PORT CLINTON

Seawater Flooding Adaptation Pathways for Yorke Peninsula Settlements

Stage 1: State of Play report

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Photograph of Port Clinton seafront supplied by Coast Protection Branch.

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GLOSSARY

ADAPTATION

Adaptations are actions taken to help communities and ecosystems cope with actual or expected changes in climate conditions.

AHD

AHD is an acronym for Australian Height Datum. When a measurement is accompanied with the letters AHD it indicates a height above mean sea level. Mean sea level was adopted in 1971 by the National Mapping Council of Australia at 0.00 AHD. For example, 3.2m AHD is 3.2 metres above mean sea level. AHD tide levels are different to the fishing charts which are called Chart Datum (CD). A subtraction of 1.45 metres from tide chart will give the correct AHD height.

ARI

ARI is an acronym for Average Return Interval and is a theoretical calculation of the probability of the return of a particular event based on observations of the past. In relation to severe storm events the longer the interval the higher the storm surge height is predicted to be. For example, a 1 in 100 year storm surge would be higher than a 1 in 50 year or 1 in 10 year storm surge height. It is important to remember that this is just a theoretical calculation and there is nothing preventing a 1 in 100 year flood happening twice in one week.

DEM

DEM is an acronym for Digital Elevation Model. The digital elevation model used in this study was created from an aircraft that bounced millions of infra-red light beams to the ground and then created a digital topographical map from the reflected beams. This digital map is combined with aerial photography and can be used to display the height of land features. A Digital Terrain Model (DTM) is a type of DEM that has been specifically prepared for flood modelling.

EROSION

Erosion is where action of the sea moves sand and vegetation from the shoreline so that the dune system is weakened. When the frontal dune system is significantly weakened it may completely erode away and the shoreline moves inland.

STORM SURGE

A storm surge is usually the combination of the highest tide (king tide), the action of the waves, and the height the water is raised when pushed up the beach, especially when driven by a high winds. The combination of these factors is given a height AHD and used by planners to work out at what height buildings and infrastructure should be placed along the shore.

Introduction

1.1 Background and scope

In February 2015 the Yorke Peninsula Council commissioned Mutual Projects Pty Ltd T/A Integrated Coastal Management to undertake the *Seawater Flooding Adaptation Pathways* study, a project jointly funded by the Commonwealth Natural Disaster Resilience Program, the Coast Protection Board, and the Yorke Peninsula Council. This project will identify the seawater flooding risks, assess current flood protection infrastructure and provide recommendations for future action to plan seawater flooding. The project will also improve community awareness of the risks associated with current and future seawater flooding. The sites under investigation are Clinton, Price, Pine Point (Billy Goat Flat) and Coobowie which are all situated along the eastern coast of the Yorke Peninsula and are considered by Council to be locations of risk.

In this report the settlement under consideration is:

Port Clinton.

Figure 1: Location Map: Port Clinton, Yorke Peninsula[1]

In August 2015, Yorke Peninsula Council requested that the southern area of Port Clinton be added to the scope of the works and this report has been amended accordingly (see also Appendix E).

[1] http://www.naturemaps.sa.gov.au/maps/viewer.aspx?site=NatureMaps

1.2 Investigative framework

This study utilises the *Local Government Association Coastal Adaptation Decision Pathways Investigative Framework* which was originally developed in 2012, and trialled at Onkaparinga and Mallala Councils. In 2013, the investigative framework was utilised in the *District Council of Mallala's Coastal Settlements Adaptation Study,* and subsequently amended to reflect the findings of that project. Each settlement is reviewed within the following framework:

1. Establish settlement history.
2. Analyse existing sea-flood protection.
3. Analyse the impact of sea-flood scenarios.
4. Analyse emergency access and egress.
5. Establish profile of the assets at risk.
6. Identify current policy framework.
7. Explore liability issues.
8. Analyse possible adaptation actions.

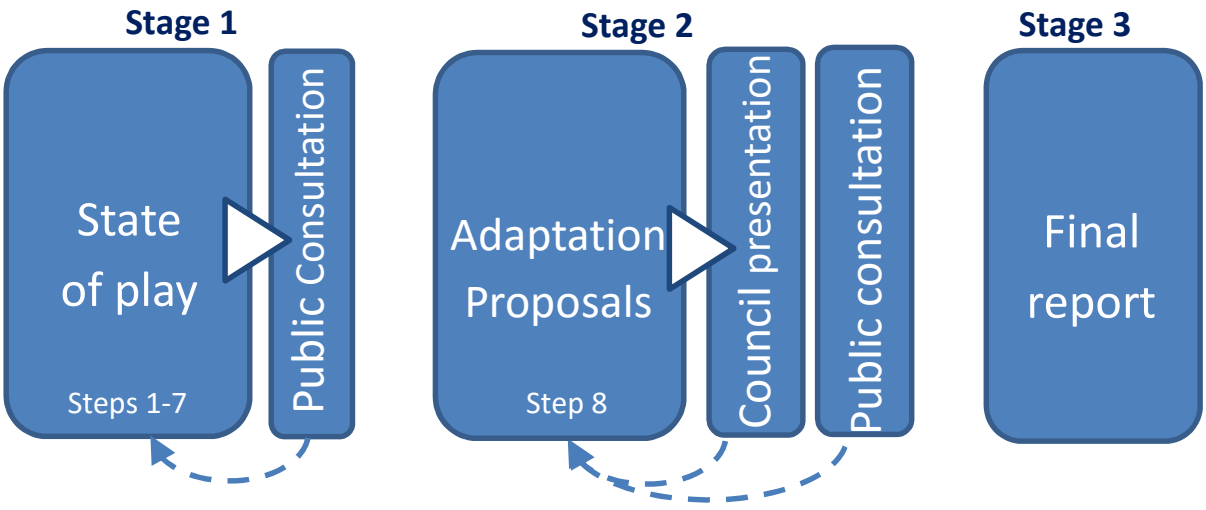
1.3 Methodology and staging

The process is to be undertaken in three main stages (Figure 1:2):

Stage 1: State of Play Report (Steps 1 – 7)

Stage 1 evaluates and reports the current and future threat. The community consultation process in Stage 1 reports *to* the community about the potential for sea level rise but also actively requests information *from* the community to create the full 'sea-flood risk picture' (See also Section 3).

Figure 1:2 The coastal adaptation study is conducted in three stages[2]



[2] Adapted from coastal analysis tool, *Dealing with the impacts of sea level rise on coastal assets (2012) (Western & Kellett)*

Stage 2: Propose adaptation options (Step 8)

Stage 2 proposes adaptation options in draft form and reports these to the Council, and then to the community by way of a second public meeting. Adaptation proposals are generally framed within the five broad ways human settlements can adapt to rising sea levels:

- **Protect:** use various means such as construction of sea walls, beach sand replenishment or installation of drainage swales to protect existing development;
- **Accommodate:** use means such as raising buildings or protecting buildings from flooding;
- **Retreat:** abandon settlements and move development inland in the face of rising sea levels. The concept of 'retreat' is also known as 'planned retreat'.
- **Defer:** threats have been assessed, and perhaps costs and options analysed but there are valid reasons to wait until to a later date to act.
- **Do nothing:** ignore the risks and do nothing.

Stage 3: Final reporting

Responses from the Council and the community from Stage 2 are taken into account for the final report. Stage 3 provides a final report to Council that includes an explanation of the adaptation options, a suggested prioritisation for action, and preliminary engineering solutions and estimated costs (where possible).

2. Framework of the Investigation

The purpose of this section is to explain the rationale and methodology for the investigation.

2.1 Establish Settlement history

A history of each settlement provides an important cultural context to the study and may also improve understanding of any initial assessments that were undertaken in relation to potential impacts of the sea. In particular in relation to coastal matters, any previous coastal studies that have been undertaken are identified and assessed.

Key assessment questions:

- When was the settlement established?
- Has any significant expansion of the settlement occurred within the last twenty years?
- What account was taken in relation to potential impacts from the sea?
- What previous flood studies have been undertaken?

2.2 Analyse existing sea-flood protection

Protection can be afforded a settlement in two ways: natural land forms such as dunes and headlands, and man-made protection works, such as sea walls, bunds or levees. There are two reasons for paying particular attention to man-made protection works. First, an analysis of the implementation of protection works in the past may provide a historical context to the current coastal issues. Second, a review of policies and cases around the world found that issues of public sector liability may be raised where protection works have been implemented[3]. Therefore, reviewing the circumstances of the implementation and historical performance of any existing protection works and whether maintenance obligations have been fulfilled, will help inform the question of current and future responsibilities for council and landowners.

Key assessment questions

- What existing natural protection exists?
- What existing man-made protection has been installed?
- Have the protection systems ever been breached?

[3] Balston et al (2012) *Climate change decision support framework and software for coastal councils*, Local Government Association of South Australia, Adelaide, SA.

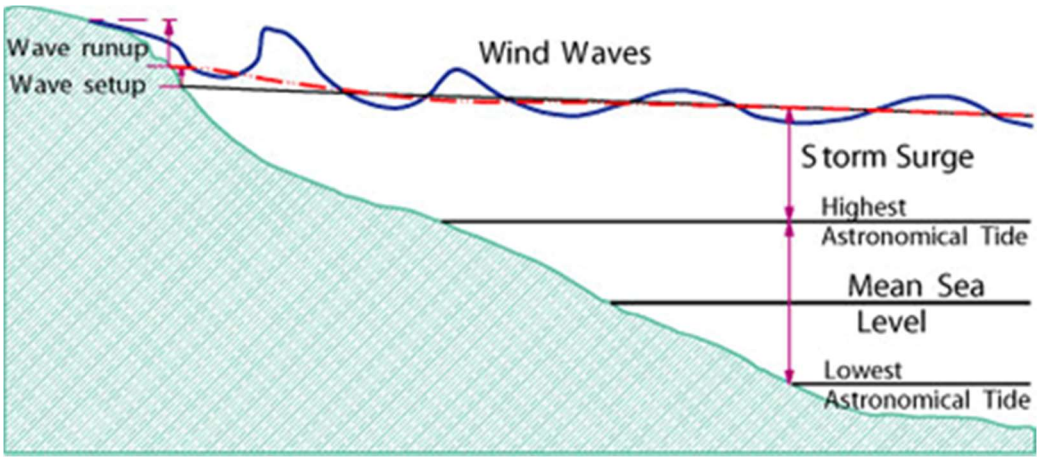
2.3 Analyse the impact of the sea upon the coast.

In accordance with the defined scope of the tender documents, the primary focus of this study is to evaluate the threat of 'sea-flooding'. However, as secondary focuses both coastal erosion and stormwater flooding from the land will be taken into account where information is available so as to provide the most comprehensive 'coastal picture' possible. Where it is not possible to deal appropriately with an erosion or storm water issue, general recommendations are made as to how to deal with these.

2.3.1 How threats from actions of the sea are assessed for planning purposes

Historically planners have evaluated potential threats of inundation from the sea by considering the compounding effect of the highest possible tide, the largest storm surge height, and the configuration and action of the waves. Water levels are expressed in terms of Australian Height Datum (AHD) which is 1.45m lower than tide charts (Chart Datum). This compounding effect is unique to each coastal location due to differing sea floor level formations and wind intensity and direction (Figure 2:1):

Figure 2:1 The factors utilised to calculate the highest likely water level



Source: http://www.ozcoasts.gov.au/climate/sd_fqa.jsp#HAT

The Average Recurrence Interval (ARI) is utilised to assess the risks associated with naturally reoccurring events such a sea-flooding. ARI is a theoretical calculation of the probability of the return of a particular event based on observations of the past. In relation to severe storm events the longer the interval the higher the storm surge height is likely to be. For example, a 1 in 100 year storm surge would be higher than a 1 in 50 year or 1 in 10 year storm surge height. It is important to note, that the ARI calculation is just the probability that a particular event might occur, based on historical observations. There is nothing to prevent two or more 1 in 100 ARI events occurring within days or weeks of each other, though this would be unusual.

For over twenty years SA Coast Protection Board has utilised the following inputs to calculate the 1 in 100 ARI event for Port Clinton (See Table 2:1).

Table 2:1 Port Clinton - 1 in 100 ARI storm event (current since 1994)

Storm surge (using 1990 level)	3.0m AHD
Wave set up	0.2m AHD
Wave run up[4]	0.2m AHD
Total Risk (total)	**3.4m AHD**

However subsequent to the findings of this study, Department of Environment and Natural Resources (CPB) has amended these sea-flood risk levels to the following (Table 2.2)

Table 2:2 Price - 1 in 100 ARI storm event –Price (amended in July, 2015)

Storm surge (using 1990 level)	2.7m AHD
Wave set up	0.1m AHD
Wave run up	0.1m AHD
Total Risk (total)	**2.9m AHD**

2.3.2 Predicted sea level rise

While there are different predictions of the rate of sea level rise around the world, local councils in South Australia rely on the 1990 benchmarks set by South Australian Coast Protection Board:

Year 2050 – 0.3 m sea level rise (from 1990 levels)
Year 2100 – 1.0 m sea level rise (from 1990 levels)

Therefore, combining the specific ARI calculation for Port Clinton with Coast Protection Board policy sea level rise rates, the following table depicts the sea-flood risk for Port Clinton.

Table 2:3 Port Clinton - 1 in 100 annual return event, with allowance for sea level rise

	1990	2050	2100
Storm surge (1990 levels)	2.7m	2.7m	2.7m
Wave set up	0.1m	0.1m	0.1m
Wave run up	0.1m	0.1m	0.1m
Sea level rise	0.0m	0.3m	1.0m
Totals (AHD)	**2.9m**	**3.2m**	**3.9m**

2.3.3 Actual sea level rise

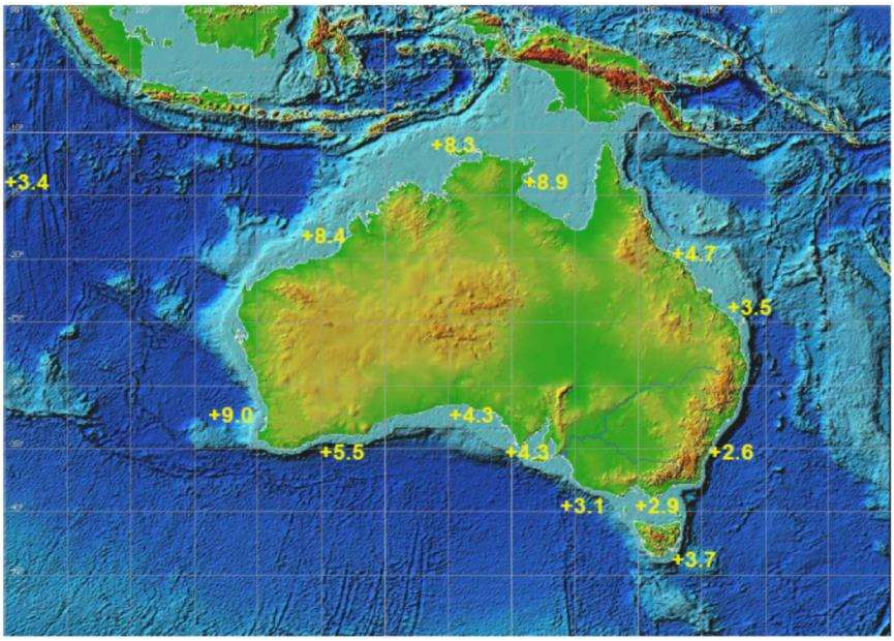
Since 1990, as part of the national Seaframe Project, two tidal gauges at Port Stanvac south of Adelaide, and at Thevernard west of Ceduna have been collecting data. These gauges remove

[4] The inclusion of the 'wave run up' increment is usually applied where the water is interacting at the face of a levee or vertical wall. Therefore when assessing the general impact of a storm surge within a settlement the storm surge height utilised will not include the 'wave run up' component.

the 'noise' from the movement of the sea and the land and calculate changes to mean sea level over time. The data from both of these gauges provide clear evidence that sea level rise from 1990 to 2010 has been an average of 4.3mm per year (Figure 2:2). By comparison, longer term monitoring from the gauge at Pt. Adelaide which has over a hundred years of data, indicates that the rate of increase over the last century was an average of 1.5mm per year. This data indicates that sea levels in the region are rising and that the rate of rise has increased over the last twenty years.

If the current rate of sea level rise remained reasonably constant until 2050, a simple multiplication of 4.3mm x 60 years suggests an increase in mean sea level of 258mm which is comparable with the SA Coast Protection Board's prediction of 300 mm (0.3m).

Figure 2:2 Tidal gauges at Thevernard and Pt Stanvac have recorded an average rise of 4.3mm[5]



Recognising that the sea has been rising since 1990 levels the current risk levels for 2015 are calculated by including a 0.1m rise[6] (Table 2:4).

Table 2:4 Port Clinton - 1 in 100 annual return event, with allowance for sea level rise

	1990	2015	2050	2100
Storm surge (1990 levels)	2.7m	2.7m	2.7m	2.7m
Sea level rise	0.0m	0.1m	0.3m	1.0m
Storm surge (current levels)	**2.7m**	**2.8m**	**3.0m**	**3.7m**
Wave set up	0.1m	0.1m	0.1m	0.1m
Wave run up**	0.1m	0.1m	0.1m	0.1m
Totals (AHD)	**2.9m**	**3.0m**	**3.2m**	**3.9m**

[5] Bureau of Meteorology, 2013
[6] 4.3mm x 25 years = 107.5mm (rounded to 0.1m).

**Note: In this study, where the location under assessment is the front face of a wall or levee, the wave run up increment is utilised. When assessing the risk of a storm surge as it might flow through a settlement, the wave run up figure is omitted.

2.3.4 Which sea level rise scenario?

The storm surge and sea level rise event calculated for the year 2050 will be primarily utilised in stage one, the State of Play report for the following reasons:

- There is more certainty around sea level rise to this date with recorded data from the last 20 years providing a degree of confidence in the policy levels of the SA Coast Protection Board.
- It provides a 37 year time frame which will allow data to be tracked and verified and more accurate predictions developed for the second half of the century. This data will also assist in identifying whether coastlines are eroding, and at what rates.
- It provides a sufficiently long time frame for adaptations to be employed to cater for the second half of the century.
- The community is more likely to be engaged within this time frame rather than using the year 2100 which is more remote.

2.3.5 Key assessment questions

- What is the likely impact on the settlement of the 2015 sea-flood scenario?
- What is the likely impact on the settlement of the 2050 sea-flood scenario?
- What is the likely impact on the settlement of the 2100 sea-flood scenario?

2.4 Analyse emergency access and egress.

Historically sea-flood events in Port Clinton have been of low velocity and low wave height. However, this observation does not imply that these events carry no risk to people. Vulnerable members of the community, the aged, disabled, or young, may be in danger, especially if an event was to occur at night and access ways flooded. Also an unrelated emergency such as a heart attack or a fire may prove more serious if emergency service vehicles are unable to access the settlements. The purpose of this investigation is to provide a filter through which a preliminary assessment can be made regarding personal safety.

<u>Key assessment questions:</u>

- In the event of the 2050 sea-flood scenario occurring, are emergency services able to access the settlement?
- In the event of the 2050 sea-flood scenario occurring, are people able to move directly away from the place where flooding is occurring (egress)?

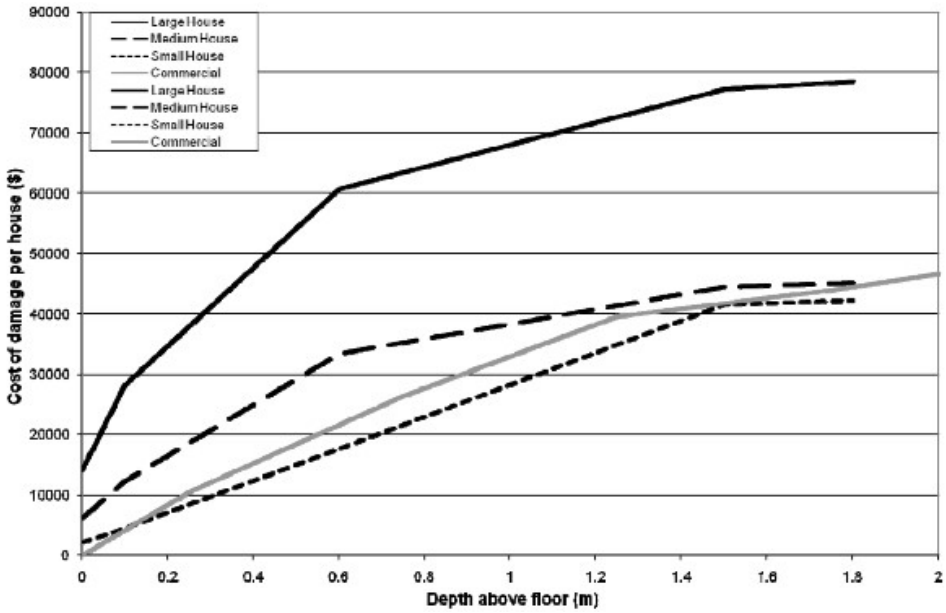
2.5 Establish profile of assets at risk

The assets under investigation in this study are those that are privately owned (houses and land), or owned by the Council (buildings, roads, shelters, public toilets, playgrounds, and equipment).

Assets owned by Telstra, SA Power Networks, and SA Water are not a focus of this study[7].

Depth of water over floor levels for buildings is ascertained for two reasons. The first is to evaluate the extent to which houses may be under threat from inundation. The second reason is that flood depth over floor level is the established way the insurance industry estimates flood damage. Figure 2:3 depicts the flood depth/damage curve that is utilised in this study[8]. The 'small house' scenario has been chosen from the curve for Port Clinton.

Figure 2:3 Flood/damage curve utilised in the study (adapted from ANUFLOOD,2008[9])



[7] The intention is to forward reports from this study to other asset owners.

[8] This flood/damage curve was used in a flood study in a small Victorian town of Barmah which has similar flood characteristics and housing stock. The flood/damage curve in that study was adapted from ANUFLOOD and factored up to 2008. This study adjusted the 2008 amounts using CPI adjustment (12 % approx) from ABS and an extra 8% due to the number of medium size houses in the area.

[9] Sinclair, Knight, Merz, 2008, Assessment of flood risk to the township of Barmah, prepared for Goulbourn Broken Catchment Management Authority.

2.6 Identify existing policy framework.

Step six of the investigative framework is to review the existing policy framework within which the Council manages the coastal environment. This study will review the strategic planning policy that is found in the *Yorke Peninsula Regional Land Use Framework (2007)* and the *Yorke Peninsula Council Strategic Plan*, and the policy found within the *Yorke Peninsula Council Development Plan* as the key statutory document against which all development applications are assessed. The two main reasons to review the existing policy framework are to understand the current parameters by which Council makes its development decisions, and to analyse whether the existing policy settings are appropriate to deal with potential sea level rise.

Key assessment questions:

- What are the key strategic planning policies in relation to coastal matters?
- What are the key development assessment policies for applications to develop in the coastal areas?
- How has Yorke Peninsula Council been operating within the statutory planning environment?

2.7 Explore liability issues.

It is important to recognise that this section is designated an 'exploration' rather than as definitive legal advice. The reason for including it is to provide the reader with a full range of the issues that need to be considered when dealing with coastal matters. Where there is any doubt about particular circumstances, these should be referred to the Council's legal advisors[10]

2.7.1 In what ways can a council become liable for loss or damage?

Liability to Councils comes under two broad categories. The first is legal liability. A Council that accepts legal liability for an asset may face claims for future damage relating to that asset from affected parties. If liability has not been clearly established such claims may result in legal action where both the Council and affected parties may have to spend time and money on court actions, with the risk of damages and costs to the losing party.

The second category is political liability. Governments can come under significant pressure to install protection works and other measures, regardless of whether they are legally obligated to protect assets which belong to others. Also, when Governments take action to mitigate the effects of rising sea levels, for example by limiting the types of development that can occur within settlements, political back lash may result.

2.7.2 In what ways can a council be legally liable?

There are two main ways a Council can incur cost relating to legal liability - through administrative appeals and tort based claims.

Administrative Appeals

Administrative appeals occur when someone appeals against a decision the Council has made. Examples include, when developers are refused a development application on the basis that sea level rise issues have not been adequately addressed, or when Councils make amendments to the Development Plan that may restrict the types of development permitted within the settlement. The liability to the Council is one of cost in defending the appeal at Court. The vast majority of climate change related cases in Australia to date have been administrative appeals.

Tort based claims

There are two types of tort based claims where Council can be liable to pay damages namely, 'nuisance' and 'negligence'. There have been no climate change related court actions relating to 'nuisance' claims at the date of writing and only one case relating to 'negligence' which was Byron Shire Council v Vaughan in NSW.

[10] The prime source for this exploration is, Australian Local Government Association (2011) *Local Council Risk of Liability in the Face of Climate Change Resolving Uncertainties*, A report commissioned by Australian Local Government Association, Sydney. Appendix 3, p. 10-17 in Balston JM et al (2012) provides an abridged synopsis of the Baker and MacKenzie (2011) report and pp. 41-59 in the same appendix provides an in depth case study of the only court action to date within Australia that relates directly to an action of the sea, Vaughan v Byron Shire Council (No 2) [2009] NSWLEC 110.

2.7.3 Possible legal defences

In common law, the defence of 'voluntary assumption of risk' provides that the defendant is not liable if it can be established that the plaintiff was fully aware of the risk, comprehended the risk, and accepted the whole risk. The concept of 'risk' has been strengthened by statute in Australia to include that the defendant is not liable for the occurrence of an obvious risk, i.e. one that is obvious to a reasonable person in the plaintiff's position.

A further statutory defence is that a defendant's liability for the 'materialisation of an inherent risk' (one that cannot be avoided by the exercise of reasonable care and skill) is limited only to a failure to warn of the risk. A contract between the plaintiff and the defendant may exempt the defendant from liability in negligence where there is a clear statement that liability for negligence is excluded. Where there is no contract, a disclaimer may give the plaintiff sufficient knowledge of the risk to satisfy the defence of voluntary assumption of risk or to constitute reasonable warning.

Additionally, a Council's financial resources are limited and the allocation of its resources cannot be challenged in Court. Therefore, while there might be protection works that may be implemented in theory, the Council may not have the resources in its budget, and its decision to allocate funds to other budgetary matters cannot be challenged.

The following may be a defence against a tort based claim:

- It is unlikely that an action would be successful against a council where it has failed to install protection works because the average person is aware of the risk from the sea, and in recent times is aware of the issue of rising sea levels.
- Councils have limited resources and have to make decisions based on this fact. The allocation or the lack of allocation of resources of a council is not challengeable at law.
- Councils that warn their constituents of their risk are likely to reduce their liability against possible claims, for example, where flood mapping is made available to residents.
- A council that incorporates the available science into its decision making reduces the possibility of liability. The Council is not required to get the science right per se and courts will judge the matter on the science that was available at the time of the decision.
- Councils that have demonstrated they have followed procedures in decision making and undertaken reviews such as this one, will improve the defence that they have upheld a duty of care.
- Finally Councils that have put in place emergency action plans for their residents accomplish two objectives: one they demonstrate a duty of care, and two, emergency action plans are an effective way to inform residents of the risk they face in living close to the sea.

In what circumstances is a council vulnerable in relation to tort based claims?

- Where the council has approved settlements against the science or advice of the time.
- Where protection works have been installed incorrectly. For example where the council installs a protection work and fails to meet the requirements set down in engineering reports.
- Where the council had an obligation to maintain works or strategies and it has not done so, or even in the absence of written obligations, where the works fail because they have not been maintained or repaired.
- Where council has not advised residents of the risk or does not have emergency action plans in place to deal with possible risk.

2.7.4 Summary

It makes logical sense to first ascertain what legal liability exists before ascertaining whether there is any political liability. This finding will at least enable the Council to act from a position of certainty if it can be determined that legal liability is unlikely in the given scenario. And finally, the absence of legal liability does not mean that the Council need not take any action to implement protection works and strategies. However, these actions need to be implemented carefully and include public awareness strategies to avoid the creation of new potential liabilities to council.

Key assessment questions:

- What obligations did Council have to assess impacts from the sea at the time the settlements were established?
- Has the settlement undergone a significant expansion over the last twenty years?
- What protection works have been implemented and were they implemented in accordance with approved plans?
- Have protection works implemented by Council been breached?
- In the case of new development within the settlements, have appropriate planning and Coast Protection Board policies been followed?
- Has the Council made sea level rise data available to residents?
- Are there any emergency warnings and/or evacuation procedures in place?

3. Community consultation report – Port Clinton (Part 1)

The community consultation process in Stage 1 reports *to* the public about the potential for sea level rise but also actively requests information *from* the public to create the full 'sea-flood risk picture'. In the first instance, the purpose is to communicate the framework in which coastal planners manage coastal risk so as to build a common understanding within the community, and also to communicate the specific findings of the study. In the second instance, the community is considered to be a source of historical knowledge that will add to the flood picture. In particular photographs, videos or anecdotes are valuable sources of information which can be checked against the current Digital Elevation Model (DEM) to assist in ascertaining the likely height of previous flood events. The community consultation strategy included three main facets.

3.1 Public awareness campaign

The following activities were undertaken to raise awareness about the flood study:

- Three Newspaper articles were run in the Yorke Peninsula Country Times (2nd March, 12th May, 19th May, 2015).
- The Council contacted the Port Clinton Progress Association to garner their support in attendance and assisting with public consultation meetings.
- The Council provided information about the flood study on its website.
- A 'fact sheet' and invitation to attend a workshop at Port Clinton Community Hall was direct mailed to all land holders in week of 13th April, 2015 (Appendix A).
- Two ABC regional radio interviews were conducted with Mark Western (lead consultant).
- Pegs were installed on 20th April to the foreshore of each settlement with markers indicating the current and future flood risks (Figure 3:1).

Figure 3:1 Public awareness - flood risk pegs were installed to the foreshore

Photograph: M. Western, 2015

3.2 Informal consultation

Whenever data collection in and around the Port Clinton settlement was underway, the consultant (Mark Western) made informal connections with numerous residents. In this informal process, often the main concerns of the settlement were identified, and residents also contributed photographs or anecdotes that improved the overall understanding of the coastal issues. With this preliminary information already gathered, the formal consultation meeting could be much better targeted.

3.3 Formal consultation

A formal meeting was held at Port Clinton Progress Association Community Hall at 2.30pm on 13th May, 2015 at which 34 residents from Port Clinton attended[11]. Mark Western presented the framework that coastal planners utilised in catering for coastal risks, and the findings from the flood mapping and other investigations. In the second half of the meeting, group facilitators[12] encouraged participants to answer prepared questions and to provide marks and comments on the provided map of Port Clinton (Appendix B).

3.4 Public consultation reporting

Rather than devoting an extensive section within the report to public consultation, contributions from the public are integrated within the flow of the report utilising green font. Where permission was not specifically obtained from those that contributed to the study in the informal part of the public consultation process, these contributors are noted as *Port Clinton Resident #* within the report. A list of names and addresses (where obtained) have been provided to Council so that the necessary validation of data can occur if required in the future.

Any public consultation issues that are not covered within the flow of the report using the green font methodology are reported at the end of the next section.

[11] And three residents from Price making total of 37 at the meeting.

[12] Group facilitators for the consultation meeting were Professor Jon Kellett (Adelaide University), Natasha Hall (Central Region Climate Change Officer), and Stephen Goldsworthy (Yorke Peninsula Council).

4. Findings of the Investigation – Port Clinton

The remainder of this report represents Stage 1, the 'State of Play' as described in the previous sections. The initial context for the investigation is given in the Yorke Peninsula Council request for quote which states the 'Port Clinton is in a low lying area with no formal protection measures in place. The risk of flooding exists within the caravan park and adjacent residents. The foreshore area is at risk from seawater flooding. Previously sea water has risen to the middle of the road'[13]. Note: The request for quote excludes the requirement to investigate the settlement on the Esplanade to the south of the caravan park[14].

4.1 Settlement History

4.1.1 When was the settlement established?

Port Clinton was proclaimed on 12th June 1862 and in its early days was the shipping centre for farmers in the area who loaded their cargo on to ketches from a 274m jetty built for that purpose. After completion of the railway between Adelaide and Wallaroo in 1878 the jetty fell into disuse and was removed[15]. District Council of Clinton was proclaimed by Act of Parliament on 28th November 1878. In 1997, Central Yorke Peninsula, Minlaton, Yorketown and Warooka Councils amalgamated with the District Council of Yorke Peninsula, which subsequently changed to *Yorke Peninsula Council* in 2013. Port Clinton has undergone expansion with a major subdivision implemented to the north of the estuary. It is unknown what assessment criteria and processes was utilised in this expansion when considering coastal impacts.

4.1.2 What obligation did Government have to take into account impacts from the sea?

Port Clinton was founded well before any Acts of Parliament were established that relate to planning and management of the coast. Therefore, there was no overarching statutory requirement for the founders of Port Clinton to take into account actions of the sea. However, Port Clinton did undergo expansion behind the estuary in the 1990s[16].

4.1.3 What previous coastal investigations have been conducted?

The purpose of this section is briefly identify any previous coastal investigations to ensure that the current study appropriately builds upon any relevant former work. The works listed below are referenced throughout the remainder of the report where appropriately relevant.

- *Coast Protection Board Site Visit (1986).*

The briefing notes for the impending visit to Port Clinton noted the intention to 'provide fencing to control vehicles along the coastline and extend rock protection around the northern carpark'

[13] Yorke Peninsula Council (2015) Request for Quote, p.18
[14] This area contains 23 dwellings that have always been free holding, and 6 former shack sites.
[15] Kate Russell, History of Port Clinton, South Australia 2014, p.1
[16] No subdivision data was available prior to 2003 to ascertain what account was taken of coastal impacts.

(p. 14). The purpose of the visit was to also review the 27 acceptable shacks and 6 unacceptable shacks controlled by the Department of Lands noting that, 'some of the acceptable shacks may be subject to future tidal flooding' (p. 14). There were no recorded findings from the visit.

- *Sea flood risk mapping of selected locations on Yorke Peninsula, Australian and State Governments (2007-2011).*

The objective of this project was to improve the coastal hazard information base for low-lying land on the Yorke Peninsula by producing a digital elevation model (DEM) and associated flood mapping for settlements deemed as a high priority. The project utilised a risk identification strategy to identify those settlements most at risk by assigning a number from 1-3 in a range of categories. Port Clinton was assigned 13th position out of 14 towns in accordance with the table below (Table 4:1).

Table 4:1 Port Clinton – Risk assignment by the Sea Flood Risk Mapping project

Port Clinton	Development pressure	Designated growth area	Land levels	Known flood risk	Total risk
Risk assignment	1	1	3	2	7
Explanation	A low number of dwellings constructed	No expansion beyond the existing township	Land levels lower than 5m AHD	Known flood history, but minor in nature	

- *Yorke Peninsula Coastal Issues Scoping Study Port Clinton, Civil and Environmental Solutions (2014)*

Civil and Environmental Solutions conducted a 'scoping study' in response to the Council's concern 'that the existing caravan park, The Parade, and foreshore reserve assets are at risk from coastal inundation from sea level rise' (p.6). The study was limited to a site visit on 6th November, 2014 and found that 'minor coastal erosion and minor tidal flood inundation' existed to the foreshore area which would 'increase in severity with sea level rise', and further study should be undertaken.

- *National Climate Change Coastal Vulnerability Assessment: Yorke Peninsula Case Study, South Australia, Australian Water Environments et al (2009)*

This federally funded project was one of six case studies conducted around Australia to assess the climate change impacts on coastal settlements of Yorke Peninsula and to provide tools to begin developing appropriate adaptive responses. The study utilised Marion Bay, Moonta Bay, and Port Broughton/Fishermans Bay as the subject sites. The study had a wider scope than this current study and was to take into account the impact of climate change generally upon the coastal environments which included both built assets and natural habitats. The study implemented a risk assessment methodology, evaluated relevant legislation and policy, and suggested adaptive actions for each of the settlements.

4.2 Analysis of existing sea flood protection

The primary purpose of this section is to analyse the existing protection from sea flooding. However, in an effort to provide the fullest 'flood picture' possible, inland flooding is also reviewed where these factors are known.

4.2.1 What existing natural protection exists?

Coastal setting

Port Clinton is positioned at the very top of Gulf St Vincent. Areas impacted by coastal processes can be divided into three main sections. The main settlement is in the middle (Figure 4:1), a strip of dwellings is situated in the south, and a third section of Clinton is situated to the north of the estuary (Figure 4:2).

Figure 4:1 The coastal setting of Port Clinton (1).

Aerial Photograph: Coast Protection Board (2014)

Figure 4:2 The coastal setting of Port Clinton (2).

Aerial Photograph: Coast Protection Board (2014)

Beach stability

A comparison of historical photographs reveals that erosion is occurring in the south at the former 'shack' area (See Appendix C). This erosion was also noted in 1972 by Coast Protection Board when comparing older photographs taken in 1945[17]. A rock armoured wall was installed in 2005 to protect the six existing dwellings from further erosion, this being a condition for obtaining a freeholding status and implemented at the cost of the owners. However, it is likely that erosion will continue to the north of the rock armour where a further 23 dwellings are situated that have always been freehold tenure.

The main beach section of Port Clinton appears to have undergone little change since 1972 and no mention was made of any erosion when comparing photographs with those of 1945.

A letter from CPB in 1980 notes 'erosion north of the boat ramp', and the rock armoured wall has since been upgraded in this location circa 2005. However, a comparison of historical photographs reveals that the beach to the north of Cumberland Road shows signs of erosion (especially in close proximity to the cul-de-sac). This section of dunes provides a protection buffer between the ocean and the estuary and settlement behind.

Figure 4:3 Erosion occurring to the north of Cumberland Road

Photograph: Coast Protection Board (2014)

Natural topography of Port Clinton

Apart from the Esplanade settlement area in the south of Port Clinton, areas south-east of the caravan park are well elevated and at no risk of flooding (See Figure 4:4). Areas to the east and north of the caravan park are generally at 2.80m AHD to 3.20m AHD and these areas are the

[17] Letter from CPB on 10th September, 1980 referring to older study completed in 1972.

subject of this investigation. Behind the Clinton settlement the hillside rises for a few kilometres to elevation in excess of 40m AHD. To the south of the former 'shack' area a row of cliffs is situated that will prevent any lateral erosion from occurring to this side of the settlement. The portion of Clinton situated to the north of the estuary is constructed on a low dune system range from heights 3.00m to 3.50m (Figure 4:3). This dune system extends further north and provides some level of natural protection from water encroaching around behind the Clinton settlement but only at a height of 2.40m AHD at the northern extremity.

Figure 4:4 The natural topography of Port Clinton

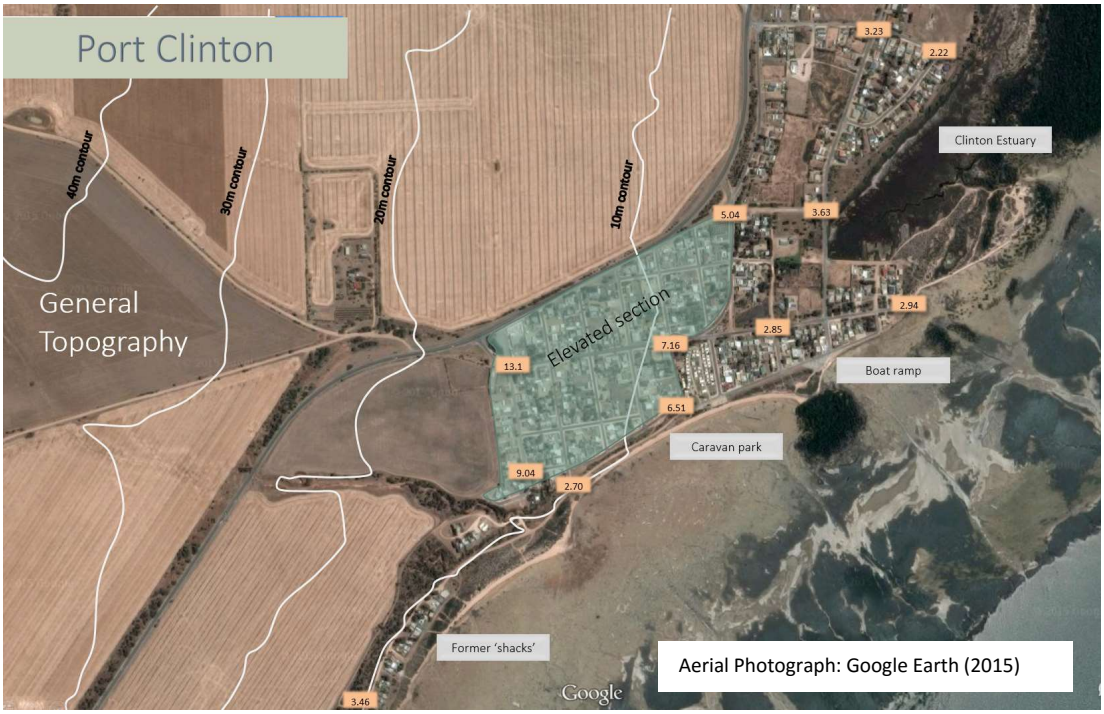


Figure 4:5 : Elevated line of dunes provides some lateral protection to Clinton

Aerial Photograph: Coast Protection Board (1997) – prior to Clinton North being established as residential.

4.2.2 What existing man-made protection has been installed?

While the focus of this study is 'sea-flooding' in an effort to provide the greatest context possible for future decision making, this section also provides an overview of the rain flood protection system that is currently installed at Clinton.

Storm water management: General Scheme

The wider storm water management scheme is designed to deal with water run-off from Yorke Highway as well as to protect Clinton from potential flooding from the extensive farmland that is situated on the elevated plains behind (Figure 4:6).

Figure 4:6 General storm water management scheme for Port Clinton

Aerial photograph: Google Earth, 2015

Sea flooding management: General Scheme

Three protection mechanisms have been installed in Port Clinton. First, a rock armoured wall was installed to the southern end of Clinton in 2005 at the owners cost and responsibility to maintain (Figure 4:7).

Figure 4:7 Rock armouring to six dwellings on the south end of Port Clinton.

Aerial Photograph: Coast Protection Board (2014)

A rock armoured wall was installed in the boat ramp area in 1980/1981 to arrest 'tidal scouring' in the area[18]. The wall was upgraded in 2003 into its present formation.

Figure 4:8 Rock armoured wall installed in boat ramp area

Aerial Photograph: Coast Protection Board (2014)

[18] First mention of rock armouring to this location was in correspondence 14th October, 1966 from SA Harbors Board

Thirdly, a levee was approved and constructed to the northern side of Manwurta Street in 1983. However, the construction of this levee was implemented before Manwurta Street was constructed in its present state and was a street in name only. The purpose of the levee was to prevent the 'high tide flooding of allotments' and was to be constructed from 'rock and earth filling'[19]. The presence of a tidal creek was noted on the accompanying plan (Figure 4:9).

Figure 4:9 Approved plan for installation of levee to Manwurta Street.

Aerial Photograph: Coast Protection Board (2014)

Subsequent to flooding in 1995, Manwurta Street was constructed (Figure 4:10) and Kulpara Street was raised and sealed (Figure 4:11) into its current configuration (Figure 4:12).

Figure 4:10 Construction of Manwurta Street in 1995

[19] Letter to District Council of Clinton from Department of Environment and Planning, 12th May,1983.

Figure 4:11 Kulpara Street was raised and sealed in 1995

Photograph: Scanned from photographs from resident, Ms. Rena Hoare (1995).

Figure 4:12 Current configuration of Manwurta and Kulpara Street

Aerial Photograph: Coast Protection Board (2014)

The location of the existing sea-flood protection in Clinton is depicted below[20].

Figure 4:13 Location of existing protection works at Port Clinton

Aerial photograph: Google Earth, 2015

Note: Rock revetment protection also exists in the southern 'shack' area of Port Clinton.

General condition of protection

Rock armoured wall to boat ramp area

- The rock revetment appears to have remained in adequate condition since its upgrade in 2003.
- The portion of rock armoured wall that is privately owned (to the east) is in fairer condition.

Rock armoured wall to southern 'shack' area

- The rock revetment was installed in 2005 and appears to not have suffered any denigration since then.

[20] Protection works also exist in the southern end of Clinton but are outside the scope of this study.

4.2.3 What is the nature of sea-flooding events that have occurred in Clinton?

The following questions are relevant to this section and were also put to the public in the consultation process:

- What sea-flood events have occurred in the past?
- What is the nature of the wave action in sea-flood events?
- What wind direction accompanies high water events?

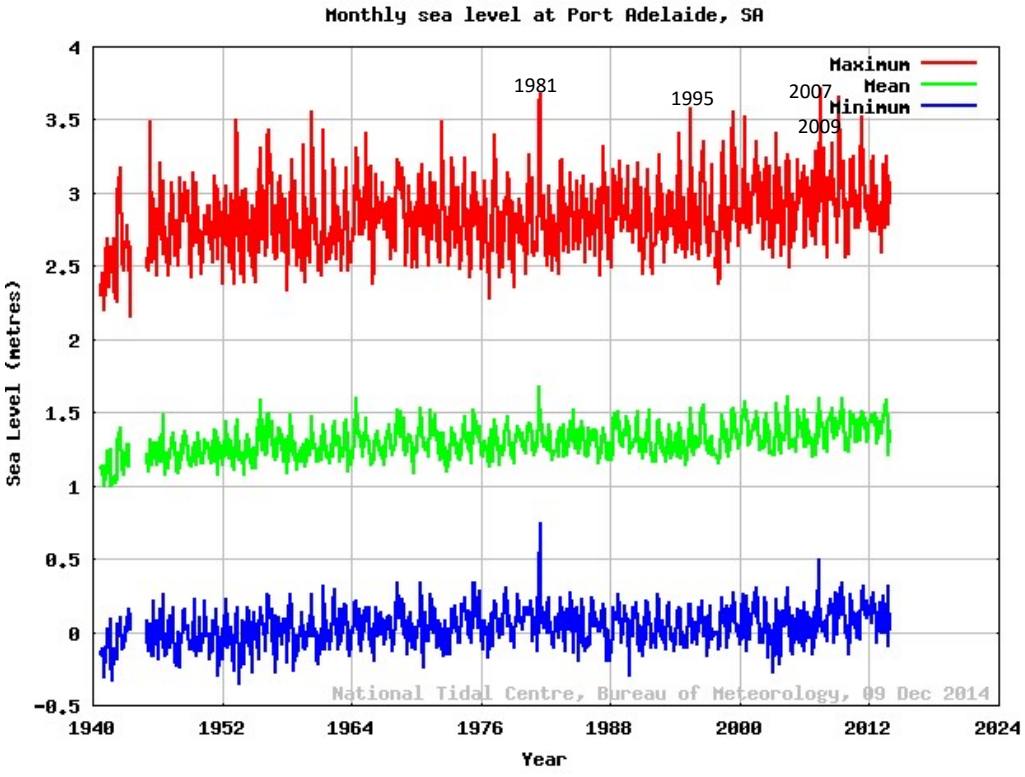
What sea-flood events have occurred in the past?

The request for quote for this study states, 'Port Clinton is in a low lying area with no formal protection measures in place. The risk of flooding exists within the caravan park and adjacent residents. The foreshore area is at risk from seawater flooding. Previously sea water has risen to the middle of the road'.

Flood events in Gulf St Vincent

The location of Port Clinton at the head of Gulf St Vincent means that any elevated water experienced in that region must be contingent upon elevated waters further down the Gulf. While local meteorological factors can influence the way the storm surge is experienced in different locations, the shallowness of the water in the Port Clinton region makes any significant increases in storm surge heights unlikely. It is therefore expected that these large storm surge events would play a significant role in the history of flooding in the Port Clinton region.

The tidal record at Port Adelaide since 1940 is represented by Figure 4:14:



Source: http://www.bom.gov.au/ntc/IDO70000/IDO70000_61600_SLD.shtml

The dates of the four highest readings since 1940 have been noted on the chart and the events are listed here:

- 1981 – June 3.579m (2.129m AHD) and July 3.679 (2.229m AHD)
- 1995 – July 13th, 3.569m (2.119m AHD)
- 2007 – July 4th, 3.707m (2.257m AHD)
- 2009 – April 25th, 3.654m (2.062m AHD)

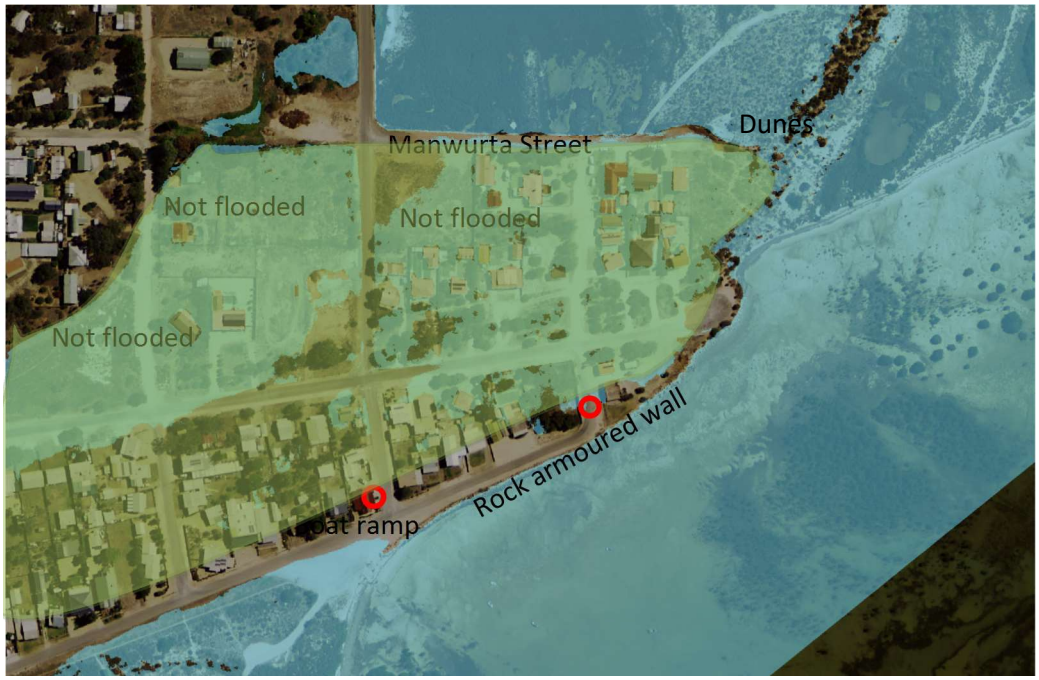
The events of 1981 and 2007 are comparable events (taking into account sea level rise) and represent the highest levels of water recorded at Port Adelaide in eighty years. The event of 2009 represents the second highest level in the Gulf at 5cms lower.

Flood events in the Port Clinton region

- **25th April, 2009**

Using the Digital Terrain Model to reflect all of the information[21] and photographs given by residents, the rendition of the flood pattern gives a height of 2.62m AHD[22]. A sample of photographs received is included on the following pages.

Figure 4:15 Digital Terrain Model rendition of flood pattern (2.62m AHD)*



DEM rendition of flood pattern: Mark Western, 2015

*Red circles denote the location that the photographs in Figures 4:14 and 4:15 were taken.

**Areas between Manwurta Street and The Parade were not flooded.

[21] The flood waters did not traverse over Manwurta Street or the dunes east of Cumberland St. The flood water did not overtop the rock armoured wall near the boat ramp, but came close. Numerous photographs picture the flood pattern on The Parade.
[22] The map is a rendition of all levels below 2.62m AHD and therefore not all areas are flooded.

Figure 4:15 View from top of rock armoured wall (25th April, 2009)

Photographer unknown: submitted in hard copy to community consultation meeting 13th April, 2015

Figure 4:16 View to boat ramp (25th April 2009)

Photograph: Jon, Resident at 25 The Parade, 2009

Figure 4:17 Digital Elevation Model rendition of flood pattern (2.62m AHD) (caravan park area)*

DEM rendition of flood pattern: Mark Western, 2015

*Red circles denote the location that the photographs in Figures 4:17 was taken.
** Note that gravel has since been placed in front of the playground and picnic area.

Figure 4:18 View on The Parade in front of the caravan park

Photographer unknown: submitted in hard copy to community consultation meeting 13th April, 2015

Figure 4:19 Digital Elevation Model rendition of flood pattern (2.60m AHD) (Port Clinton - South)

Land owner at 16 The Esplanade confirmed that water just encroached on to the bottom of his drive on the sea-side of his house. Land owner at 32 The Esplanade indicated where he recalls the water in this flood event on this day. The height of water is further confirmed at 2.60m AHD in the Port Clinton region on 25th April, 2009.

DEM rendition of flood pattern (M. Western, 2015)
Inset photograph (M. Western, 2015), land owner Lyndon indicates where he recalls the flood encroachment (used with permission).

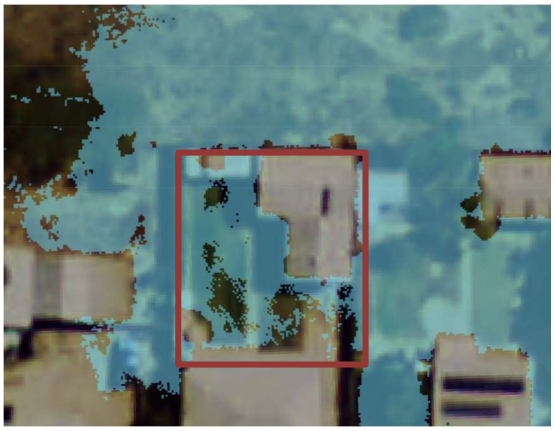
- **13th July, 1995**

In this event no photographs are available of the foreshore but are available from the Manwurta Street region. It is important to note that this event precedes the installation of Manwurta Street and precedes the elevation and sealing of Kurilla Street.

Figure 4:19 Photograph taken from the rear of 51 Cumberland Ave (no rear fence)

Photograph: Rena Hoare, 1995 (scanned from hard copy)

Figure 4:20 Flooding of the rear of 51 Cumberland and DEM rendition



Photograph: Rena Hoare, 1995 (scanned from hard copy) DTM rendition: Mark Western, 2015

Using the flood pattern in the rear of 51 Cumberland (with no rear fence at that time) to produce a similar pattern on the DEM suggests that the height of this event was 2.46m AHD[23].

In regard to the other major events that were experienced at Port Adelaide, the communities at Price and Port Clinton had no memory of the impact of these high water events locally.

[23] It is likely the height of the flood on the foreshore was slightly higher as water in this region had to traverse through the channels of the estuary and make its way some distance to this location.

- **Manwurta Street – possible sub terrain water movement**

On 25th April, 2009, water did not flow over Manwurta Street but bubbled up through holes in the ground (Figure 4:21). The Murrays (Lot 8 Manwurta) inform that this phenomenon occurs regularly on king tides. Coastal Engineer, Geoff Fisher (AWE) inspected the site on 24th May, 2015 informed that once water has begun to find a path through soil it will repeat that path more easily on the next occasion until the stability of the soil is affected.

Figure 4:21 Water 'bubbled up' through holes in ground on flood event 25th May, 2009.

Photograph: Marie Murray, resident on Manwurta, 2009

What is the nature of the wave action in sea-flood events?

The flood photographs all show that there is minimal wave action in the vicinity of the Port Clinton settlement in extreme high water events. Residents in formal consultation generally supported this view:

'During high tide events – no high wave action. Can get wave up to 4 ft – nothing to do with tides' (Group 1).

What wind direction accompanies high water events?

Residents in formal consultation suggested that the wind direction in high water events was from the north/north west but that it also 'backed around to the south west'.

'South-west/ north-west' (Group 1) 'South-west' (Group 2) 'N/NW backing SW' (Group 4)

4.2.3 What rain events have occurred in the past in Port Clinton?

As a general note, previous work by Australian Water Environments and Tonkin Consulting has demonstrated that 'storm surge and high rainfall events are independent for this region' (ie, the Yorke Peninsula region)[24]. In other words, the weather systems that produce storm surge events are deemed to be unrelated to the weather systems that produce high rainfall events.

Resident 'Gus' (16 The Esplanade) noted that in rain events water traverses down the north through the storm water gully and streams out across the Esplanade. On occasions these events prevent vehicles other than four wheel drives from accessing the road in this place. This resident also recalls a large rain event in the 1980s (or 1970s) that caused a mudslide from area above the Port Clinton South that descended into the residential section.

Figure 4:22 Stormwater flows across the Esplanade after rain events.

Photograph: M. Western, 2015

Resident Michael (11-15 Kurilla Street) provided photographs of water that lay across the road and within his property for 'weeks' in September 2014. The reason for undertaking further investigation of this issue was that this area of land lies in the former path of estuarine flow (refer Figure 4:4). This factor, combined with evidence that sea water may be traversing underneath Manwurta Street to the north east, meant that it was critical to ascertain the likely source of the water.

A preliminary investigation of the surrounding area suggests that subsequent to the paving and curbing of the roads north of Cooper Street an increased amount of water is finding its way down Manwurta Street (eastern end)[25].

[24] Australian Water Environments (2009) National Climate Change Coastal Vulnerability Assessment: Yorke Peninsula Case Study, SA, p. 25

[25] Stephen Goldsworthy (Yorke Peninsula Council) informed that the Council is working on this problem.

Figure 4:23 Stormwater accumulated in Kurilla St in September 2014

Photograph: Resident – Michael (2014)

3.2.4 Conclusions

The following preliminary conclusions can be made in relation to the protection system at Port Clinton:

- The general topography of Clinton would indicate that dwellings in the north-eastern part of the settlement, and in the south-western sectors are vulnerable to sea-flooding.
- Port Clinton is not likely to be vulnerable to lateral erosion from the south-west which would undermine the integrity of the settlement over longer periods of time. The dune system to the north-east is lower at heights 2.40 to 2.60m AHD and may be vulnerable to flooding.
- The highest level of flood water in the last 20 years is likely to have been 2.62m AHD on 25th April, 2009. This date may also represent the highest levels experienced in Port Clinton since 1940.
- Large over-land flooding is unlikely due to the installation of a diversion system to the north of Clinton. However, there has been over-land flooding in the Port Clinton (south) that has flowed over the embankment and down into the residential section.
- In rain events some water flows across the Esplanade at the exit point of the storm water gully and there appears to be increased run off from newly paved areas into Kurilla Street.

4.3 Analyse the impact of sea-flood scenarios

4.3.1 Coastal Processes

The location of Port Clinton at the head of Gulf St Vincent means that any elevated water experienced in that region must be contingent upon elevated waters further down the Gulf. While local meteorological factors can influence the way the storm surge is experienced in different locations, the shallowness of the water in the Port Clinton region makes any significant increases in storm surge heights unlikely.

In Gulf St Vincent

Modelling study

Work begun by Easton (1970), and Noye (1998) was built upon by Grzechnick[26] whose modelling study in 2000 found that elevated storm surges in Gulf St Vincent are unable to be generated by tide, wind or currents alone (with the exception of a south-west wind which has the 'longest reach' from the Southern Ocean through Investigator Strait and can raise water levels at Port Adelaide). Elsewhere in the gulf he contends that storm surges are contingent on the presence of larger swells coming through Investigator Strait that are generated by weather conditions in the Great Australian Bight.

Observations

Flinders Ports operates seven ports in South Australian waters and make the following observations on water patterns in the gulf regions[27]:

> The shape of the two gulfs and Investigator Strait..contribute to the wind effects. At Port Adelaide, north westerly winds cause the highest tides, raising the sea level up to 1 metre above normal, while south easterly winds depress it as much as 0.5m.
>
> In the northern part of Spencer Gulf[28] the most marked weather effects on the tide occur with the passage of a deep depression across the Southern Ocean. As the barometer starts falling and with the onset of northerly winds the tides are below prediction, but as the wind backs to the north-west, an increase in level occurs, with a gradual build-up if the wind remains steady. A strong gusty north-westerly wind, with such as depression , backing to the west south-west at about the time of low water, will cause a storm surge of maximum amplitude, and heights may be expected from 1m to 2m above prediction. These high levels will continue until the barometer starts to rise, and the wind backs rapidly to the south east within 12 hours, and with a rapidly rising barometer the tides return to normal (or below) in about that time.

[26] Grzechnick M P (2000) Three-Dimensional Tide and Surge Modelling and Layered Particle Tracking Techniques Applied to Southern Australian Coastal Seas, Doctoral Thesis, University of Adelaide.
[27] http://www.flindersports.com.au/pdf/PtUserGuideGeneralInfo.pdf
[28] Note: the context here is Spencer Gulf, but the weather pattern described is also related to Gulf St Vincent region.

In Port Clinton region

In the weather conditions described above by Flinders Ports, either the north-west or a west wind blows off-shore from Port Clinton. A south-west wind would blow obliquely across the region, but certainly wouldn't be 'on-shore'. These factors account for the calm water which historically have accompanied high water events[29].

Other than depth of water, additional factors that influence the impact of a flood on a settlement are the velocity of the water (speed) and the duration of the flood (how long it lasts). How much warning is possible in anticipation of flooding determines how prepared the community can be, and the topography of the settlement will influence how easily people are able to enter or leave the settlement. The general characteristics of a sea-flood in Port Clinton are shown in Table 4:2.

Table 4:2 Sea flood characteristics for Port Clinton coastal region.

Flood characteristic	Clinton region
Depth of water	Shallow
Velocity of water	Low, due to tidal action and ocean terrain
Wave action	Minimal due to depth of water and sheltered from any westerly winds by the land
Direction of water	From the east
Duration of flood	Short 1-2 hours relating to combination of tide and storm surge
Warning	Predictable as flood will relate to tide.

In flood calculation it is common to reduce the estimated amount of damage taking into account a number of factors: the velocity of the water, the likely duration of the event, how much warning of the flood can be given, and how experienced is the community in dealing with floods. Some of this factoring is illustrated in Table 4:3.

Table 4:3 Proposed ratios of actual : potential damages[30]

Warning time	Experienced community	Inexperienced community
Less than 2 hour	0.8	0.9
2 to 12 hours	Linear reduction from 0.8 at 2 hours to 0.4 at 12 hours	0.8
Greater than 12 hours	0.4	0.7

While a reduction of actual damages may be warranted, in this study no such factoring has been applied, but the rationale is included here to emphasize the advantages of the Port Clinton region in dealing with potential flooding.

[29] A review of all photographic evidence for Clinton, Price, Pine Point and Coobowie which are situated on the eastern side of Yorke Peninsula demonstrates that all incidents of extreme high water events were accompanied by calm water, the one exception being in Coobowie in the June 1981 event. Residents in informal and formal consultation were in general agreement about the nature of the water in high water events.

[30] Victorian Government (2000) Rapid Appraisal Method (RAM) for Floodplain Management.

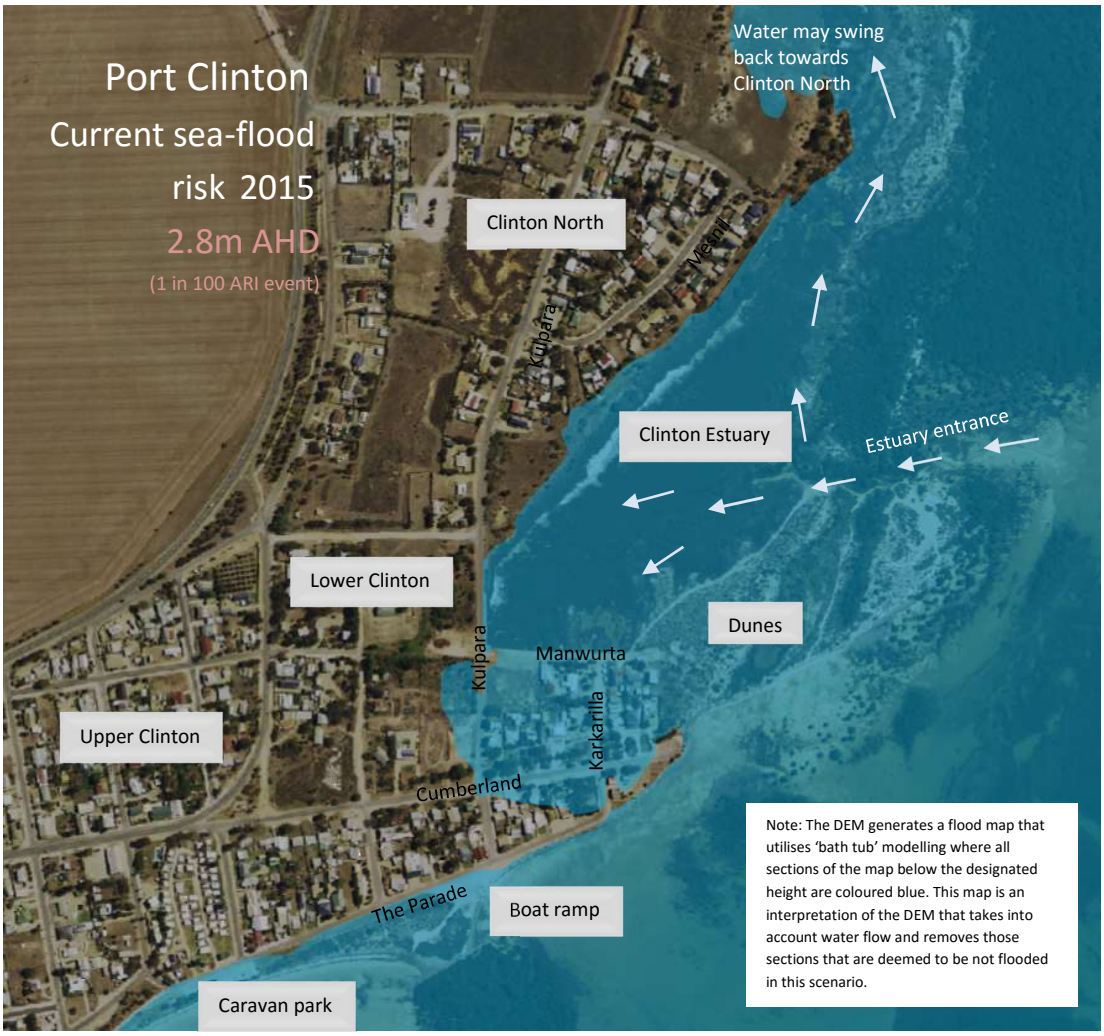
4.3.2 Likely impacts in selected sea-flood scenarios

What is the likely impact on Port Clinton of a 2.8m[31] AHD event (2015 sea-flood scenario)

General Possible Impact

The flood mapping generated from data from the DEM gives a broad overview of the impact of a 2.80m AHD flood to Port Clinton, if the event was of significant duration and not just a short overtopping of the defences. It is also important to recall that this flood scenario is the 1 in 100 ARI event, and therefore an extremely rare event.

Figure 4:24 Sea-flood risk mapping scenario for 2.80m AHD 1 in 100 ARI event (2015 scenario).



Interpretive rendition of flood map based on DEM (M.Western, 2015)

Note: Refer also to Appendix E for flood mapping for the southern portion of Port Clinton.

[31] Wave effects have not been included in this figure for the following reasons: (1) Research suggests that the highest water into the Clinton region in the last eighty years was 2.60m AHD in 2009. Therefore 2.80m AHD is significantly higher than this historical flood height. (2) Assessment is being undertaken of significant areas behind the shore line where wave effects are diminished and extra time is required for water to traverse through channels to reach these locations. (3) The level of water above ground level is very low in most areas that are inundated and wave effects are likely to be quickly dissipated.

Specific possible impacts

Using the visual representation of the DEM, and the surveying points of the surveyor, the likely impacts of a sea flood of 2.80m AHD are listed in Table 4:4 below.

Table 4:4 Location and nature of breaches (Sea-flood scenario 2.80m AHD, 2015)

Location	Location and nature of breaches	Notes	Depth Of water over defences/ or foreshore	Depth Over The Parade (or other road)	Depth Within residential area
Clinton (South)	All sections of The Esplanade road in the residential section are at or above 2.80m AHD. Some inundation of residential area to the south.	Water circumnavigate the rock revetment defences	1m (at shoreline)	0m	Areas in south at 0.2m Dwellings 50 -54 at 0.6m
Caravan Park section	Water would inundate the Parade entirely in front of the caravan park and portion of the Parade to the east.	Depth of water generally shallow in this region	0.1-0.2 m over playground sleepers	0.1 m	0 m
Boat ramp area	Water would inundate The Parade in the boat ramp area but not cross over into residential area. Water may overtop the rock wall on private property adjacent Kararilla St.		Minor over-topping 0.1m	0.1 m	0 m
Dunes	Dunes are generally at 2.5m to 2.6m AHD. Water would overtop dunes at end of Cumberland and Manwurta Streets.	No evidence of over-topping in the past	0.2m to 0.3 m	NA	NA
Manwurta St area	Manwurta Street is generally at height 2.5 to 2.6m AHD would be overtopped by 0.2m - 0.3m. Kulpara Street prevents water from travelling further west.	Residential allotments in this area are set at lower height than Manwurta.	0.2m	0.2 m	0.2 to 0.5m
Clinton North	Unlikely to be flooded directly from the Estuary. Possible that water could traverse the dune to the north and swing back into the settlement but due to the long distance of travel, unlikely.	Dunes in north are as low as 2.4m	0.3m across dunes to the north (possible, but unlikely)	NA	NA

Summary:

If a 2.80m AHD event of significant duration occurred minor flooding would occur along The Parade, more significant flooding would occur across Manwurta Street into the low lying areas between that street and the foreshore, but flooding unlikely into Clinton North. Minor flooding would occur in the Clinton (South) with more major flooding to three of the 'shacks'

What is the likely impact on Port Clinton of a 3.1m[32] AHD event (2050 sea-flood scenario)

General Possible Impact

The flood mapping generated from data from the DEM gives a broad overview of the impact of a 3.10m AHD flood to Port Clinton, if the event was of significant duration and not just a short overtopping of the defences. It is also important to recall that this flood scenario is the 1 in 100 ARI event, and therefore an extremely rare event.

Figure 4:25 Sea-flood risk mapping scenario for 3.10m AHD 1 in 100 ARI event (2050 scenario)

Interpretive rendition of flood map based on DEM (M.Western, 2015)

Note: See also Appendix E for sea-flood mapping for Clinton (South)

[32] Allowance for wave run up has been omitted from this figure due to the large area of land that is not on the sea front. Extra time is required for water to reach inland, and wave effects in these locations would be expected to be almost zero.

Specific possible impacts

Using the visual representation of the DEM, and the surveying points of the surveyor, the likely impacts of a sea flood of 3.10m AHD are listed in Table 4:5 below.

Table 4:5 Location and nature of breaches (Sea-flood scenario 3.10m AHD, 2050)

Location	Location and nature of breaches	Notes	Depth Of water over defences/ or foreshore	Depth Over The Parade (or other road)	Depth Within residential area
Clinton (South)	Some flooding of residential properties (up to 0.5m depth) in southern sector. Properties 50, 52, 54 would suffer major inundation up to 0.9m deep.	Water would encroach towards dwellings 2 – 38 Esplanade	1.3 (at shoreline)	Up to 0.3m	To 0.5m but some up to 0.9m
Caravan Park section	Water would inundate The Parade in front of the caravan park, portion of the caravan park, and flow into portion of the caravan park and some residential sections.		0.4-0.5 m over playground sleepers	0.3- 0.4 m	0.2 – 0.3 m
Boat ramp area	Water would inundate The Parade in the boat ramp area and cross over into residential area. Water would overtop private rock wall in places (property adjacent Karkarilla).	Water depth in residential area would be very low in foreshore regions but deeper further back	Over top of rock walling to east of boat ramp – 0.2m	0.1 m	varies 0.2 -0.8 m
Dunes	Dunes generally at 2.5m to 2.6m AHD. Water would overtop dunes at end of Cumberland and Manwurta Streets.		0.5m to 0.6 m	NA	NA
Manwurta St area	Manwurta Street is generally at height 2.5m to 2.6m AHD would be overtopped by 0.5m. Kulpara Street prevents water from travelling further west.	Allotments in this area are set at lower heights than the street.	0.5m	0.5 m	0.5 to 0.9m
Clinton North	Flooding would occur directly from the Estuary and water would likely traverse the dune to the north and swing back into the settlement.		0.2m from estuary 0.7m across dunes to the north	NA	NA

Summary:

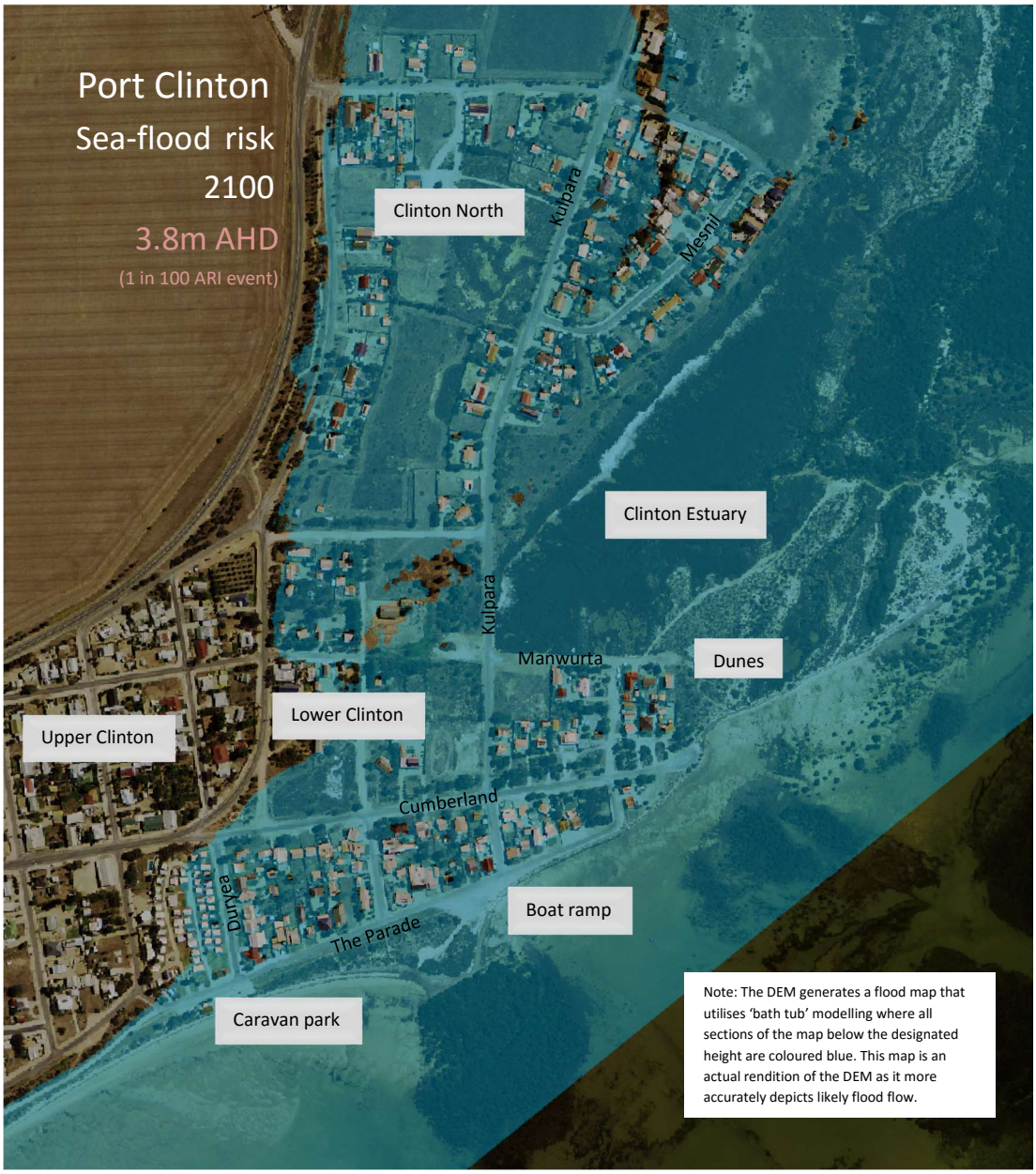
If a 3.10m AHD of significant duration occurred, water would traverse The Parade and enter a small portion of the caravan park and a substantial portion of the residential area between The Parade and Manwurta Street. Water would also enter this residential area from the estuary across Manwurta Street. More minor flooding would occur in Clinton (North) where two points of water access are likely. In Clinton (South) water would enter a number of properties in the southern sector, a few at significant depth.

What is the likely impact on Port Clinton of a 3.8m[33] AHD event (2100 sea-flood scenario)

General Possible Impact

The flood mapping generated from data from the DEM gives a broad overview of the impact of a 3.80m AHD flood to Port Clinton, if the event was of significant duration and not just a short overtopping of the defences. It is also important to recall that this flood scenario is the 1 in 100 ARI event, and therefore an extremely rare event.

Figure 4:26 Sea-flood risk mapping scenario for 3.80m AHD 1 in 100 ARI event (2100 scenario).



Rendition of flood map from DEM (M.Western, 2015)

See also flood mapping for Clinton (South) in Appendix E.

[33] Allowance for 0.1m wave run up has been omitted from this figure

Specific possible impacts

The concept of flood mapping this far into the future is to enable policy makers to consider the long term effect of planning decisions, as infrastructure and housing have long life spans. It is also acknowledged that this flood scenario is dependent on the rate in which sea level rises accelerating in the second half of the century. It is expected that scientists will monitor the rate of sea level rise over the coming decades and will be able to more accurately forecast anticipated rises by the end of the century. In summary, the impact of this flood scenario within Port Clinton is shown in Table 4:6 below.

Table 4:6 Location and nature of breaches (Sea-flood scenario 3.80m AHD, 2100)

Location	Location and nature of breaches	Notes	Depth Of water over defences/ or foreshore	Depth Over The Parade (or other road)	Depth Within residential area
Clinton (south)	Water would significantly inundate all areas of Clinton South		2.0m (at shoreline)	0.7m to 1.0m	Varies 0.8 – 1.6m
Caravan Park section	Water would inundate half of the caravan park and residential area. Water would likely traverse through to the estuary.		1.1- 1.2 m over playground sleepers	1.0- 1.2 m	Varies 0.8 – 1.6 m
Boat ramp area	Water would flow from the sea and meet water flowing from Manwurta Street.		At top of boat ramp: 1.5 to 1.6m	1.0 m	varies 0.2 -0.8 m
Dunes	Water would flow from sea, estuary, and from Manwurta Street making one sheet of water.		1.2m to 1.3 m	NA	NA
Manwurta St area	Manwurta Street is generally at height 2.6m AHD would be overtopped by 1.2m. Kulpara would be overtopped and water would flow towards the caravan park.		NA	1.2 m	1.4 to 1.6m
Clinton North	Flooding would inundate Clinton North		NA	NA	0.8 to 1.4m

Summary:

If a 3.80m AHD of significant duration occurred, the lower portions of Port Clinton (north and south) would be severely inundated at levels up to 1.6m.

4.4 Analyse emergency egress and access

For reasons outlined in the introduction (p. 12) an analysis of emergency egress and access issues for the 3.1m AHD sea-flood scenario for 2050 will be utilised. This assessment takes no account of any protection works that may be implemented subsequent to this study. In conducting this assessment it is also important to recall the nature of sea flooding in the Port Clinton area (Table 4:7).

Table 4:7 Sea flood characteristics for Port Clinton coastal region.

Flood characteristic	Clinton region
Depth of water	Over The Parade and Esplanade 0.2m – 0.3m
Velocity of water	Low, due to tidal action and ocean terrain
Wave action	Minimal due to depth of water
Direction of water	From the south
Duration of flood	Short 1-2 hours
Warning	Predictable as the flood will relate to tide.

In 3.1m AHD flood could residents move away from the flood and move to a safe place?

The map below highlights areas within the flood region of the Clinton (main and north) where roads and surfaces would have flood depths less than 0.3m. The arrows indicate the best routes out of the settlement.

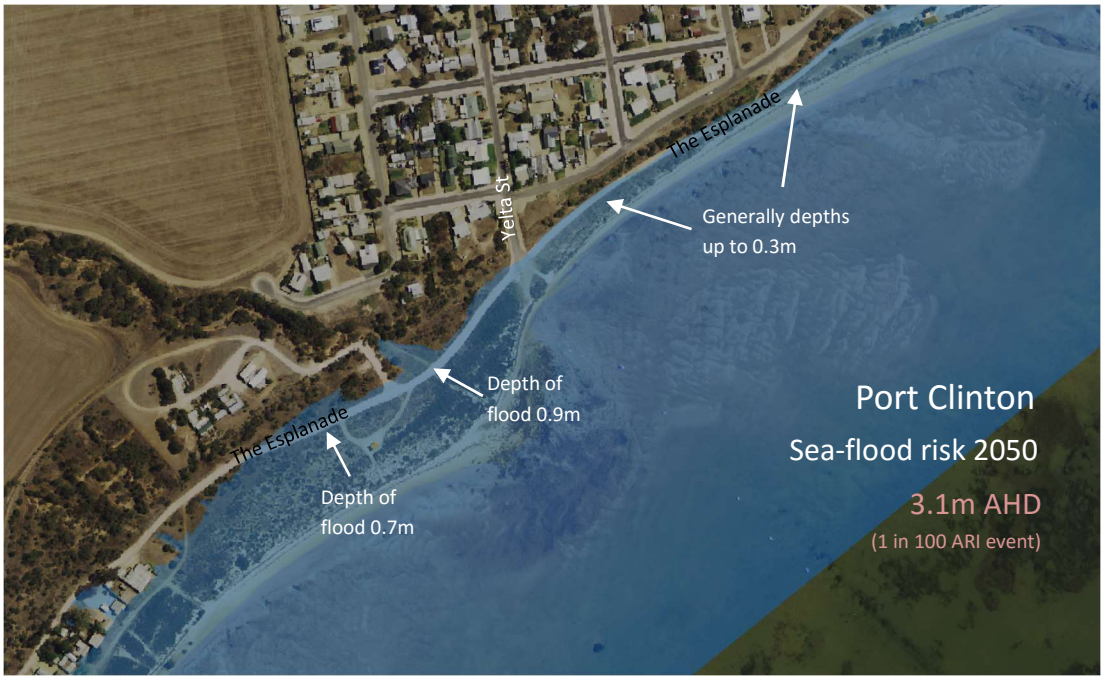
Figure 4:27 Emergency access and egress issues in 2050 sea-flood scenario (2050).

In most instances residents will be able to move to areas of water depth less than 0.3m. The two main ways out of the settlement would be through the caravan park area, or Kulpara Street. However, Kulpara Street has a short section where water would be at depths of up to 0.5m. There are no higher points in the area towards the end of Cumberland Ave where residents could obtain refuge from the water. However, many of the new houses in this area would have floor levels above this height.

In Clinton (north) area, there are many places where residents can find higher ground above the 3.1m AHD flood scenario. However, Mesnil Drive and Kulpara Drive may be flooded by up to 0.6m in depth.

In Clinton (south) area The Esplanade would be cut off in several places, the most significant being where the stormwater channel empties into the sea (refer Figure 4.6, p. 22). At this point depth of water would be 0.9 m and would be impassable by many vehicles. Should a sea-flood event be combined with a rain event this area could prove dangerous for all vehicles.

Figure 4:27 Emergency access and egress issues in 2050 sea-flood scenario (2050) (Clinton south)



In a 3.1m AHD flood event could emergency vehicles access Port Clinton?

Provided that emergency service vehicles can access roads with up to 0.3m flood water, then access is available into most areas. The main problem areas would be:

- Accessing the residential section in eastern end of Cumberland Ave (between Manwurta and Cumberland)
- Accessing Mesnil and Kulpara Streets in Clinton North (although distances to higher ground would be short)
- The short section of Kulpara Street (near intersection with Cumberland) may mean that access is not possible to the foreshore using this route.

However, Clinton (south) would likely to be inaccessible from the corner of Yelta Street to the residential sector both to emergency service vehicles and for vehicles attempting to egress from the residential section in Clinton (south). The main problem is not so much that person might be in danger from the sea-flood itself, but more that if a medical emergency occurred, this area of Clinton would be cut off until the tide subsided.

4.5 Establish profile of assets at risk

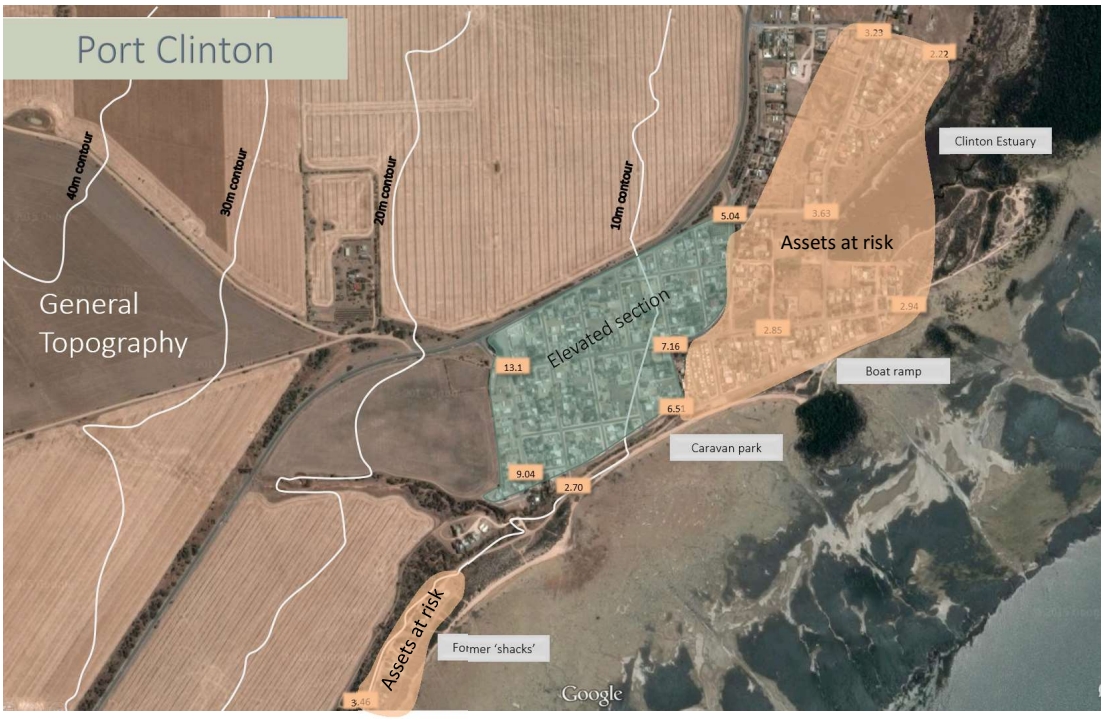
The purpose of this section is to identify the built assets at risk from sea-flood divided into two main categories: privately owned assets, and council owned assets. Identifying the different construction types provides appropriate data from which to offer some solutions for future adaptation. Identifying the value of the assets provides a context for future decision making, and assigning approximate damage costs in each flood scenario assists in prioritising future actions.

4.5.1 Strategy and area of assessment

The purpose of this section is to identify the built assets at risk from sea-flood divided into two main categories: privately owned assets, and council owned assets. Identifying the different construction types provides appropriate data from which to offer some solutions for future adaptation. Identifying the value of the assets provides a context for future decision making, and assigning approximate damage costs in each flood scenario assists in prioritising future actions.

Figure 4:28 illustrates the two 'at risk' areas in Port Clinton and includes all of the residential settlement to the south (not all shown).

Figure 4:28 The portion of Clinton from which assets will be assessed for flood risk



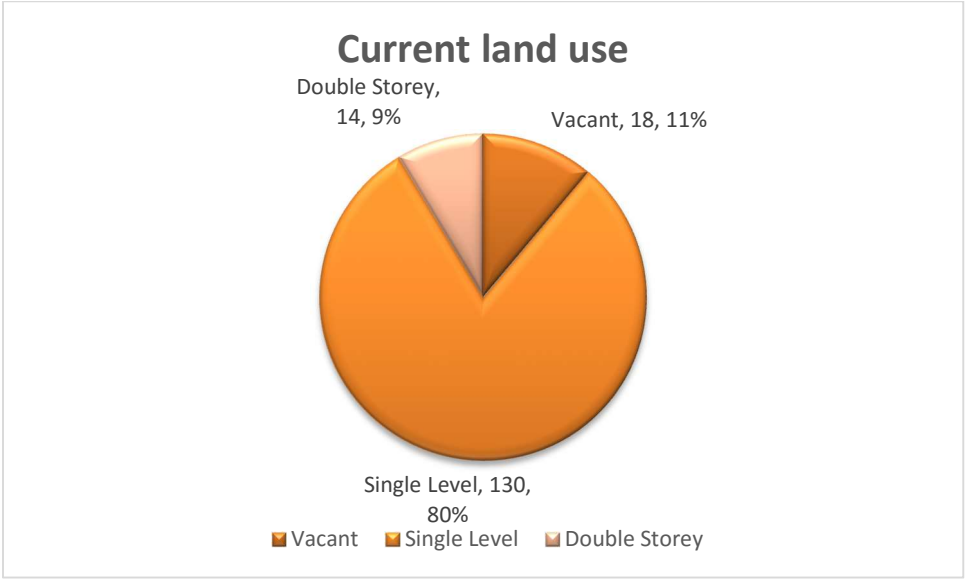
Aerial photograph: Google, 2015

4.5.2 Privately owned assets:

Current land use

The current land use of the privately owned allotments in the 'at risk' area in the Port Clinton 'at risk' area is depicted in Figure 4:29.

Figure 4:29 Current land use in Port Clinton (at risk areas).



Yorke Peninsula Council valuation records for 2015 show that the land and buildings for privately owned assets in the 'at risk area' are valued at:

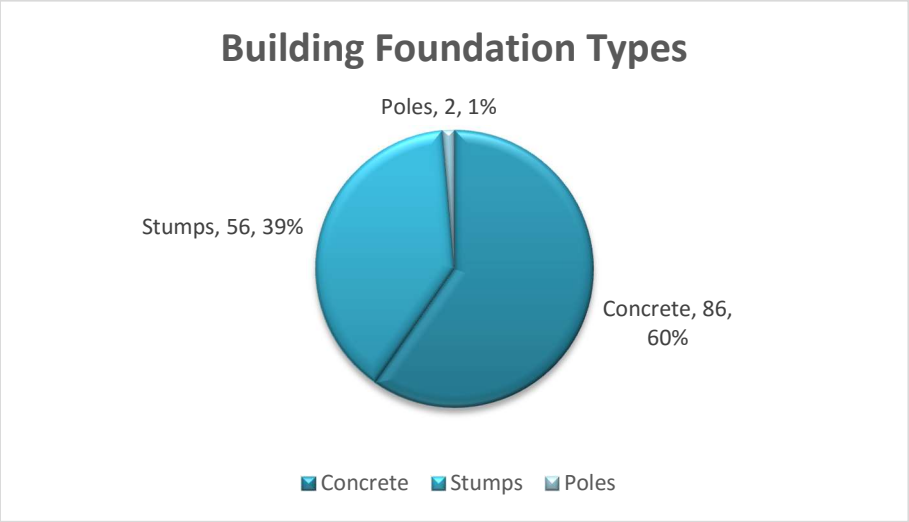
Table 4:8 Value of housing assets - Port Clinton 'at risk' area.

Location	Site Value	Improvements	Total Capital Value
The Parade	$10,571,000	$6,077,000	$16,648,000
The Esplanade	$4,270,000	$1,320,000	$5,590,000
Other areas	$4,784,000	$5,211,000	$9,995,000
Total	$19,625,000	$12,608,000	$27,193,000

Building foundation types

The foundation types utilised in 144 buildings in the Port Clinton 'at risk' areas are depicted in Figure 4:30.

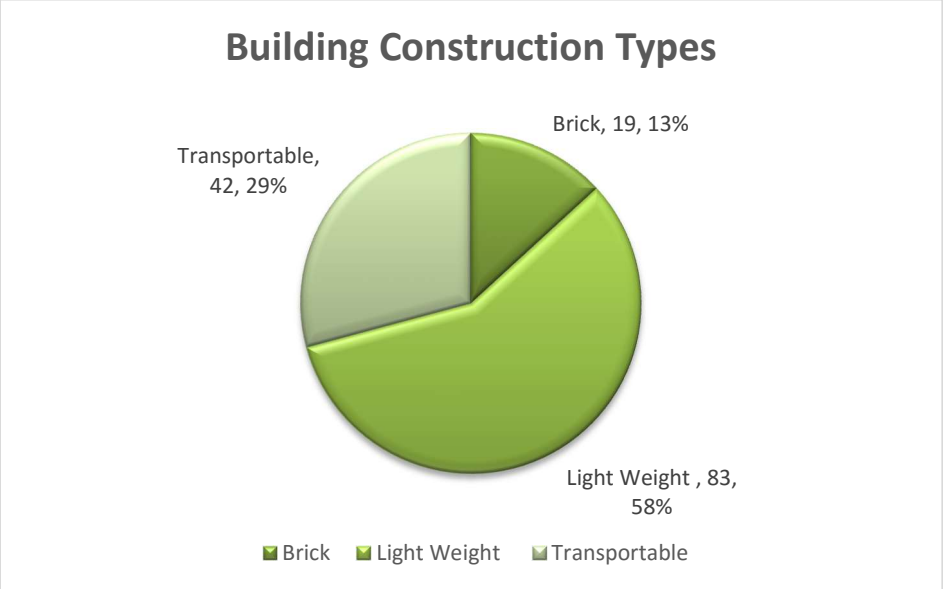
Figure 4:30 Current building foundation types in Port Clinton (at risk areas).



Building construction types

The building construction types utilised in 144 buildings in the Port Clinton 'at risk' area is depicted in Figure 4:31.

Figure 4:31 Current building construction types in Port Clinton (at risk area).

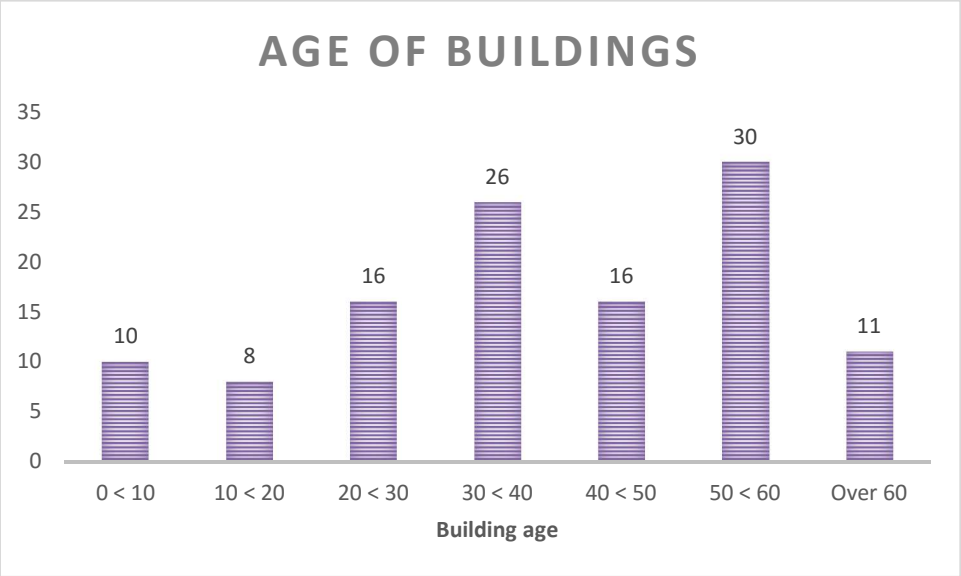


*Note: some interchange exists with designation 'light weight' and 'transportable'.
Also, 'light weight' includes 8 corrugated iron dwellings in Clinton (south)

Building age (approximate)

The age of the 117 existing buildings within the Port Clinton 'at risk' area was estimated and the findings are represented by Figure 4:32.

Figure 4:32 Approximate age of dwellings in Port Clinton 'at risk' area.



Note: the age of the dwellings in Clinton (south) was not estimated. Generally, most of the dwellings are in advance of 50 years. The construction method of light weight (fibro sheeting) on concrete slab is a method not used in recent years.

4.5.3 Impact of sea-flood scenarios upon assets

Using the surveyed floor levels the depth of flood is calculated for each dwelling in the 'at risk' areas.

Damage costs for each of the scenarios are assigned based on depth of flood over floor level and are reported in present day values. Assigning damage costs in this way provides a methodology for comparison between scenarios in one settlement and assists in prioritising actions in comparison with other settlements. The purpose is not to predict what the cost might be in the future for 'doing nothing'.

Scenario 2015

If the 2015 one in one hundred ARI sea-flood scenario occurred in 2015, and it lasted for a significant duration of time (not just a brief overtopping of the defences), 27 dwellings in the Port Clinton 'at risk' areas are likely to be inundated with a potential damage cost to buildings of $282,000.

Figure 4:33 Clinton 'at risk' area– impact of 2.8m AHD sea-flood event on buildings.

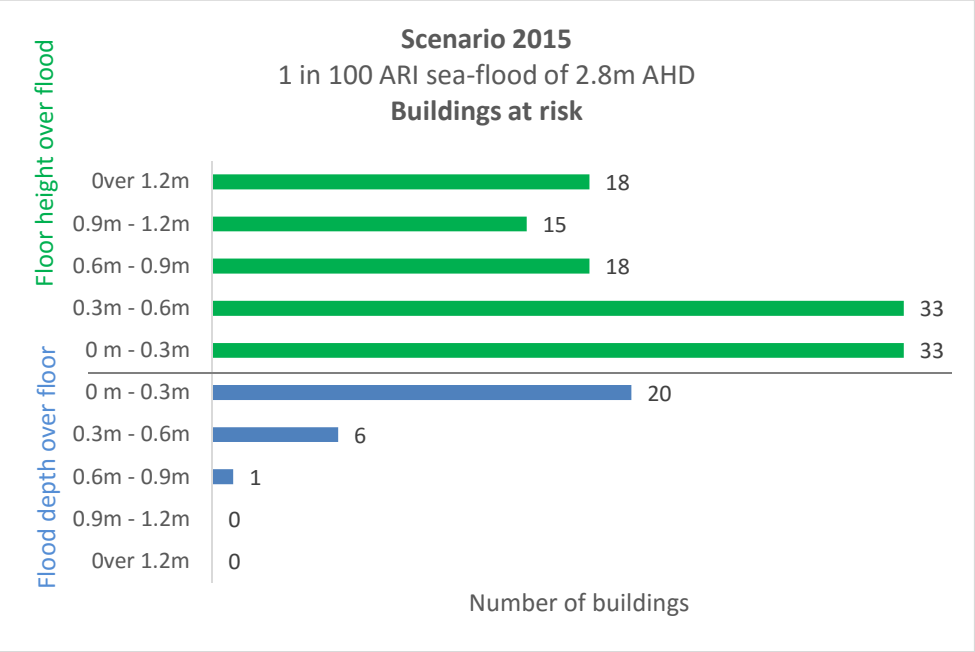


Table 4:9 Port Clinton 'at risk' area (2.8m AHD event) – potential damage cost to buildings.

Potential damage in 2.8m AHD sea-flood event		
Water over FFL	Buildings	$ damage
>0.00	10	$60,000
>0.10	8	$72,000
>0.20	2	$24,000
>0.30	2	$30,000
>0.40	4	$72,000
>0.50	0	0
>0.60	1	$24,000
>0.70	0	0
>0.80	0	0
>0.90	0	0
>1.00	0	0
>1.10	0	0
Total	27	$282,000

Scenario 2050

If the 2050 one in one hundred ARI sea-flood scenario occurred in 2015, and it lasted for a significant duration of time (not just a brief overtopping of the defences), 60 dwellings are likely to be inundated with a potential damage cost of $819,600.

Figure 4:34 Port Clinton 'at risk' area– impact of 3.1m AHD sea-flood event on buildings.

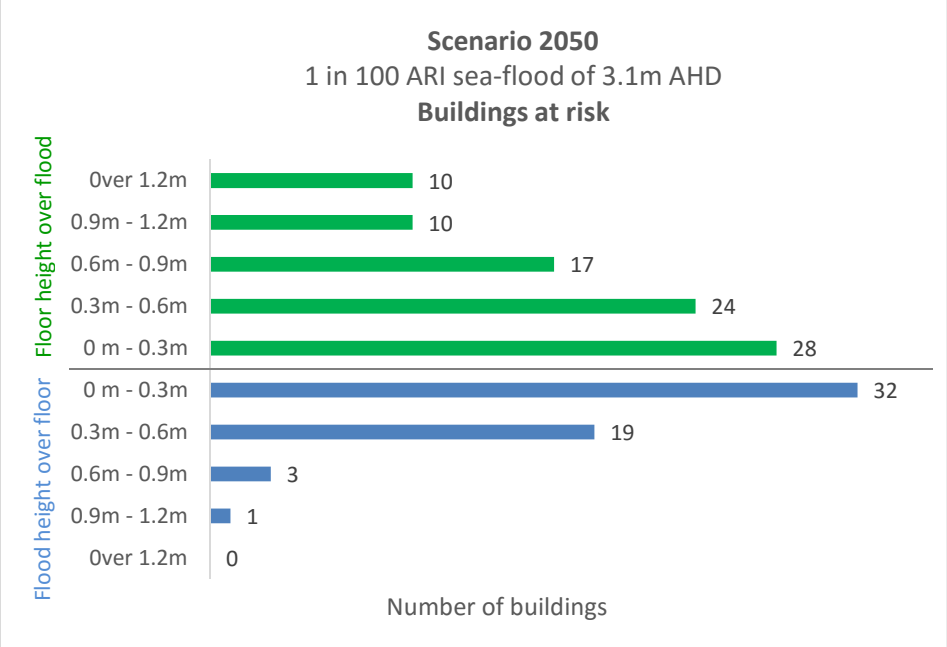


Table 4:10 Port Clinton 'at risk' area (3.1m AHD event) – potential damage cost to buildings.

Potential damage in 3.1m AHD sea-flood event		
Water over FFL	Buildings	$ damage
>0.00	11	$66,000
>0.10	10	$90,000
>0.20	10	$117,000
>0.30	11	$156,000
>0.40	7	$133,000
>0.50	4	$78,000
>0.60	2	$48,000
>0.70	1	$27,000
>0.80	3	$81,000
>0.90	1	$33,600
>1.00	0	0
>1.10	0	0
Total	60	$819,600

Scenario 2100:

If the 2100 one in one hundred ARI sea-flood scenario occurred in 2015, and it lasted for a significant duration of time (not just a brief overtopping of the defences), 118 dwellings in the Port Clinton 'at risk' area are likely to be inundated with a potential damage cost of $3,629,800.

Figure 4:35 Port Clinton 'at risk' area– impact of 3.8m AHD sea-flood event on buildings.

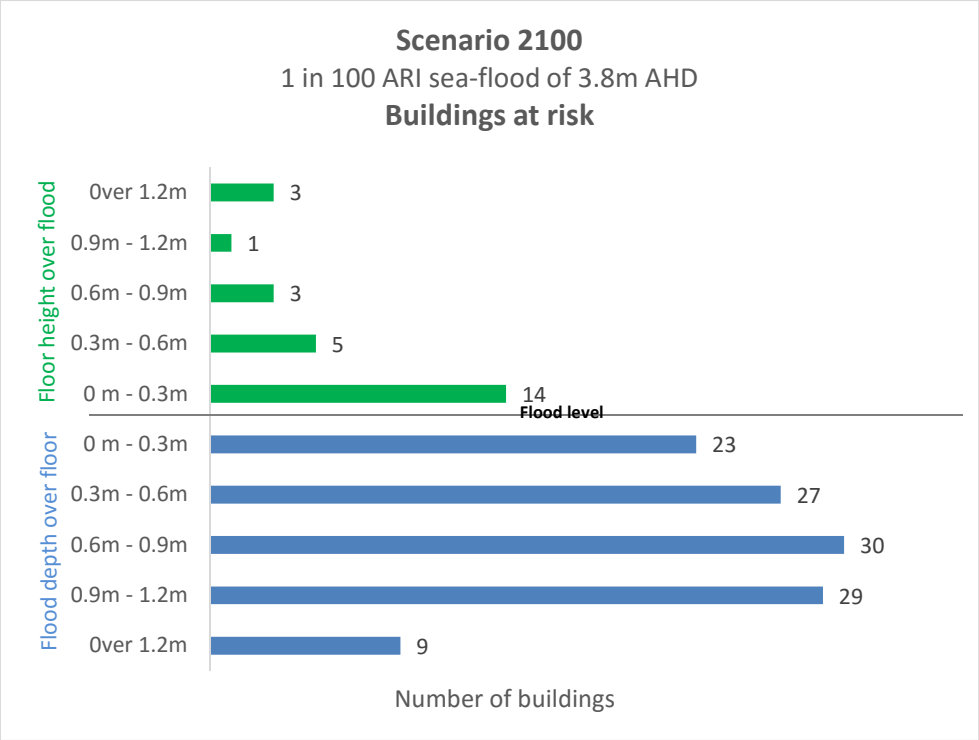


Table 4:11 Port Clinton 'at risk' area (3.8m AHD event) – potential damage cost to buildings.

Potential damage in 3.8m AHD sea-flood event		
Water over FFL	Buildings	$ damage
>0.00m	8	$48,000
>0.10m	4	$36,000
>0.20m	11	$132,000
>0.30m	3	$45,000
>0.40m	9	$162,000
>0.50m	15	$315,000
>0.60m	9	$216,000
>0.70m	10	$270,000
>0.80m	11	$330,000
>0.90m	12	$403,200
>1.00m	9	$334,800
>1.10m	8	$326,400
>1.20m	9	$399,600
Total	**118**	**$3,629,800**

4.5.3 Council owned assets:

Yorke Peninsula Council's assets in Port Clinton are *buildings*, *structures* such as public toilets, shelters, picnic facilities, and *public roads and footpaths*. Assets likely to be subject to inundation are identified and the full value of the assets at risk calculated. However, taking into account the nature of the flood waters in the Port Clinton region (see p. 46) and that these flood events are tidal and therefore short lived, qualifications are added to contextualise the damage risk appropriately. Only assets in the Port Clinton 'at risk area' are listed and assessed for flood risk (see Figure 4:28, p. 48).

It is recognised that most of the assets listed below will be obsolete by 2100. The impact of the 2100 sea-flood scenario has been applied so as to provide appropriate data from which to make future decisions.

Buildings and Structures (Council owned)

Table 4:11 Council owned buildings (and inundation damage risk assessment)

Council Assets – Buildings and Structures				**Subject to inundation**		
Specific Item	**Location**	**Street**	**Total Value**	**2015 2.8m**	**2050 3.1m**	**2100 3.8m**
Caretaker's Residence/ Office	Caravan Park	The Parade	Not listed	No	No	Minor 0.2m
Ablution Block	Caravan Park	The Parade	Not listed	No	Minor 0.1m	Moderate 0.8m
Standard Cabins x3 (elevated at 0.6m)	Caravan Park	The Parade	Not listed	No	No	Minor 0.1m (over floor level)
Deluxe Cabin x1	Caravan Park	The Parade	Not listed	No	No	No
Playground equipment	Gordon Miles Picnic Area	The Parade	Not listed	Minor 0.3m	Minor 0.6m	Minor 1.3m
Shelter and concrete infrastructure	Gordon Miles Picnic Area	The Parade	Not listed	Minor 0.2m	Minor 0.5m	Minor 1.2m
BBQ and picnic facilities	Gordon Miles Picnic Area	The Parade	Not listed	Minor 0.2m	Moderate 0.5m	Moderate 1.2m
Shelter	Foreshore	The Parade	Not listed	Minor 0.4	Minor 0.7	Minor 1.4

Contextualisation notes:

The outlook for Council owned assets to 2050 is positive with no significant building likely to be under threat. The ablution block on the south end of the caravan park would be unlikely to suffer any major damage as predicted flooding is very minor. Shelters listed above would only suffer inundation at their bases and therefore may not suffer any significant damage.

Flood protection measures - not on asset register (Council owned))

Table 4:12 Items not on asset register (and inundation risk assessment)

Council asset profile				Subject to inundation		
Specific Item	**Location**	**Street**	**Total Value $**	**2015 2.1m**	**2050 2.3m**	**2100 3.0m**
Rock revetment	Boat ramp area	The Parade	Not listed	NA	NA	NA

Roads and associated infrastructure (Council owned)

The DEM indicates that there is minimal current flooding risk to roads and associated infrastructure. The exception is Manwurta Street that currently experiences water flow *through* the road (and to its surface) in king tide events. The event of 25th April, 2009 caused flooding of Karkarilla Street and neighbouring properties from water that came from the estuary and through the road (see p.35).

The DEM indicates that should the 2050 sea flood scenario occur, roads would be inundated at various levels from 0 to 0.6m[34], with one section of The Esplanade at depth 0.9m.

Ways to calculate possible cost of damage to roads are to ascertain the length of road affected by flood waters and then multiply the asset value of the road by 5% (Balston et al, 2012) or apply $8350.00 per km of length affected (Victorian Government 2000) but both of these methods appear arbitrary. The works manager (Keith Earl) from DC Mallala who has had experience with localised flooding in that region was of the opinion that due to the rarity of the event, the short lived nature of the event, and the more benign nature of the movement of water that damage and associated costs were likely to be minimal to roads.

However, this assumes that the water is capable of draining away within a short time period after the event. In the 2050 sea-flood scenario water would enter into the Cumberland Street basin area[35], and into the low lying areas behind the estuary in Clinton North with no means to drain this water away. Damage to infrastructure and vegetation would be anticipated to be higher unless a way was found to remove the water (eg. pumping it out).

The total value of roads in the 'at risk' area is $735,000[36] (see Appendix D), but excluding The Esplanade.

[34] Assumes that no protection measures are installed.
[35] Assumes that no protection measures are installed.
[36] Note: The Parade road does not seem to be on the register.

4.5.4 Summary:

This section provides an overall picture of the assets that are situated in the 'at risk' area of Port Clinton that are likely to be under threat if either a 2015 or 2050 sea-flood event occurred.

In these two sea-flood scenarios, the potential damage cost to residential assets is $282,000 (2015) and $819,600 (2050). Such an event may not just occur once, but could occur multiple times and therefore damage bills would also be multiple and become more prohibitive. Council assets in the 'at risk' area are limited to structures and caravan park cabins. The floor levels of the cabins appear to have been set high enough to be above the sea-flood risk level for 50 or 60 years on current projections. Other structures should prove to be resilient in a flood event and obsolescence will take place prior to the anticipated flood heights towards the end of the century.

Flood water would inundate most roads in the 'at risk' area in the 2050 flood scenario but due to the short-lived nature of the event and low velocity of the water, damage costs are expected to be minimal. The main problem will be that flood water will lay in the Cumberland Road basin and behind the dunes in Clinton North which will increase the damage costs and inconvenience subsequent to the flood event.

However, if a 3.8m AHD event were to occur as predicted in the latter part of this century, the damage would be significant for both residential and Council owned infrastructure. This factor should be utilised in the longer term planning for the settlement and will be incorporated into the second stage of this study.

4.6 Identify current policy framework

Yorke Peninsula Council makes planning decisions regarding Port Clinton in the context of broader strategic policies and within the statutory requirements of the Development Act 1993.

Assessment questions: .

1. What is the strategic planning policy environment in which Council makes coastal decisions?
2. What are the key development assessment policies for coastal development applications?
3. How has Yorke Peninsula Council been operating within the statutory planning environment?

4.6.1 What is the strategic policy environment in which Council makes coastal decisions?

South Australian State strategic policy framework

The report *Prospering in a Changing Climate: Climate Change Adaptation Framework for South Australia* relates to the entire state but recognising the importance of regional variation, provides for the development of locally relevant responses for each of the twelve state regions. The report notes that adaptation response should be prioritised by assessment of risk, cost and equity using the best available science. The vulnerability of the coast to sea level rise is noted with particular note taken of the Yorke Peninsula.

"*Regional areas such as Yorke Peninsula are particularly vulnerable. Increasing development in the region, which is popular for retirees and people seeking a sea change, increases the risks.*" (p35).

Coastal landowners and lenders are highlighted as vulnerable to losses from inundation and erosion caused by rising sea levels. The policy recognises the importance of securing new settlements from foreseeable sea level rise and other coastal impacts of climate change and also guiding the adaptation of existing communities to cater for the impacts of climate change.

Regional strategic policy framework

There are a number of strategic level plans and policy documents which have some bearing on the issue of sea level rise.

- *Central Local Government Region Integrated Climate Change Vulnerability Assessment - 2030.*

This report notes the importance of decision making on infrastructure such as roads during this period as having implications as far forward as 2100 and beyond when sea level rise of a metre or more is possible (p16). In other words decisions in the near future need to take into account longer range predictions and the threats they imply. A vulnerability assessment score is generated by assigning scores individually for exposure, sensitivity, potential impact and

adaptive capacity for each of the three factors above. For the region as a whole the vulnerability index is medium with a high score for environmental factors.

- *Yorke and Mid North Climate Change Action Plan*

This policy document sets out the priorities for addressing climate change in the region. It notes this as a process of reducing risk, improving resilience and maximising opportunities. It notes the importance of planning decisions in respect of risk and sustainable limits. Resilience within local communities, especially in respect of emergency management, is stressed as important. One of three priority projects noted is the need for digital elevation modelling of the 800km of coast in the region to improve understanding of the threats from sea level rise and storm surge impacts on communities, industries and the environment.

- *Yorke Peninsula Regional Land Use Framework 2007*

This document forms part of the Planning Strategy for South Australia which guides strategic land use policy across the state. It notes that in recent years coastal settlements on the Yorke Peninsula have experienced a surge in demand for both residential and holiday accommodation and industry and tourism have expanded. In some areas on the Yorke Peninsula 40% of residential properties are holiday homes and whilst in the past these may have been shacks many are now being upgraded to more substantial properties (p11). Also the permanently resident population is amongst the oldest in South Australia with a third of the population in 2006 aged over 60.

Policy statements relevant to sea level rise include:

- Plan for the impacts of climate change, including sea level rise and storm surges
- Ensure planning minimises risk to property and people, especially in low lying coastal areas subject to erosion and flooding
- Manage coastal development and tourism activities
- Manage coastal township growth to avoid inefficient linear development and exposure of people and property to hazards (eg flooding, coastal erosion) (p15).

Port Clinton is identified as a settlement within one hour commute of the proposed expansion of the livestock industries in the Wakefield Plains (p.46).

- *Yorke Peninsula Council Strategic Plan 2012-2015*

The Plan sits within the broader context set out in the South Australia State Strategic Plan which *inter alia,* notes that citizens should actively participate in shaping the future of the state and that the state should be prepared for natural disasters.

The plan commits Council to work with state government and other agencies to ensure adequate coastal protection work, required to maintain the significant coastline, is undertaken (Sustainable Communities 2.2).

4.6.2 What are the key development assessment policies for coastal development applications?

Current statutory framework

Yorke Peninsula Council assesses proposals for new development under the Development Act 1993 using policy set out in the Council's Local Development Plan.

The South Australian Coast Protection Board provides the state-wide policy for dealing with coastal matters and this policy finds its expression and application through local Development Plans. The Development Act 1993 and Development Regulations 2008 require Councils to refer new development in coastal zones to Coast Protection Board for 'regard' or 'direction'. A typical matter for 'regard' relates to the height above 0 AHD that a housing site or floor level is to be set. Matters for 'direction' include the implementation of coastal protection works. Coast Protection Board policy since 1991 has been to advise Councils to set floor levels 0.25m above the one in hundred ARI event and an additional 0.3m to allow for sea level rise by 2050. New development should also be able to demonstrate how it will cater for an additional 0.7m sea level rise by 2100.

Local Development Plan

The Yorke Peninsula Council Development Plan (consolidated 6th November, 2014) is the statutory policy document to manage new development in the region. The Development Plan has been revised using the *Better Development Plan* process and therefore does contain the current Coast Protection Board policy.

The four main land use zones applied within Port Clinton are (Figure 4:36):

- Settlement Zone
- Coastal open space (foreshore along the Esplanade)
- Coastal Conservation Zone (the dunes and estuary to the east)
- Rural Living (to the east behind the estuary)

In the absence of any residential zones with the word 'coastal' in the title only developments within 100m of the high water mark are required to be referred to Coast Protection Board[37]. Since 2003, eleven applications were forwarded to Coast Protection Board that related to those developments in close proximity to the coast, larger scale subdivision (s), and the freeholding of the six dwellings in the south of Clinton and associated installation of rock armour.

However, the Development Plan does contain Principle of Development Control 20 (p. 26) that states that 'development…should be protected from sea level rise by ensuring all of the following apply:

(a) Site and building floor levels are in accordance with those outlined in *Table YoP/1 – Coastal Areas: Site/Building Floor Levels*

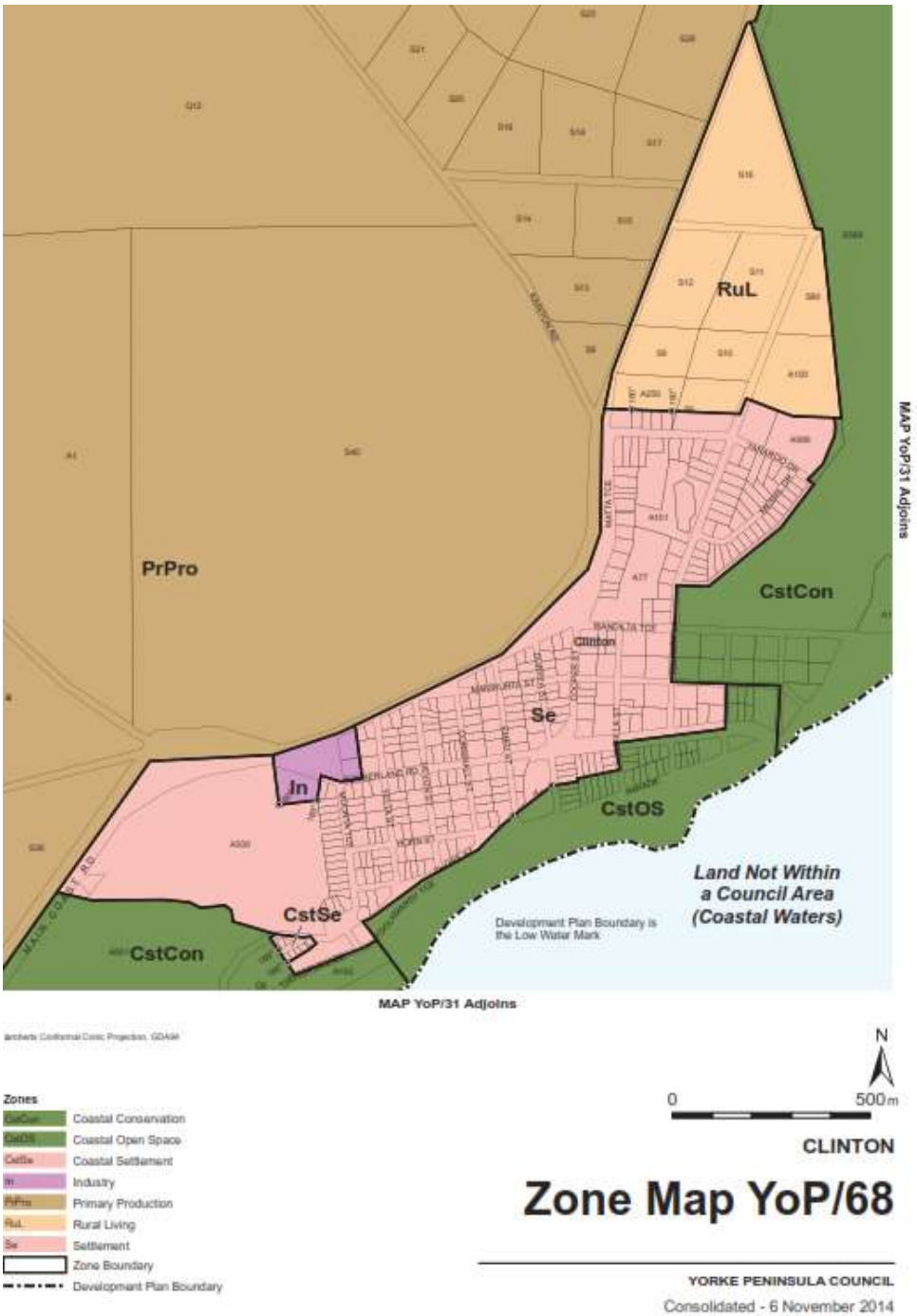
(b) There are practical measures available to protect the development against an additional sea level rise of 0.7 metres…'

[37] Scehdule 8, Development Regulations 2008.

The policy heights recorded in the Development Plan for Port Clinton are 3.7m AHD for sites, and 3.95m AHD for floor levels, these reflecting the current sea-flood risk levels. A review of four recent dwelling constructions reveals that these levels have not always been achieved[38], three of these having been referred to Coast Protection Board for advice.

Note: the sea-flood risk levels have been reviewed as a result of this study and revised lower figures adopted (refer p. 7)

Figure 4:36 Port Clinton zone map (Yorke Peninsula Council Development Plan)



[38] Floor level heights AHD: 7 The Parade (3.988), 31 The Parade (3.634m), 61 Cumberland (3.775m v. close), 17 Kulpara (3.41m)

4.6.3 Conclusions

- The broader strategic policy outlook for Port Clinton is that it may incur some population growth with the proposed expansion of the livestock industries in the Wakefield Plans region.

- The Yorke Peninsula Council Development Plan does contain current Coast Protection Board policy.

- Eleven Development Applications were referred to Coast Protection Board for advice since 2003. Some of these applications were for larger scale subdivisions.

- A brief review of a sample of four newer dwellings within Clinton demonstrated that floor levels have not always been achieved in accordance with Development Plan policy heights.

4.7 Explore liability issues

- **What obligation did the Council have to take into account impacts from the sea at the establishment of Port Clinton?**

Port Clinton was established in 1862 over 100 years before there was any formal planning legislation. There was no overarching statutory requirement for those who established Port Clinton to take into account actions of the sea.

- **What protection works have been implemented and were they implemented in accordance with approved plans?**

Table 4:13: Implementation of protection works

Works	Implemented by:	Installation Date	Planning Approvals	Responsibility
Rock armoured wall to boat ramp area	Council	2003	Yes, obtained and 'direction' received from CPB	Council to maintain
Levee to Manwurta Street	Council	1995	Yes, obtained (check)	Council to maintain
Rock armour to southern shack site	Council / Resident's cost	2010 (Check)	Yes, obtained and 'direction' received from CPB	Residents to maintain

- **Have protection works implemented by Council been breached?**

There have been no major breaches of protection works implemented by Council apart from minor over topping of rock armoured wall near the boat ramp.

The incidents of sea water coming through pores in Manwurta Street may require further review. The streets themselves are not 'coastal protection' works by definition, but there is a question as to how Manwurta Street was constructed and whether adequate strategies were employed to install a road across an active samphire flat.

- **In the case of new development within the settlements, have appropriate planning and Coast Protection Board policies been followed?**

A check of sample applications reveals that Council is forwarding development applications to Coast Protection Board for advice. However, the required floor levels are not always being achieved (see p. 60).

New subdivisions have been established within Clinton subsequent to the requirement of Development Plans to take into account sea level rise. For example, to the north of the estuary was established in the 1990s and more recently a 1 into 14 subdivision was approved on Yoolmardy Drive[39]. Further research is required to ascertain what advice was given by Coast Protection Board (if any), and whether Council followed this advice.

- **Has the Council made available sea level rise data to residents?**

Yes, a sea level rise fact sheet has been mailed to all land owners, and one round of community consultation was held where sea level rise issues were explained and flood mapping presented. This State of Play report will be published on the Council website.

- **Are there any emergency warnings and/or evacuation procedures in place?**

No, and recommendations will be made in the second half of this study.

Summary

In relation to the tort based claims of nuisance and negligence where the payment of damages can eventuate, the following points are relevant to the discussion:

- Port Clinton was founded in the 1800s so the Council has no liability stemming from the founding of the settlement. But major settlement (s) were introduced behind the estuary in 1990s.
- While there is a general statute that Councils are to act to keep their resident's safe (see Local Government Act) it is unlikely that the Council is legally required to implement protection works per se´ and the limit of its direct financial liability is likely be to that of its own assets.
- It is common knowledge that threats can emanate from the sea and those that choose to live near the sea personally accept that risk (similar to those who choose to live in bushfire regions or in earthquake zones).
- In relation to liability in respect of protection works, the Council is likely to have a responsibility to ensure that its own protection works are adequately maintained in integrity and height. A further review is required surrounding the Manwurta Street sub terrain movement of water.

[39] DEWNR was unable to locate referrals prior to 2003 at short notice. It has been assumed that the original subdivision and rezoning of this portion of Clinton must have been referred to CPB for direction/advice and that it was deemed at appropriate elevation. A further subdivision was approved in 2006 on Yoolmardy Drive.

- While there is no legal responsibility to implement protection works, Councils do have a responsibility to warn their constituents of any danger of which Council is aware. Therefore, the Council should make the findings and mapping from studies such as this one available to the public. The Council is hosting two rounds of public consultation meetings with residents as a first step in achieving this outcome.

- Warning systems and evacuation procedures can be implemented and overseen by local resident's associations and also fulfil the Council's responsibility to ensure that residents are as safe as possible. This matter will be reviewed in Stage 2 of the study.

Administrative appeals may arise out of the solutions proposed to mitigate the threat of increased sea levels and storm surge heights. For example, if the Council were to restrict the types of development that could be approved, appeals to these decisions may be likely. However, the recent trend in Court decisions indicates that the Court will take into account climate change related factors.

5. Community consultation report – Clinton (Part 2)

As noted in Section 3, the reporting of both formal and informal community consultation outcomes has been reported within the flow of the main body of this report. The purpose of this section is to identify any issues raised in the formal community consultation meeting of 13th April, at which thirty-six members from Port Clinton attended, that has not been yet reported:

In relation to sea-flooding:

- Resident's view was that highest water levels occur from April to September.
- Residents felt most vulnerable to flooding at caravan park area, boat ramp area, and Manwurta Street.
- Some residents were also concerned about flooding in Clinton (northern section, behind the estuary)

In relation to rainwater flooding:

- Resident's view was that water lay in Kurrilla Street and in some areas of Kulpara Street.

In relation to reaction to flood mapping:

- Something needs to be done (Group 1).
- Future looks grim (Group 1)
- Council needs to make sure that floor levels are right (Group 1).
- Necessary (Group 3)

In answer to, *What do you think is the most important issue in relation to flooding?*

- Levee bank needs to be fixed and not permeable. Not band-aid job.
- Mangroves protect coast and wave action.
- Council needs to make sure that floor levels are right.

6. Summary and Conclusion

6.1 Summary Table – Clinton

Stage	Question	Summary comment
1. Site history	When was the settlement founded?	1862
	Were climate change and sea level rise issues relevant?	No
2. Existing protection	What existing natural protection exists?	Western side of Clinton is elevated, eastern side has little protection. Low height dunes to the east.
	What breaches have occurred?	Flooding of Esplanade Road in front of caravan park and minor flooding through to boat ramp. Water has not breached Manwurta Street since installation in 1995, but sea water floods through pores in the ground.
	What man-made protection works have been installed into the settlement?	Rock armoured wall to boat ramp area, installation of Manwurta Street to act as levee, rock revetment to southern area.
3. Impact of storm events	What is the likely impact for a 2.8 m AHD event?	Minor flooding to The Parade. Manwurta St over-topped and flooding of some properties. Minor flooding of some areas in south.
	What is the likely impact for a 3.1 m AHD event?	The Parade overtopped, Manwurta St overtopped and inundation to many houses. The dunes to the rear of the estuary would be flooded and Clinton North inundated as well. The southern section of Clinton (south) would suffer some inundation.
	What is the likely impact of a 3.8m AHD event?	The entire lower region of Clinton would be inundated.
4. Emergency access and egress	Egress issues in a 3.1 AHD event	Residents could egress on foot in water less than 0.3m in most parts. Areas on the eastern end of Cumberland would suffer deeper water. Residents could not egress from the Clinton (south).
	Emergency vehicle access in a 3.1m AHD event.	Provided vehicles can access water up to 0.3m most areas area accessible. The eastern end of Cumberland may prove to be difficult to access. Most emergency vehicles could not access Clinton (south)
5. Profile of assets at risk	How many buildings are likely to be affected in 2.8m event?	27 dwellings, but 22 of these with water at depths lower than 0.3m. Approximate damage cost $282,000. Council buildings and structures would suffer minimal damage (if any).
	How many buildings are likely to be affected in 3.1m event?	60 dwellings, but 31 of these with water at depths lower than 0.3m. Approximate damage cost $819,600 in current value. Council buildings would not suffer any damage, and perhaps minor damage to structures (such as playground area).
	How many buildings are likely to be affected in 3.8m event?	118 dwellings, approximate damage cost $2,986,000 in current value.

6. Statutory policy framework	What are key development polices?	Development Plan incorporates current Coast Protection Board polices. Site and building heights for Clinton will require amendment
	How has Council operated within the statutory planning environment?	Council refers applications to CPB, applies advice received, and applies building and site levels.
7. Liability issues	Does liability exist if Council fails to implement protection?	No
	Have residents been informed of sea-flood risks?	A newspaper article and mail out to all residents have begun this process. Pending public consultation meetings will also be occasions where residents will be informed of the sea-flood risks.
	Have emergency procedures been implemented?	No
	Are there conditions relating to the maintenance of protection works	No
	Is there a maintenance regime of protection works?	Council staff review protection works as part of general duties as required but there is no formal maintenance regime of protection works.
	Has the settlement undergone recent expansion (and was Coast Protection Advice obtained and applied)	Clinton (north) was expanded in the 1970s.
	Have development applications been appropriately referred to CPB, advice followed, or development plan policy applied.	Evidence was sighted that demonstrated Council follows necessary protocols. Floor levels of new houses have not always achieved Development Plan policy levels.

6.2 Conclusion

Stage one and two of the Coastal Settlements Adaptation Study have now been completed and the findings are contained in this report. In stage one, the coastal settlements of Port Clinton was assessed utilising the first seven steps of the investigative framework:

1. Establish settlement history.
2. Analyse existing sea-flood protection.
3. Analyse the impact of sea-flood scenarios.
4. Analyse emergency access and egress.
5. Establish profile of the assets at risk.
6. Identify current policy framework.
7. Explore liability issues.

The overarching purpose of conducting the investigation is to provide a basis to make recommendations for adaptation options. These options can be categorised as:

- **Protect:** use various means such as construction of sea walls, beach sand replenishment or installation of drainage swales to protect existing development;
- **Accommodate**: use means such as raising buildings, protecting buildings from flooding;
- **Retreat**: abandon settlements and move development inland in the face of rising sea levels. The concept of 'retreat' is also known as 'planned retreat'.
- **Defer:** threats have been assessed, and perhaps costs and options analysed but there are valid reasons to wait until to a later date to act.
- **Do nothing:** ignore the risks and do nothing.

An analysis of these adaptation options will be the focus of Stage 2 of the project, and Step 8 in the investigative framework.

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8. Appendices:

Appendix A – Community Sea Level Rise Fact Sheet

Appendix B – Community Consultation Maps – with participant's contributions.

Appendix C - Photographic analysis of beach stability

Appendix D - Council Asset Register – Roads

Appendix E - Flood mapping for Clinton (south)