Development of a MIKE 21 model to assess the risk of flooding from wave overtopping and tidal inundation of a site in Co. Clare, Ireland

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Outline of presentation

- Overview of site
- January 2014 event
- HD Model development
- Wave overtopping methodology
- Accounting for the wave volumes in the HD model
- Model results

Cloughaninchy Location

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Cloughaninchy

Clougher Revetment

Natural dune system

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January 2014 event – erosion and damage

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January 2014 event – flooding

HWM

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Emergency repairs

Assessment of January 2014 event

- Low rainfall event
- Surge event along the Clare Coast ~ 200 yr. event
- Projecting a 200yr level (3.2m OD) onto the site does not flood the houses: **wave overtopping the likely primary source of flooding**
- Residents confirmed significant volumes overtopped on the night in question
- Significant breach formation reduced the crest level of the embankment

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Development of HD model

- Two dimensional hydrodynamic model developed in MIKE 21 FM
- Calculates the time varying water level and current velocities on an irregular grid in response to various forcing functions
- Numerous model parameters are required to be defined as part of the model build

Computational mesh – full extent

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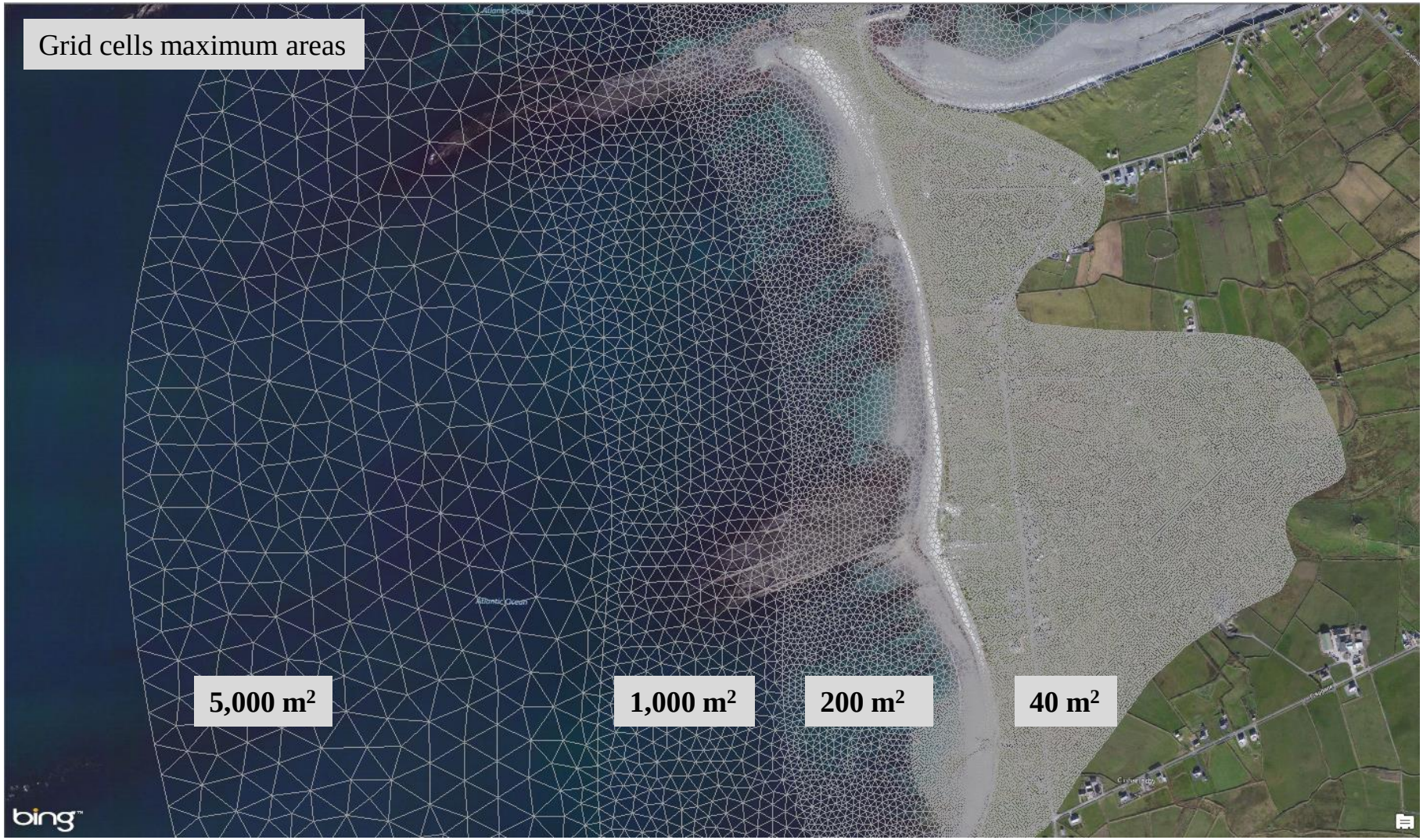
Computational mesh – zoom in



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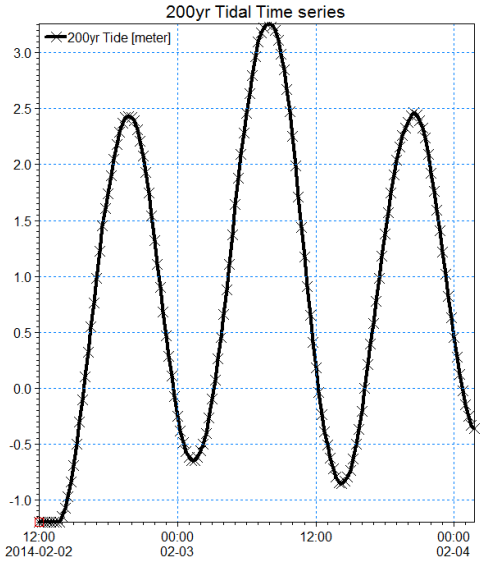
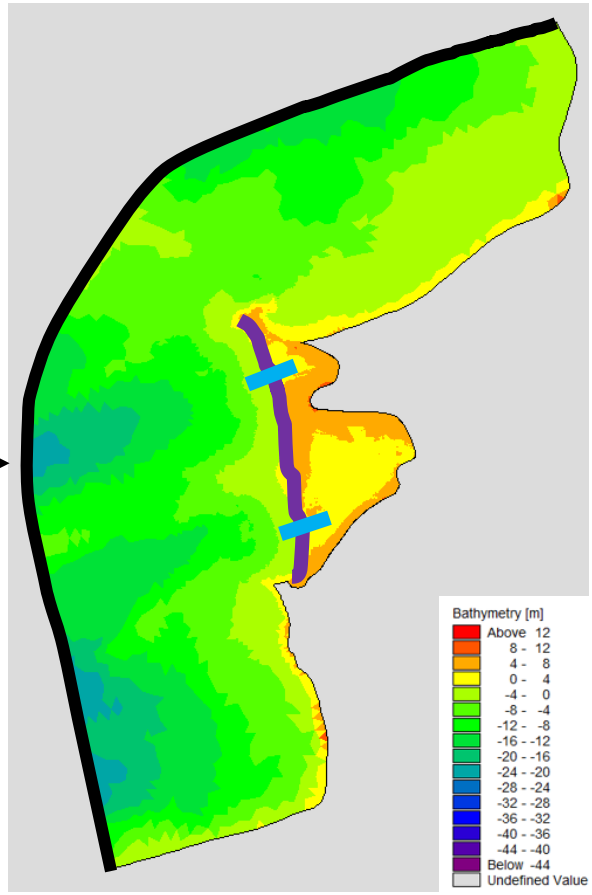
Running the hydrodynamic model

Tidal Boundary Condition





Wind Forcing
River flow data
Time step
Flooding/drying depth
Bed resistance
Eddy viscosity

Wave OT
Discharges

HD Result File: Time varying water level and current velocities

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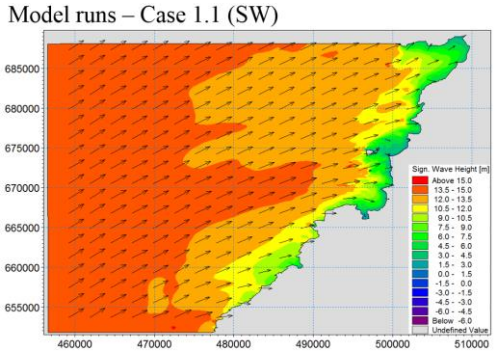
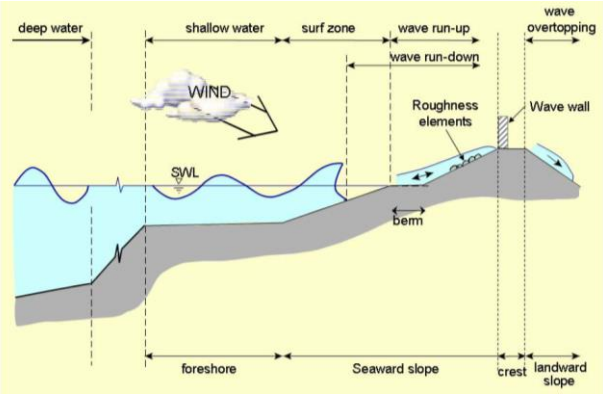
Wave overtopping estimation methodology

Step 1 – **Nearshore Spectral Wave Model (MIKE 21 SW)**



Step 2 – **Wave OT calcs – Eurotop & CIRIA Rock Manual**



Step 3 – **Inclusion of source discharge points in the model**

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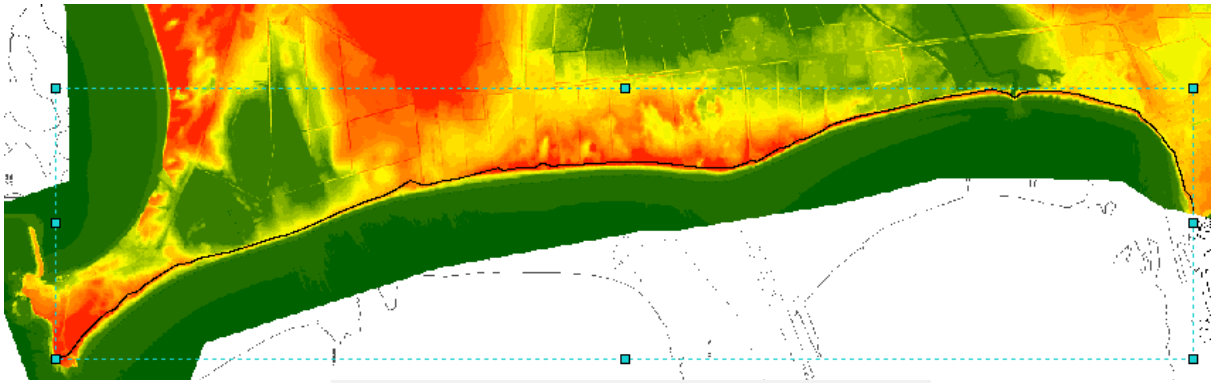
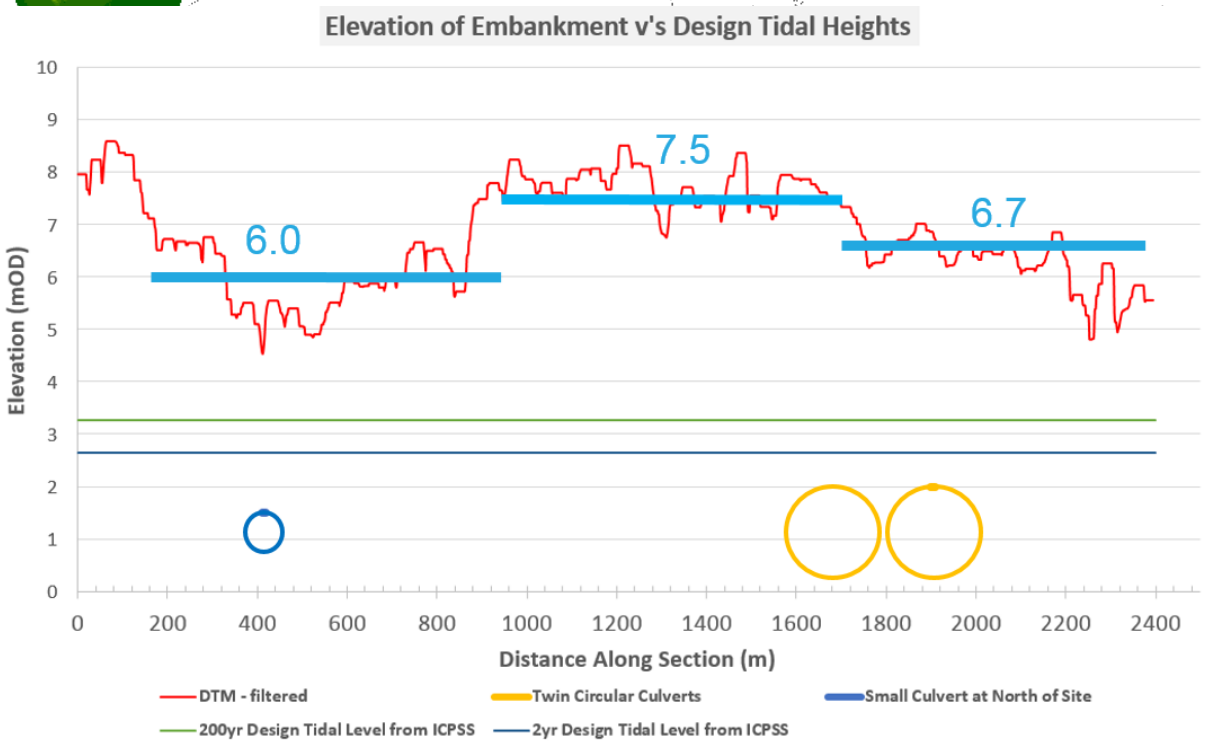
Applying the OT methodology to Cloughaninchy

- Overtopping calc calculates the **l/s/m** in overtopping for a specific cross section - how do we apply it to the Cloughaninchy?
- Simplify the geometry of the embankment & make a number of assumptions on the overtopping
- Wave overtopping: Order of magnitude accuracy!

Geometry of the embankment

Embankment simplified into three sections of approximate equal crest level





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OT duration assumptions

THREE: Time between successive wave overtoppings: 17.5s (wave period)

ONE: Wave OT Threshold set at 2mOD

Q - OT calcs l/s/m	No of secs above threshold (*from tidal curves*)	Duration of single wave overtopping	Time between sucessive wave overtopping	Duration of OT per tidal cycle	OT Vol per m
					Q1
	secs	secs	secs	secs	m3/m
8	12600	2.5	17.5	1800.0	51.379

From OT calcs

TWO: Duration of a single overtopping wave: 2.5s

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Specification of source discharge points

- Source discharge points defined at 60m intervals on the land side of the embankment

Q1
m3/m
51.379

* 60

Check on crest level geometry:

Tide + WH + OT Factor > crest level

OT volumes applied as a steady discharge

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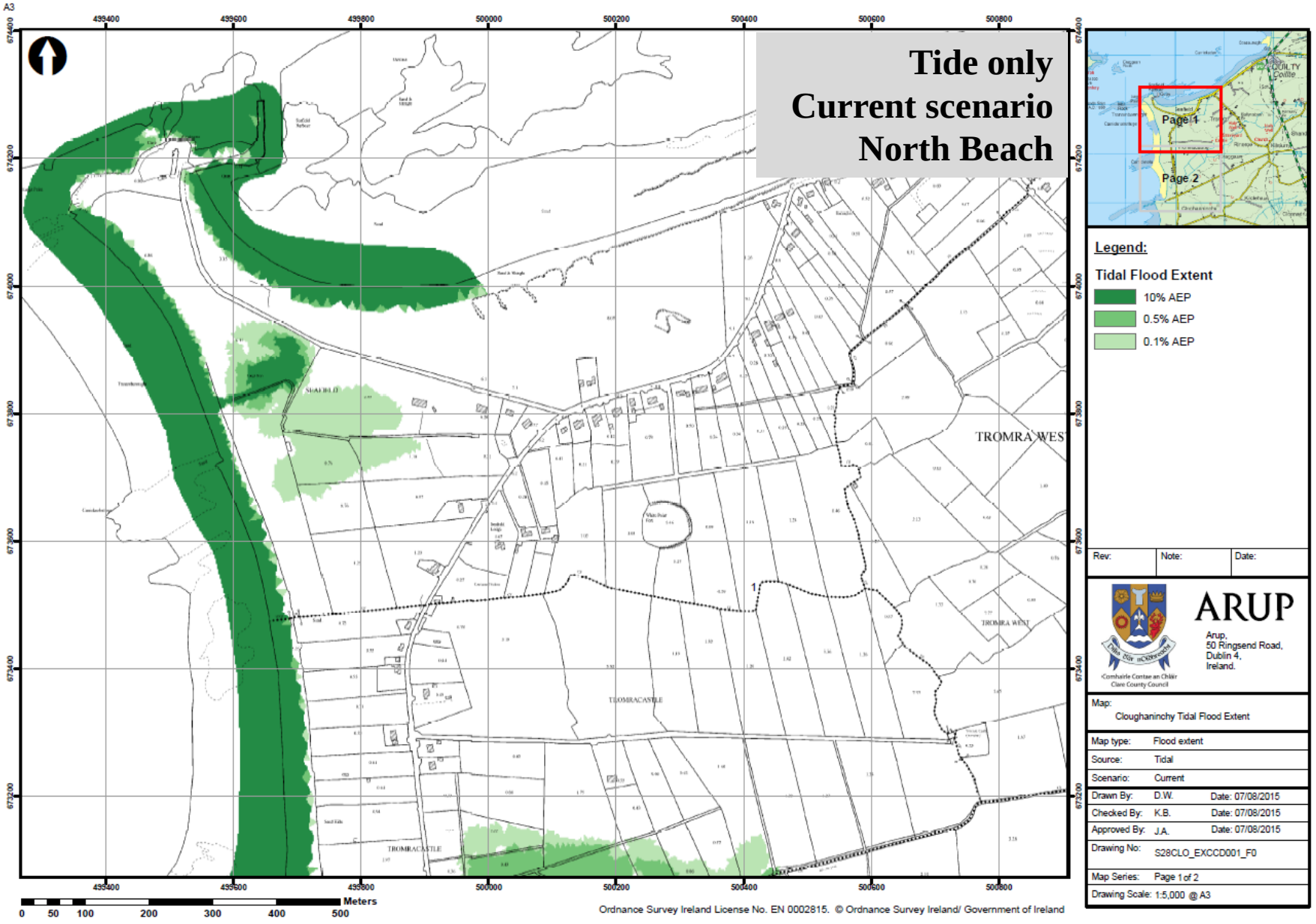
Modelling results

- Return periods considered: 2yr, 10yr, 50yr, 100yr, 200yr, 1000yr
- Scenarios: Current, MRFS, HEFS
- Sources:
  - Tide only
  - Tide + Wave Overtopping
  - Tide + Wave Overtopping + Breach


A3
Tide only
Current scenario
North Beach
Page 1
Page 2
Legend:
Tidal Flood Extent
10% AEP
0.5% AEP
0.1% AEP
Rev:
Note:
Date:
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Arup,
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Comhairle Contae an Chláir
Clare County Council
Map:
Cloughaninchy Tidal Flood Extent
Map type: Flood extent
Source: Tidal
Scenario: Current
Drawn By: D.W. Date: 07/08/2015
Checked By: K.B. Date: 07/08/2015
Approved By: J.A. Date: 07/08/2015
Drawing No: S28CLO_EXCCD001_F0
Map Series: Page 1 of 2
Drawing Scale: 1:5,000 @ A3
TROMRA WEST
TROMRACASTLE
SHACKLID
0 50 100 200 300 400 500 Meters
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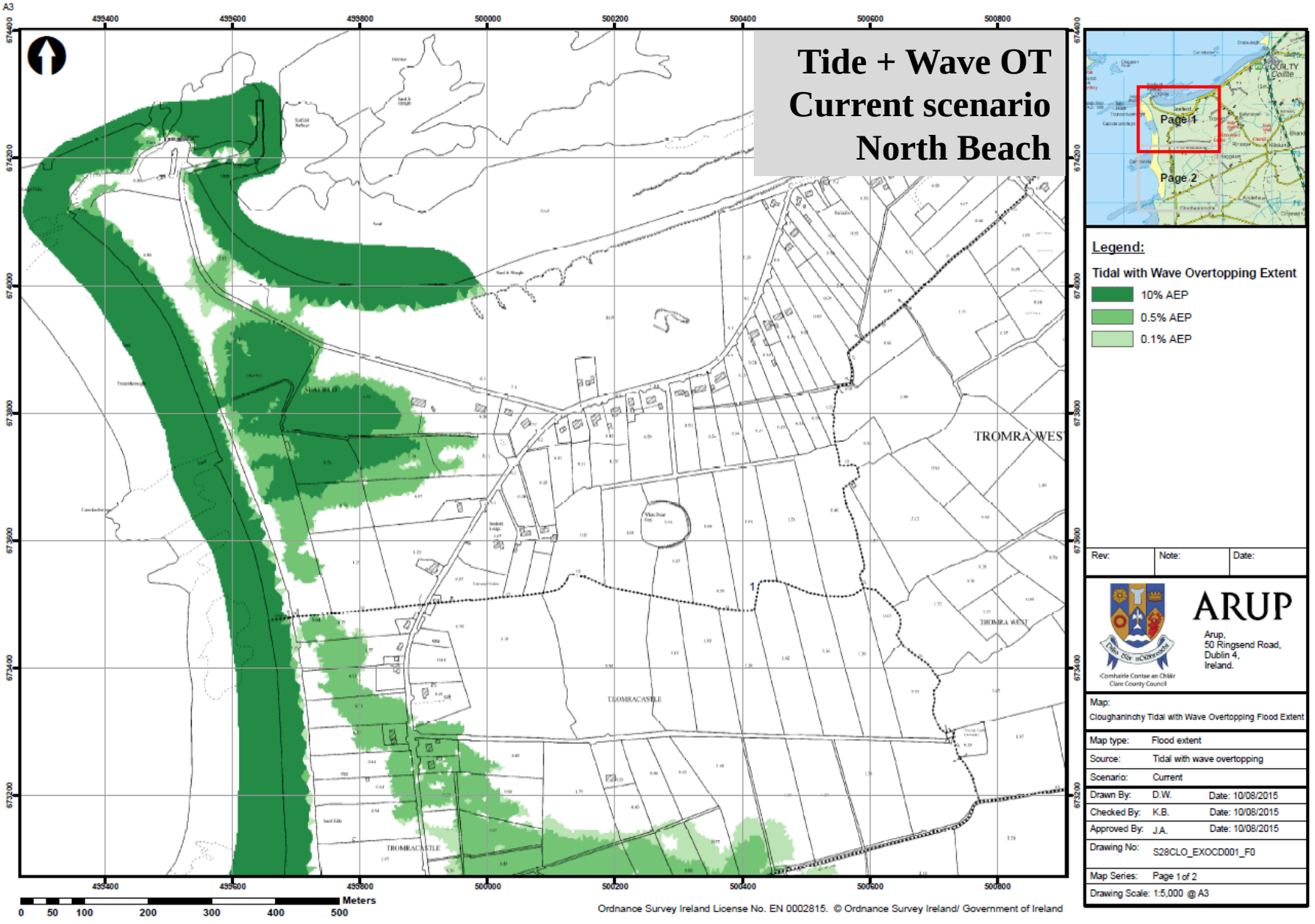
Tide + Wave OT
Current scenario
North Beach
A3
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TROMRA WEST
TROMRA WEST
TROMRACASTLE
TROMRACASTLE
Page 1
Page 2
Legend:
Tidal with Wave Overtopping Extent
10% AEP
0.5% AEP
0.1% AEP
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Cloughaninchy Tidal with Wave Overtopping Flood Extent
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Meters
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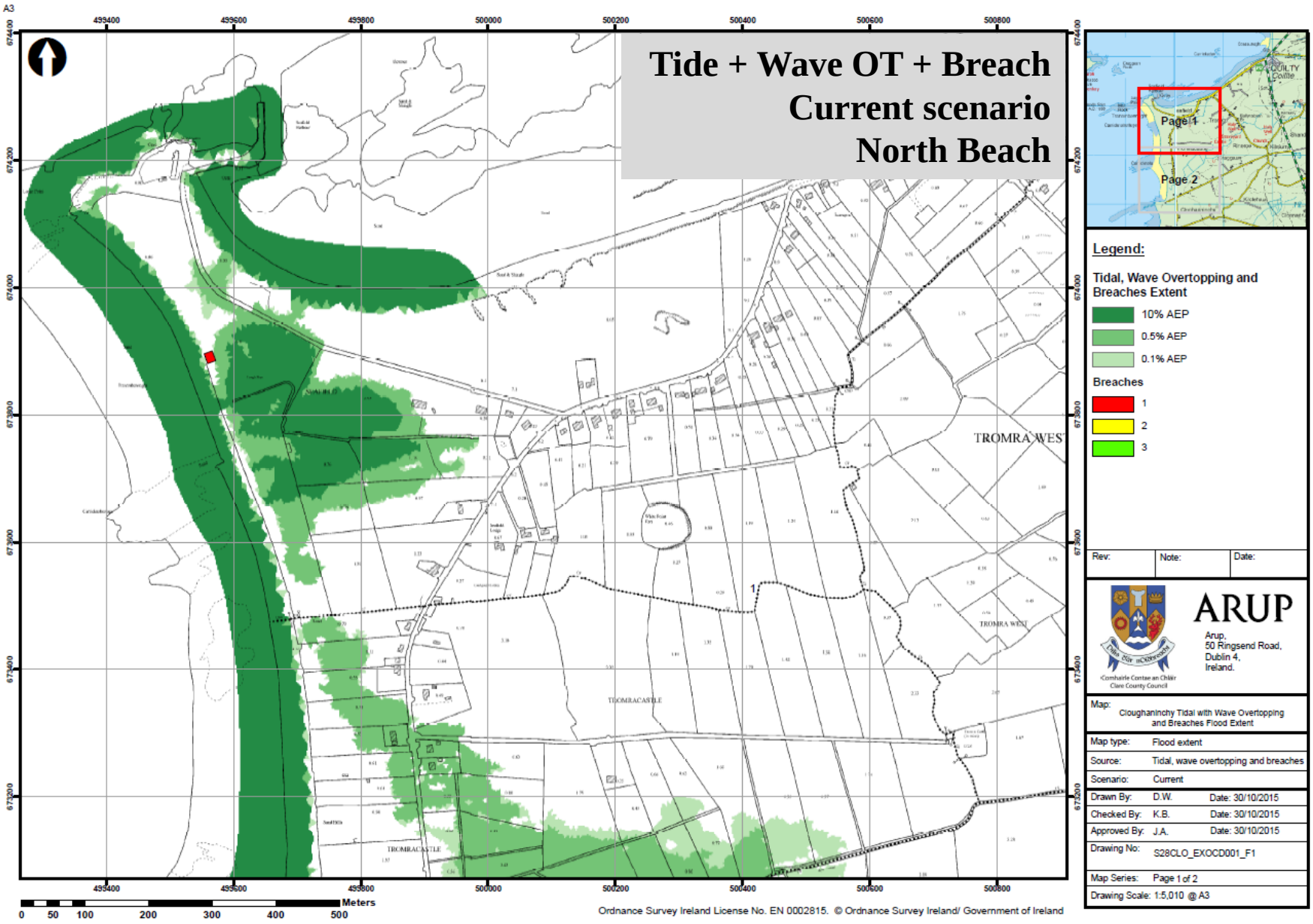
Tide + Wave OT + Breach
Current scenario
North Beach
A3
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TROMRA WEST
TROMRACASTLE
Page 1
Page 2
Legend:
Tidal, Wave Overtopping and Breaches Extent
10% AEP
0.5% AEP
0.1% AEP
Breaches
1
2
3
Rev:
Note:
Date:
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Clare County Council
Map:
Cloughaninchy Tidal with Wave Overtopping and Breaches Flood Extent
Map type: Flood extent
Source: Tidal, wave overtopping and breaches
Scenario: Current
Drawn By: D.W. Date: 30/10/2015
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Approved By: J.A. Date: 30/10/2015
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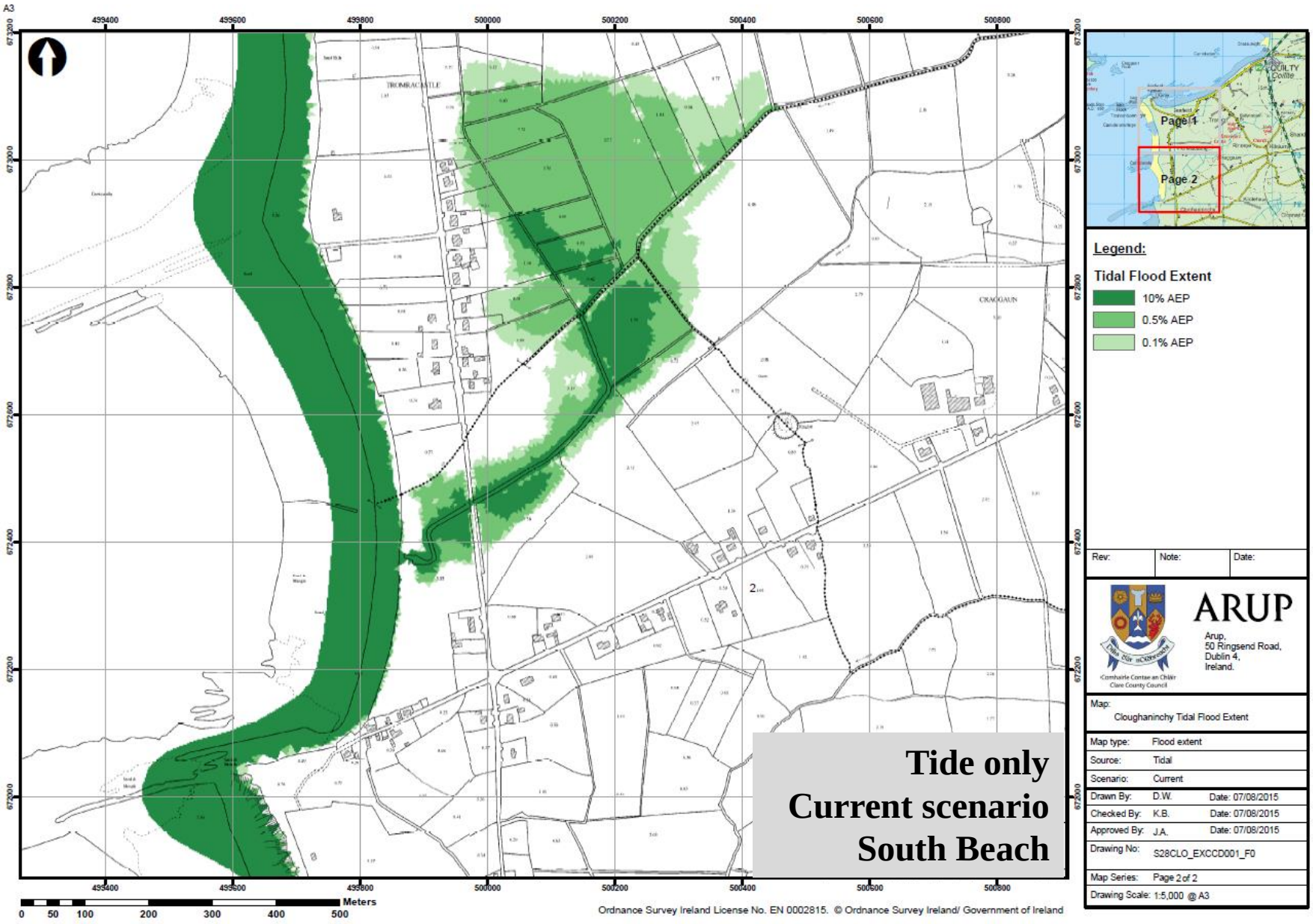
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Tide only
Current scenario
South Beach
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Meters
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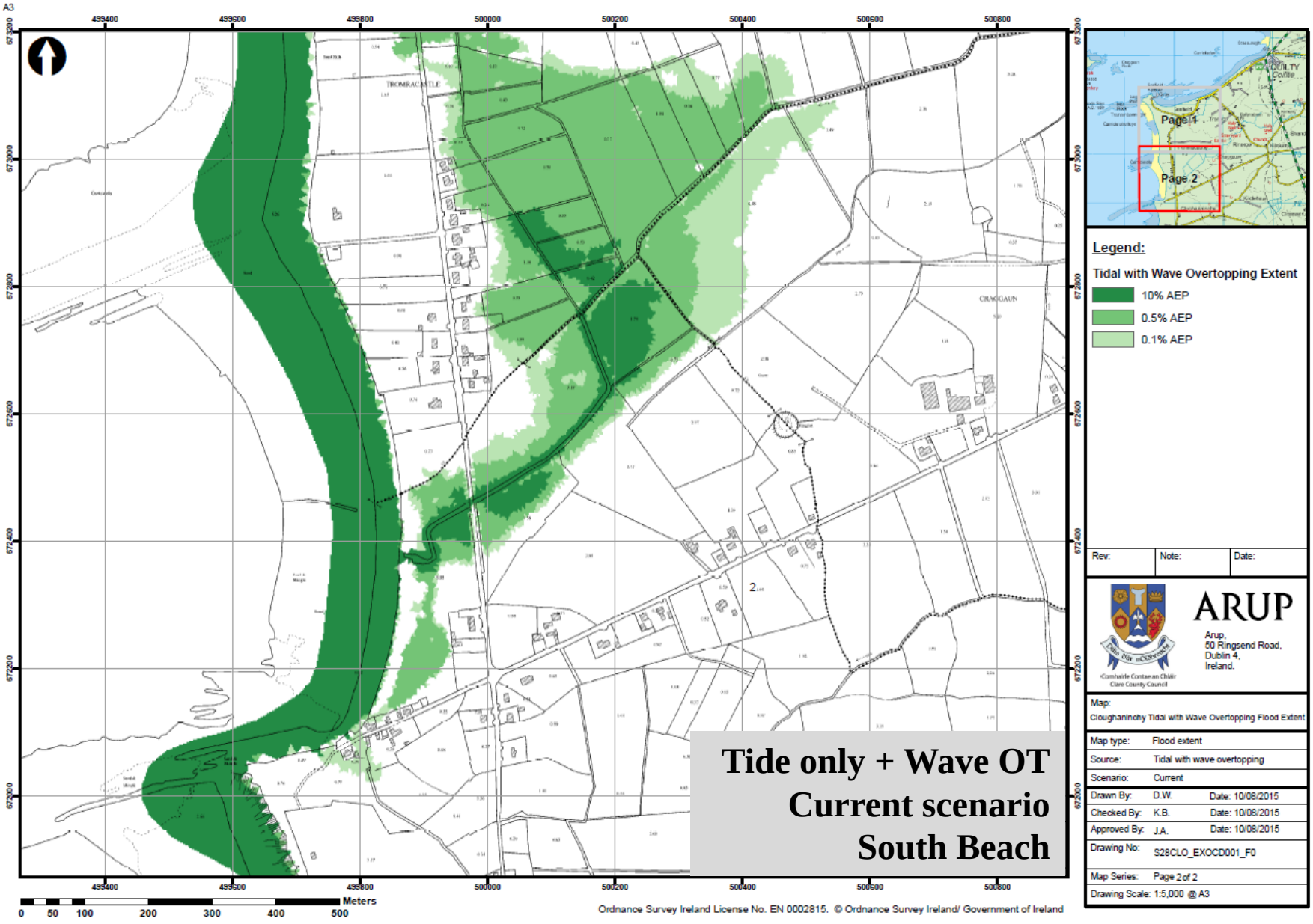
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Clare County Council
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Drawing Scale: 1:5,000 @ A3
Tide only + Wave OT
Current scenario
South Beach
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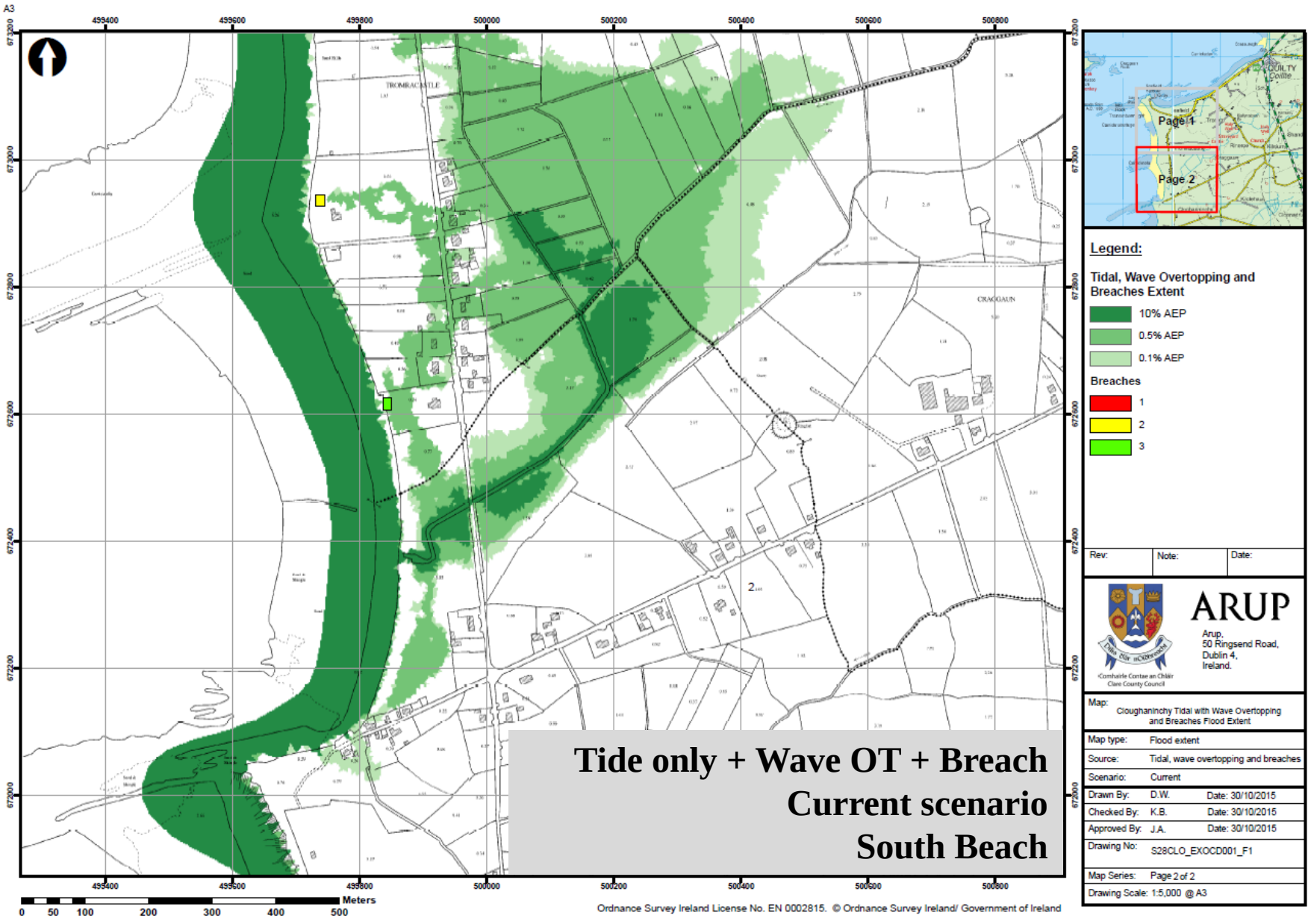
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Tide only + Wave OT + Breach
Current scenario
South Beach
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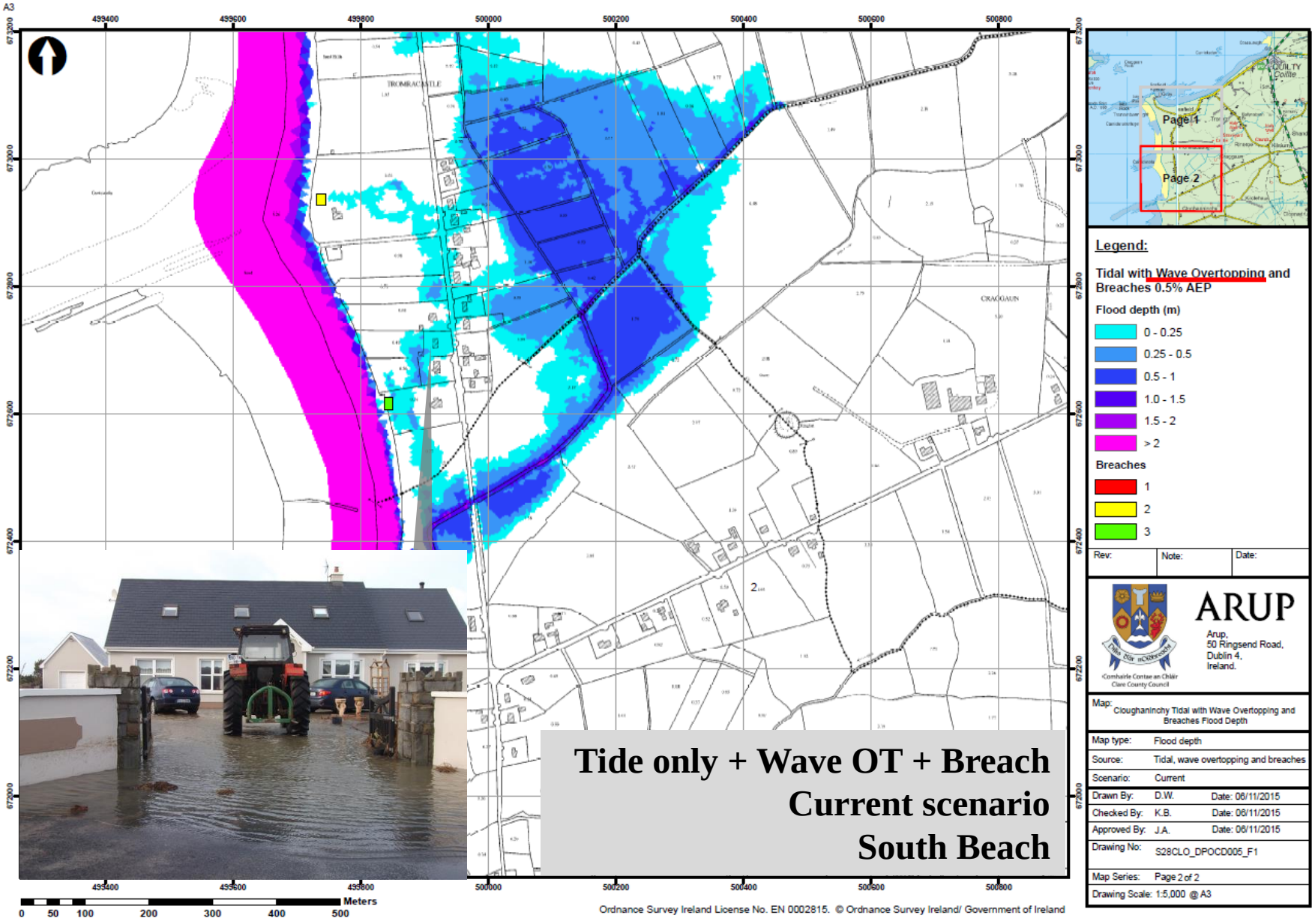

Tide only + Wave OT + Breach
Current scenario
South Beach

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Conclusions

- Flood risk from wave overtopping can be overlooked in the assessment of coastal flood risk, but at Cloughaninchy it proved to be the primary source of flooding
- Engineering solutions required for Cloughaninchy and are currently being advanced
- Justification of defences in remote rural areas can be difficult due to benefit cost ratio being less than 1

Questions?

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