Better Understanding Coastal Flood Risk in Plymouth

Role of Plymouth Breakwater

February 2018

Wave Study – Introduction

We have undertaken a study to better understand the impact of coastal flood risk to the city of Plymouth. Our focus has been to assess areas at risk of flooding when considering the impact of large waves, storm surges and storm force winds. The coastal conditions have been assessed over a wide range of scales, from the frequent storms to the rare and extreme events in order to build a picture of the risk. We have also factored in the impact of climate change, with increasing sea levels and higher waves as well as assessing the present day risks.

The study has been undertaken by JBA Consulting under our project management and at the time of writing this note the project is in its final stages and is due to be published in April 2018. The information presented here is based on the outputs of the final model runs and therefore can be viewed as 'pre-release' information.

The study has assessed coastal flood risk in three stages. The first stage involved calculating the offshore conditions, such as wave height and water level. Using a computer model of Plymouth Sound this data has been transformed to near shore conditions. The second stage is to take the information on near shore conditions and convert this into the amount of water that is conveyed on to land by each wave in a storm. This is known as wave overtopping. The third and final stage is to map the area that is flooded (inundated) by the storm using wave overtopping information and knowledge of ground levels that are lower than the sea level. This mapping is generated by modelling a storm in real time, which allows the impact of sustained wave impact and high water levels over a tidal cycle to be fully understood.

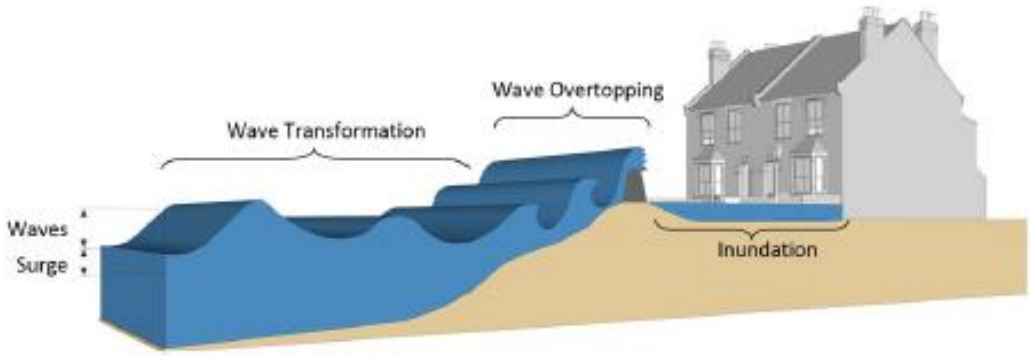

Image courtesy of JBA Consulting

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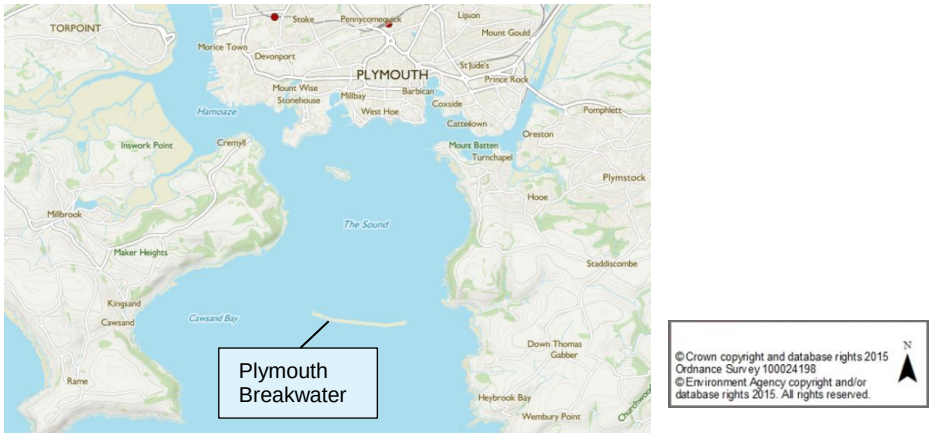
Plymouth Breakwater

This information has been compiled to assist in understanding the role of Plymouth Breakwater in managing coastal flood risk to the city of Plymouth. The computer model has simulated storm events with the Plymouth Breakwater in place and with the breakwater removed. For the removed scenario the height of the breakwater has been lowered by 13m however there still remains a raised sea bed in the location of the breakwater as the structure below sea level is so large. It was considered unnecessary to remove the whole subsea structure.

The final full coastal study report will contain a range of storm return periods and for the purpose of this information we have selected two, the 1 in 20 year event and the 1 in 200 year event. The 1 in 20 year storm, being more frequent is of a smaller scale than the 1 in 200 year storm. In order to understand how risk changes with predicted climate change, such as sea level rise we have included outputs for a 1 in 200 year event in the year 2115.

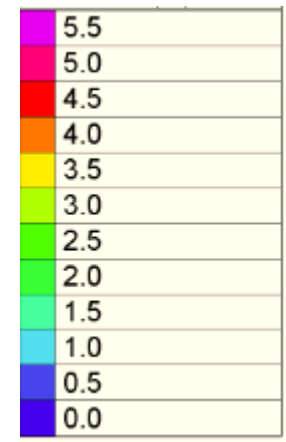


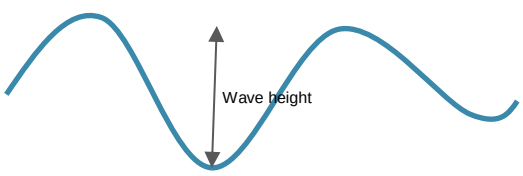
Study Results

The results of the study are provided in two forms, wave height in Plymouth Sound and the overtopping rate of locations along Plymouth's shoreline.

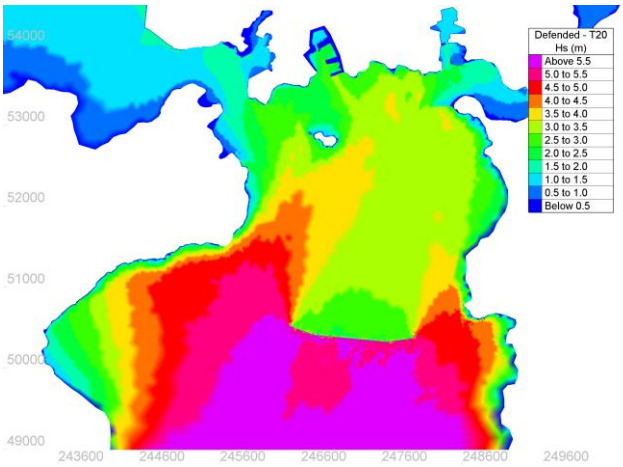
Wave Height

In order to visualise the effect of Plymouth Breakwater on wave height a series of images are provided that illustrate the average wave height (known as Hs) for a given storm return period and scenario, either with the breakwater in place or with it removed. The colour pallet to the right has been used and the colours refer to the wave height in meters, ranging from 0 to 5.5m.

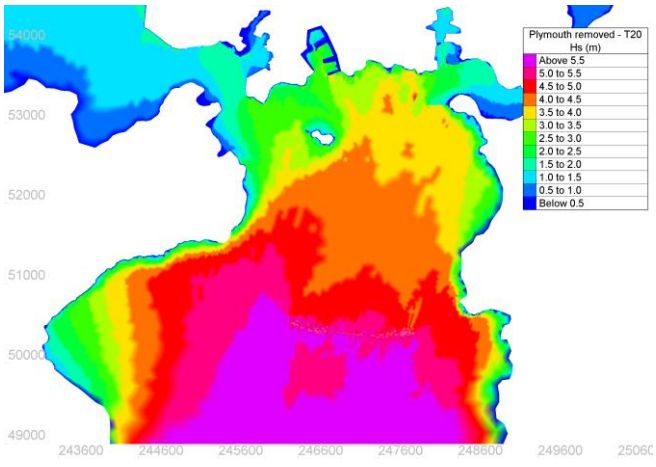




1 in 20 year Storm Event Present Day

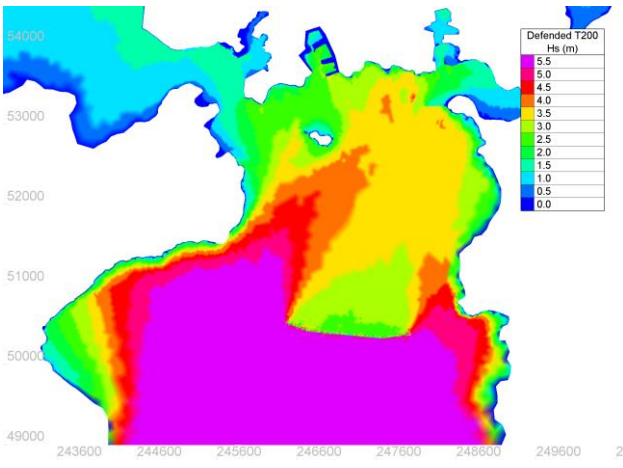


Breakwater in place

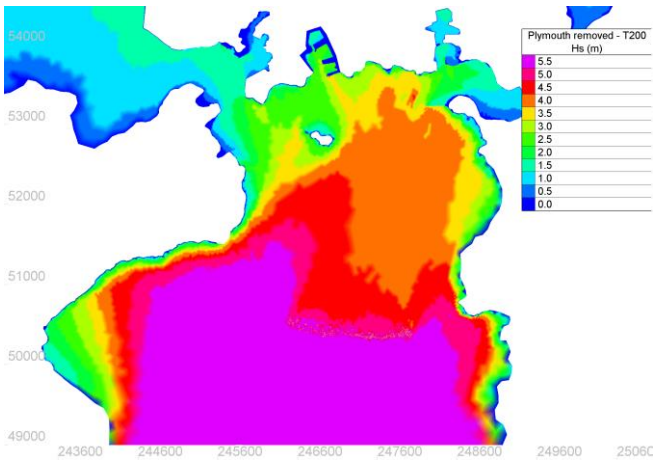


Breakwater removed

1 in 200 year Storm Event Present Day

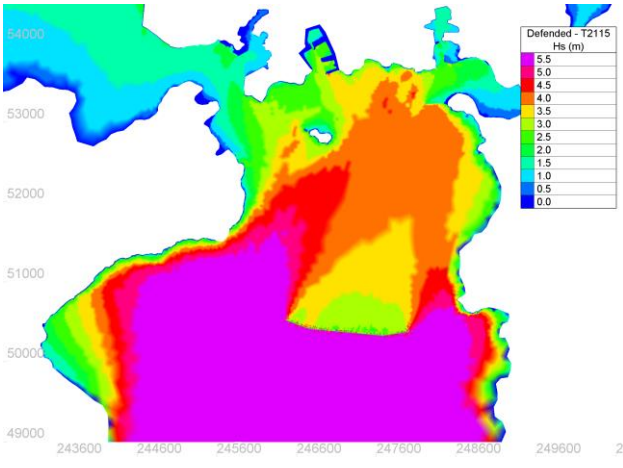


Breakwater in place

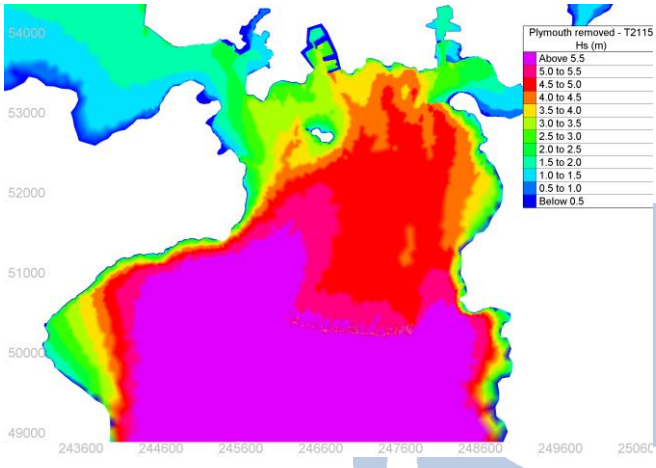


Breakwater removed

1 in 200 year Storm Event 2115



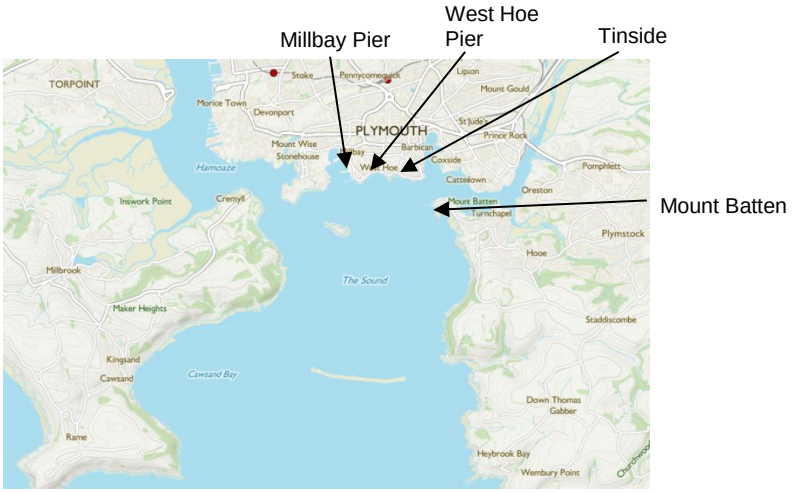
Breakwater in place



Breakwater removed

Overtopping Rate

The volume of water that is carried by a wave onto the land during a storm has been assessed with the Plymouth Breakwater in place and with it removed. Results at four locations along the coastline are provided. The units used for measuring the overtopping rate is litres per second per meter. So per linear meter of coastline when a wave breaks against it the number corresponds to the amount of water that is carried onto the shore.



	Maximum Overtopping Rate (litres per second per minute)					
	20yr (Present Day)		200yr (Present Day)		200yr (2115)	
Location	With Breakwater	Breakwater Removed	With Breakwater	Breakwater Removed	With Breakwater	Breakwater Removed
Millbay Pier	17	28	35	74	241	338
West Hoe Pier	85	107	120	132	235	680
Tinside	176	204	342	425	489	537
Mount Batten	425	566	601	743	622	810

Interpretation of Results

The results of the coastal modelling highlight that Plymouth Breakwater reduces wave height within Plymouth Sound during storm conditions and reduces the wave overtopping rate. Overtopping rates are reduced between 15-30% by the breakwater during a 1 in 20 year event and between 10-50% during a 1 in 200 year event for the selected locations.

Reduced wave height and lower overtopping rates results in less erosive forces on the coastline and decreased hazards.

The publication of the Plymouth Coastal Study in April 2018 will include maps of the flooded area for the scenarios and return periods covered in this note. From a review of the draft maps the areas inundated by flood water increase when the Plymouth Breakwater is removed for both the 20 year and 200 year return periods. The increases in flooded areas with the breakwater removed are relatively small in scale suggesting that the main impact of the breakwater removal on the coastline are higher hazards and erosive forces from overtopping.