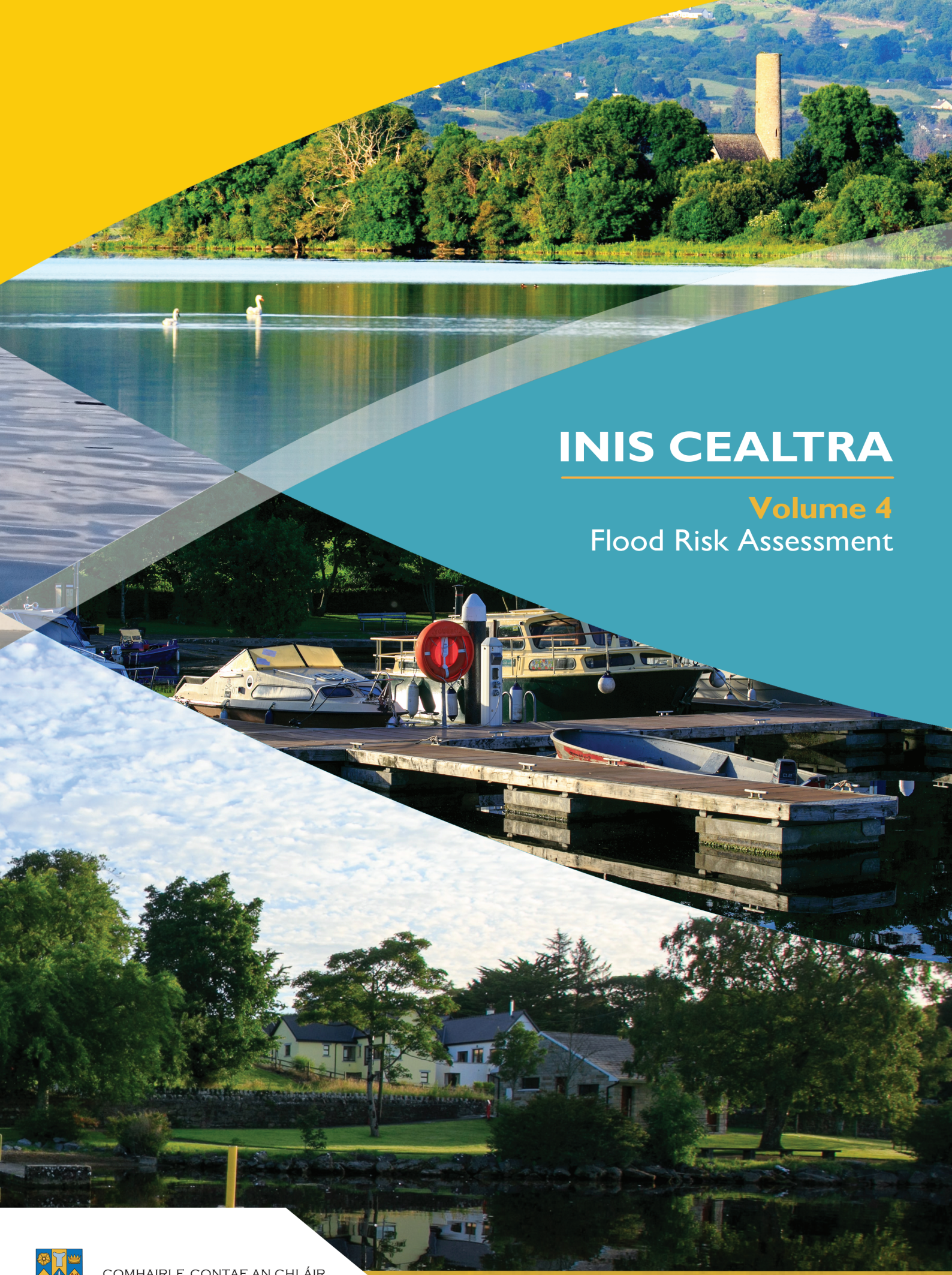

INIS CEALTRA

Volume 4
Flood Risk Assessment

COMHAIRLE CONTAE AN CHLÁIR
CLARE COUNTY COUNCIL

Prepared for Clare County Council
by **Solearth Architecture**

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
V1.0 February 2017	First Issue	Clare County Council
V2.0 March 2017	Text amendment	Clare County Council

Contract

This report describes work commissioned by Clare County Council by an email dated 3 February 2017. Clare County Council's representative for the contract was Brian O'Brien of Solearth Architects. Ross Bryant and Jonathan Cooper of JBA Consulting carried out this work.

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Abbreviations

AEP	Annual Exceedance Probability
CFRAM	Catchment-Based Flood Risk Assessment and Management Study
DoEHLG	Department of the Environment, Heritage and Local Government
EC	European Community
ESB	Electricity Supply Board
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
GEV	General Extreme Value Distribution
GL	General Logistic Distribution
mOD	Meters above Ordnance Datum
OPW	Office of Public Works
PFRA	Preliminary Flood Risk Assessment

1 Introduction

Under *The Planning System and Flood Risk Management Guidelines for Planning Authorities*[1] (the Planning Guidelines), a development in an area of flood risk must undergo a Flood Risk Assessment to ensure sustainable development and effective management of flood risk.

1.1 Terms of Reference

JBA was appointed by Clare County Council, to prepare a Flood Risk Assessment (FRA) for a proposed Inis Cealtra VMSTDP (Visitor Centre) in Mountshannon. JBA Consulting undertook a review of the development proposals in the context of the Planning Guidelines noted above.

1.2 Flood Risk Assessment: Aims and Objectives

This study is being completed to assess the level of flood risk to the current site. It aims to identify, quantify and communicate to Planning Authority officials and other stakeholders the risk of flooding to land, property and people and the measures that would be recommended to manage the risk.

The objectives are to:

- Identify potential sources of flood risk;
- Examine existing flood outlines for the location and, if possible, improve upon their accuracy;
- Develop appropriate flood risk mitigation and management measures which will allow for the long term development of the site;
- Assess the impact of the development on surrounding areas and properties.
- Provide sufficient material evidence to demonstrate flood risk with respect to the development proposals are in accordance with the Planning Guidelines.

A review of the likely effects of climate change, and the long term impacts this may have on the site has also been undertaken.

1.3 Report Structure

Section 2 of this report gives an overview of the study location and associated watercourses. Section 3 contains background information and initial assessment of flood risk. An overview of the technical approaches to Flood Risk Assessment (FRA) and site specific mitigation measures are included in Section 3. Conclusions and recommendations are highlighted in Section 4.

For general information on flooding, the definition of flood risk, flood zones and other terms see 'Understanding Flood Risk' in Appendix A.

1 The Planning System and Flood Risk Management – Guidelines for Planning Authorities, November 2009

2 Flood Risk Identification

As discussed in Section 1, the Planning Guidelines require that the potential for flood risk is identified for built development. This section includes a description of the site location and topography, a review of historic flooding and identification of the sources and scale of flood risk issues.

2.1 Site Description & Proposed Development

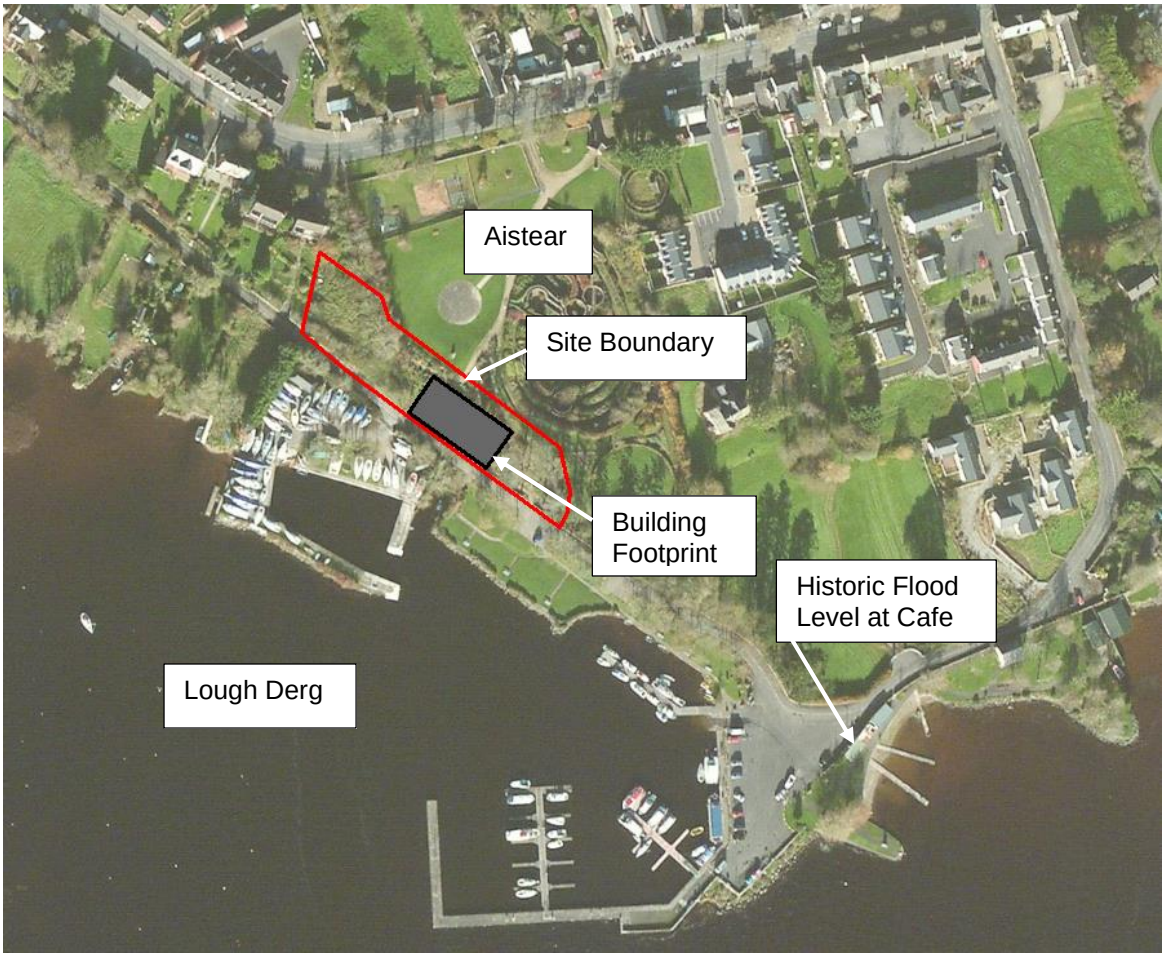
The proposed development consists of a Visitor Centre, embarkation point and associated services. Its role would be to serve visitors arriving in Mountshannon to study or learn about Inis Cealtra in particular and East Clares heritage in general, to facilitate their needs and to provide services for them including embarkation point to Inis Cealtra itself.

The site is located in the centre of Mountshannon Village at the southern end of the Aistear park. Lough Derg is located immediately to the south, across a local access road.

Building GIFA would be no more than 1250sqm under 2 scenarios;

a. If Flood risk assessment indicates lowest FFL can be within 200m of the current lake front road; 30 to 40% of brief on lower (lake road level) eg including ferry ticketing and embarkation, access to island ferry, perhaps café, and other with remainder on level above (and accessed from park).
b. If FRA indicates FFL cannot be within 500mm of this road level; only part of brief that can withstand flooding (embarkation, marshalling etc) to lake road level and remainder (most of brief) to park level above.

Figure 2-1 Location of Site



World_Imagery - Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

2.2 Historic Flooding

2.2.1 Lough Derg and Historic Recorded Lake Levels

Lough Derg is the lowest lake on the Shannon system and has a surface area of 118km^2. Water level data on Lough Derg has been recorded at a number of stations dating back to 1932. Levels are monitored by the ESB for Portumna and Killaloe. Taken relative to a central axis of the lake Portumna is located 19km to the north and Killaloe is 15km to the south.

November 2009 is the highest level on record for Lough Derg (Portumna and Killaloe). According to Cawley & Cunnane[2], the 2009 event has an estimated 0.6% AEP (1 in 172 years). The 2015/16 flood event ranked as second highest.

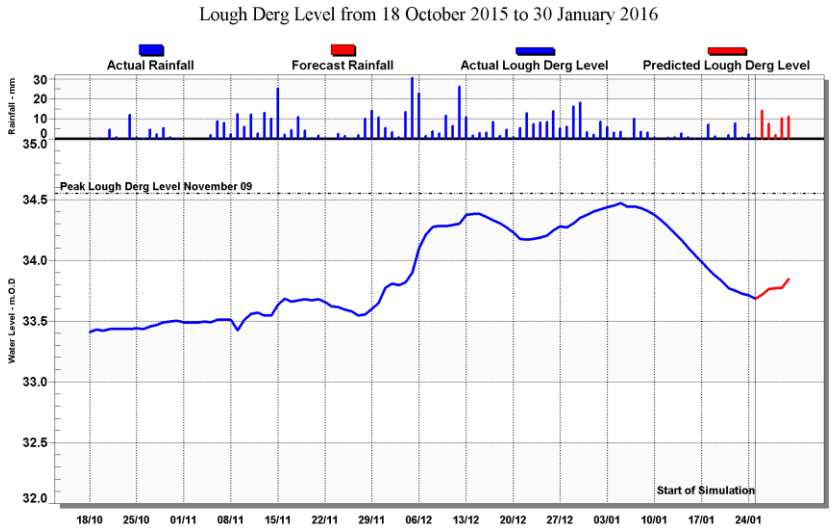
A more comprehensive record of historic levels is presented in the table below, which was supplied by ESB. Levels have been converted from Poolbeg to Malin Head datum by deducting a value of 2.71m. With a mean difference of 0.42m between the two stations the water surface gradient is approximately 0.0124m/m. Using this gradient an adjustment of -0.24m can be made to Portunma water levels to estimate potential levels at Mountshannon.

Figure 2-2 provides a graphical representation of the levels for Winter 2015/2016 - note that the y axis is in Poolbeg datum. Peak lake levels were on 13 December 2015 and 4/5 Jan 2016.

Table 2-1 ESB Historic Peak Levels for Portumna and Killaloe

Flood Event	Portumna Peak Level (mOD Malin)	Killaloe Peak Level (mOD Malin)	Difference Portumna - Killaloe (m)	Estimated Level @ Mountshannon
Winter 1994/1995 (March 1995)	31.69	31.3	0.39	31.46
Winter 1999/2000 (December 1999)	31.59	31.19	0.4	31.36
Winter 2006/2007 (January 2007)	31.59	31.2	0.39	31.36
Winter 2009/2010 November 2009	32.05	31.62	0.43	31.82
Winter 2015/2016 January 2016	31.97	31.55	0.42	31.74
Highest since 1932 (November	32.05	31.62	Mean Diff 0.42	-

Figure 2-2 ESB Level/Forecasting Winter 2015/2016



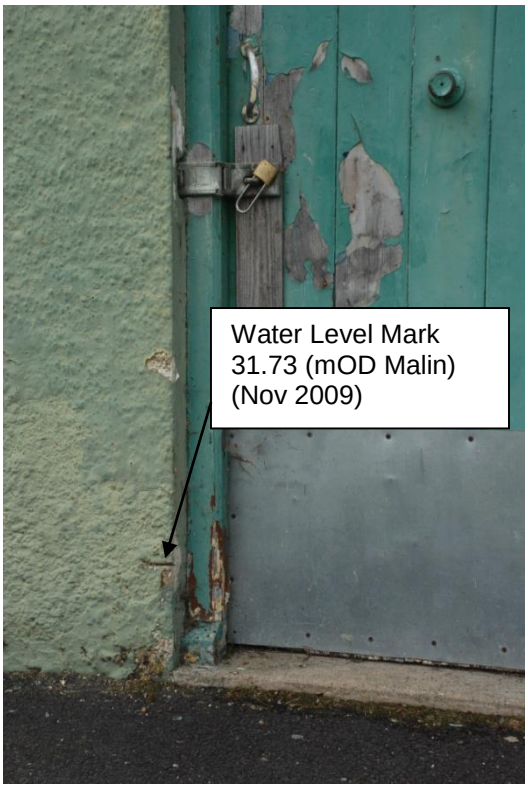
2 Cawley, A. and Cunnane, C., 2010: Comment on the November 2009 Flooding in the Shannon and Corrib Systems. Irish National Hydrological Conference 2010

2.2.2 Local Anecdotal Evidence

2.2.2.1 November 2009

A local Café situated a short distance from the Aistear, adjacent to the marina, flooded during the November 2009 event. A flood mark was recorded on the neighbouring property and this is shown in Figure 2-3 below. Flooding from this event encroached into the car park adjacent to the Café, but no further images or references are available for the November 2009 event. The flood level estimate of 31.73mOD Malin is 0.09m lower than that estimated from the water surface gradient in Table 2-1.

Figure 2-3 Flood Mark at adjacent property (November 2009)



2.2.2.2 Winter 2015/16

Six storms affected the country in November and December 2015: Abigail on 12 November, Barney on 17 November, Clodagh on 29 November, Desmond on 4/5 December, Eva on 23 December and Frank on 29/30 December. The most significant of these for flooding were Abigail Desmond and Frank[3]. Levels on the Shannon system were high from mid-November 2015 to mid-January 2016.

The second largest flood event on record for Lough Derg occurred in early January 2016 it was recorded at Portumna as being 80mm lower than 2009 with a level of 31.97mOD Malin. There was also a peak around 13 December 2015 in the aftermath of Storm Desmond.

Updated analysis from the 2015 event is yet to be published, but the 2015 event was still a significant hydrological event on the Shannon catchment.

A review of online data located several photographic records of flooding in Mountshannon. These are reproduced over the page and indicate that the public road, the Aistear and proposed development site were not impacted by flooding during December 2015 and January 2016.

3 Oliver Nicholson, Dr. Fasil Gebre: 07 - OPW response to the Winter 2015/16 flooding in Ireland, National Hydrology Conference 2016.

Figure 2-4 Aerial Flood Image 10 December 2015

Source: https://www.youtube.com/watch?v=HRgDFCPVW3Q

Figure 2-5 Flooding adjacent to site 18 December 2015

Source: http://floatingboater.blogspot.ie/2015/12/not-quite-as-bad-as-2009-but-very-close.html

2.2.3 Floodmaps.ie

The OPW have established a National Flood Hazard Mapping website, www.floodmaps.ie, which highlights areas at flood risk through the collection of recorded data and observed flood events. Although the website provides significant national data there are no records of flooding at or within the local area of the proposed development site.

2.3 Predictive Flood Mapping Sources

The Mountshannon area has been subject to three predictive flood mapping or modelling suites:

1. OPW Preliminary Flood Risk Analysis (2011),
2. OPW Shannon CFRAM Study modelling and mapping (2016),
3. Clare County Development Plan 2017-2023,

The level of detail presented by each method varies according to the quality of information used and approaches involved. The Shannon CFRAM Study is currently the most detailed assessment of flood extent and supersedes the fluvial flood outlines presented by the OPW PFRA study. The Shannon CFRAM Study mapping was utilised and displayed within the Clare County Development Plan 2017-2023.

2.3.1 OPW Preliminary Flood Risk Analysis (PFRA)

The preliminary Flood Risk Assessment (PFRA) is a requirement of the EU Flood Directive (2007/60/EC). One of the PFRA deliverables is flood probability mapping for various sources: pluvial (surface water), groundwater, fluvial (surface water) and tidal. The PFRA is a preliminary or 'indicative' assessment and analysis has been undertaken to identify areas potentially prone to flooding. The fluvial data has largely been superseded by the latest CFRAM mapping however the PFRA flood maps still provide valuable information regarding pluvial and groundwater flooding. See Figure 2-6 for OPW PFRA flood extents at the site and surrounding area.

Review of the PFRA flood maps do not show pluvial or groundwater extents at the site or immediate surrounding area.

Figure 2-6 OPW PFRA Mapping

2.3.2 Shannon CFRAM

The Shannon Catchment Flood Risk Assessment and Management Study (Shannon CFRAM) commenced in June 2011 and is expected to conclude by the end of 2017. The study involves detailed hydraulic modelling of rivers and their tributaries.

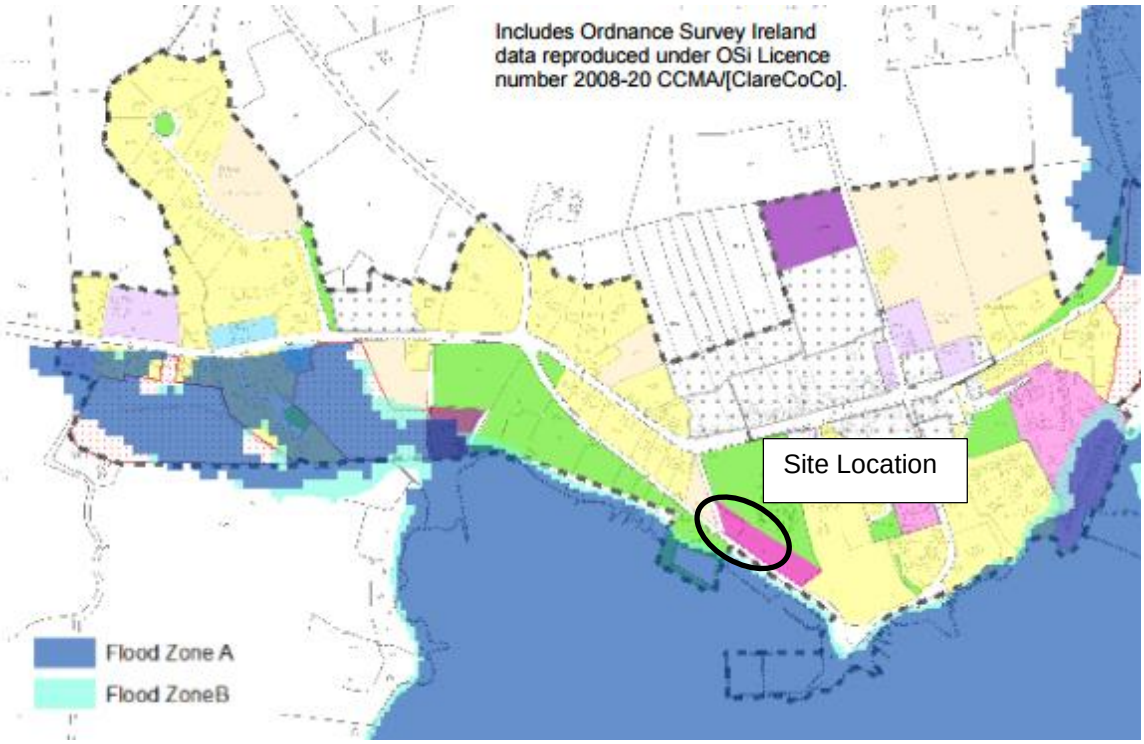
The River Shannon and Lough Derg were included under the CFRAMS. Flood maps for the 10%, 1% and 0.1% AEP are publicly available through the CFRAMS website, however mapping in Mountshannon is currently unavailable from this source, but it is reproduced by the Clare County Development Plan in Section 2.3.3 below. It should be noted that the CFRAM mapping did not specifically model lake levels to a high degree of accuracy.

2.3.3 County Development Plan

The Clare County Development Plan takes cognisance of the Planning and Development Act 2000 (as amended) and also The Planning System & Flood Risk Management – Guidelines for Planning Authorities (DoEHLG & OPW Nov 2009).

The Clare County Development Plan 2017-2023 includes the use of the latest OPW CFRAM mapping. Figure 2-7 shows the relevant extract for the development site. The development site is indicated as being within Flood Zone C, the mapping does indicate partial flooding of the marina carpark and open space as noted in Section 2.2.2.

Figure 2-7 Extract from Clare County Development Plan 2017-2023



2.4 Sources of Flooding

Following the Planning Guidelines, Stage 1 of a Flood Risk Assessment requires the identification and consideration of potential sources of flooding.

The potential sources of flooding at the development site are as follows:

- Fluvial
- Pluvial / Surface Water
- Groundwater

2.4.1 Fluvial

Lough Derg is fed by the River Shannon and is a potential source of flooding. This is reflected by the Clare County flood risk mapping, see Figure 2-7, which places the site within Flood Zone C. Records of flooding adjacent to the site do support the predictive mapping and there is a clear risk of flooding to the car park and open space at and surrounding the marina. However, none of the Predictive Flood mapping sources mentioned in Section 2.4 above fully model lake flooding and further investigation of potential lake levels is required, estimates place the November 2009 event at approximately 31.8mOD Malin and Winter 2015/2016 at approximately 31.74mOD Malin.

The risk of fluvial flooding is discussed in more detail in Section 3 of this report.

2.4.2 Pluvial

Pluvial flooding is the result of rainfall-generated overland flows which arise before run-off can enter any watercourse or sewer. It is usually associated with high intensity rainfall. Flood risk from pluvial

sources exists in all areas. Adequate storm water drainage systems will minimise the risk from pluvial flooding sources.

The PRFA mapping does not predict any pluvial flooding in the locality of the site.

2.4.3 Groundwater

Groundwater flooding results from high sub-surface water levels that impact upper levels of the soil strata and overland areas that are usually dry. Groundwater flood risk is expected to be very low as confirmed by the OPW PFRA mapping and thus it has been screened out at this stage.

3 Flood Risk Assessment

3.1 Introduction

This section will investigate flood zones, flood levels and AEP's in a level of detail that is appropriate to the scale of development.

The available flood maps and evidence of flooding nearby indicates that the level of flood risk at the site requires a more detailed assessment to accurately determine the potential impacts and required mitigation measures at the proposed development site. A combination of lake level analysis and site topographic data will be combined to assess the risk and recommend mitigation measures.

3.2 Lough Derg Water Levels & Annual Exceedance Probability

The following paragraphs will introduce the analysis that has been used to derive the AEP flood levels and hence re-classify the site with regard to the Flood Zones A, B and C, as introduced in Appendix A.

3.2.1 Flood Frequency Analysis Methodology

A statistical analysis of the historic level data has been undertaken for the data from the gauging station of Portumna (introduced in Section 2.2.1). The results are a representation of flood level for the site location.

The level of analysis follows the principles of a single site flood frequency analysis in accordance with the Flood Estimation Handbook (FEH)[4]. Data recording at the gauging station in Portumna started in 1932. The station provides a total of 84 years of annual maximum records, which has been used to estimate a flood frequency curve that correlate to the AEP. The detail of the flood frequency analysis is included in Appendix B.

3.2.2 Final Flood Frequency Analysis Results

The Flood Frequency Analysis has been undertaken and based on the goodness of fit investigation, the Generalised Extreme Value (GEV) distribution has been chosen as the best analysis for the data. The GEV distribution is considered to be the most appropriate for flood frequency analysis on Irish catchments. The results Table 3-1 include an estimate of Water Levels and a 95% Confidence Interval for each of the AEP events. At the 1% AEP the uncertainty in level would be +300mm approximately and at the 0.1% AEP it is +480mm. Finally, the table includes an interpolated water level at Mountshannon using the method discussed in Section 2.2.1.

Table 3-1 Final Flood Levels from Flood Frequency Analysis (GEV)

Annual Exceedance Probability	Level estimated at Portumna (mOD Malin)	95% CI Level estimated at Portumna (mOD Malin)	Interpolated Level at Mountshannon (mOD Malin)
50%	31.22	(31.18, 31.26)	30.99
20%	31.42	(31.36, 31.48)	31.19
10%	31.55	(31.46, 31.64)	31.32
4%	31.70	(31.56, 31.86)	31.47
2%	31.82	(31.62, 32.04)	31.59
1% (Flood Zone A)	**31.93**	**(31.67, 32.22)**	**31.70**
0.5%	32.04	(31.69, 32.38)	31.81
0.2%	32.18	(31.67, 32.60)	31.95
0.1% (Flood Zone B)	**32.28**	**(31.64, 32.76)**	**32.05**

* the 1000yr (0.1% AEP) can be used as an indicative surrogate for the future Climate Change 1% AEP (100yr) flood level.

4 Flood Estimation Handbook, NERC 1999

The maximum levels for the 1% AEP and 0.1% AEP events are considered to be 31.92mOD and 32.28mOD Malin respectively taken at the Portumna gauge - Mountshannon levels are interpolated as being approximately 0.24m lower than this. The calculations are fully displayed in Appendix B.

3.2.3 Verification and Uncertainty

Flood levels, based on recorded levels at Portumna, for the November 2009 event was 32.05mOD Malin. This level would indicate an AEP exceeding the 0.5% AEP event. Verification with the Cawley & Cunnane[5] AEP estimate of 0.6% suggests that the JBA AEP results in more conservative design levels.

Although not used to delineate the Flood Zones, acknowledgement should be given to the 95% Confidence Interval maximum values for Flood Zone A and B, which lie at 32.22mOD and 32.76mOD Malin respectively. At the Upper Confidence Interval level, we can be 95% certain that these levels will not be exceeded. The 95% Confidence Interval Levels for Portumna are also displayed in Appendix B.

3.2.4 Climate Change

The planning guidelines are clear that the impacts of climate change shall be considered at all stages of activity under the national Flood Risk Management Programme. However, these guidelines recognise that detailed mathematical models are not necessarily available.

Whilst our flood level estimates do not directly take climate change into account, climate change flood extents can be assessed by using the 0.1% AEP (Flood Zone B) outline as a surrogate for 1% AEP (Flood Zone A), as suggested in the Planning Guidelines.

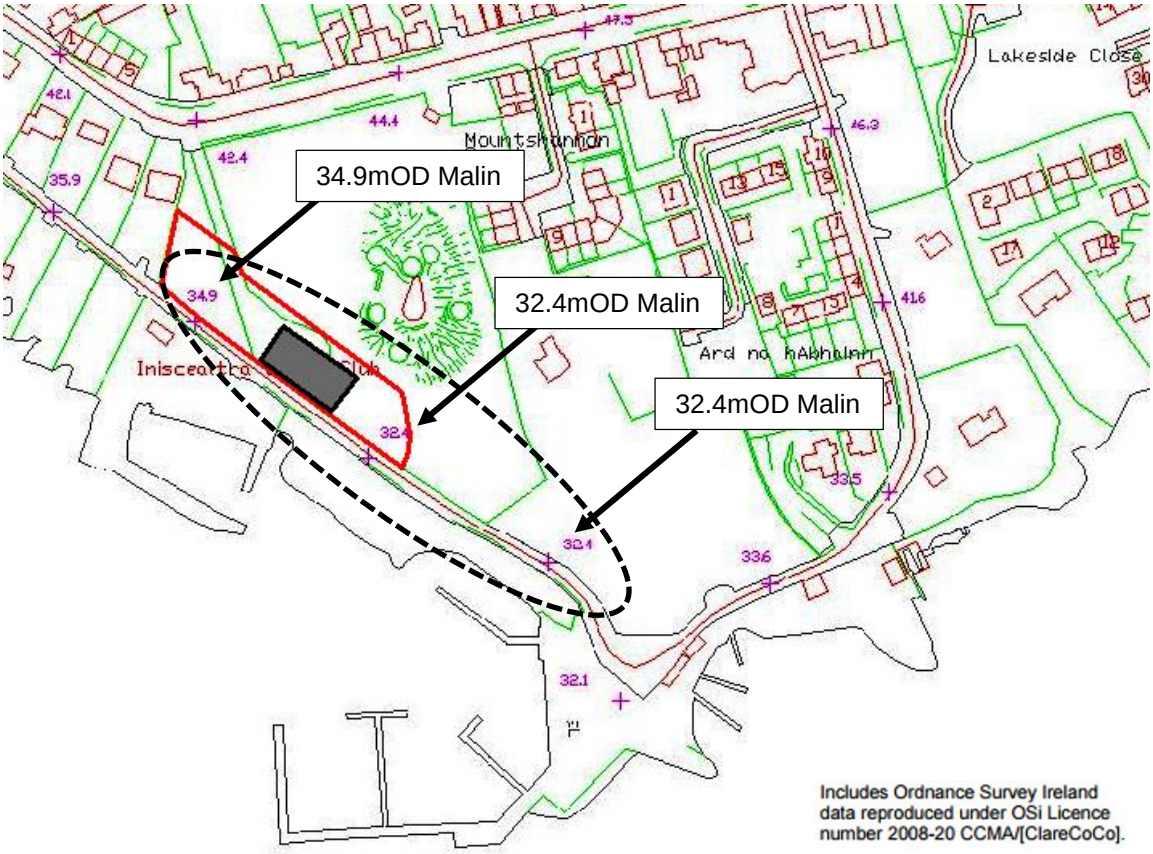
3.3 Risk Assessment and Mitigation

Detailed site topographic survey has not been provided for the site location although JBA understands that the public road level immediately to the south of the site is likely to have a minimum level of 32.4mOD Malin. This is evident from the detailed OS mapping presented in Figure 3-2 over page, the Aistear and proposed development site then rise rapidly, as seen in Figure 3-1 below.

Figure 3-1 Site Location (Google Streetview image)

5 Cawley, A. and Cunnane, C., 2010: Comment on the November 2009 Flooding in the Shannon and Corrib Systems. Irish National Hydrological Conference 2010

Figure 3-2 Site Layout and Background Mapping with Spot Levels



3.3.1 Risk Assessment

From the spot levels, site photos and from examining the historic flood levels and extents it is therefore possible to verify that the road and site are most likely to be located in Flood Zone C, with minimum road levels of 32.4mOD Malin, 0.35m higher than the predicted 0.1% AEP level at Mountshannon and 0.12m higher than the predicted level in Portumna. This makes the site suitable for highly or less vulnerable development types. A Visitor Centre, which will not facilitate overnight accommodation would qualify as less vulnerable development. The impacts from Climate Change are also anticipated to be low.

Detailed site topography would be required to fully confirm the above statement.

3.3.2 Mitigation Measures

The on-site visitor centre should be constructed with an FFL greater than the 1% AEP + Climate Change + Freeboard. It is recommended that the future 0.1% AEP level is used to account for climate change and that a freeboard of 480mm is applied to account for uncertainty (as derived from the 0.1% AEP, 95 percentile offset noted in Table 3-1. The recommended minimum FFL is therefore 32.53mOD Malin.

Foul and surface water connections should be directly into the public system. On-site foul treatment/percolation system to groundwater is unlikely to be suitable at this location. This is to avoid any potential negative impacts to Lough Derg. The stormwater design should be agreed with Clare County Council engineers with attenuation and maintenance of greenfield runoff rates recommended, with no direct discharge to Lough Derg without adequate on-site treatment.

4 Conclusion

JBA Consulting was commissioned to carry out a Flood Risk Assessment in support of a planning application for the proposed Visitor Centre in Mountshannon, Co. Clare. The detail presented in this FRA provides a comprehensive review of the flood risk to the existing site.

Having concluded a comprehensive study of Predictive Flood Mapping Sources and the Lough Derg Water Levels, the current site is anticipated to lie within flood Zone C, which is defined in the Planning Guidelines as having a low probability of flooding. Mitigation of flood risk at the site is achieved through the proposed FFL of 32.53mOD Malin, which is based on the 0.1% AEP event and associated freeboard. The surface water and foul system have also been subject to specific recommendations.

The position of the site within Flood Zone C and with clear access to the main road which is also in Flood Zone C ensures that there are no restrictive conditions placed on the development type and mitigation measures. Referring back to the development scenarios contained in Section 2.1, the site would be suitable for Scenario a; lowest FFL can be within 200m of the current lake front road; 30 to 40% of brief on lower (lake road level) eg including ferry ticketing and embarkation, access to island ferry, perhaps café, and other with remainder on level above (and accessed from park).

As a result of the above measures the proposed development is in overall compliance with the Core Objectives of the Planning System and Flood Risk Management Guidelines.

Appendices

A Understanding Flood Risk

Flood risk is generally accepted to be a combination of the likelihood (or probability) of flooding and the potential consequences arising. Flood risk can be expressed in terms of the following relationship:

Flood Risk = Probability of Flooding x Consequences of Flooding

A.1 Probability of Flooding

The likelihood or probability of a flood event (whether tidal or fluvial) is classified by its Annual Exceedance Probability (AEP) or return period (in years). A 1% AEP flood has a 1 in 100 chance of occurring in any given year.

In this report, flood frequency will primarily be expressed in terms of AEP, which is the inverse of the return period, as shown in the table below and explained above. This can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval, and is the terminology which will be used throughout this report.

Table: Conversion between return periods and annual exceedance probabilities

Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

A.2 Flood Zones

Flood Zones are geographical areas illustrating the probability of flooding. For the purposes of the Planning Guidelines, there are 3 types or levels of flood zones, A, B and C.

Zone	Description
Flood Zone A	Where the probability of flooding is highest; greater than 1% (1 in 100) from river flooding or 0.5% (1 in 200) for coastal/tidal flooding.
Flood Zone B	Moderate probability of flooding; between 1% and 0.1% from rivers and between 0.5% and 0.1% from coastal/tidal.
Flood Zone C	Lowest probability of flooding; less than 0.1% from both rivers and coastal/tidal.

It is important to note that the definition of the flood zones is based on an undefended scenario and does not take into account the presence of flood protection structures such as flood walls or embankments. This is to allow for the fact that there is a residual risk of flooding behind the defences due to overtopping or breach and that there may be no guarantee that the defences will be maintained in perpetuity.

Indicative Flood Zones (OPW & DoEHLG 2009)

A.3 Consequence of Flooding

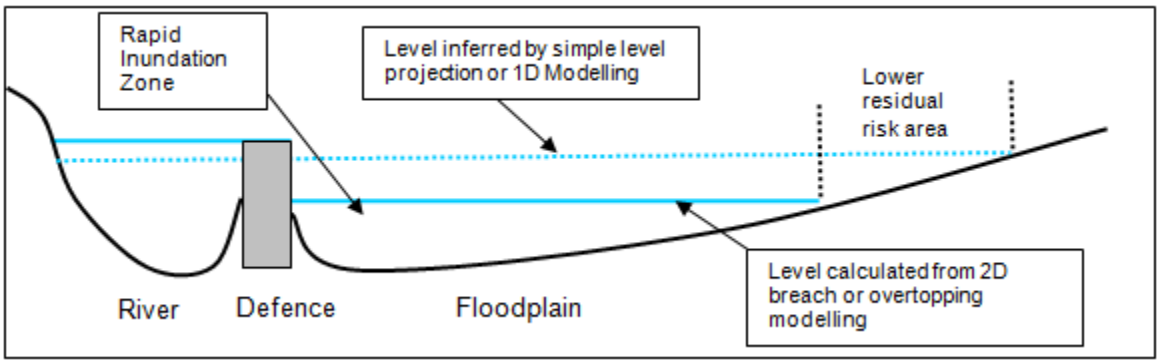
Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure, of the population, presence and reliability of mitigation measures etc.).

The 'Planning System and Flood Risk Management' provides three vulnerability categories, based on the type of development, which are detailed in Table 3.1 of the Guidelines, and are summarised as:

- **Highly vulnerable**, including residential properties, essential infrastructure and emergency service facilities;
- **Less vulnerable**, such as retail and commercial and local transport infrastructure;
- **Water compatible**, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

A.4 Residual Risk

The presence of flood defences, by their very nature, hinder the movement of flood water across the floodplain and prevent flooding unless river levels rise above the defence crest level or a breach occurs. This is known as residual risk.



B Flood Frequency Analysis

B.1 25051 Portumna

Used WINFAP for flood frequency analysis at Portumna with 83 years of annual maximum water level data.

	Location	Scale	Shape	Bound
L - LMOM	31.257	0.119		
GL - LMOM	31.227	0.115	-0.154	30.483
G - LMOM	31.157	0.172		
GEV - LMOM	31.159	0.176	0.024	38.396

Return Period	**L - LMOM**	95% Confidence Intervals	**GL - LMOM**	95% Confidence Intervals	**G - LMOM**	95% Confidence Intervals	**GEV - LMOM**	95% Confidence Intervals
2	31.26	(31.20, 31.30)	31.23	(31.18, 31.27)	31.22	(31.18, 31.26)	31.22	(31.18, 31.26)
5	31.42	(31.35, 31.49)	31.40	(31.33, 31.46)	31.42	(31.34, 31.48)	31.42	(31.36, 31.48)
10	31.52	(31.43, 31.60)	31.53	(31.43, 31.61)	31.55	(31.45, 31.63)	31.55	(31.46, 31.64)
25	31.64	(31.53, 31.74)	31.70	(31.54, 31.85)	31.71	(31.59, 31.81)	31.70	(31.56, 31.86)
50	31.72	(31.60, 31.84)	31.84	(31.61, 32.04)	31.83	(31.69, 31.95)	31.82	(31.62, 32.04)
*** 100**	31.81	(31.67, 31.94)	32.00	(31.67, 32.26)	31.95	(31.78, 32.10)	31.93	(31.67, 32.22)
*** 200**	31.89	(31.74, 32.03)	32.17	(31.74, 32.51)	32.07	(31.88, 32.24)	32.04	(31.69, 32.38)
*** 500**	32.00	(31.83, 32.16)	32.42	(31.81, 32.91)	32.23	(32.01, 32.42)	32.18	(31.67, 32.60)
*** 1000**	32.08	(31.90, 32.26)	32.64	(31.85, 33.25)	32.35	(32.10, 32.56)	32.28	(31.64, 32.76)

*** Return Period exceeding data record**

B.2 Summary of Results: Portumna

Results from flood frequency analysis at Portumna, including the Generalised Extreme Value distribution level results and the upper 95% Confidence Interval levels.

	Portumna	
Return Period (years)	Level (mOD Malin)	Upper 95% CI (mOD Malin)
2	31.22	(31.18, 31.26)
5	31.42	(31.36, 31.48)
10	31.55	(31.46, 31.64)
25	31.70	(31.56, 31.86)
50	31.82	(31.62, 32.04)
100	31.93	(31.67, 32.22)
200	32.04	(31.69, 32.38)
500	32.18	(31.67, 32.60)
1000	32.28	(31.64, 32.76)

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