

# Irish Coastal Protection Strategy Study Phase 2 - South East Coast

Work Package 9A - Appendix 2 - Flood Mapping for High End Future Scenario

IBE0104/November 2013







**Office of Public Works**

**Irish Coastal Protection Strategy Study - Phase 2**

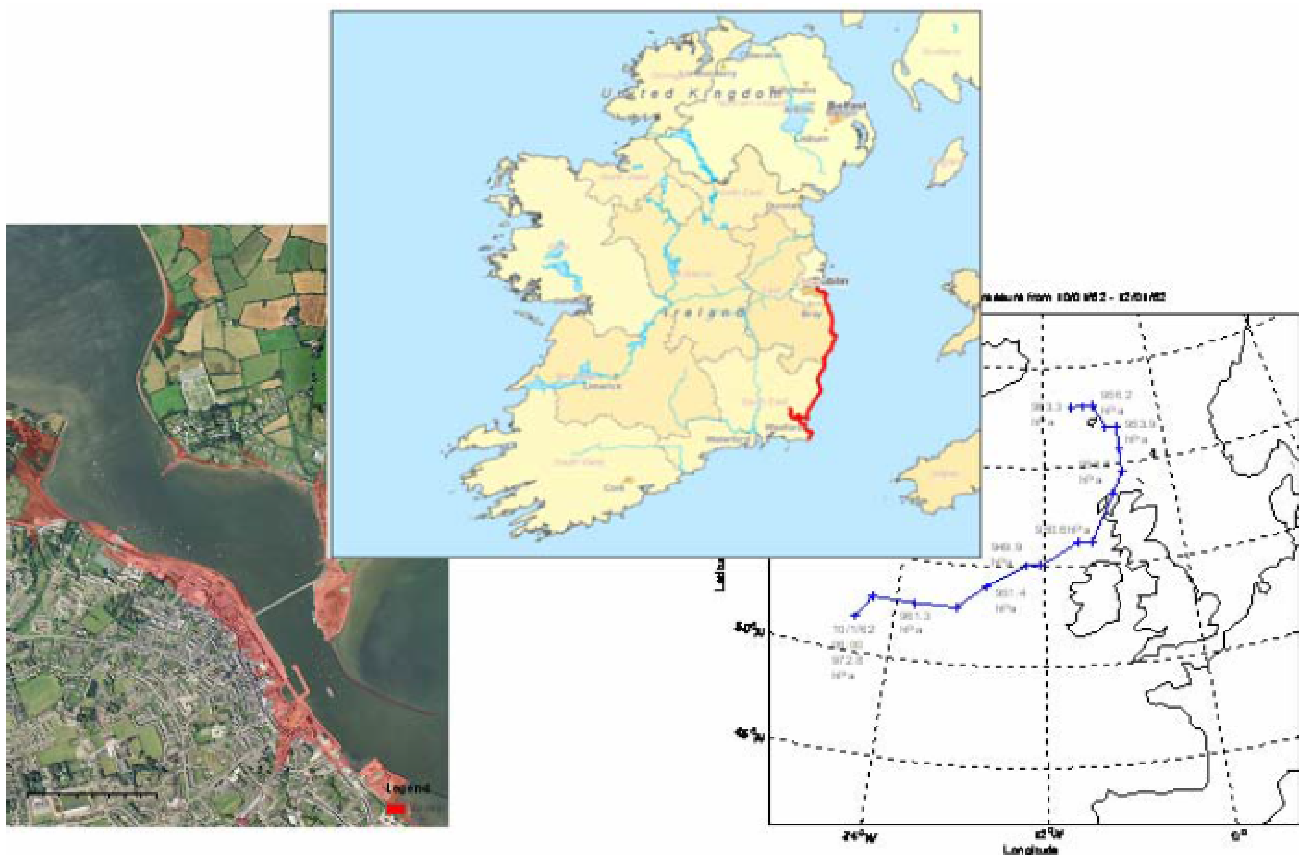
**Work Package 9A**

**Strategic Assessment of Coastal Flooding Extents – Future Scenario**

**South East Coast – Dalkey Island to Carnsore Point**

Appendix 2 - Flood Mapping for High End Future Scenario

November 2013







**Office of Public Works**

**Irish Coastal Protection Strategy Study - Phase 2**

**Work Package 9A**

**Strategic Assessment of Coastal Flooding Extents – Future Scenario**

**South East Coast - Dalkey Island to Carnsore Point**

Appendix 2 - Flood Mapping for High End Future Scenario

November 2013

**DOCUMENT CONTROL SHEET**

Client	Office of Public Works
Project Title	Irish Coastal Protection Strategy Study, Phase 2, Work Package 9A
Document Title	Strategic Assessment of Coastal Flooding Extents – Future Scenario
Document No.	IBE0071/ FS_App9A_R01
Document Date	November 2013

## **IMPORTANT DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE FOR FLOOD MAPS**

### **COASTAL FLOOD MAPS FOR HIGH END FUTURE SCENARIO FOR SOUTH EAST COAST**

**Please read the disclaimer, guidance notes and conditions of use below carefully to avoid incorrect interpretation of the information and data provided on the maps contained in this volume. The maps must be used only in conjunction with these notes, and must not be used in isolation.**

#### **PURPOSE OF THE MAPS**

The maps contained within this bound volume were prepared under the following project:

- ***Project Name: Irish Coastal Protection Strategy Study (ICPSS)***
- ***Project Period: 2005 – 2013***

The maps were prepared for the purpose of assessing the degree of flood hazard and risk to assist in the identification and development of measures for managing the flood risk. They may, however, also be of use to the public, Local Authorities and other parties as indicative maps of flood-prone areas for a range of purposes, including raising awareness of flood hazard and risk, preparedness and response planning for flood events, assisting in planning and development decisions, adaptation to climate change etc.

#### **DISCLAIMER**

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## **GUIDANCE NOTES**

This bound volume contains future scenario flood maps. How these maps have been derived, and what they do and do not present, is described below.

### ***Derivation of Maps***

The maps included within this bound volume are 'predictive' flood maps, as they provide predicted flood extent and other information for a future scenario 'design' flood event (High End to 2100) that has an estimated probability of occurrence (e.g., the 0.5% AEP event – see below), rather than information for floods that have occurred in the past (which is presented on 'historic' flood maps).

The predicted extents are based on analysis and modelling. This includes:

- Numerical Modelling of combined storm surges and tide levels which was used to estimate extreme water levels along the coastline
- Statistical extreme value analysis and joint probability analysis to both historic recorded tide gauge data and data generated by numerical modelling, which allowed an estimation of the extreme water levels of defined annual exceedance probability (AEP) to be established along the coastline
- Definition of the plan extent of the predictive floodplain, by use of a Digital Terrain Model (DTM) commissioned by the Office of Public Works. The predictive flood outlines shown on these maps were calculated by combining the results of the surge and tide level modelling, the statistical analysis, the DTM using GIS technology and incorporating future allowances for both mean sea level rise and glacial isostatic adjustment (GIA).

The maps have been produced at a strategic level to provide an overview of coastal flood hazard and risk in Ireland, and minor or local features may not have been included in their preparation. A DTM is used to generate the maps, which is a 'bare earth' model of the ground surface with the digital removal of man-made and natural landscape features such as vegetation, buildings, bridges and embankments. The mapping process can show some of these man-made features, such as bridges and embankments, as flooded on the flood maps, when in reality they do not flood. In addition, 'cleansing' is undertaken during flood map production, which involves various processes such as the removal of very small areas of flooding that is remote and isolated, the removal of very small islands within the flooded area, etc. Therefore, the maps should not be used to assess the flood hazard and risk

associated with individual properties or point locations, or to replace a detailed local flood risk assessment. Local factors such as flood defence schemes, structures in or around river channels (e.g. bridges), buildings and other local influences, which might affect a coastal flood, have not been accounted for.

The maps were produced based on survey data captured prior to, and during the early part of the project. They do not account for changes in development, infrastructure or topography that occurred after the date of survey data capture (except for GIA).

The DTM is derived from airborne survey data. The majority of this data is Light Detection and Ranging (LiDAR) data. Where LiDAR data was not available, Interferometric Synthetic Aperture Radar (IfSAR) data has been used to derive the DTM.

Detailed explanations of the methods of derivation, survey data used, etc. are provided in the relevant reports produced for the project under which the maps were prepared. **Users of the maps should familiarise themselves fully with the contents of these reports in advance of the use of the maps.**

### ***Flood Event Probabilities***

The maps refer to flood event probabilities in terms of a percentage Annual Exceedance Probability, or 'AEP'. This represents the probability of an event of this, or greater, severity occurring in any given year. These probabilities may also be expressed as odds (e.g., 100 to 1) of the event occurring in any given year. They are also commonly referred to in terms of a return period (e.g., the 100-year flood), although it should be understood that this does not mean the length of time that will elapse between two such events occurring, as, although unlikely, two very severe events may occur within a very short space of time.

Table 1 below sets out a range of flood event probabilities expressed in terms of AEP, and identifies their parallels under other forms of expression.

Table 1: Flood Event Probabilities

Annual Exceedance Probability (%)	Odds of Occurrence in any Given Year	Return Period (yrs)
50	2 : 1	2
20	5 : 1	5
10	10 : 1	10
5	20 : 1	20
2	50 : 1	50
1	100 : 1	100
0.5	200 : 1	200
0.2	500 : 1	500
0.1	1000 : 1	1000

### ***Uncertainty***

Although great care and modern, widely-accepted methods have been used to prepare the maps, there is a range of inherent uncertainties within the process of preparing the predicted flood extents maps. These include:

- Uncertainty in Flood Levels: This can arise due to uncertainties in topographic, bathymetric and other survey data, meteorological data, assumptions and / or approximations in the hydraulic / hydrodynamic models in representing physical reality, assumptions in the hydraulic / hydrodynamic modelling, and datum conversions, etc.
- Uncertainty in Flood Extents: This can arise due to uncertainties in flood levels, topographic and other survey data, assumptions and / or approximations in the way that flooding spreads over a floodplain, etc.

The flood maps are therefore only indicative, and the potential for inaccuracy should be recognised if these maps are to be used for any purpose.

### ***Types of Flood Map***

This volume contains only flood extent maps as outlined below. Further details on this type of map, including the methods of derivation, assumptions made, data used, etc. are provided in the relevant project reports.

#### ***Flood Extent Maps***

Flood extent maps contained in this volume show the predicted extents of flooding for future scenario flood events of two estimated probabilities of occurrence:

- 0.5% AEP flood event
- 0.1% AEP flood event

It should be noted that the flood extent maps indicate the predicted maximum extent of flooding (subject to limitations referred to herein), and flooding in some areas, such as near the edge of the flooded area, might be very shallow.

Due to the various uncertainties within the process of preparing the maps (see 'Uncertainty' above), it is not possible to state that the maps are absolutely accurate.

### ***Consideration of Projected Future Changes in Climate***

The maps produced in this bound volume represent a projected future scenario for the year 2100 and include allowances for projected future changes in climate and glacial isostatic adjustment (GIA). The maps represent a High End Future Scenario (HEFS) reflecting changes that are within the typical range projected.

The allowances used for this High End Future Scenario are as follows:-

Mean Sea Level Rise: + 1000 mm (to 2100)  
Land Movement (GIA): Varies + 0.1 to - 0.2 mm/year (South East Coast)

This volume includes maps that show the predicted extents of (tidal/coastal) flooding for the HEFS for flood events of two estimated probabilities of occurrence:-

0.5 % AEP  
0.1% AEP

The future scenario water levels shown on the maps are relative to Ordnance Datum Malin and include the above mean sea level rise allowance (+ 1000mm) but have not been adjusted for GIA.

### ***Sources of Flooding Not Mapped***

The maps indicate only the extents associated with flooding from coastal areas and the sea. There are however many other possible sources of flooding, such as fluvial flooding from rivers, surcharged urban drainage systems, ponding rainwater, groundwater, overtopping or breaching of water retaining structures (such as embankments and reservoirs), etc. Flooding from these other sources have not been mapped, and so areas that are not shown as being within a flood extent may therefore be at risk from flooding from one of these other sources.

## **CONDITIONS OF USE**

Please read the following statements and conditions of use of the maps in this bound volume carefully. Use of these maps is conditional upon the following:-

The user of these maps shall be deemed to have agreed to, and unconditionally accepted all of these statements and conditions.

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## **CONTACTS REGARDING MAP INFORMATION**

Any user who has reason to believe that these maps contain an error, or who wishes to contribute additional information, is requested to contact the Office of Public Works Engineering Services Section at the following address:

Flood Mapping Queries  
Engineering Services  
Office of Public Works  
17-19 Lower Hatch Street  
Dublin 2

## Predicted Extreme Water Levels Associated with Combined Tide and Surge

PREDICTION POINT ID	ANNUAL EXCEEDANCE PROBABILITY (AEP)								CO-ORDINATES OF PREDICTION POINTS	
	50%	20%	10%	5%	2%	1%	0.5%	0.1%	EASTINGS	NORTHINGS
Point 3	3.24	3.37	3.47	3.57	3.71	3.81	3.90	4.14	327384	225848
Point 4	3.23	3.36	3.45	3.55	3.68	3.78	3.88	4.11	326410	223376
Point 5	3.10	3.23	3.33	3.43	3.56	3.66	3.76	3.99	329598	213102
Point 6	3.18	3.32	3.42	3.52	3.65	3.75	3.85	4.09	327404	219431
Point 7	3.14	3.27	3.37	3.47	3.60	3.70	3.80	4.02	329042	216068
Point 8	3.07	3.20	3.30	3.40	3.53	3.63	3.73	3.96	330519	211617
Point 9	2.89	3.03	3.13	3.23	3.36	3.46	3.56	3.80	331780	207274
Point 10	2.79	2.92	3.01	3.11	3.24	3.33	3.43	3.65	331879	202768
Point 11	2.70	2.82	2.91	3.01	3.13	3.22	3.32	3.53	331305	198336
Point 12	2.65	2.77	2.86	2.96	3.08	3.17	3.26	3.48	331916	194344
Point 13	2.36	2.47	2.56	2.64	2.75	2.84	2.92	3.12	333867	190828
Point 14	2.21	2.31	2.39	2.47	2.57	2.65	2.73	2.91	332235	185606
Point 15	2.06	2.16	2.24	2.32	2.42	2.50	2.58	2.76	331211	180564
Point 16	2.00	2.10	2.18	2.26	2.36	2.44	2.52	2.70	328414	178175
Point 17	1.96	2.06	2.14	2.22	2.31	2.39	2.47	2.66	326226	174323
Point 18	1.93	2.04	2.12	2.20	2.29	2.37	2.45	2.63	325596	171445
Point 19	2.00	2.10	2.17	2.25	2.34	2.41	2.49	2.66	325633	166947
Point 20	1.98	2.08	2.16	2.24	2.33	2.41	2.48	2.66	324087	163585
Point 21	1.95	2.05	2.12	2.20	2.29	2.37	2.44	2.62	321839	159752
Point 22	1.94	2.04	2.11	2.18	2.28	2.35	2.42	2.60	321139	158031
Point 23	1.94	2.03	2.10	2.16	2.25	2.32	2.39	2.55	320512	153466
Point 24	1.94	2.03	2.10	2.17	2.26	2.33	2.40	2.56	321495	150606
Point 25	1.94	2.03	2.10	2.17	2.26	2.33	2.41	2.57	322408	146072
Point 26	2.02	2.12	2.20	2.28	2.37	2.45	2.53	2.71	320923	142781
Point 27	2.07	2.17	2.25	2.32	2.42	2.49	2.57	2.74	319336	140162
Point 28	2.12	2.22	2.29	2.36	2.45	2.53	2.60	2.77	316835	136696
Point 29	2.14	2.23	2.31	2.38	2.47	2.54	2.61	2.78	314392	132381
Point 30	2.14	2.24	2.31	2.38	2.47	2.54	2.61	2.77	312030	128205
Point 31	1.96	2.05	2.13	2.21	2.30	2.37	2.44	2.60	312161	122778
Point 31b	2.09	2.22	2.32	2.42	2.54	2.62	2.71	2.91	308323	123694
Point 32	2.09	2.24	2.36	2.45	2.58	2.67	2.76	2.95	303741	124466
Point 33	2.04	2.19	2.31	2.41	2.55	2.64	2.74	2.97	305869	121462
Point 33b	2.02	2.15	2.26	2.36	2.50	2.60	2.70	2.93	306094	118984
Point 34	2.00	2.12	2.21	2.30	2.41	2.49	2.57	2.75	308574	117690
Point 35	2.21	2.30	2.38	2.45	2.54	2.61	2.69	2.86	310256	118888
Point 36	2.20	2.29	2.36	2.42	2.51	2.58	2.64	2.80	310437	115491
Point 37	2.20	2.28	2.34	2.40	2.48	2.54	2.60	2.74	313596	113201
Point 38	2.38	2.49	2.57	2.65	2.75	2.83	2.91	3.09	315046	110348
Point 39	2.45	2.55	2.62	2.69	2.79	2.86	2.94	3.11	313434	106626
Point 40	2.61	2.72	2.79	2.87	2.97	3.05	3.13	3.31	311878	103067

### Notes

1 - All water levels shown are in metres and referenced to Ordnance Datum Malin

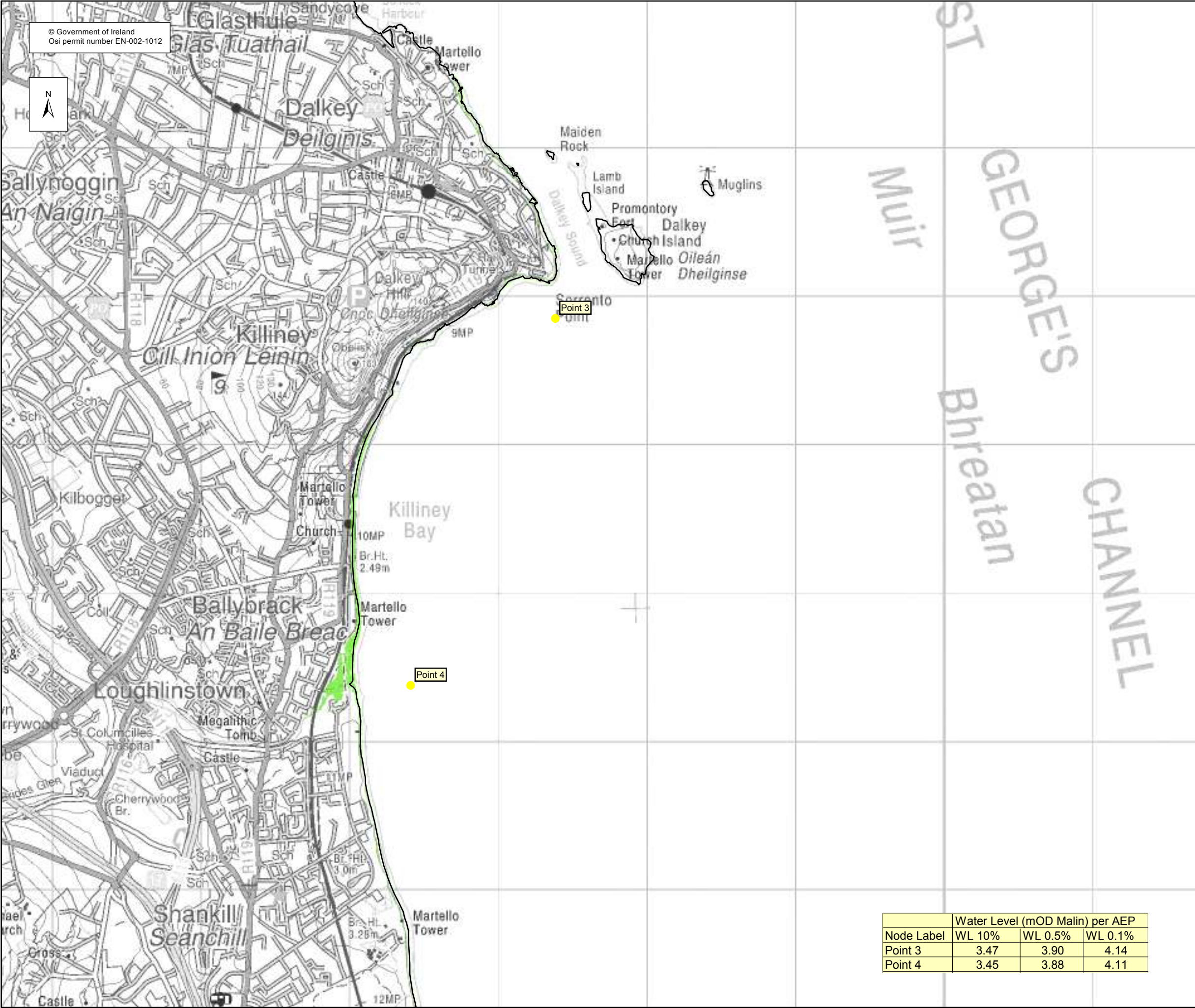
2 - All co-ordinates shown are in Irish Grid (TM65)

3 - AEP denotes Annual Exceedance Probability

Prepared By: RP Date: June 2012

Checked By: JMC & JR Date: June 2012

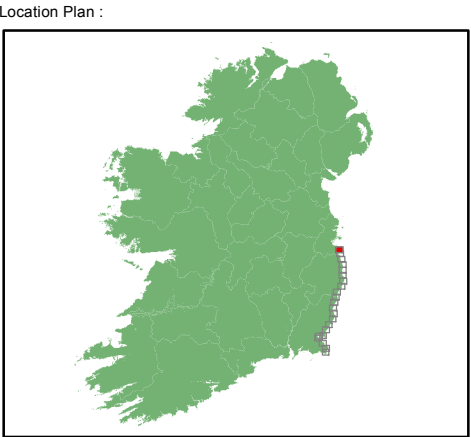
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	Water Level (mOD Malin) per AEP		
Node Label	WL 10%	WL 0.5%	WL 0.1%
Point 3	3.47	3.90	4.14
Point 4	3.45	3.88	4.11



EXTENT MAP

Legend:

- 0.5% AEP FLOOD EXTENT  
(1 in 200 chance in any given year)
- 0.1% AEP FLOOD EXTENT  
(1 in 1000 chance in any given year)
- High Water Mark (HWM)
- Node Point

Point 34 Node Label (refer to table)

USER NOTE :

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Northern Ireland



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Dublin 2  
Ireland

Project :

IRISH COASTAL PROTECTION STRATEGY  
STUDY - PHASE II

Map :

SOUTH EAST COAST FLOOD EXTENT MAP

Map Type : FLOOD EXTENT

Source : TIDAL FLOODING

Map area : RURAL AREA

Scenario : HIGH END FUTURE SCENARIO

Figure By : PJW

Date : Sept 2012

Checked By : JMC & JR

Date : Sept 2012

Figure No. :

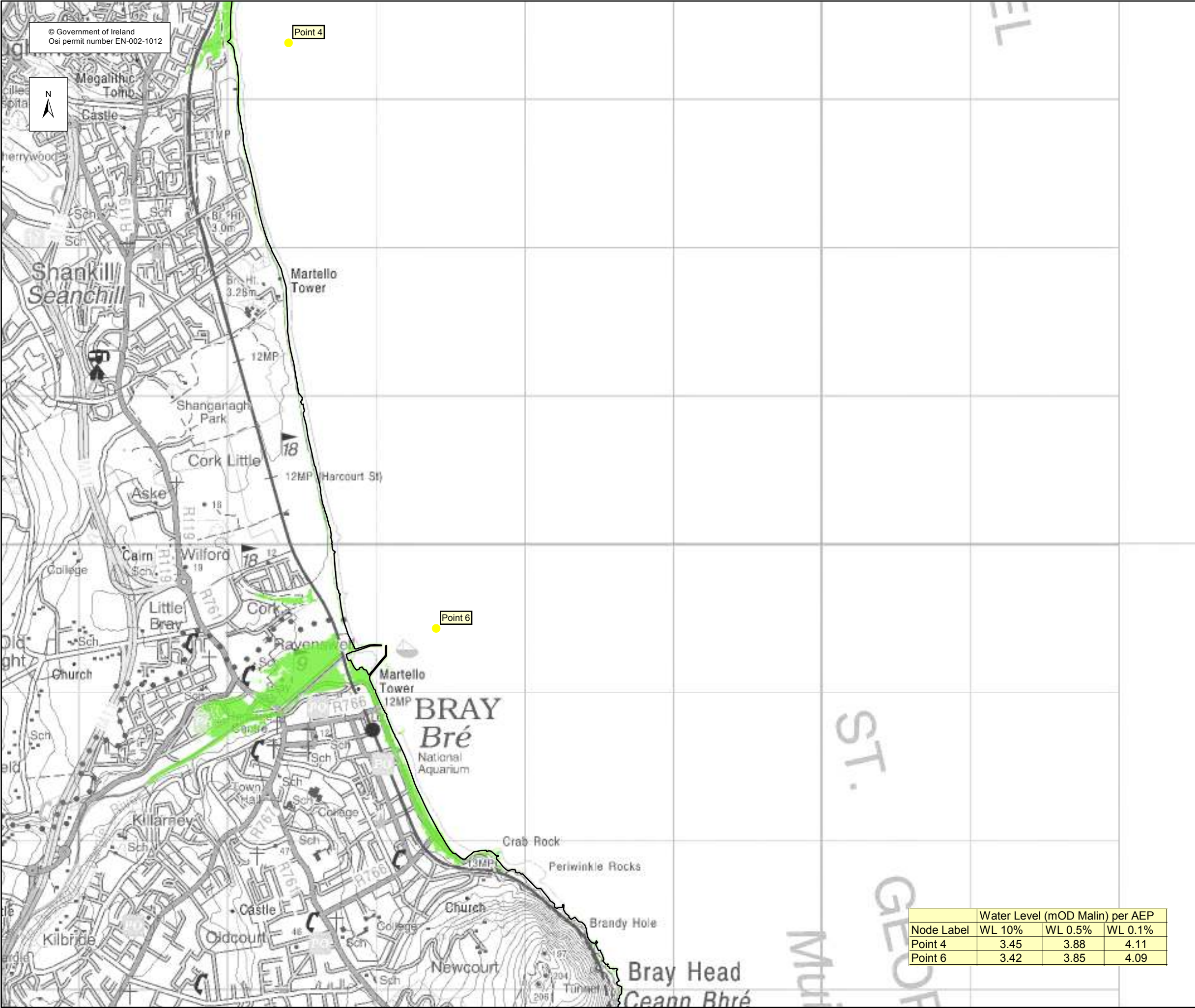
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Revision

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Plot Scale : 1:1 @ A3



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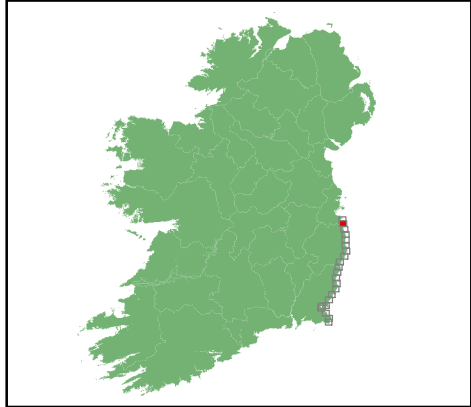


Point 4

Point 6

Node Label	Water Level (mOD Malin) per AEP		
	WL 10%	WL 0.5%	WL 0.1%
Point 4	3.45	3.88	4.11
Point 6	3.42	3.85	4.09

Location Plan :



EXTENT MAP

Legend:

- 0.5% AEP FLOOD EXTENT  
(1 in 200 chance in any given year)
- 0.1% AEP FLOOD EXTENT  
(1 in 1000 chance in any given year)
- High Water Mark (HWM)
- Node Point

Point 34 Node Label (refer to table)

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STUDY - PHASE II

Map :

SOUTH EAST COAST FLOOD EXTENT MAP

Map Type : FLOOD EXTENT

Source : TIDAL FLOODING

Map area : RURAL AREA

Scenario : HIGH END FUTURE SCENARIO

Figure By : PJW

Date : Sept 2012

Checked By : JMC & JR

Date : Sept 2012

Figure No. :

SE / RA / EXT / HEFS / 2

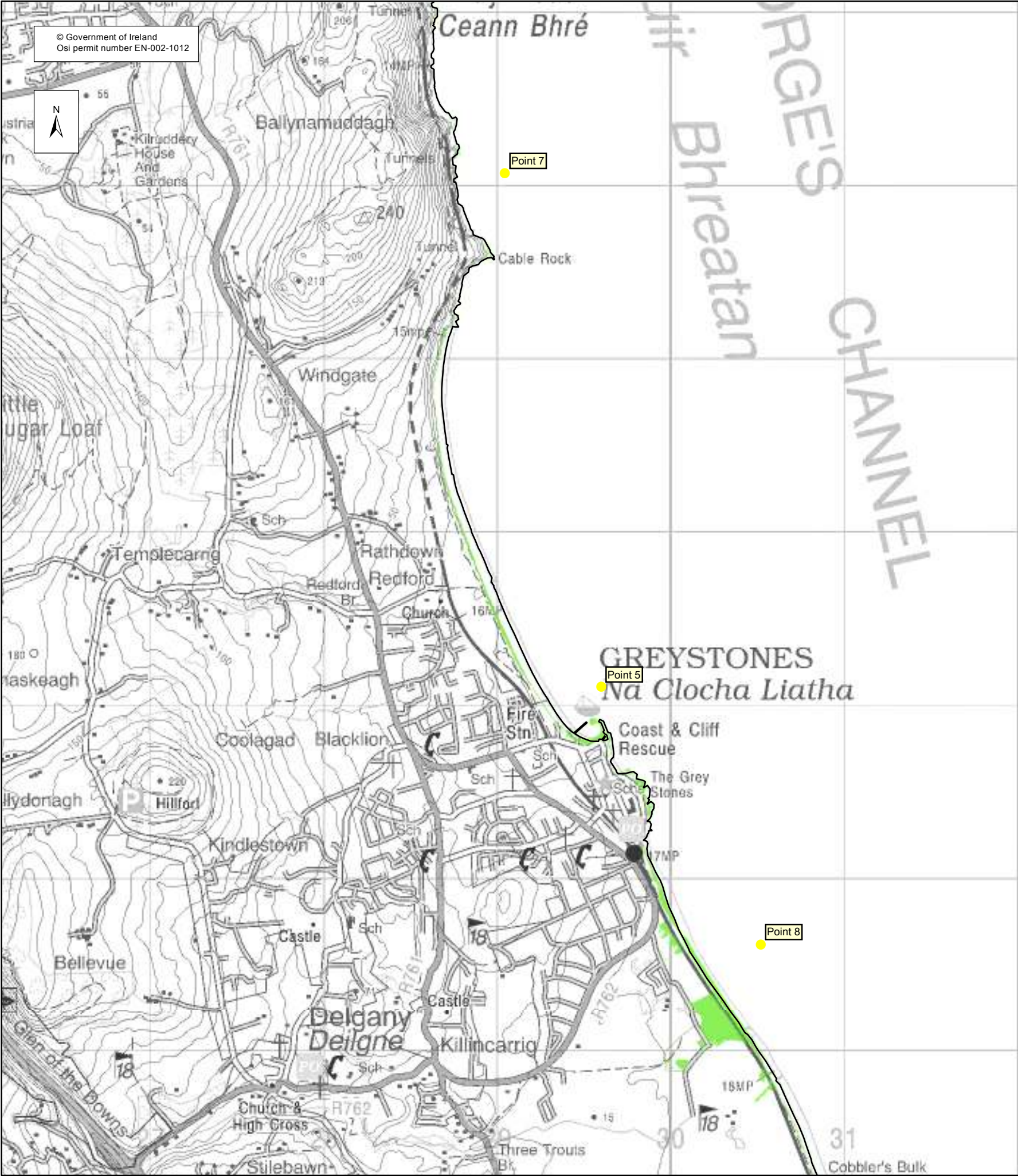
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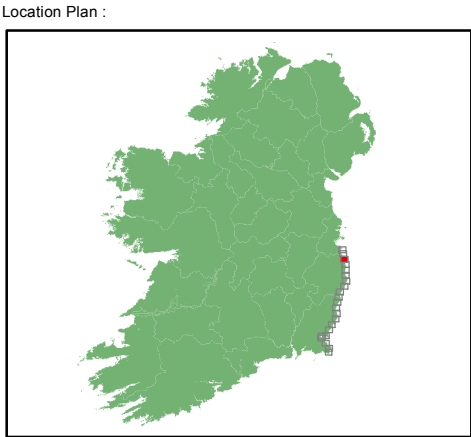
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Plot Scale : 1:1 @ A3





Node Label	Water Level (mOD Malin) per AEP		
	WL 10%	WL 0.5%	WL 0.1%
Point 5	3.33	3.76	3.99
Point 7	3.37	3.80	4.02
Point 8	3.30	3.73	3.96



**EXTENT MAP**

Legend:

- 0.5% AEP FLOOD EXTENT (1 in 200 chance in any given year)
- 0.1% AEP FLOOD EXTENT (1 in 1000 chance in any given year)
- High Water Mark (HWM)
- Node Point
- Point 34 Node Label (refer to table)

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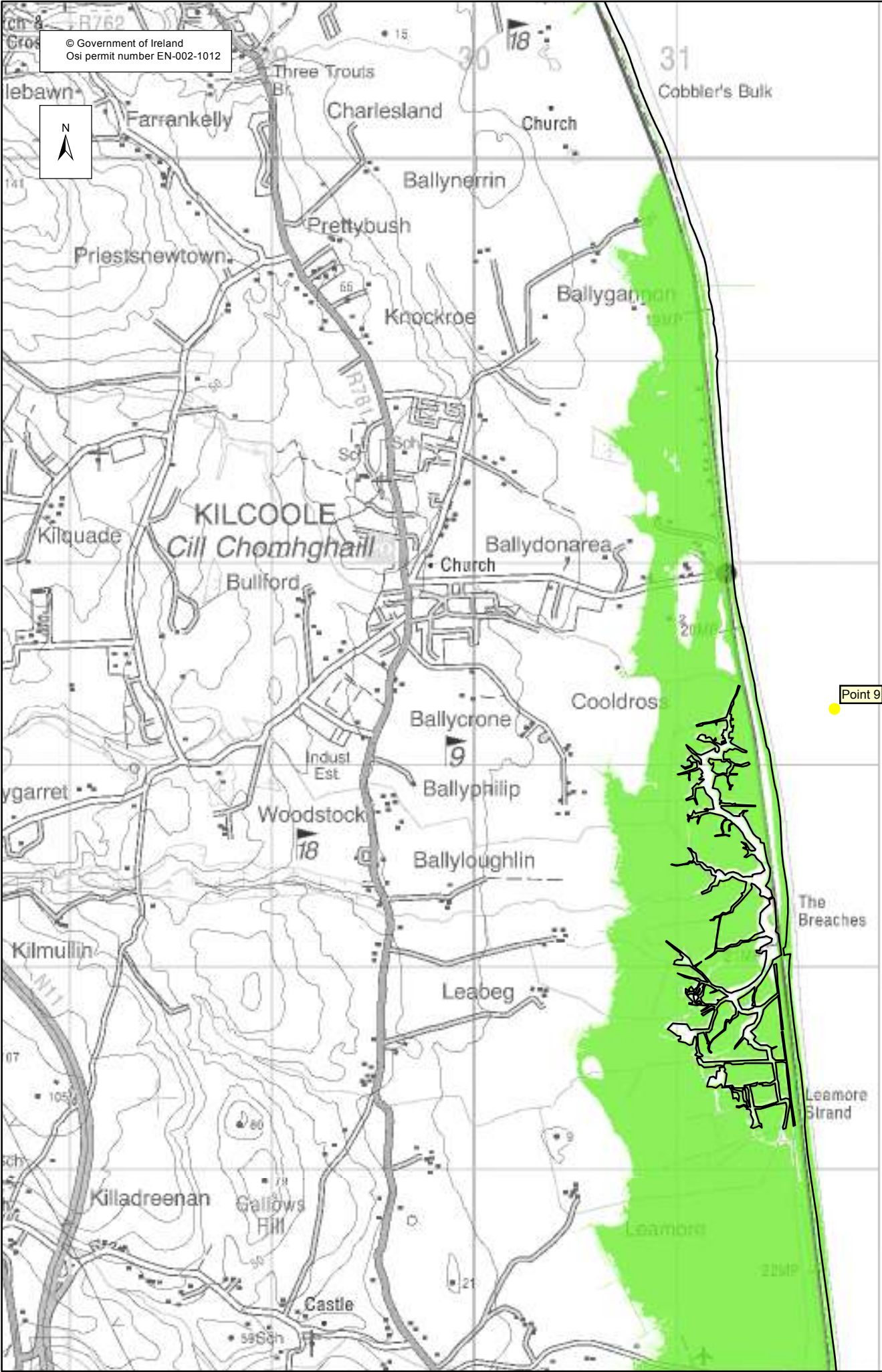
Map :  
SOUTH EAST COAST FLOOD EXTENT MAP

Map Type : FLOOD EXTENT  
Source : TIDAL FLOODING  
Map area : RURAL AREA  
Scenario : HIGH END FUTURE SCENARIO

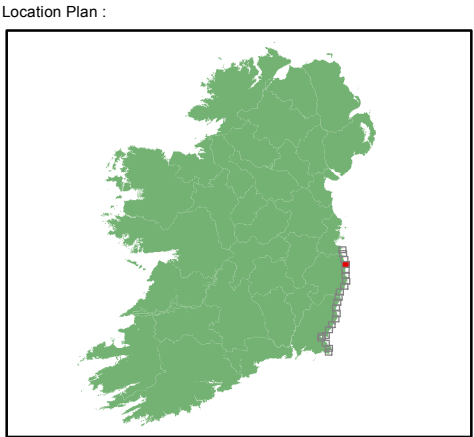
Figure By : PJW Date : Sept 2012  
Checked By : JMC & JR Date : Sept 2012

Figure No. : SE / RA / EXT / HEFS / 3 Revision : 0

Drawing Scale : 1:25,000 Plot Scale : 1:1 @ A3



Node Label	Water Level (mOD Malin) per AEP		
	WL 10%	WL 0.5%	WL 0.1%
Point 9	3.13	3.56	3.80



**EXTENT MAP**

Legend:

- 0.5% AEP FLOOD EXTENT (1 in 200 chance in any given year)
- 0.1% AEP FLOOD EXTENT (1 in 1000 chance in any given year)
- High Water Mark (HWM)
- Node Point

**Point 34** Node Label (refer to table)

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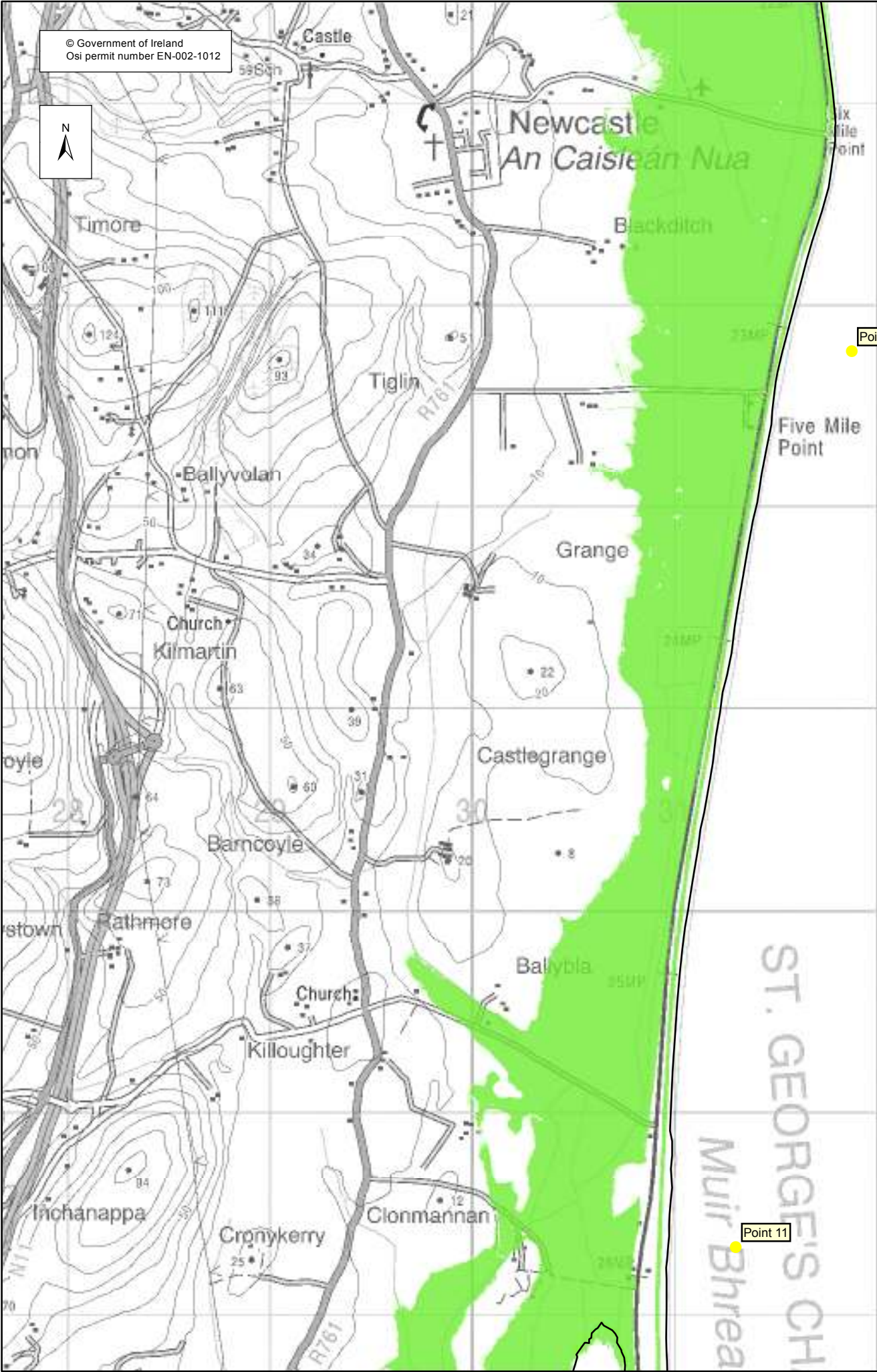
Project :  
IRISH COASTAL PROTECTION STRATEGY  
STUDY - PHASE II

Map :  
SOUTH EAST COAST FLOOD EXTENT MAP

Map Type :	FLOOD EXTENT	
Source :	TIDAL FLOODING	
Map area :	RURAL AREA	
Scenario :	HIGH END FUTURE SCENARIO	
Figure By :	PJW	Date : Sept 2012
Checked By :	JMC & JR	Date : Sept 2012

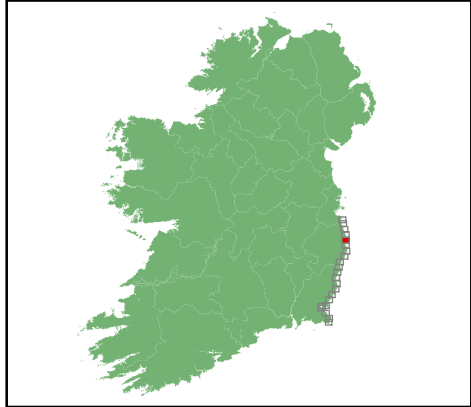
Figure No. :	Revision
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Drawing Scale : 1:25,000 Plot Scale : 1:1 @ A3



	Water Level (mOD Malin) per AEP		
Node Label	WL 10%	WL 0.5%	WL 0.1%
Point 10	3.01	3.43	3.65
Point 11	2.91	3.32	3.53

Location Plan :



EXTENT MAP

Legend:

- 0.5% AEP FLOOD EXTENT  
(1 in 200 chance in any given year)
- 0.1% AEP FLOOD EXTENT  
(1 in 1000 chance in any given year)
- High Water Mark (HWM)
- Node Point

Point 34 Node Label (refer to table)

USER NOTE :

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Northern Ireland



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17-19 Lower Hatch Street  
Dublin 2  
Ireland

Project :

IRISH COASTAL PROTECTION STRATEGY  
STUDY - PHASE II

Map :

SOUTH EAST COAST FLOOD EXTENT MAP

Map Type : FLOOD EXTENT

Source : TIDAL FLOODING

Map area : RURAL AREA

Scenario : HIGH END FUTURE SCENARIO

Figure By : PJW

Date : Sept 2012

Checked By : JMC & JR

Date : Sept 2012

Figure No. :

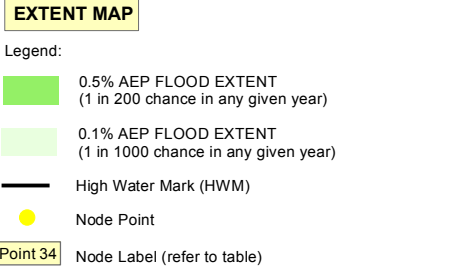
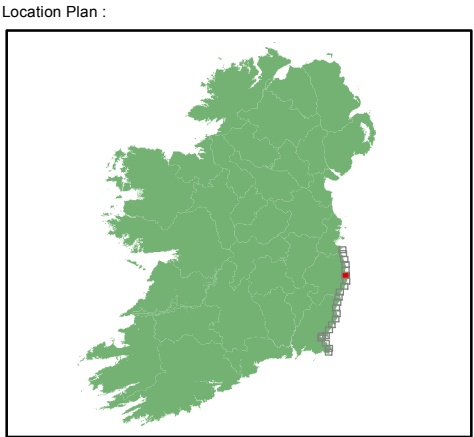
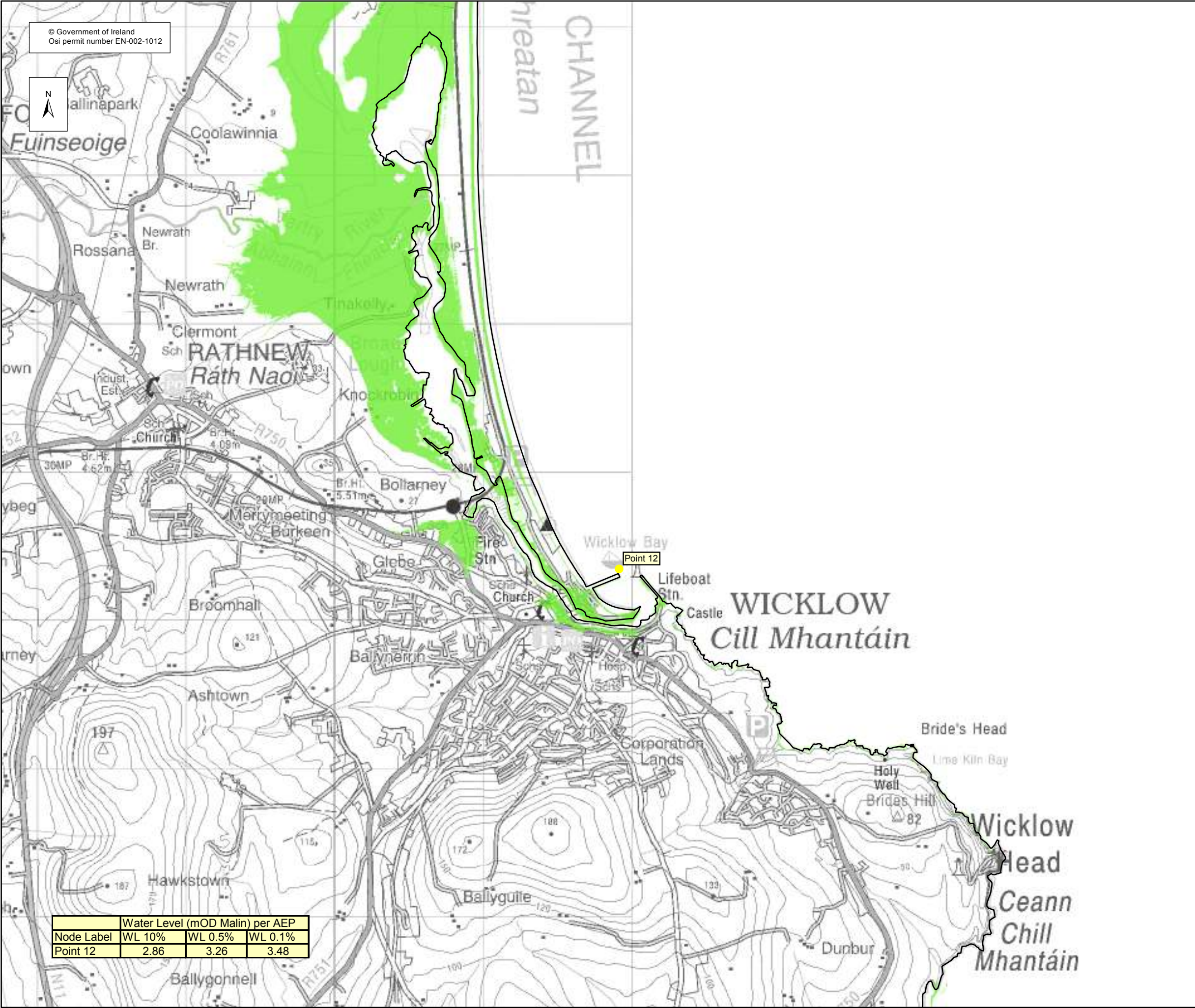
SE / RA / EXT / HEFS / 5

Revision

0

Drawing Scale : 1:25,000

Plot Scale : 1:1 @ A3



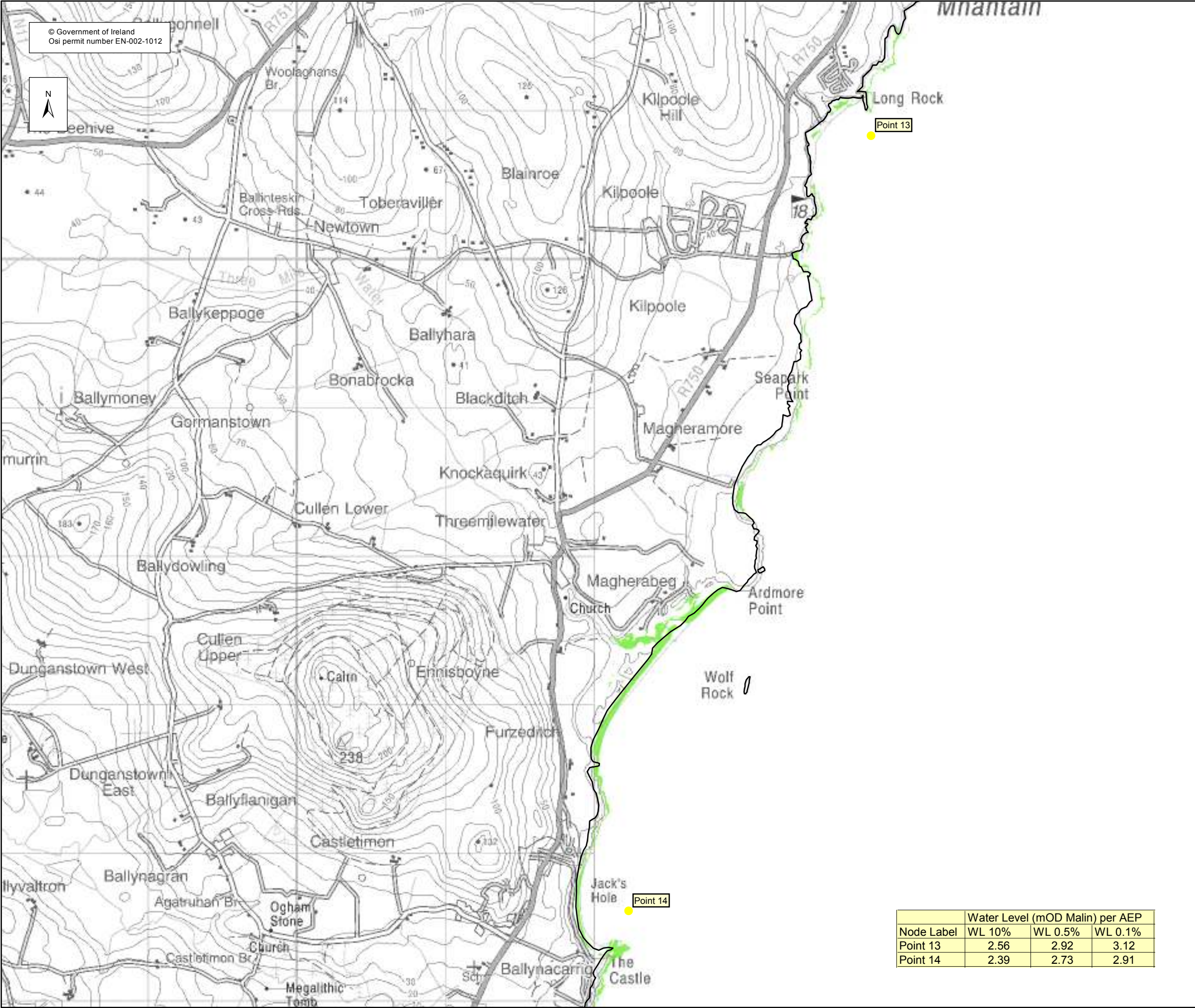
USER NOTE :

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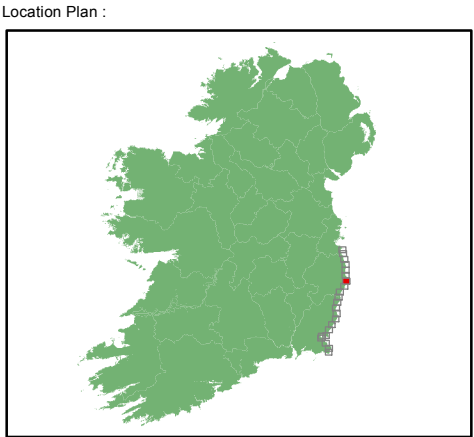
Project :	
IRISH COASTAL PROTECTION STRATEGY STUDY - PHASE II	
Map :	
SOUTH EAST COAST FLOOD EXTENT MAP	
Map Type :	FLOOD EXTENT
Source :	TIDAL FLOODING
Map area :	RURAL AREA
Scenario :	HIGH END FUTURE SCENARIO
Figure By :	PJW
Date :	Sept 2012
Checked By :	JMC & JR
Date :	Sept 2012
Figure No. :	
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Revision	
0	
Drawing Scale : 1:25,000	
Plot Scale : 1:1 @ A3	



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Node Label	Water Level (mOD Malin) per AEP		
	WL 10%	WL 0.5%	WL 0.1%
Point 13	2.56	2.92	3.12
Point 14	2.39	2.73	2.91



EXTENT MAP

- Legend:
- 0.5% AEP FLOOD EXTENT  
(1 in 200 chance in any given year)
  - 0.1% AEP FLOOD EXTENT  
(1 in 1000 chance in any given year)
  - High Water Mark (HWM)
  - Node Point
  - Point 34 Node Label (refer to table)

USER NOTE :

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STUDY - PHASE II

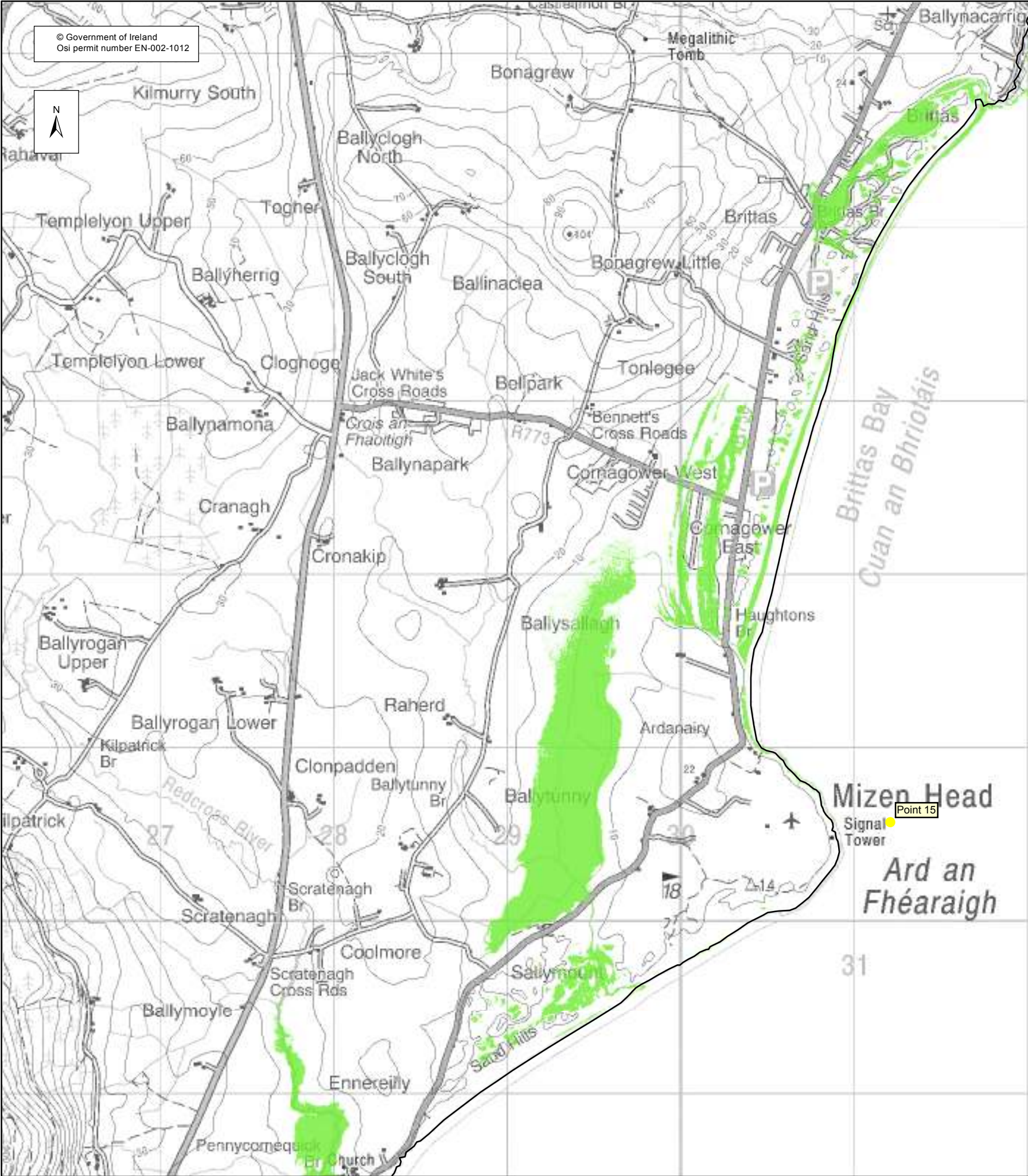
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SOUTH EAST COAST FLOOD EXTENT MAP

Map Type : FLOOD EXTENT  
Source : TIDAL FLOODING  
Map area : RURAL AREA  
Scenario : HIGH END FUTURE SCENARIO

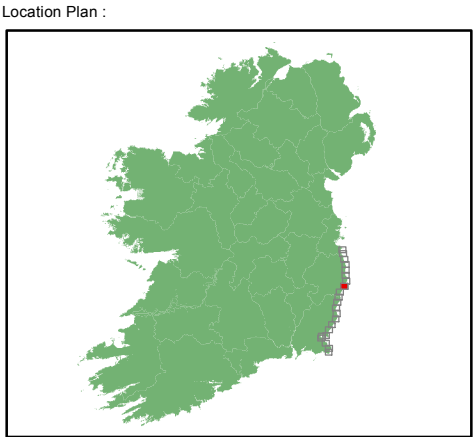
Figure By : PJW Date : Sept 2012  
Checked By : JMC & JR Date : Sept 2012

Figure No. : SE / RA / EXT / HEFS / 7 Revision : 0

Drawing Scale : 1:25,000 Plot Scale : 1:1 @ A3



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**EXTENT MAP**

Legend:

- 0.5% AEP FLOOD EXTENT  
(1 in 200 chance in any given year)
- 0.1% AEP FLOOD EXTENT  
(1 in 1000 chance in any given year)
- High Water Mark (HWM)
- Node Point

**Point 34** Node Label (refer to table)

**USER NOTE :**

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Project :  
**IRISH COASTAL PROTECTION STRATEGY  
STUDY - PHASE II**

Map :  
**SOUTH EAST COAST FLOOD EXTENT MAP**

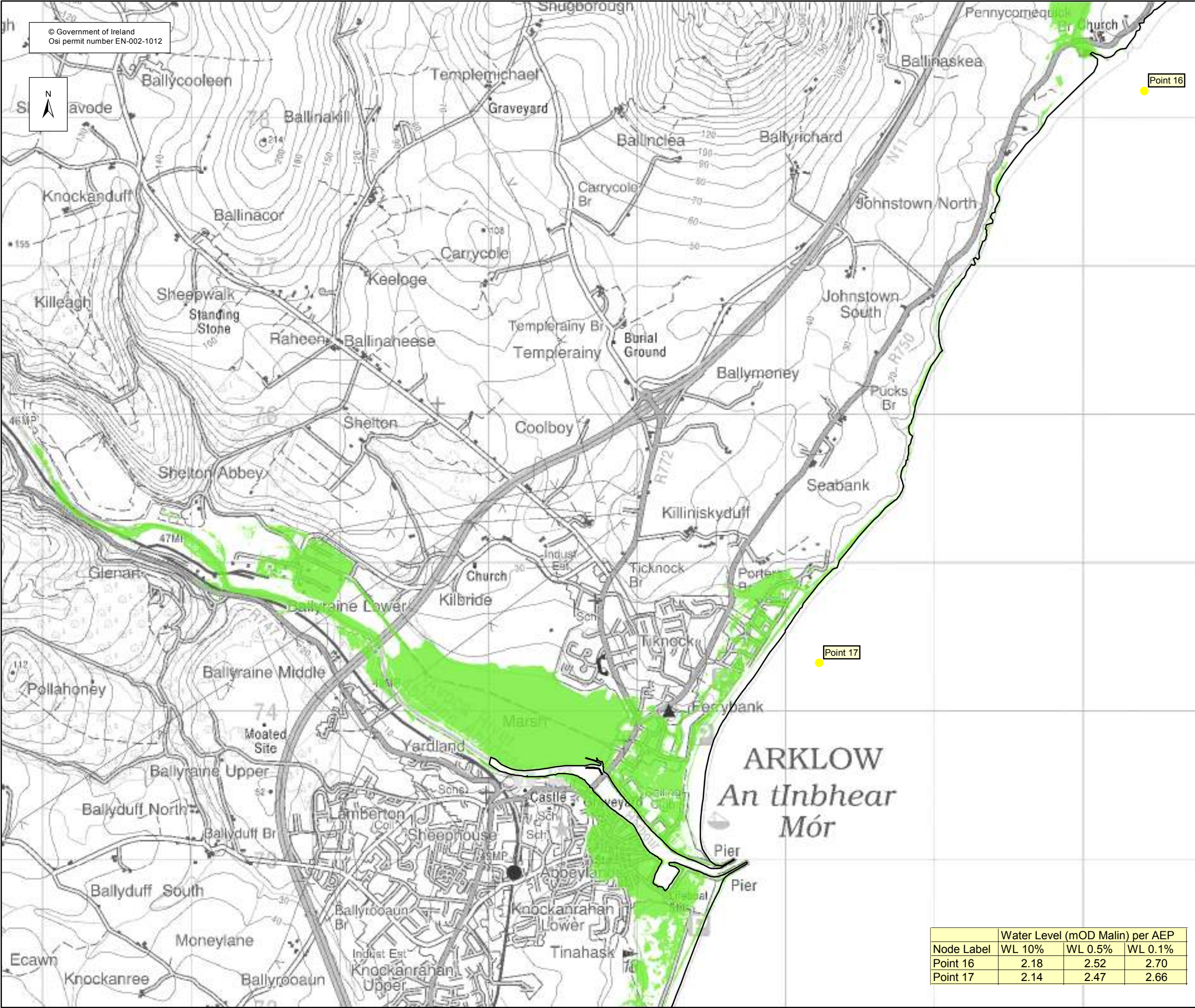
Map Type : FLOOD EXTENT  
Source : TIDAL FLOODING  
Map area : RURAL AREA  
Scenario : HIGH END FUTURE SCENARIO

Figure By : PJW Date : Sept 2012  
Checked By : JMC & JR Date : Sept 2012

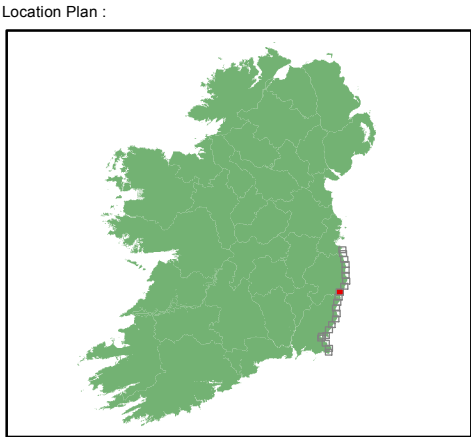
Figure No. :  
**SE / RA / EXT / HEFS / 8** Revision  
**0**

Drawing Scale : 1:25,000 Plot Scale : 1:1 @ A3

	Water Level (mOD Malin) per AEP		
Node Label	WL 10%	WL 0.5%	WL 0.1%
Point 15	2.24	2.58	2.76



Node Label	Water Level (mOD Malin) per AEP		
	WL 10%	WL 0.5%	WL 0.1%
Point 16	2.18	2.52	2.70
Point 17	2.14	2.47	2.66



EXTENT MAP

- Legend:
- 0.5% AEP FLOOD EXTENT (1 in 200 chance in any given year)
  - 0.1% AEP FLOOD EXTENT (1 in 1000 chance in any given year)
  - High Water Mark (HWM)
  - Node Point
  - Point 34 Node Label (refer to table)

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Map Type : FLOOD EXTENT  
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Scenario : HIGH END FUTURE SCENARIO

Figure By : PJW Date : Sept 2012  
Checked By : JMC & JR Date : Sept 2012

Figure No. : SE / RA / EXT / HEFS / 9 Revision : 0

Drawing Scale : 1:25,000 Plot Scale : 1:1 @ A3