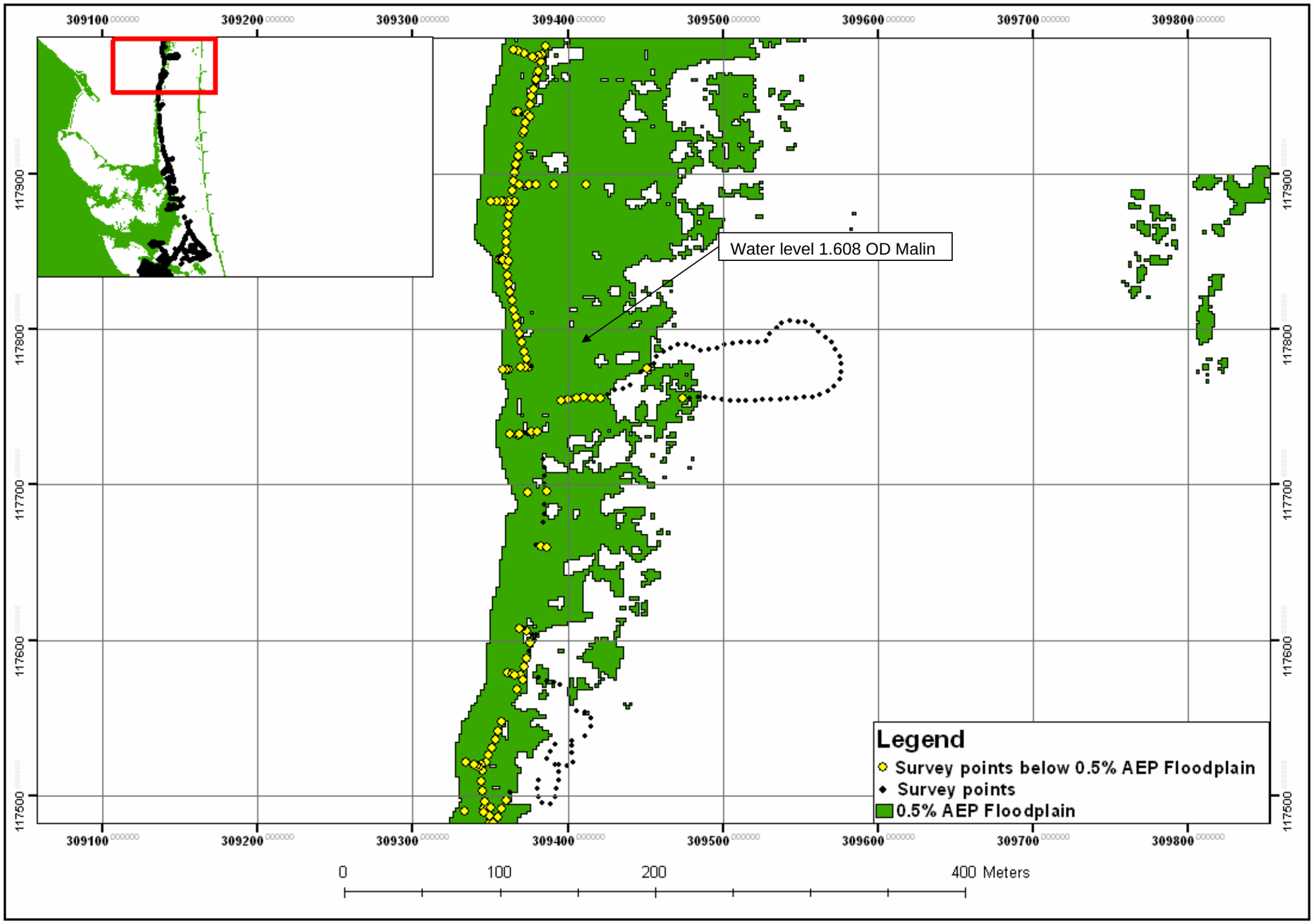


Figure 26: Comparison of 0.5% AEP Floodplain and Survey Data – Rosslare sub-area

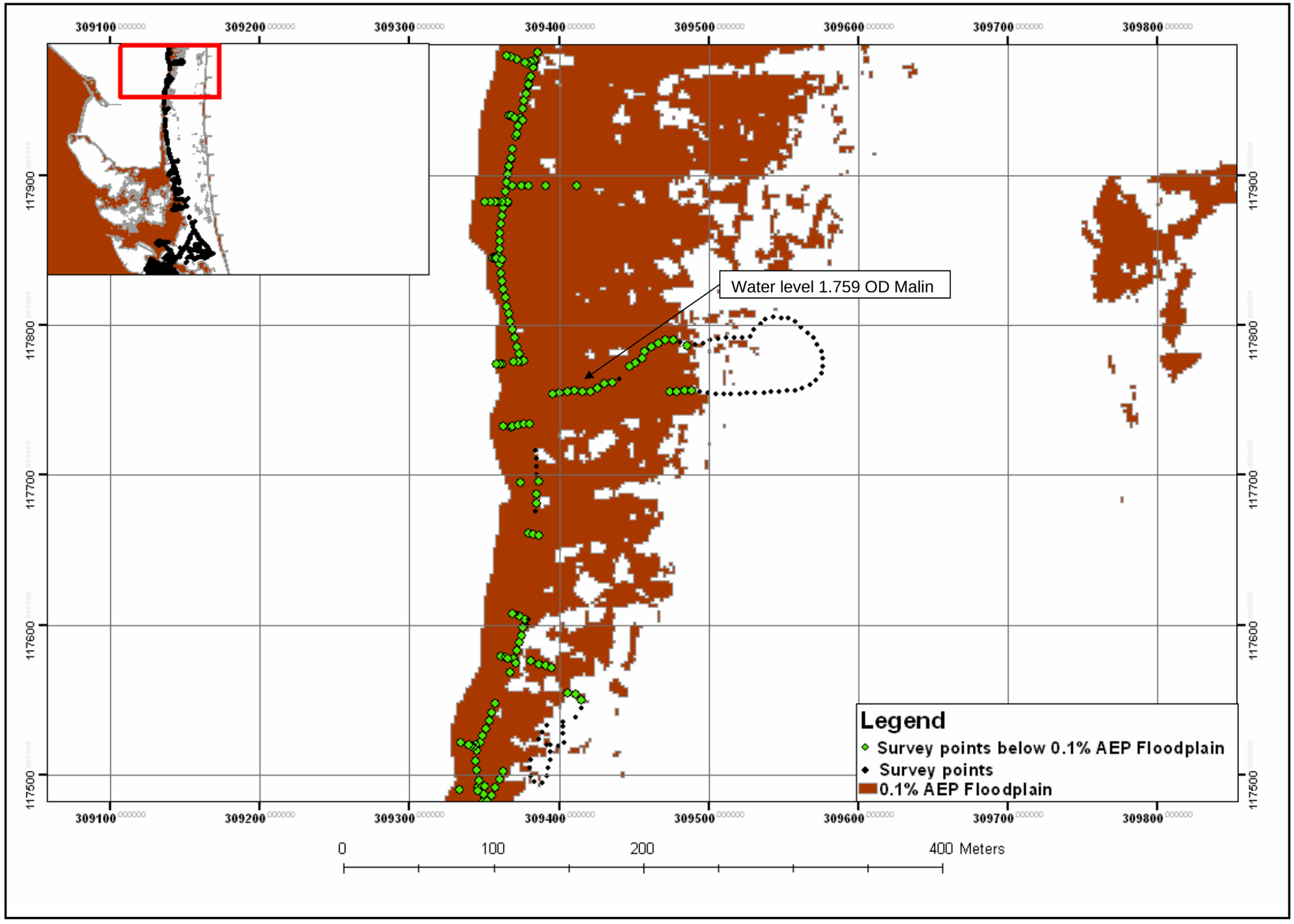


Figure 27: Comparison of 0.1% AEP Floodplain and Survey Data – Rosslare sub-area

Appendix 7: Floodplain maps including flood extent maps for 0.1% and 0.5% AEP events, and flood depth maps for 0.5% AEP event (issued under separate cover)

Appendix 8: Erosion Maps for 2030 and 2050 (issued under separate cover)

Appendix 9: Confidence in Flood Extents and Erosion Lines

Appendix 9a: Confidence in Flood Extents

IRISH COASTAL PROTECTION STRATEGY STUDY – ANALYSIS OF CONFIDENCE IN FLOOD EXTENTS

1.0 Introduction

A fundamental issue in the delivery of the final flood extents as part of the Irish Coastal Protection Strategy Study was the level of confidence which they could be assigned. Data used in the production of any flood extents is rarely of consistent accuracy and may vary depending on location. Therefore a measure of confidence was required to reflect the reliability of the input data, together with any discrepancies in the methodology of determining the flood extents.

Consequently RPS developed a quantitative methodology for determining the level of confidence in the flood extents, based on a scoring and weighting system, and the establishment of five confidence classifications based on various parameters in the flood extent determination.

This report describes the methodology used and the outcome of the flooding confidence analysis for the south east coast study area.

2.0 General Methodology

The methodology adopted was based on the scoring and weighting of various parameters which influenced the position of the flood extents, and it established the level of confidence to be assigned to these flood extents; from very high, high or medium confidence to low or very low confidence. The parameters analysed are listed below.

- DTM Accuracy of the Digital Terrain Model (DTM)
- MALIN Accuracy of the conversion from Mean Sea Level (MSL) to Ordnance Datum (OD) Malin
- MODEL Accuracy and level of detail of the model
- MET Accuracy and quantity of meteorological data

A matrix was established using the above parameters, which were assigned a confidence rating, from 1 (complete confidence) to 10 (no confidence) at intervals along the study coastline. This range was large to allow a reasonable scale for future updates of these values. The individual confidence ratings were then squared and multiplied by a weighting, depending on the potential size of error in the flood extents, due to each parameter. To compute the final score, the root sum of the squares of the component confidence ratings times the weightings were calculated and expressed as a percentage of the potential score range. This was equivalent to applying the Gaussian equation generally used for error analysis. The matrix was then used to determine the overall confidence (very high, high, medium, low or very low) of the flood extents for the particular segment of coast.

The Confidence SumTotal was given by;

$$\sqrt{W_1 C_{DTM}^2 + W_2 C_{Malin}^2 + W_3 C_{Model}^2 + W_4 C_{Met}^2}$$

Where $W_{1\text{-}4}$ represented the relevant weighting and the C values represented the confidence factors.

This simplified approach ignored interdependencies between the confidence components and the fact that these confidences may have related to over or under estimation of the flood levels, where the net effect was reduced or null. It also assumed that the individual confidence ratings were approximately normally distributed about the mean and it tended to highlight the least confident parameter.

It was noted that a feature of methods with multiple confidence sources is that the user tends to under-estimate the confidence, as there is a tendency to always assign some uncertainty to each category. For this reason, the default values were ascribed to give medium confidence (~50%) providing scope for movement in either direction.

2.1 Accuracy of the DTM

As the DTM was established for the purpose of a strategic study, the level of detail may have not been as high as that of a more localised or detailed study and this was considered when assigning confidence ratings. The detail of the DTM also varied from location to location along the coastline, and was generally more detailed in those urban areas where medium and high resolution LiDAR data was captured, compared to other areas where low resolution LiDAR or stereo photogrammetry data was captured. For example, the 2001 Infoterra DTM was less detailed in terms of points per square metre than the 2005 Arklow 'Flimap' survey which was of a much higher resolution.

The accuracy of the DTM was thus considered in terms of the mean height difference and the average of the 95% Confidence limits, where height difference referred to the difference between the DTM and the Quality Control Survey for each stretch of coastline.

2.2 Mean Sea Level to OD Malin Conversion

The Mean Sea Level (MSL) to OD Malin conversion model used in this study to help define the flood extents has been improved in recent years, but remained another factor affecting the level of confidence in the flood extents. Future modelling of the coastline may use an enhanced MSL to OD Malin conversion model, and so, as a necessity, the methodology and scale was developed to take account of this and allow room for improvement.

2.3 Accuracy and Level of Detail of the Model

Model accuracy and detail depended on factors such as cell size, time step and the internal stability of the model. Ideally, all these factors would have been represented in the confidence analysis; however cell size and time step should actually vary depending on the requirements of the model and on the features within it. For example, model output from an open coastline with a cell size of 20-50 metres, would not yield any more accurate results compared to a grid size of 200 metres. However, the modelling of a tidal inlet quite often necessitates cell sizes of 20-50 metres for sufficient accuracy. Even with a highly detailed model, if the bathymetry data is not available at sufficient resolution to compliment the cell size, no more accurate results can be obtained, compared to a model of less detail. Determination of cell size therefore depended upon judgement of the modeller setting up the simulations and was difficult to quantify.

For this strategic study, the correlation of model data with relevant tide gauge data was considered to better represent the accuracy of the model outcome.

The confidence in the model was taken from four factors;

- the distance between the water level points extracted from the model and the location under analysis,
- the general type of coastline under consideration, for example, open coastline or narrow sea loughs
- the confidence limits of the statistical analysis achieved on output of the model results and
- the correlation of the model results with tide gauge data.

While the first three factors were considered independent, model calibration and hence ‘tuning’ of the model depended on the level of accuracy of the gauging data used for comparison. The gauges used were located at different sites, where shallow water effects may have been dominant, which might not have been picked up by the methodology used for calibration. Furthermore, tide gauges on tidal river sections may have been influenced by river flow, thus affecting the harmonic analysis and the resulting astronomic tide. These influences along with factors such as damaged gauges, systematic errors and length of gauge data available were taken into account for the model calibration parameter.

2.4 Accuracy of Meteorological Data

The computational modelling of water levels required both meteorological and tidal records over as long a time period as possible. The simulations for this study were run on a hindcasting basis, using historical recorded atmospheric pressure and wind data generated from the European Centre for Medium-Range Weather Forecasts (ECMWF). The meteorological records used dated from the 1950's to present and have increased in accuracy over time as the meteorological models have been improved. The grid spacing of the ECMWF models has improved, with a resolution of 1.125° used between 1957 and 1991, 0.5° between 1991 and 2007, and 0.25° post 2007. The ECMWF models are also modified and improved frequently. Therefore the more events used from recent years, the more confident we can be in the meteorological data, meaning that future modelling of the coastline has more potential for high confidence, with an increase in the number of recent events. However, it should be noted that this can only apply when a reasonable spread of data has been taken, over a significant number of years. For example, a dataset hosting only results from recent years would not give a true representation of extreme storm surge events over a 50 year period. From a statistical point of view, it is better to have as many events as possible, spread over the analysis period. Otherwise, it would have to be assumed that a trend exists, which would limit the validity of the statistical analysis.

In the initial stages of producing the confidence methodology for the flood outlines, a factor named 'Event Dependency' was used, referring to the proportion of events used in more recent years gaining higher confidence ratings. However, upon further consideration a decision was made to remove this factor, as it was a misleading and inaccurate representation of MET confidence. Although the events used in recent years may have had a higher accuracy of meteorological data, in order for the statistical analysis to be reliable, a reasonable spread of events was mandatory. Therefore the proportion of recent events should be similar for all coastlines.

The selection of the storm surge events which were used to produce the water levels for the flood extents, was directly related to the reliability of historic tide gauge data. While the quality of the recorded data was of lesser importance, it was vital that the records did not omit any significant events. Even if the records had gaps and thus a large event had not been recorded or archived for a particular tide gauge location, then provided there were sufficient other tide gauges covering the section of coast, it should have been possible to identify the event. Therefore, the accuracy of the water level predictions from the tide gauges depended more on the number of storm surge events used to compute the water levels. Accuracy was also increased by having more historic records of storm surges available for assessing which periods to simulate for each stretch of coastline.

Consequently two factors were used to establish the overall confidence in the meteorological data; the number of years of tide gauge data available and the number of events used.

3.0 Confidence Analysis Results

To present the results of the confidence analysis it was necessary to create a raster grid of confidence ratings for the entire south east coast. This grid utilised a 500m x 500m spacing, and showed the high water mark and a 2000m buffer for geographical reference. Confidence values for DTM, MALIN, MODEL and MET were established using various computations on Microsoft Excel, as described in this Section. The confidence ratings were represented in the grid both manually and through computational interpolation. Each of the parameters are described in the following sub-sections.

3.1 Accuracy of the DTM

The confidence analysis of the DTM was based on the accuracy assessment of the DTM undertaken as part of this study (refer Quality Control Survey Report, Appendix 6). The south east coast accuracy was assessed through two different surveys by OPW and RDS Ltd. It was decided to combine the ground control points from the two surveys into one complete dataset, from which a series of accuracy statistics could be derived.

The accuracy of the DTM was considered in terms of the mean height difference and the average of the 95% confidence limits, where height difference referred to the difference between the DTM and the Quality Control Survey points for each stretch of coastline. The average of the 95% confidence limits was derived by ignoring the negative value for the lower limit, and assuming both limits to be positive. It was further assumed that the number of Quality Control Survey points was chosen, to provide a representative sample in the context of statistics and that the survey itself was of the highest possible accuracy, as otherwise this comparison would have become meaningless.

The accuracy statistics for all surveyed areas are shown in Table 1. The mean height differences ranged from -0.197m at Wexford Harbour to 0.180m at Arklow. Castlebridge had the lowest average 95% confidence limit of 0.204m, with Wexford Harbour having had the highest at 0.888m.

Table 1: Accuracy Statistics for Areas on South East Coast

South East Locations	Mean Height Difference (m)	Lower 95% Confidence Limits (m)	Upper 95% Confidence Limits (m)	Average 95% Confidence Limits (m)
Arklow	0.180	-0.214	0.582	0.398
Bray	0.167	-0.276	0.504	0.390
Breaches	-0.027	-0.891	0.296	0.593
Brittas Bay	0.058	-0.266	0.743	0.505
Castlebridge	-0.048	-0.264	0.144	0.204
Courtown	0.060	-0.235	0.356	0.295
Curracloe	-0.073	-0.280	0.278	0.279
Rosslare	-0.173	-0.882	0.210	0.546
Wexford	-0.090	-0.728	0.241	0.485
Wexford Harbour	-0.197	-1.074	0.703	0.888
Wicklow	-0.058	-0.488	0.228	0.358

A rating system was established for both statistical parameters, as shown in Table 2. A rating of 1 was awarded for a mean height difference between 0 and 0.02m, with a rating of 10 for difference values over 0.25m. The average 95% confidence limit ranged from 0 to 0.1m for a rating of 1, to over 0.9m for a rating of 10. These ratings were assigned for mean height difference and average 95% confidence limits for the different areas listed in Table 1. Both parameters were considered to be of equal weighting, hence were averaged to produce the final rating for each area, as shown in Table 3. For example, Bray had a mean height difference of 0.167m and an average 95% confidence limit of 0.390m, which corresponded to ratings of 8 and 4 respectively. The average of these two ratings was 6, which produced a final confidence rating of 6 for the Bray DTM, as shown in Table 3. The values were added to the relevant areas on the raster grid.

Table 2: Ranges for each Rating for all Statistical Parameters

Rating	Mean Height Difference (+/-)	Average 95% Confidence Limit (+/-)
10	0.25+	0.9+
9	0.19 - 0.25	0.8 - 0.9
8	0.16 - 0.19	0.7 - 0.8
7	0.13 - 0.16	0.6 - 0.7
6	0.10 - 0.13	0.5 - 0.6
5	0.08 - 0.10	0.4 - 0.5
4	0.06 - 0.08	0.3 - 0.4
3	0.04 - 0.06	0.2 - 0.3
2	0.02 - 0.04	0.1 - 0.2
1	0.00 - 0.02	0.0 - 0.1

Table 3: Final Confidence Ratings for all South East Areas

South East Locations	
Arklow	6
Bray	6
Breaches	4
Brittas Bay	5
Castlebridge	3
Courtown	3
Curracloe	4
Rosslare	7
Wexford	5
Wexford Harbour	9
Wicklow	4

3.2 Mean Sea Level to OD Malin Conversion

The Mean Sea Level to OD Malin conversion was originally based on individual points with conversions from UK Hydrographic Office tide tables. This was developed further and for the purpose of this study, the OD Malin Geoid was used for the conversion, as described in Section 6 of the main report. Thus, the Mean Sea Level to OD Malin conversion had improved compared to the initial methodology; however it had not been tested against a sufficient number of tide gauge locations, to get a measure of the accuracy of this conversion. Thus the confidence was considered medium and is expected to improve in the future with more data. Consequently a confidence rating of 5 was applied to the extents of the south east coast on the raster grid.

3.3 Accuracy and Level of Detail of the Model

The confidence in the model was taken from four factors as outlined in Section 2.3 above.

Each of these factors was considered to have equal weighting and are discussed in detail in the following sections.

3.3.1 Distance of flood outline to water level point

The distance between each water level extraction point along the coast was assessed in detail as part of the initial study for the south east coast model analysis. Water levels were extracted from the model and the Extreme Value Analysis (EVA) fitted at specific points. Trials were carried out in order to establish the ideal frequency of the water level points along the coast. It was found that there was very little variation in water level between the points along the open coast, and thus the spacing was selected such that any error in the water levels was significantly lower than the uncertainty in the spatial distribution. Therefore it was assumed, with regard to water level, that the same confidence could be applied to the south east coast between the water level extraction points, when in open water.

As the water level was extrapolated inland the confidence in these water levels changed. It was decided to increment the confidence initially at 500m spacings, increasing thereafter as shown in Figure 1. High confidence was assigned to those cells around the water level extraction points and along the high water mark, denoted by a bold red line. With distance inland, confidence in the water levels decreased non-linearly, as shown in Figure 1. A non-linear manner was chosen in order to facilitate the spreading of confidences over the entire analysis area, with more focus on areas near to the high water mark.

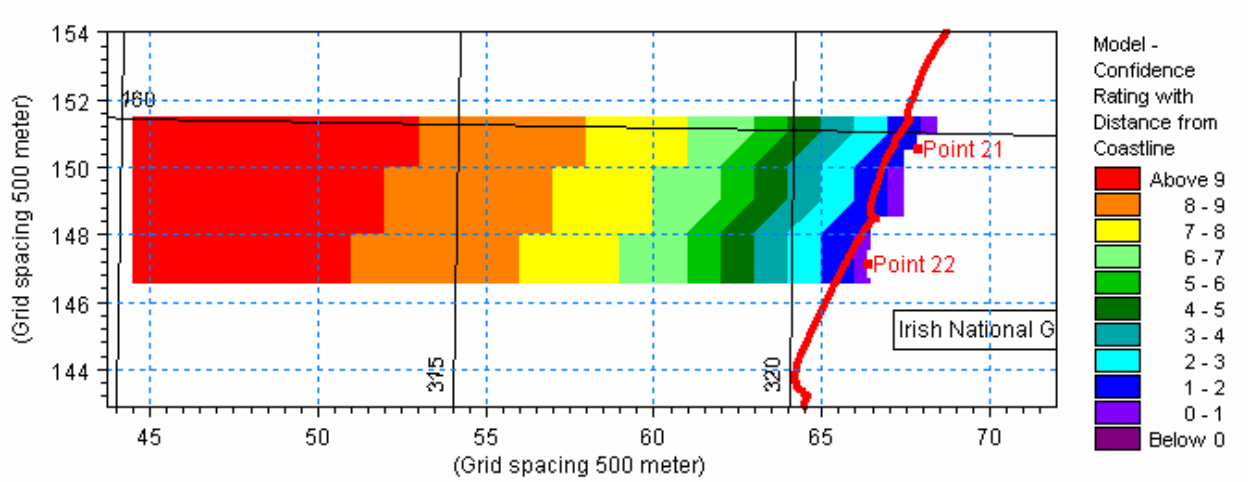


Figure 1: Confidence awarded to cells with distance inland

3.3.2 Type of coastline

A key consideration behind the assessment of the type of coastline for model confidence is that complex coastlines are more likely to be inaccurately represented in a model than simple coastlines, even if the same degree of calibration is used. Where a model features open coastline with a good correlation to a nearby tide gauge, then the water levels along that section of coastline are very likely to be accurate. In contrast, narrow sea loughs and fjords can produce complex resonance effects, which are more difficult to simulate correctly. Furthermore the bathymetry could change with time, thus changing the tidal response of the estuary. Tidal sections of rivers are largely influenced by fluvial flows, local wind effects and changes in bed level, making them one of the least confident stretches of coastline to simulate.

The ratings applied to different types of coastal segments ranged from a rating of 1 for very open coastline, to a rating of 10 for tidal sections of rivers. This is shown in Table 4. The coastline was reviewed and the ratings applied along the high water mark on the raster grid. In this case, the values ranged from 4 to 10, as higher confidence would only be awarded for more open coastlines, such as at the Atlantic Ocean. These ratings on the high water mark were interpolated to produce values for all inland cells.

Table 4: Confidence Ratings for Type of Coastline

Rating	General Type of Coastline
10	Tidal sections of rivers
9	
8	
7	Narrow Sea Loughs
6	
5	
4	Open
3	
2	
1	Very Open e.g. Atlantic

3.3.3 Statistical confidence limits of Extreme Value Analysis (EVA)

The Extreme Value Analysis (EVA) used the Jack-Knife re-sampling method to define statistical confidence limits, as described in Section 5 of the main report. It was decided to use the 1.0% AEP water level standard deviations in order to assess of the accuracy of the model output. In principal, it did not matter which AEP was chosen, as in the Jack-Knife method, the confidence limits are proportional for the various return periods. Confidence ratings depended on the number of events taken, i.e. the number of storm surge events, which was also considered as part of the confidence in the meteorological conditions.

Values could be extracted from the south east coast EVA, to represent the statistical confidence of the water levels for each of the forty south east coast water level extraction points. Each of these forty values were awarded a confidence rating between 1 and 10, where 10 coincided with a 200mm standard deviation or higher and a rating of 1 for 0 to 20mm, as shown in Table 5. These confidence ratings were transcribed to the raster grid, and interpolated to fill in the gaps.

Table 5: Confidence Ratings for Statistical Confidence

Rating	Confidence limits of Output - EVA _ Standard Deviation (1 in 100 year) (mm)
10	200+
9	150-200
8	120-150
7	90-120
6	70-90
5	60-70
4	50-60
3	40-50
2	20-40
1	0-20

3.3.4 Validation of the Model

The fourth parameter for model confidence related to the correlation of the tide gauge data with the model. This correlation was based on a comparison of the high water levels from the model and tidal predictions at a given location over a one month period (two full neap/spring tide cycles). As this method relied heavily on the accuracy of the tidal prediction itself, the gauge data was required to be assessed as well. The confidence in the gauge data was estimated using three factors with varying weightings; namely the location of the gauge, whether any problems had been encountered with the gauge and the length of gauge data used. Five gauges were used in the model calibration for the south east coast. The results for each gauge are shown in Table 6.

Table 6: Confidence Parameters for South East Coast Calibration Gauges

Categories		South East Coast Gauges				
		Rosslare	**Courtown**	**Arklow**	**Wicklow**	**Dublin Port**
1	**Location of Gauge**	Harbour	Pier	Harbour - fluvial influence	Harbour	Port
2	**Severity of Gauge Problems**	Early problems with Siltation - later data fine	Low tides missing	None	Freshwater influence	Seiching
3	**Length of Gauge data (months)**	15	1	14	12	36

Again, each gauge parameter needed to be scaled from 1 to 10. The confidence ranges corresponded to the scale of 1 to 10 for each of the three parameters shown in Table 7. For gauge location, a rating of 1 described perhaps a pelagic location, for example an open island, with a rating of 10 for a river location. A rating of 1 was awarded to a gauge with no recorded problems, whilst a rating of 10 was given to an extremely unreliable gauge. It

should be noted that for the severity of gauge problems, gauges were rated according to the type of problems encountered. For example, a problem with a datum was considered not as severe as a siltation problem. Gaps in the dataset were also undesirable. For length of gauge data, 61 months or over was awarded a rating of 1, with a rating of 10 given to a gauge with only 0 to 1 month of data, or a gauge derived from information from the UK Tide Tables.

Table 7: Ratings for Gauge Parameters

Rating	Location of Gauge	Severity of problems with gauge	Length of Gauge Data (Months)
10	D - River	Extremely Unreliable	Tide Tables or 0-1 month
9		Unreliable	2-4 months
8		Poor	5-8 months
7	C - harbour/port - other influences	Below Satisfaction	9-12 months
6		Satisfactory	13-16 months
5		Good	17-20 months
4	B - open harbour/port	Very Good	21-30 months
3		Extremely Good	31-40 months
2		Excellent	41-60 months
1	A - Pelagic, open, e.g. Island	Perfect - No recorded problems	61+ months

A confidence rating was established for each of the five gauges individually, by applying the relevant weightings, as shown in Table 8. A weighting of 1 was used for gauge location and gauge problems, and a weighting of 2 for the length of available gauge data, as this was considered to potentially give rise to greater error in the flood extents. Table 8 also provides an example of how the final confidence rating was established for the Rosslare gauge. Each of the confidence ratings were multiplied by their corresponding weighting. The sum total of these three numbers was divided by four (which represented the total of the three weightings), in order to produce one single value for confidence in the Rosslare gauge. Similarly, the confidence ratings for the other four gauges were computed and are shown in Table 9. The Dublin gauge was awarded the most confident rating of 4.00, with the Courtown gauge being noted as the least confident with a rating of 7.50.

Table 8: Weightings of Confidence Parameters for Validation of Model

	Rosslare			
	Weighting	Rating	Weighted*Rating	Confidence
Location of Gauges	1	5	5	6.5
Severity of problems with gauges	1	7	7	
Length of Gauge Data (Months)	2	7	14	

Table 9: Confidence Ratings for Gauge Parameters

South East				
Arklow	Rosslare	Courtown	Wicklow	Dublin Port
6.25	6.50	7.50	5.50	4.00

On completion of the determination of the reliability of the tide gauge data, it was necessary to assess the correlation of this gauge data with the actual model data. This was achieved through the computation of a correlation coefficient for each gauge, established from the high waters of each data set. The correlation coefficients for each gauge on the south east coast are shown in Table 10.

Table 10: Correlation Coefficients for South East Coast

South East	Arklow	Rosslare	Courtown	Wicklow	Dublin
Correlation Coefficient	0.936	0.970	0.914	0.979	0.993

The ratings applied to each gauge for model correlation are shown in Table 11. These correlation coefficients only described the goodness of fit between the predicted and simulated data sets, but for the overall model calibration, the ratings needed to be taken in conjunction with the accuracy of the gauge data itself. Thus the two ratings for each gauge were multiplied, and the square root taken, in order to produce the final combined confidence ratings for model calibration, as shown in Table 12. For example, a gauge rating of 6.5 for Rosslare was established as described above, and multiplied by a correlation rating of 6, from Table 11. The square root was taken to produce a rounded value of 6, which is the overall confidence rating for model calibration in Table 12. The overall confidence ratings were then applied to the south east coast grid at the relevant locations.

Table 11: Confidence ratings for Model Correlation with Tide Gauge Data

Correlation between predicted and model high waters	Rating	Arklow	Rosslare	Courtown	Wicklow	Dublin
<0.9	10					
0.900-0.940	9	9		9		
0.940-0.960	8					
0.960-0.970	7					
0.970-0.976	6		6			
0.976-0.981	5				5	
0.981-0.985	4					
0.985-0.988	3					
0.988-0.990	2					
0.990+	1					1

Table 12: Overall Confidence Ratings for Model Calibration

Arklow	Rosslare	Courtown	Wicklow	Dublin
8	6	8	5	2

3.3.5 Overall Model Ratings

Each of the four overall model parameters was considered to be of equal weighting, and thus they were averaged, in order to compute a total model confidence for each cell.

3.4 Accuracy of the Meteorological Data

Two factors were used to establish the overall confidence in the meteorological data;

- the number of events simulated, and
- the number of years of tide gauge data available.

To gain an understanding of the number of events simulated, the south east coast was considered in conjunction with the north east and south coasts, for the purpose of this study. The number of events simulated for each coastline was recorded in Table 13. A total of 55 events were simulated for the south east coast, with 79 and 76 events being simulated for the north east and south coasts respectively.

Table 13: Number of Events used in Model Simulations

Number of events used	SE	NE	S
Total	55	79	76

A confidence rating was applied to the south east coast, according to the scale in Table 14, with a value of 5 representing the 55 events simulated.

Table 14: Confidence Ratings for Number of Events Simulated

Number of events used	Rating	SE
0-10	10	
10-20	9	
20-30	8	
30-40	7	
40-50	6	
50-60	5	5
60-70	4	
70-80	3	
80-110	2	
110-150	1	

This study was limited to 50 years of gauge data or less, due to limits on the available meteorological data. Ideally, 50 years of data from two separate tide gauges would have been used, or a combination of more tide gauges spread along the coast, in order to cover the required years of simulation and coastline. Therefore 100 years of tidal data would have been required from each coastline to achieve high confidence with respect to the gauge data. The available tide gauge data from Fishguard and Dublin, used for the south east coast is shown in Table 15. The maximum number of years required from one gauge, or a combination of gauges was fifty years, hence the final row in the table was produced (51 was capped to 50). The values of 43 and 50 for Fishguard and Dublin respectively were added to give a final value of 93, which was used to establish a rating of 3 for the south east coast, as shown in Table 16.

Table 15: Gauge Data available for South East Coast

	South East		
Name of Gauge	Fishguard	Dublin	**Total**
Length of data (years)	43	51	-
Length of data - max 50years	43	50	**93**

Table 16: Confidence Ratings for Number of Years of Gauge Data

Number of Years of Gauge Data	Rating	SE
<40	10	
40-50	9	
50-60	8	
60-70	7	
70-80	6	
80-85	5	
85-90	4	
90-95	3	3
95-100	2	
100+	1	

An overall individual confidence rating for the south east coast was established by averaging the ratings from the two MET factors; 5 for the number of events simulated and 3 for the available gauge data. This average value of 4 is shown in Table 17 and was applied to the raster grid, over the entire south east coast area.

Table 17: Weightings for Number of Events Used and Gauge Data, along with Final Ratings for Meteorological Data

	Weighting	SE	NE	S
Number of events	1	5	3	3
Gauge Data	1	3	1	4
Average		**4**	**2**	**4**

4.0 Results of Combined Confidence

With all four confidence parameter ratings transcribed to the raster grid, under individual items, the combined confidence for the entire south east coast was established. Weightings were assigned to each of the confidence parameters; 5 for DTM, 1 for Malin, 4 for Model and 3 for Met, as shown in Table 18. These weightings were assigned depending on the potential size of error the flood extents could be subject to, due to each parameter. Consideration was given to these weightings, and various analyses carried out to determine the optimum weightings, relative to each other and on a broad scale.

Table 18: Weightings assigned to individual confidence parameters

Confidence Divisions		Weighting
W1	DTM	5
W2	Malin	1
W3	Model	4
W4	Met	3

The final confidence value for each of the cells in the raster grid was calculated using the following formula:

$$\sqrt{W_1 C_{DTM}^2 + W_2 C_{Malin}^2 + W_3 C_{Model}^2 + W_4 C_{Met}^2}$$

Potential scores from the formula ranged from 3.606 (using all 1 ratings) to 36.056 (using all 10 ratings). These were shifted to produce high confidence for a value of 0 and low confidence for a value of 32.45. The uncertainty values for each cell were then expressed as a percentage of the range (32.45) and subtracted from 100 percent to produce the confidence score.

Confidence scores ranged for example from circa 55% to 61% in Bray, 47% to 56% in Wexford and 46% to 55% in Rosslare. Figure 2, Figure 3 and Figure 4 show a representation of the final confidence percentages for Bray, Rosslare and Wexford respectively.

It was decided to classify the final scores into five groups in terms of very high, high, medium, low and very low confidence. These confidence ratings are shown in Table 19. For example, flood extents in the Bray area were considered as having high or medium confidence, with both Rosslare and Wexford having both low and medium confidence. The final flood extents with assigned confidences for the entire south east coast are shown in Appendix 7 of this report. Most of the flood extents were classified as having high or medium confidence, with a number of areas showing low confidence. Very few areas were assigned very low confidence, but those that were are located mostly around Wexford Harbour. It should be noted that very low confidence was assigned to any flood extents which coincided with the landward limit or boundary of the DTM as it was not possible to identify the location of the flood extent in the absence a DTM.

Table 19: Overall Confidence Ratings

Confidence	Range
Very High	70%+
High	60-70%
Medium	50-60%
Low	40-50%
Very Low	<40%

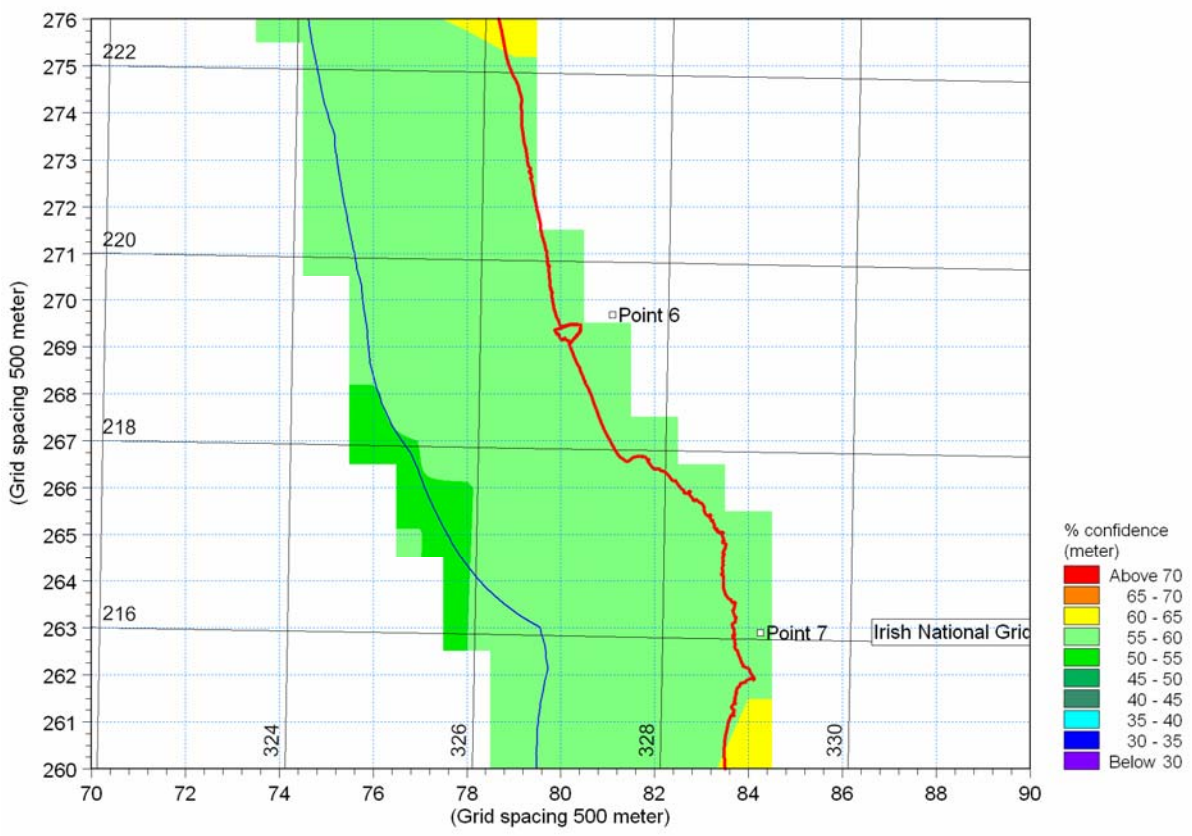


Figure 2: Final Confidence Results for Bray (Blue line represents 2km buffer and Red line represents High Water Mark)

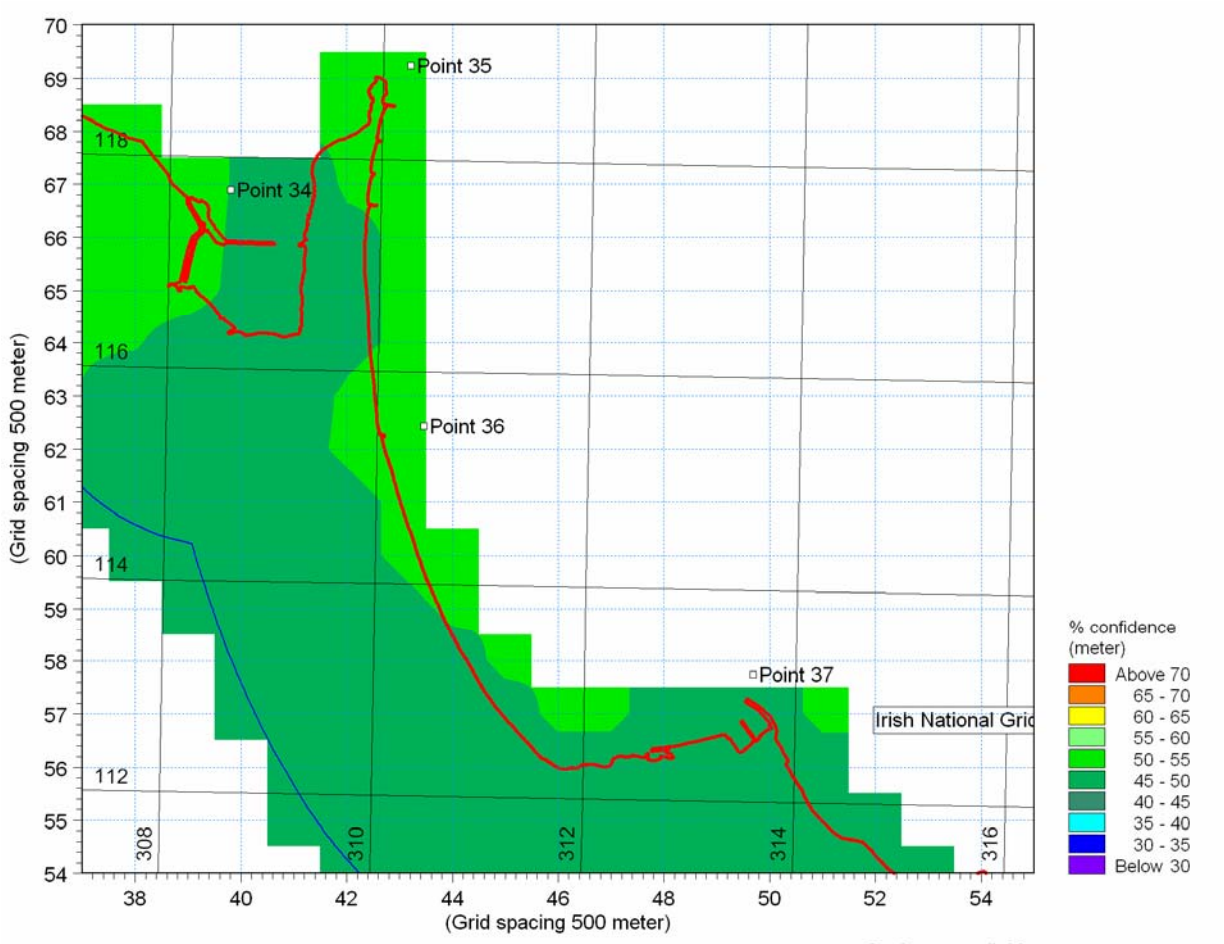


Figure 3: Final Confidence Results for Rosslare (Blue line represents 2km buffer and Red line represents High Water Mark)

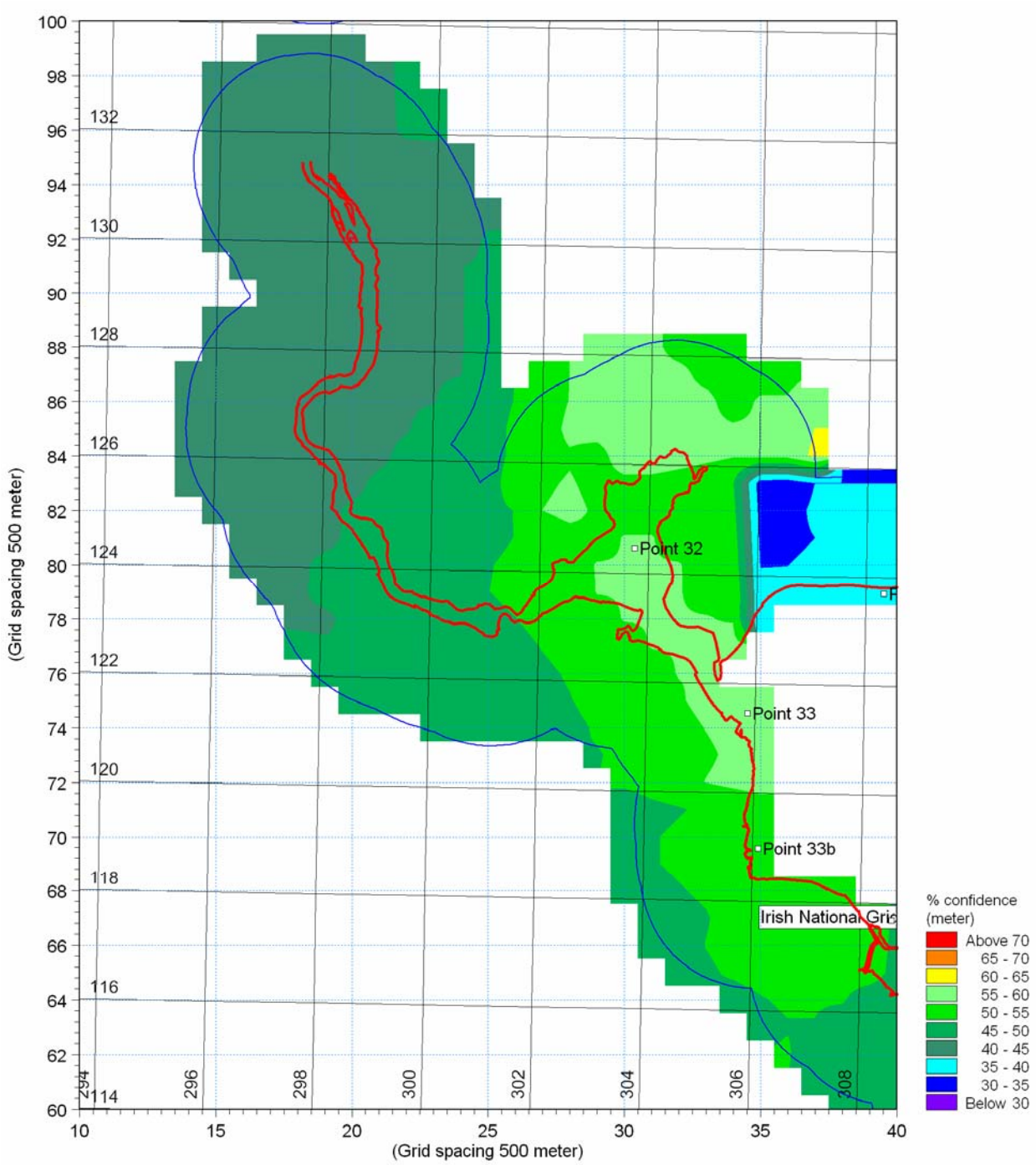


Figure 4: Final Confidence Results for Wexford (Blue line represents 2km buffer and Red line represents High Water Mark)

5.0 Conclusions

The confidence analysis methodology used to assign confidence to the flood extents has been tested and modified to produce the optimum analysis for this strategic project. It involved the collaboration of qualitative and quantitative information into one overall quantitative database. The results were presented in the form of a raster grid, geographically showing the confidence of flood extents within the study area. The scoring and weighting system has established very high, high, medium, low or very low confidence for various parameters in the flood extent determination; i.e. DTM, MALIN, MODEL and MET. It should be noted that as this methodology required the translation of many qualitative values to quantitative, many assumptions have had to be made.

All cells in the raster confidence grid were expressed in terms of very high, high, medium, low or very low confidence. Very high confidence was represented by a score of over 70%, with high confidence between 60-70%, medium confidence between 50-60%, low confidence between 40-50% and very low confidence being represented by a result of less than 40%. For example, flood outlines in the Bray area were considered as having high or medium confidence, with both Rosslare and Wexford having low and medium confidence.

The final flood extents with assigned confidence for the entire south east coast are shown on the flood extent maps presented in Appendix 7 of the main report. Digital copies of these are also appended to the main report. Most of the flood extents were classified as having high or medium confidence, with a number of areas showing low confidence. Very few areas were assigned very low confidence but those that were are located mostly around Wexford Harbour.

Appendix 9b: Confidence in Erosion Lines

IRISH COASTAL PROTECTION STRATEGY STUDY – ANALYSIS OF CONFIDENCE IN EROSION LINES

1.0 Introduction

A fundamental issue in the delivery of the final erosion lines is the level of confidence which can be assigned to the prediction of erosion along the coastline. The level of confidence should reflect the reliability of the input data, together with any discrepancies in the methodology used to determine the potential erosion risk. Data used in any erosion assessment is rarely of consistent accuracy and often shows significant spatial variation in accuracy.

RPS have therefore developed a quantitative methodology for determining the level of confidence in the erosion lines, which is based on a scoring and weighting system, establishing five confidence classifications based on various parameters in the erosion extent determination.

This report describes the methodology used and the outcome for the south east coast study area.

2.0 General Methodology

The methodology adopted is based on the scoring and weighting of various parameters which could influence the position of the final erosion lines, and establishes the level of confidence to be assigned to these erosion lines; from very high, high or medium confidence to low or very low confidence.

Four principal parameters were identified for inclusion within the analysis as listed below;

- **Geology** Accuracy and availability of underlying geology
- **Imagery** Geographical accuracy of historical/ recent aerial imagery
- **Resolution** Resolution of assessment
- **Protection** Presence of Coastal Protection Structures

A matrix was established using the above parameters, which were assigned a value of confidence ranging from 9 (complete confidence) to 1 (no confidence) at intervals along the study area coastline. The values were then squared and multiplied by a weighting, depending on the potential magnitude of the error in the position of the final erosion lines, which would result from inaccuracy in each parameter. To compute the final score, the root sum of the squares of the component confidences times the weightings was calculated and expressed as a percentage of the maximum allowable score.

The overall Confidence Sum Total is given by;

$$C_{OVERALL} = \sqrt{W_1 C^2_{IMAGERY} + W_2 C^2_{PROTECTION} + W_3 C^2_{GEOLOGY} + W_4 C^2_{RESOLUTION}}$$

Where $W_{1\text{-}4}$ represent the relevant weightings and the C values represent the confidence factors.

This was equivalent to applying the Gaussian equation generally used for error analysis. The matrix was then used to determine the overall confidence (very high, high, medium, low or very low) of the erosion lines for the particular segment of coast.

This simplified approach ignores any interdependencies between the component parts of the confidence analysis and the fact that these confidences may have resulted in over or under estimation of the erosion rates, where the net effect of combination would be reduced or null. It also assumes that the confidences were approximately normally distributed about the mean and tends to highlight the least confident source.

It should be noted that a feature of methods with multiple confidence sources is that the user tends to under-estimate the overall confidence, as there is a tendency to always assign some uncertainty to each category. For this reason, the default values were ascribed to give medium confidence (~50%) providing scope for movement in either direction.

Only three parameters were actually used in the final assessment of erosion confidence for the south east coast as outlined in further detail below. Originally a fourth parameter, geographical accuracy of the historical 'imagery' was proposed for inclusion in the confidence analysis, however this was removed from the methodology, due to the format in which the original imagery was supplied making it virtually impossible to quantify the accuracy of the subsequent geo-referencing i.e. all locations would be subject to the same level of confidence and hence this parameter would have no impact on the overall confidence output.

2.1 Underlying Geology

In developing the predictive erosion lines for the years 2030 and 2050, it was assumed that the annual rate of coastal change would be similar to that observed over the past circa 30 years. This is a fair assumption where the period of projection is not overly long and where the underlying geology does not change significantly with distance from the coastline.

The potential for the underlying geology to introduce uncertainty into the fundamental assumption that erosion in the future is going to continue at a similar rate to that observed over the past circa 30 years was considered by reference to the GSi Quatenary sub-soils dataset. A confidence scoring was assigned to each section of the coast based on the coverage and complexity of this information.

2.2 Resolution of Assessment

The erosion assessment was generally undertaken at a resolution consistent with a strategic level assessment i.e. at circa 1km intervals along the coast, however the actual spacing of the assessment points varied depending on spatial variations in the observed rate of coastal change and variation in coastal form. In order to address the potential impact of the spacing of the analysis points on the final output, confidence values were assigned to this parameter based on the distance between adjacent assessment points.

2.3 Protection Status of the Coast

As previously stated the fundamental assumption of the adopted methodology was that coastal erosion would continue in the future at the same rate as was observed over the past circa 30 years. Thus in order to produce a predictive erosion line for a particular section of coast some change in the plan position of the coast had to have been observed during the analysis period.

The presence of coastal protection structures at the start of the analysis period, or the introduction of such structures at some time during the analysis period, would obviously have a significant impact on the prediction of future erosion lines for a particular segment of coast which would reduce the level of confidence in that prediction. Conversely there are some areas of coast that

are naturally resistant to erosion e.g. where the coastline comprises outcrops of hard rock, thus giving a high degree of confidence in the prediction of no potential erosion risk in these areas.

The presence of coastal protection structures or naturally resistant coastlines was established by reference to plan aerial photography, both historic and recent, and also by reference to the Coast of Ireland, Oblique Imagery Survey of 2003.

3.0 Confidence Analysis Results

To present the results of the confidence analysis it was necessary to create, three GIS shapefiles for the entire length of the south east coastline. Confidence ratings for each of the individual parameters were manually assigned to the appropriate sections of these lines to produce individual confidence lines for the effects of underlying 'geology', coastal 'protection' and 'resolution' of the erosion analysis. These were then combined to form one line representing confidence on the south east coast, which was displayed on the baseline used for the erosion analysis, the vegetation line as derived from the 2000 aerial photographic series.

3.1 Underlying Geology

Due to the extensive spatial extent of the study area the confidence analysis for the effect of underlying geology was based on the use of spatial datasets rather than specific site inspections. For the south east coast the GSi Quatenary sub-soils dataset was used to determine the complexity of the underlying geology along and behind the present coastline.

The level of detail provided within this dataset varied spatially along the coast both as a result of variations in the complexity of the underlying geology and also due to data availability. Thus a confidence scoring was assigned to each section of the coast based on the coverage and complexity of the information contained within the GSi sub-soils dataset.

In areas where there was no information on the underlying geology a low confidence score (1) was assigned. Where the underlying geology was shown as extensive occurrences of the same or similar material a high confidence score was awarded (8). All other areas were assigned a confidence score somewhere between these two extreme values (2-7), the actual score being dependent on the complexity of the sub-surface geology indicated by the GSi dataset. Figure 1 shows an example of the GSi data and resulting geological confidence scoring in the Wexford Harbour area while Figure 2 shows the same information for the coastline between Greystones and Wicklow.

Approximately 10% of the south east coast has a very low geological confidence (<2) with the most extensive area occurring in the Ballyvaldon, Blackwater Harbour area where there is a stretch of circa 15km of coast for which no geological information was available. Conversely over 50% of the south east coast achieved a high geological confidence score (>7) with the majority of the remainder of the coast scoring between 4 and 6. Overall the mean geological confidence score for the south east coast is 6.1 which equates to medium/high confidence.

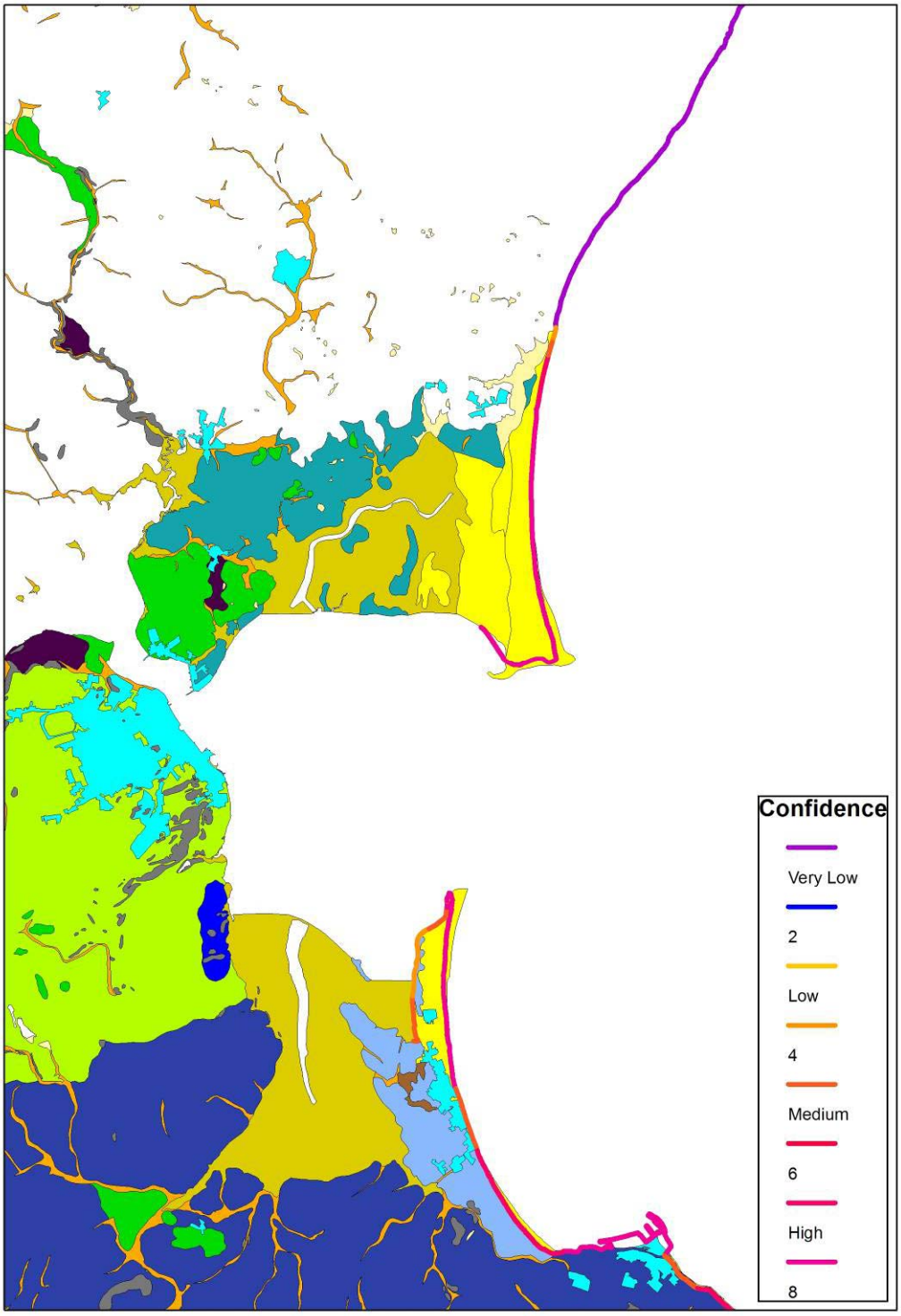


Figure 1 Geological Confidence Line – Wexford Harbour Area

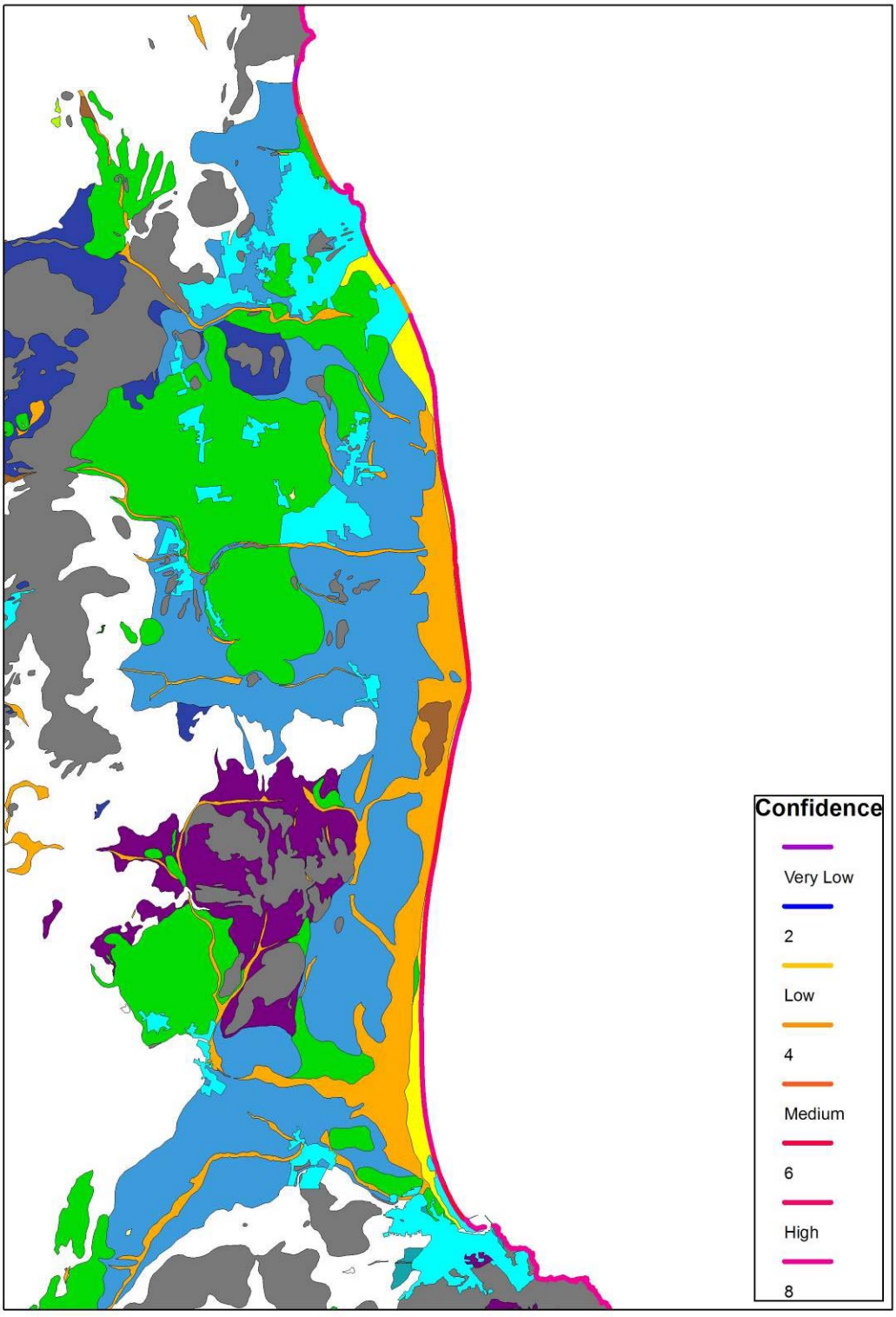


Figure 2 Geological Confidence Line – Greystones to Wicklow

3.2 Resolution of Assessment

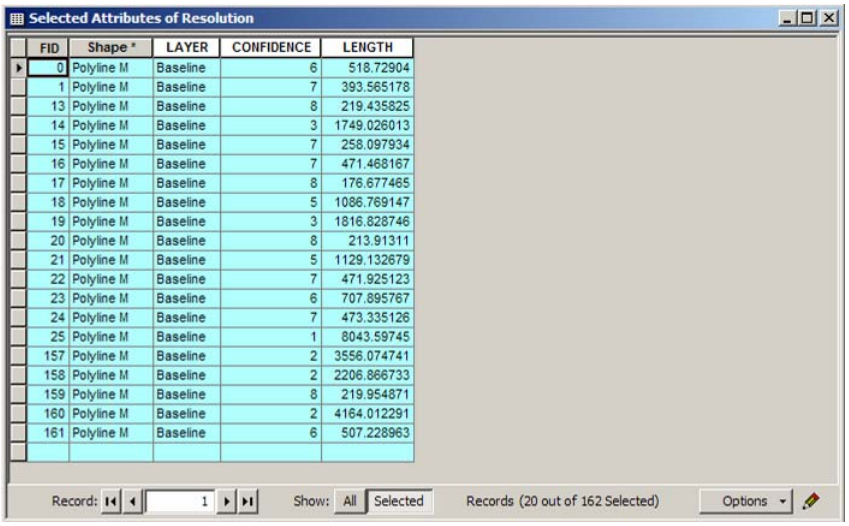
Whilst generally being undertaken at a resolution consistent with that of a strategic level assessment (circa 1 km intervals) the actual spacing of the assessment points varied depending on the spatial variation in the observed rate of coastal change and coastal form. GIS spatial analysis tools were used to calculate the length of each coastline segment used in the original erosion analysis and to assign an appropriate confidence score.

Where assessment points were less than 100m apart, a high confidence score (9) was assigned, whilst in areas where the assessment points were greater than 3,000m apart a low confidence score (1) was assigned. All other areas were awarded confidence scores between 8 and 2 depending on the actual spacing of the analysis points as shown in Table 1.

Table 1: Resolution Confidence Ratings

Confidence Score	Spacing
9	<100
8	100-250m
7	250-500m
6	500-750m
5	750-1,250m
4	1,250-1,500m
3	1,500-2,000m
2	2,000-5,000m
1	>5000m

An example of the contents of the resulting GIS attribute table for the section of coastline north of The Raven, Co Wexford is shown as Figure 3 below with the corresponding Resolution Confidence Line shown graphically in Figure 4.


Selected Attributes of Resolution

FID	Shape *	LAYER	CONFIDENCE	LENGTH
0	Polyline M	Baseline	6	518.72904
1	Polyline M	Baseline	7	393.565178
13	Polyline M	Baseline	8	219.435825
14	Polyline M	Baseline	3	1749.026013
15	Polyline M	Baseline	7	258.097934
16	Polyline M	Baseline	7	471.468167
17	Polyline M	Baseline	8	176.677465
18	Polyline M	Baseline	5	1086.769147
19	Polyline M	Baseline	3	1816.828746
20	Polyline M	Baseline	8	213.91311
21	Polyline M	Baseline	5	1129.132679
22	Polyline M	Baseline	7	471.925123
23	Polyline M	Baseline	6	707.895767
24	Polyline M	Baseline	7	473.335126
25	Polyline M	Baseline	1	8043.59745
157	Polyline M	Baseline	2	3556.074741
158	Polyline M	Baseline	2	2206.866733
159	Polyline M	Baseline	8	219.954871
160	Polyline M	Baseline	2	4164.012291
161	Polyline M	Baseline	6	507.228963

Record: 1 Show: All Selected Records (20 out of 162 Selected) Options

Figure 3 Resolution Confidence Values – The Raven Co Wexford

Figure 4 Resolution Confidence Line – The Raven Co Wexford

Approximately 60% of the south east coast was assessed using line segments of greater than 1km in length and was therefore assigned a low

resolution confidence score. This statistic however is masked by three lengths of rocky coast which account for approximately 30% of this length.

The overall mean assessment interval for the south east coast was 936m which is in line with the target resolution for a strategic study. The mean resolution confidence score for the south east coast was 3.5 which equates to a low/medium confidence. This statistic however is skewed by the existence of some long lengths of class 2 confidence in areas where there are relatively constant rates of coastal change e.g. around Blackwater/Ballinesker/The Raven.

3.3 Protection Status of the Coast

The potential impact of the natural coastal form and coastal protection structures on the results of the erosion confidence analysis was assessed by reference to the plan aerial photography, both historic and recent, and also by reference to the Coast of Ireland, Oblique Imagery Survey of 2003

For areas of the coast that were shown to be protected in any of these aerial photography surveys, a low confidence score (2) was assigned. (Refer Figure 5).

Figure 5 Typical Protected Area of Coast from 2003 Oblique Imagery Survey (Cahore)

Figure 6 Protection Confidence Ratings (Cahore)

Conversely where examination of these aerial photography surveys indicated a predominately rocky coastline, (Refer Figure 7), a high confidence score (8) was assigned.

Figure 7 **Typical Area of Rocky Coastline from 2003 Oblique Imagery Survey (Mizen Head)**

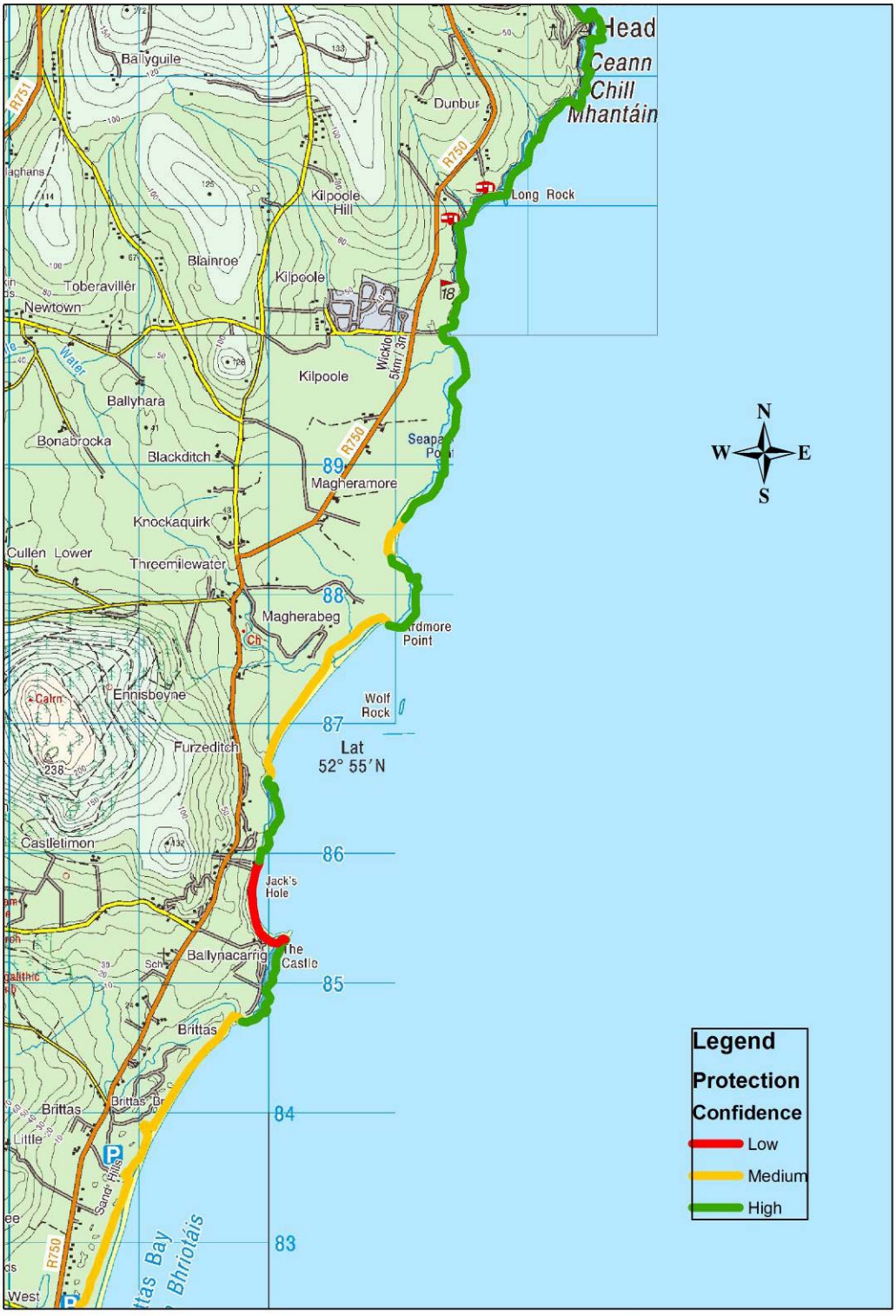


Figure 8 Protection Confidence Ratings (Mizen Head)

All other areas of the coast (un-protected soft coastline) were assigned a medium confidence level (5). Classification of the coastline in terms of the

potential for erosion resistance resulted in 16% of the coast being assigned a low confidence rating due to the presence of coastal protection structures while 27% was given a high confidence rating due to the fact that the coast comprised erosion resistant rock. Thus some 56% of the south east coastline was deemed to be unprotected soft coast and could be considered to have erosion potential.

4.0 Results of Combined Confidence

With all three confidence parameter ratings transcribed to individual lines, the combined confidence for the entire south east coast could be established. Weightings were assigned to each of the confidence parameters; 1 for Underlying 'Geology', 1 for 'Resolution' of Assessment and 2 for the 'Protection Status of the Coastline'. These weightings were assigned on the basis of the perceived potential size of the error likely to be produced in the predicted erosion lines due to inaccuracies in each parameter.

The three separate confidence lines ('Geology', 'Resolution', 'Protection') whilst based on the same initial GIS baseline were divided into different numbers of segments following the individual confidence assessments. This anomaly in the make up of the individual confidence lines resulted from the insertion of break points as required along the coast where the confidence level of the parameter under consideration changed. In order to combine the three individual confidence lines into one overall confidence line, each individual confidence line had to contain the same number and distribution of segments.

Thus the 'Protection' confidence line, was first sub-divided into 5m length segments with further breaks created at all direction change nodes and line end nodes. Each 5m segment was assigned the appropriate confidence level from the original 'Protection' confidence line to form the basis of the overall Erosion Confidence line. Spatial joins were then carried out within GIS between the 'Geology' and 'Resolution' confidence lines and the sub-divided 'Protection' confidence line using proximity based techniques to transfer the appropriate 'Geology' and 'Resolution' confidence scores to a new attribute for each section of the Erosion Confidence line. This technique effectively transferred the closest confidence value from each of the individual confidence lines to each segment of the overall erosion confidence line.

To ensure that the spatial joins had worked correctly the relevant attribute of the overall line was plotted against the original confidence line using GIS and the values compared along the entire length of the coast. The attribute table of the overall erosion confidence line was therefore populated with confidence values from all three parameters at approximately 5m intervals along the entire south east coast. A random sample from the overall erosion confidence shapefile is presented in Figure 9 where the columns headed RES_CONF, GEO_CONF and PRO_CONF contain the individual confidence values assigned to the 'Resolution', 'Geology' and 'Protection' parameters respectively.

Attributes of Overall_Confidence_Sample

FID	Shape *	LENGTH	RES_CONF	GEO_CONF	PRO_CONF	Percentage	CONF_LEVEL	Confidence
78	Polyline M	5	7	1	5	56	Medium	10
79	Polyline M	5	6	8	5	68	Medium	12.25
183	Polyline M	5	2	8	2	48	Low	8.72
200	Polyline M	5	2	8	8	78	High	14
430	Polyline M	2.089355	7	2	2	43	Low	7.81
431	Polyline M	5	7	6	2	54	Low	9.64
506	Polyline M	5	2	8	2	48	Low	8.72
552	Polyline M	5	2	4	5	46	Low	8.37
587	Polyline M	5	2	8	8	78	High	14
612	Polyline M	5	7	5	5	62	Medium	11.14
660	Polyline M	3.012382	2	5	5	49	Low	8.89
685	Polyline M	5	7	5	2	50	Low	9.06
705	Polyline M	5	2	8	8	78	High	14
730	Polyline M	5	2	8	5	60	Medium	10.86
840	Polyline M	5	2	4	5	46	Low	8.37
886	Polyline M	5	2	8	8	78	High	14
946	Polyline M	5	8	8	8	89	Very High	16
953	Polyline M	5	7	5	2	50	Low	9.06
985	Polyline M	5	8	5	2	55	Low	9.85
1012	Polyline M	5	2	8	8	78	High	14
1023	Polyline M	5	8	5	5	65	Medium	11.79
1031	Polyline M	5	8	8	8	89	Very High	16
1041	Polyline M	5	2	4	5	46	Low	8.37
1042	Polyline M	5	2	8	8	78	High	14
1105	Polyline M	5	2	8	5	60	Medium	10.86
1115	Polyline M	5	2	8	8	78	High	14
1366	Polyline M	1.981433	8	8	5	74	High	13.34
1393	Polyline M	5	7	8	5	71	High	12.77
1394	Polyline M	5	4	7	2	47	Low	8.54
1401	Polyline M	5	2	8	8	78	High	14
1553	Polyline M	5	4	5	2	39	Very Low	7
1597	Polyline M	5	4	7	2	47	Low	8.54
1609	Polyline M	5	7	8	2	61	Medium	11
1711	Polyline M	5	2	5	5	49	Low	8.89
1748	Polyline M	5	2	8	5	60	Medium	10.86
1763	Polyline M	5	2	8	2	48	Low	8.72
1764	Polyline M	5	2	8	5	60	Medium	10.86
1765	Polyline M	5	2	8	2	48	Low	8.72
1767	Polyline M	5	2	8	5	60	Medium	10.86
1768	Polyline M	5	2	8	2	48	Low	8.72
1771	Polyline M	5	2	5	2	34	Very Low	6.08
1774	Polyline M	5	2	8	2	48	Low	8.72
1822	Polyline M	5	7	8	2	61	Medium	11
1847	Polyline M	5	2	8	2	48	Low	8.72
1858	Polyline M	5	7	8	2	61	Medium	11
1859	Polyline M	5	4	8	2	52	Low	9.38
1860	Polyline M	5	4	5	2	39	Very Low	7
2047	Polyline M	5	7	5	2	50	Low	9.06
2053	Polyline M	5	7	8	2	61	Medium	11
2054	Polyline M	5	7	8	5	71	High	12.77
2076	Polyline M	5	8	8	5	74	High	13.34
2077	Polyline M	5	2	8	5	60	Medium	10.86
2078	Polyline M	5	2	5	5	49	Low	8.89
2123	Polyline M	5	2	4	5	46	Low	8.37
2168	Polyline M	5	2	5	5	49	Low	8.89

Figure 9 Sample of Overall Confidence Rating Attribute Table

The confidence ratings at each point were subsequently weighted and combined to give a final overall confidence rating for each line segment. The formula used to weight and combine the individual confidence ratings was as follows;

$$C_{OVERALL} = \sqrt{W_1 C^2_{PROTECTION} + W_2 C^2_{GEOLOGY} + W_3 C^2_{RESOLUTION}}$$

Where $W_{1\text{-}3}$ represents the relevant weightings and the C values represent the individual confidence factors.

The resulting potential combined confidence scores lay in the range 2 (all individual confidences scores 1) to 18 (all individual confidence scores 9). The combined confidence values for each line segment were then converted to a percentage of the possible maximum score before being classified into one of 5 groupings, Very High, High, Medium, Low or Very Low as shown in Table 2**.**

Table 2: Overall Confidence Ratings

Confidence	Range
Very High	>85%
High	70-85%
Medium	55-70%
Low	40-55%
Very Low	<40%

The percentage bands listed above are different from those used for the flooding confidence analysis however this is a function of different parameter scorings and weighting used in the two analyses. The actual percentage bands were selected to give what was considered a realistic distribution of confidence class along the south east coast in terms of erosion.

The overall confidence value for each segment of the coast calculated using the equation outlined above is contained in the column headed “Confidence” in Figure 9, while the resulting overall percentage score and confidence class are in the columns headed “Percentage“ and “CONF_LEVEL“ respectively.

Statistical analysis of the distribution of overall confidence values along the south east coast indicates that the mean confidence rating for the erosion assessment of the south east coastline between Dalkey and Carnsore Point was 60.65% i.e. Medium Confidence. Only 0.6% of the coastline was assigned a very high overall confidence rating while 11% was assigned a very low overall confidence rating. Inspection of the distribution of sections of the coastline with very low overall confidence ratings indicates that the majority of these are located in areas where coastal protection structures were observed to be present.

5.0 Conclusions

The confidence analysis methodology used to assign confidence to the erosion lines has been tested and modified to produce the optimum analysis for this strategic project. It involves the combination of qualitative and quantitative information into one overall quantitative database. The results are presented in the form of an overall confidence rating for the erosion analysis of the south east coast at approximately 5m resolution. The methodology which is based on scoring and weighting confidence in individual parameters likely to impact on the accuracy of the erosion assessment has established whether confidence in the erosion extent determination is very high, high, medium, low or very low based on three principal parameters; i.e. Underlying 'Geology', 'Resolution' of the Assessment and 'Protection' status of the coast.

All sectors of the overall erosion confidence line have been assigned a confidence rating. Very high confidence was represented by a score of over 85%, with high confidence between 70-85%, medium confidence between 55-70%, low confidence between 40-55% and very low confidence being represented by a result of less than 40%. Overall the analysis indicates that there is generally a medium level of confidence in the position of the erosion lines identified for the south east coast. There are however some localised areas where the analysis has identified a very low confidence generally as a result of the presence of coastal protection works. The principal areas of very low confidence in the erosion assessment are; Killiney, Bray, Newcastle, Jacks Hole, Glennaglogh, Courtown, Pollshone, Cahore, Blackwater, and Rosslare.

The final erosion lines with assigned confidence for the entire south east coast are shown on the erosion maps presented in Appendix 8 of the main report. Digital copies of these are also appended to the main report.

As this methodology requires assigning quantitative values to what is in many cases essentially qualitative data, the results may be subject to variations in user's interpretation. It is difficult to assess the impact of variations in interpretation on the reliability of the current methodology, until further areas are investigated; however any such impact has been at least partially mitigated by ensuring that the same personnel have undertaken the assessment for all areas of the coast.