

# PORT CLINTON

## Seawater Flooding Adaptation Pathways for Yorke Peninsula Settlements

### Stage 2: Adaptation Options



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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.

## 1. Introduction

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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. In August, 2015 the Yorke Peninsula Council broadened the scope of works to include the southern area of Port Clinton that is situated along the base of the escarpment and connected by The Esplanade. The aim of the project is to identify the seawater flooding risks, assess current flood protection infrastructure and provide recommendations for future action to cater for 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.

### 1.1 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. Propose adaptation actions.

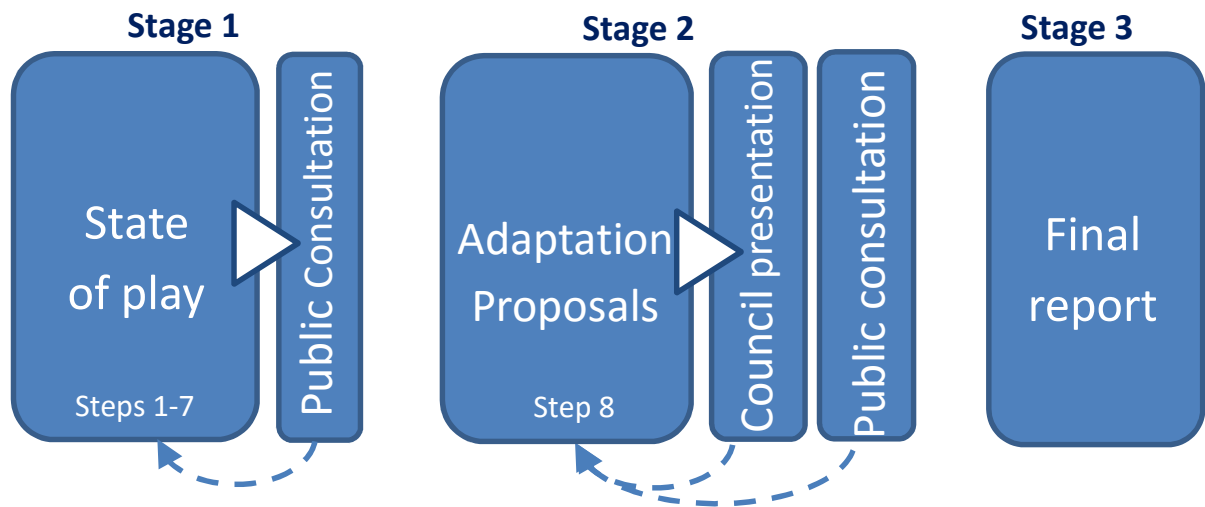
### 1.2 Staging of the project

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).

Stage 1 is now complete and this report represents the findings of Stage 2.

**Figure 1:1 The coastal adaptation study is conducted in three stages<sup>1</sup>****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).

<sup>1</sup> Adapted from coastal analysis tool, *Dealing with the impacts of sea level rise on coastal assets (2012)* (Western & Kellett)

### 1.3 Reporting and consultation

While the scope of the *Seawater flooding adaptation pathways for Yorke Peninsula Council* covers the four settlements of Clinton, Price, Pine Point (Billy Goat Flat) and Coobowie, adaptation responses options available to each settlement are reported separately. This report contains the adaptation options for:

## Port Clinton.



**Figure 1:2 Location Map: Port Clinton, Yorke Peninsula<sup>2</sup>**

In preparing the adaptation options in this report the following agencies and individuals were consulted:

- James Guy, Department of Energy, Water, and Natural Resources,
- Dwayne Werfel, Yorke Peninsula Council, Works Supervisor (North),
- Geoff Fisher, Australian Water Environments (AWE), on 2<sup>nd</sup> June, 2015 inspected Port Clinton settlement and environs, also reviewed the adaptation proposals and offered technical advice on 26<sup>th</sup> August, 2015,
- Geoff Wilde, Managing Director, Geoff Wilde Earthmoving.

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<sup>2</sup> <http://www.naturemaps.sa.gov.au/maps/viewer.aspx?site=NatureMaps>

## 1.4 Methodology

Adaptation responses in this study take into account: the nature of the threat, the protection of infrastructure, the safety of people, and the appropriate timing of response until 2100.

### 1.4.1 Adaptation responses that relate to the nature of the threat.

Other than depth of water, additional factors that influence the impact of a flood on a settlement are: the velocity of the water (speed), the duration of the flood (how long it lasts), and the topography of the settlement. How much warning is possible for possible flooding is a factor that enables the settlement to prepare for the flood more effectively. The general characteristics of a sea-flood in the Port Clinton region are shown in **Table 1:1**.

**Table 1:1 Sea flood characteristics for Port Clinton coastal region.**

<b>Flood characteristic</b>	<b>Port Clinton region</b>
Depth of water	Shallow (near the coast)
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.

To contextualise the flood risk in the Port Clinton region, **Table 1:2** illustrates how insurance companies may discount their flood risk when adequate flood warning can be provided and the community is prepared to deal with a flood. For example, where the community is experienced and there is a greater warning time than 12 hours, the predicted actual cost of damages can be discounted by 0.4 (Victorian Government, 2000).

**Table 1:2: Proposed ratios of actual:potential damages (Victorian Government, 2000)**

<b>Warning time</b>	<b>Experienced community</b>	<b>Inexperienced community</b>
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

Historically, storm surges that have threatened settlements in the Port Clinton coastal region have been in conjunction with the highest astronomic tide (often referred to as a 'king tide') which would in the majority of cases, provide a greater than 12 hour warning period. In summary, and based on historical data, the flood threat is normally related to predictions of high tides, likely to be of low intensity in relation to velocity of water, and of short duration.



Finally, adaptation responses are proposed and analysed using the three one in one hundred ARI scenarios provided in the State of Play report (**Table 1:3**). These scenarios assist in providing the context from which to make decisions that relate to the viability and also the timing of responses.

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

	2015	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	0.1m	0.3m	1.0m
<b>Totals (AHD)</b>	<b>3.0m</b>	<b>3.2m</b>	<b>3.9m</b>

#### 1.4.2 Adaptation responses that relate to infrastructure and people.

##### Infrastructure

In proposing adaptation responses, Councils are required to take the long view. For example, a house constructed today is likely to have a life span of 60 to 80 years, so future risks from actions of the sea are required to be taken into account in current planning policies. Councils are also required to take into account Coast Protection Board policy and advice. Such policy includes being able to demonstrate that development is capable of being protected for the sea-flood risk for the 1 in 100 ARI event adopted for 2050, but also that reasonable steps can be taken to adapt the development to the sea-flood risk for the 1 in 100 ARI event adopted for 2100 (Coast Protection Board, 2004).

##### People

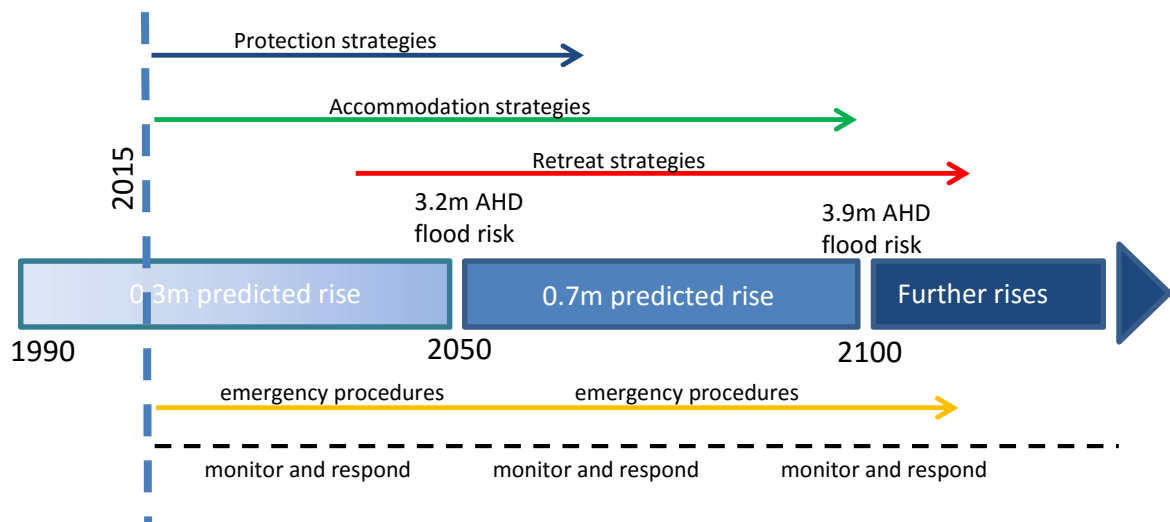
Adaptation responses should also take into account the safety of people in a flood event. These include warning and emergency procedures, the ability of people to be able to move safely away from the flood, and the ability of emergency vehicles and personnel to move into the settlement.

#### 1.4.3 Adaptation responses that take into account time

The *State of Play Report* (SOP) has already analysed the possible impact of the three 1 in 100 ARI flood scenarios (2015, 2050, 2100) upon the settlements. It is proposed here to draw upon that data and deal with adaptation responses in the following order:

- What level of protection can be realistically provided (at current threat, 2050 threat, 2100 threat).
- Where protection falls short, what accommodation responses can be employed?
- Where protection and accommodation strategies fall short, what longer term retreat options should be employed (if any)?

Finally, responses canvassed within this report may be implemented over the coming decades but also may be contingent on each other. For example, a protection strategy employed now may mean that other accommodation strategies are not required until a later date. The limitation of a protection strategy may mean that accommodation or retreat strategies are required to cater for that shortfall later in the century. Figure 1.2 provides a pictorial overview of the adaptation strategy.



**Figure 1.3** Adaptation responses are time related and sometimes contingent on each other but also contingent on the rate of sea level rise which is to be monitored over time (M. Western, 2015).

#### 1.4.4 Adaptation responses that do not take into consideration:

- The effect of rising sea levels on ground water within Port Clinton,
- The potential for a rain flood event either combined or not combined with a king tide (although the State of Play report found that there was a low correlation between sea-flooding events and rain flooding events),
- The possibility of a sea-flood event caused by an unforeseen event such as a tsunami.

## 2. Port Clinton protection options

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The 'at risk' areas of Port Clinton are best reviewed as Clinton (south), Clinton (main, lower section), and Clinton (north) (See Figures 2:1,2). The general topography of all three areas is similar, with residential areas located in areas at elevation 2.60m AHD to 3.2m AHD (with some residential areas situated on ridge lines at elevations higher than these).

**Figure 2:1 The coastal setting of Port Clinton (1).**



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



Photographs (Coast Protection Branch, 2014)

In brief the findings of the State of Play (SOP) report were:

- The general topography of Clinton would indicate that dwellings and infrastructure in all three 'at risk' areas are vulnerable to flooding (see SOP. P 19).
- 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 of the settlement is lower, at heights 2.40 to 2.60m AHD, and may be vulnerable to flooding and increased erosion (see SOP pp 19-27).
- The highest level of flood water in the last 20 years is likely to have been 2.60m AHD on 25<sup>th</sup> April, 2009. This date may also represent the highest levels experienced in Port Clinton since 1940 (see SOP, pp 27-33).
- 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 Port Clinton (south) that has flowed over the embankment and down into the residential section. In rain events 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 (see SOP p. 34-35).
- Available evidence indicates that the beach at Port Clinton (south) and the coast line north of the boat ramp has been undergoing erosion over the last few decades. The main beach section of Port Clinton appears to have remained relatively stable (SOP, p. 20)<sup>3</sup>.

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<sup>3</sup> Anecdotal note: One resident in the community consultation session maintains that sand deposits in the general beach area have increased by up to 8 feet in depth over the last 30-40 years (using the old jetty pylons as a gauge). Where the tidal flat was a 'mud' flat, it is now a sand flat.



## 2.1 What level of protection can be realistically provided to cater for the sea-flood risk at 2100 (3.9m AHD)?

In brief, the State of Play report found if a 3.90m AHD of significant duration occurred, the lower portions of Port Clinton (main, north, south) would be severely inundated at levels up to 1.6m (See also flood mapping for Clinton (south) in State of Play report, Appendix E).

**Figure 2:3 Flood mapping for sea-flood scenario 1 in 100 ARI event of 3.8m AHD (2100 scenario).**



### Conclusion:

In pure engineering terms it may be possible to construct levees at heights up to 1.70m high adjacent the Parade (Clinton main), but it is unlikely that Kulpara and Manwurtia Streets could be raised high enough to provide long term protection. To protect Clinton (south), levees as high as 1.90m would be required. North of the Clinton settlement it is likely extensive protection systems would be required to prevent water circumnavigating the protection and flowing back into the town. The other main impact would be the likely erosion of the existing dune system from the entire length of Port Clinton which would leave the settlement very exposed to ongoing erosion and flooding. Finally, if the sea level does increase as predicted, there is nothing to suggest that it won't keep rising past 2100, thereby rendering any defences at 3.9m AHD ineffective. The conclusion of this study is that protection options are not realistically viable to cater for the predicted rises of sea level at the end of this century and into the next.

## 2.2 What level of protection can be realistically provided to cater for the sea-flood risk at 2050 (3.2m AHD)?

In contrast to the 2100 flood scenario, protection options for Port Clinton should be considered for the 2050 1 in 100 ARI flood risk (3.2m AHD) for the following reasons:

- Protection measures are feasible and likely to be effective (see **Figure 2:4, 2:5**);
- Protection of development to cater for the 2050 flood scenario (3.2m AHD) is Coast Protection Board policy (Coast Protection Board, 2012);
- Installation of protection measures now will provide a 30-40 year time in which data can be tracked over time to assess the rate of change in sea level.
- Installation of protection measures now will provide a 30-40 year time frame in which accommodation measures can be implemented to cater for sea level rises past 2050.

## 2.3 Protection options for Port Clinton

### 2.3.1 Clinton (Main and North sections)

**Figure 2:4 Protection options to cater for 1 in 100 ARI event of 3.2m AHD (2050 scenario).**



Rendition of Sea-flood scenario based on DEM (by M. Western, 2015)



Note, the cost estimates provided below have been prepared based on very limited data and without engineering design calculations. They are therefore indicative only and have been prepared to assist council with the setting of priorities. They should not be relied on for budgeting or construction cost management purposes. All costs exclude GST.

### 1. Raise Manwurta Street to 3.1m AHD.

The prime purpose of these works is to minimise the risk of sea-water entering Clinton from the north. Kulpara Street, which intersects with Manwurta Street, is at height 3.10m AHD (approx) and provides existing protection from water flowing into Clinton from the east.

**Figure 2:5 Intersection of Manwurta Street with Kulpara Street.**



Photograph (M.Western, 2015)

**Figure 2:6 Section of Manwurta Street to be raised (including culdesac)**



From DEM (M.Western, 2015)

Note: In the 25<sup>th</sup> April, 2009 flood event Manwurtta Street was of sufficient height so that it wasn't over-topped, but should the current risk level of 2.80m AHD occur, the road would be significantly over-topped and residential areas significantly inundated.

Note: In order to cater for three drive way crossovers, it is suggested that only half of Manwurtta Street east of Karkarilla Street be raised and the cul-de-sac the place where the difference in the road level is adjusted for vehicular travel (Table 2.1 does not take this concept into consideration).

**Table 2:1 Preliminary cost calculation : Raise Manwurtta Street to 3.10m AHD<sup>4</sup>**

<b>1. Preliminary cost calculation: Manwurtta St to 3.1m AHD</b>								
Location	Existing road elevation	Raise	Length	Width (inc batter)	Area	Volume	*Unit cost	Estimated cost
Manwurtta	2.60m	0.5 m	180m	8m	1440m <sup>2</sup>	720m <sup>3</sup>	\$66	\$48,000
Manwurtta Culdesac	2.50m				280m <sup>2</sup>	140m <sup>3</sup>	\$40	\$ 5,600
*Estimate:					Total			\$53,600

Preliminary cost estimate:

Yorke Peninsula Council estimates the cost to raise Manwurtta Street at \$53,600.

Important Note:

The State of Play report found that Manwurtta Street is likely to be subject to sub terrain movement of sea-water moving under the street when king tides encroach on to the northern embankment of Manwurtta Street (SOP, p.33) with resultant flooding of Karkarilla Street and surrounding properties. Consultants to this project, Australian Water Environments, recommend that further investigation is undertaken to ascertain the likelihood of repeat flooding occurring, and what action might be required to remediate the problem. It might be found that a membrane is required to be installed on the northern side of Manwurtta Street to prevent water from flowing under the road.

These works have not been costed.

<sup>4</sup> The proposed height of the works at Manwurtta Street do not include 0.1m wave run up due to the direction of the water travelling from the north (and into the prevailing wind of south-west). Additionally, Kulpura Street is only at elevation 3.07 – 3.10m AHD and therefore there is no point raising Manwurtta Street higher than this street.



## 2. Install flood minimisation measures at height 3.2 m AHD to the dunes.

The prime purpose of these works is to minimise the risk of sea-water entering Clinton through the dunes from the east<sup>5</sup>. The current height of these dunes varies from 2.50m AHD to 2.80m AHD. This would suggest that the dunes may act as a defence if another sea-flood such as the 25<sup>th</sup> April, 2009 event should reoccur (2.60m AHD), but should the current risk event of 2.80m AHD occur, then water would traverse through the dunes into the settlement.

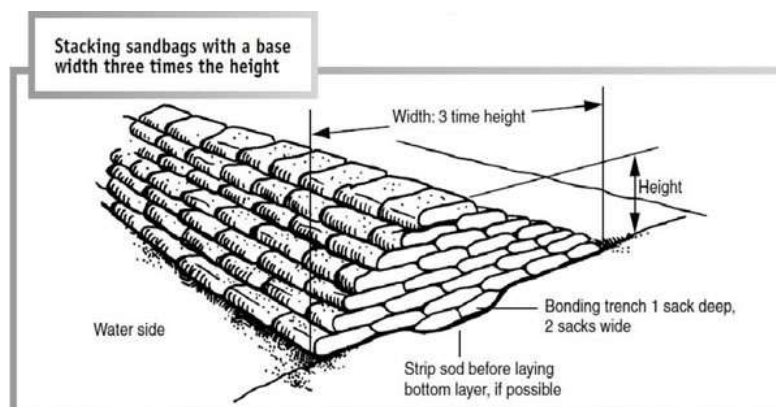
**Figure 2:7 Location of dunes to the east of Clinton**



### **Option 1:**

Install sandbags to 'pick a line' between high points in the dunes, cover with sand and revegetate. Figure 2:8 illustrates the methodology to be employed. Note, the required height is likely to be 3 or 4 sandbags high making the base much narrower than depicted.

**Figure 2:8 Configuration of proposed sandbag installation**



<http://www.extension.org/pages/26483/sandbagging-for-flood-protection#.VfJb3TYVjIU>

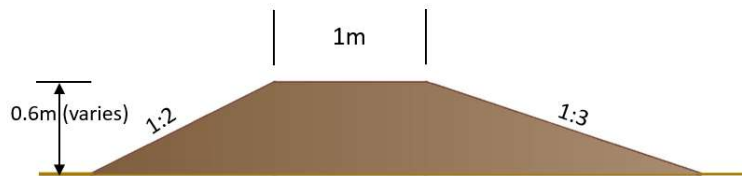
<sup>5</sup> In public consultation meeting of 18<sup>th</sup> August, 2015, a resident explained that in the 25<sup>th</sup> April, 2009 event, water entered Clinton from the north-east, and subsequent to this event a mound was installed (see Figure 2.7)

The advantages of Option 1 are:

- The existing dune system and associated vegetation can be left largely intact.
- The sandbags can be covered over with sand and revegetated ensuring that the dune system retains its natural appearance.
- Should a flood event occur, minor repairs or upgrades can be made at minor cost.
- Sand could be sourced locally (perhaps from Clinton south)

### **Option 2:**

Remove vegetation and portion of the dune (at 6m – 7m wide) and install dirt bund with 3.2m AHD top (0.6m – 0.8m high).



**Table 2:2 Preliminary cost calculation : Install earthen bund at 3.20m AHD**

2. Preliminary cost calculation: Installation of earthen bund to dunes							
Location	Existing elevation	Levee height increase	Levee length	Area of profile face	Volume (approx) m <sup>3</sup>	*Cost per m <sup>3</sup>	Cost (approx)
Dunes	2.5 m to 2.7m AHD	0.6m	85m	1.5m <sup>2</sup>	120m <sup>3</sup>		\$ 6,100

### **Preliminary cost estimate:**

Yorke Peninsula Council estimates the cost to install earthen levee to the eastern dunes at \$6,100. The cost to implement Option 1 is likely to be around this figure, or less.

### 3. Review existing rock revetment protection (and install minor works where required) and provide ongoing monitoring.

Existing protection in this location is divided between private and public ownership and the works vary in constituency and integrity (Figure 2:9).

**Figure 2:9 Rock revetment north of boat ramp – publicly and privately owned**



Photograph: Coast Protection Branch (2014)

The general height of natural ground in the vicinity of the publicly owned works is 2.80m AHD but an extra 0.2 to 0.3m height is provided by the rock revetment (Figure 2:10). This suggests that the existing protection in this location approaches the risk level for 2050 of 3.2m AHD.

**Figure 2:10 Height profile of existing rock revetment.**



Photograph: M. Western, 2015



The general height of natural ground in the vicinity of the privately owned works is 2.70m to 2.80m AHD but an extra 0.3m to 0.4m height is provided by the mounds of rubble that have been installed to the perimeter of the property by the owner (Figure 2:11). How the dumped rubble would perform in flood conditions is unknown.

**Figure 2:11 The height of the existing privately owned protection is likely to be 3.10m AHD**



Flood mapping for a 2.80m AHD flood scenario indicates that there are two low points in the existing defences (See Figure 2:12). Note: low point also observed in Figure 2.11.

**Figure 2:12 Possible low points in the current protection system.**



The proposal is to review the existing works for consistency in height at 3.10m – 3.20m AHD and raise or strengthen where required. Ongoing monitoring under flood conditions will inform future decision making. Both low sections are likely to be located in the public area.

Preliminary cost estimate:

A contingency sum of \$2,500 (for works in public area)

#### 4. Install flood protection works to foreshore to height 3.2m AHD.

The prime purpose of these works is to minimise the risk of sea-water entering Clinton from the south-west. Two options are provided below: one that is predominantly the installation of a dirt bund system, and the second that takes into consideration that as the main foreshore area of the community, amenity issues may be important. The proposed works are divided into three sections, with section 4 (c) having three subsections.

**Figure 2:13 Proposed location of protection works to foreshore of Port Clinton**



Photograph: Coast Protection Branch (2014)

**Figure 2:14 Proposed location of protection works to foreshore of Port Clinton**



Illustration: Mark Western (2015)



## Option 1: Dirt bund system (with associated works in the playground section)

### 4.a Install 30m of dirt bund with top at 3.2m AHD

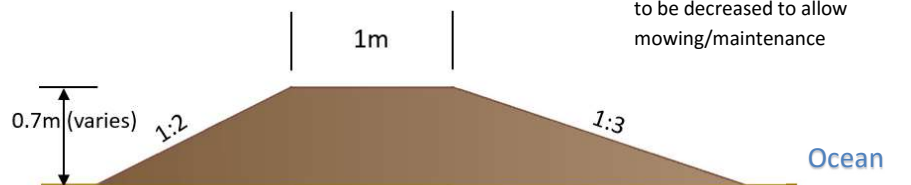
Install 30 m of dirt bund with top at 3.2m AHD to connect with proposed works around the playground and BBQ area, and raise a small portion of The Esplanade road by 0.4m.

Figure 2:15 Proposed location of dirt bund to foreshore



Photograph: M.Western, 2015

Figure 2:16 Suggested profile of dirt bund



#### 4a. Preliminary cost calculation: Installation of levee to foreshore

Location	Existing elevation	Levee height increase	Levee length	Area of profile face	Volume (approx) m <sup>3</sup>	*Cost per m <sup>3</sup>	Cost (approx)
The Parade	2.5 m AHD	0.7m	30 <sup>6</sup> m	1.9m <sup>2</sup>	95m <sup>3</sup>	\$35	\$ 4,250

#### Preliminary cost estimate:

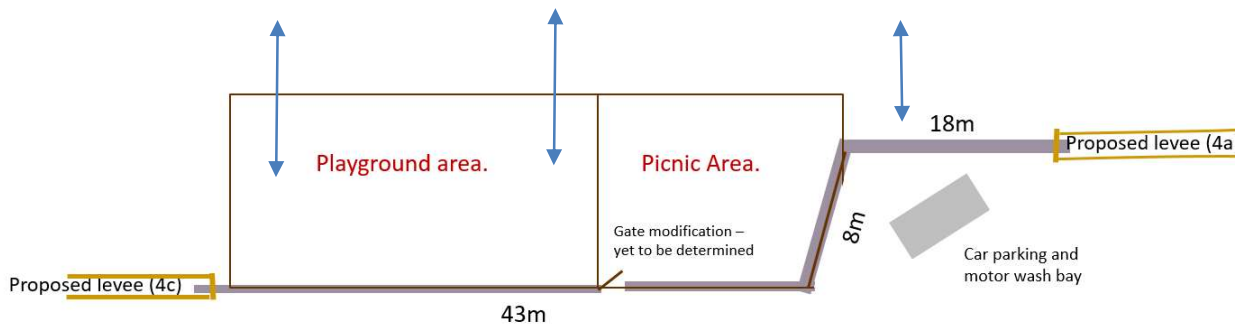
Yorke Peninsula Council estimates the cost of these works at \$4,250 and a contingency of \$500 to raise The Esplanade Road has been added.

<sup>6</sup> Original quotation from Council was based on 48 LM of bund whereas second concept requires only 30LM

#### 4.b Install concrete plinth to northern side of playground and BBQ area

AS the BBQ area fronts directly on to the beach, and the playground area has minimal dunes separating it from the beach, the proposal is to provide an edge to the playground on the northern side and to allow water to inundate the playground and BBQ area in a flood event.

**Figure 2:17 Proposed adaptation to playground and picnic area on northern side.**



There are a number of ways this could be achieved:

1. Remove existing fence, install new fence posts, install a 0.4m wide concrete plinth (with fence posts in the centre) with top at 3.2m AHD, and replace fencing panels.
2. Remove existing fence, Install appropriately engineered retaining wall system, weld fence posts to retaining wall beams, and replace fencing panels.

Example:

Note: in this example the flood protection is a temporary installation



#### Preliminary cost estimate:

This item has not been costed but a contingency sum included at \$15,000<sup>7</sup>.

<sup>7</sup> AWE and Mutual Projects

#### 4.c Install 245 LM of dirt bund to edge of existing dune system

In this option the dirt bund is to become part of the existing dune system and the existing profile of the foreshore retained in its present form. There are three main sections of natural ground height elevations within this region (Figure 2:18).

**Figure 2:18 Proposed location of levee within the edge of the existing dune system.**



**Figure 2:19 Proposed location of levee within the edge of the existing dune system.**



Portion of the carpark is to be reclaimed as part of the natural reserve to enable the levee to be extended into the existing carpark system to provide appropriate protection in this area. The dirt bund should be vegetated so that it appears as part of the dune system.



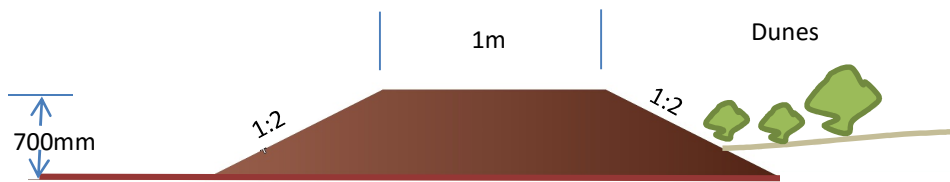
**Figure 2:20 Possible levee profile to be installed within the edge of the existing dune system**

Illustration: M. Western (2015)

**4c.1 Preliminary cost calculation: Installation of levee to foreshore**

Location	Existing elevation	Levee height increase	Levee length	Area of profile face	Volume (approx) m <sup>3</sup>	*Cost per m <sup>3</sup>	Cost (approx)
The Parade	2.7 m to 2.9m AHD	0.4m	60m	0.8m <sup>2</sup>	48m <sup>3</sup>	\$	\$ 4250

**4c.2 Preliminary cost calculation: Installation of levee to foreshore**

Location	Existing elevation	Levee height increase	Levee length	Area of profile face	Volume (approx) m <sup>3</sup>	*Cost per m <sup>3</sup>	Cost (approx)
The Parade	2.6 m AHD	0.6m	60m	1.50m <sup>2</sup>	90m <sup>3</sup>	\$	\$ 5100

**4c.3 Preliminary cost calculation: Installation of levee to foreshore**

Location	Existing elevation	Levee height increase	Levee length	Area of profile face	Volume (approx) m <sup>3</sup>	*Cost per m <sup>3</sup>	Cost (approx)
The Parade	2.3 m AHD	0.9m	125m	2.90m <sup>2</sup>	360m <sup>3</sup>	\$	\$ 17,150

Preliminary cost estimate:

Yorke Peninsula Council estimates the cost of these works at \$26,500 (No allowance has been made for the cost of vegetation of the bund).

Total costs of adaptation measure 4 (Option 1):

Estimated cost: \$46,250

**Option 2: Raise foreshore adjacent the Parade (with associated works in the playground)**

In this option the foreshore area is raised adjacent The Parade so as to provide a foreshore area that has increased amenity value.

**4.a Raise foreshore area with incline south of The Parade.**

Raise the carpark area by 0.6m on the sea side with a 1 in 20 incline from The Parade. Note: portion of these works may involve a bund to connect to the road as in Option 1.

**Figure 2:21 Raise foreshore area with incline to elevation 3.20m AHD**



**Figure 2:22 Raise foreshore area with incline to elevation 3.20m AHD**



#### 4.b Install concrete plinth to northern side of playground and BBQ area

These works are the same as in Option 1 above (see p. 20).

#### 4.c Raise verge adjacent The Parade with a top of 3.20m AHD.

In this option the existing grassed verge adjacent The Parade is to be raised with a top of 3.20m AHD with a slow decline down towards the edge of the dunes. This would enable the area to be continually maintained with mowing.

**Figure 2:23 Proposed location of levee within the edge of the existing dune system.**



Option 2 is likely to be the preferred option as it would have a better outcome as far as the amenity of the foreshore is concerned and it could be appropriately maintained. Storm water runoff measures could also be installed to drain water from The Parade around (or through the raised section of earth).

#### Preliminary cost estimate:

The costs associated with Option 2 of Adaptation measure 4 have not been determined but may be similar to Option 1 at \$46,000.

## 5. Formalise boat ramp entry point

The purpose of these works is to narrow the entry point to the boat ramp area while maintaining appropriate access for vehicles. Temporary flood control measures will need to be employed to close the remaining gap in the system should a flood event occur.

### Notes:

- Raise ground level between end of Option 4 and the rock revetment wall to 2.80m AHD (a general increase of 0.3m).
- Install traffic island at 0.4m height with appropriate signage
- Devise temporary flood control measures (sand bags or planking system).

**Figure 2:24 Raise portion of boat ramp area and install traffic island.**



### Preliminary cost estimate:

This item was not costed but allow contingency sum of \$10,000.



## 6. Install earthen bund to ridgeline

The purpose of these works is eliminate the possibility of water flowing over the ridgeline into Clinton (north).

Figure 2:25 Install earthen bund to ridge line (Option 6)

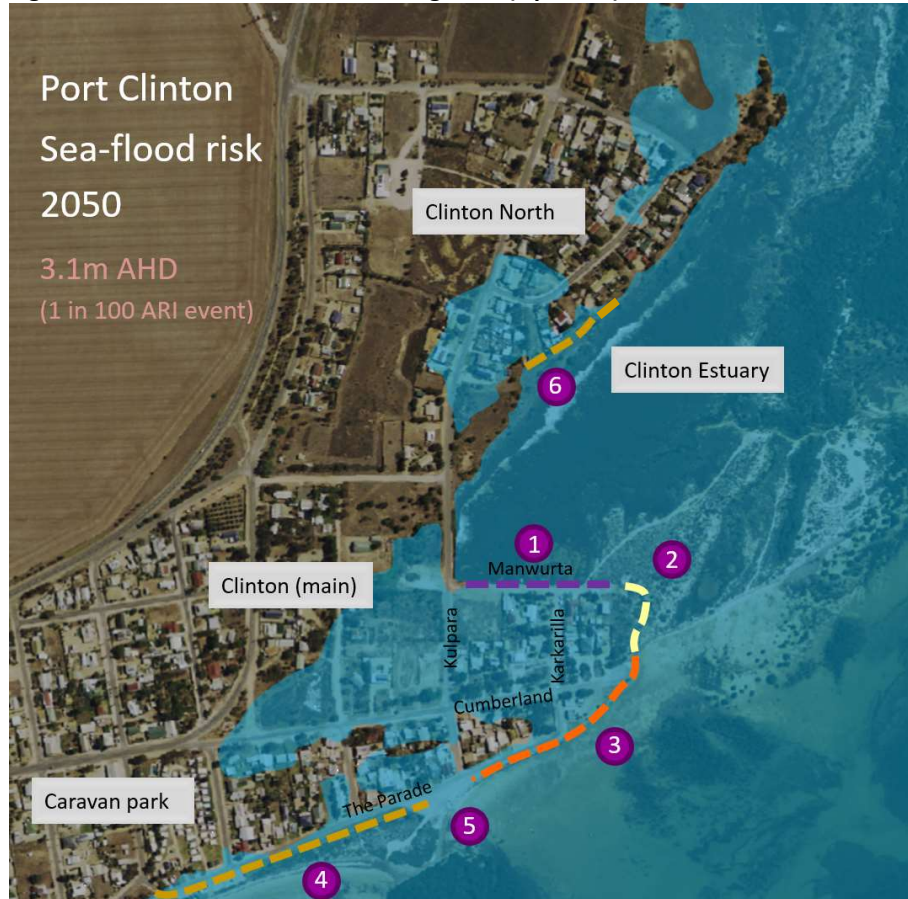
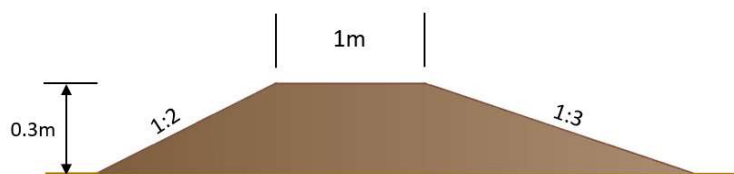


Figure 2:26 Proposed profile of earthen bund (Option 6)



### 6. Preliminary cost calculation: Installation of bund to ridgeline

Location	Existing elevation AHD	Levee height increase	Levee length	Area of profile face	Volume (approx) m <sup>3</sup>	*Cost per m <sup>3</sup>	Cost
Clinton North	2.8 m to	0.3m	120m	0.53m <sup>2</sup>	64m <sup>3</sup>	\$	\$ 5750

### Preliminary cost estimate:

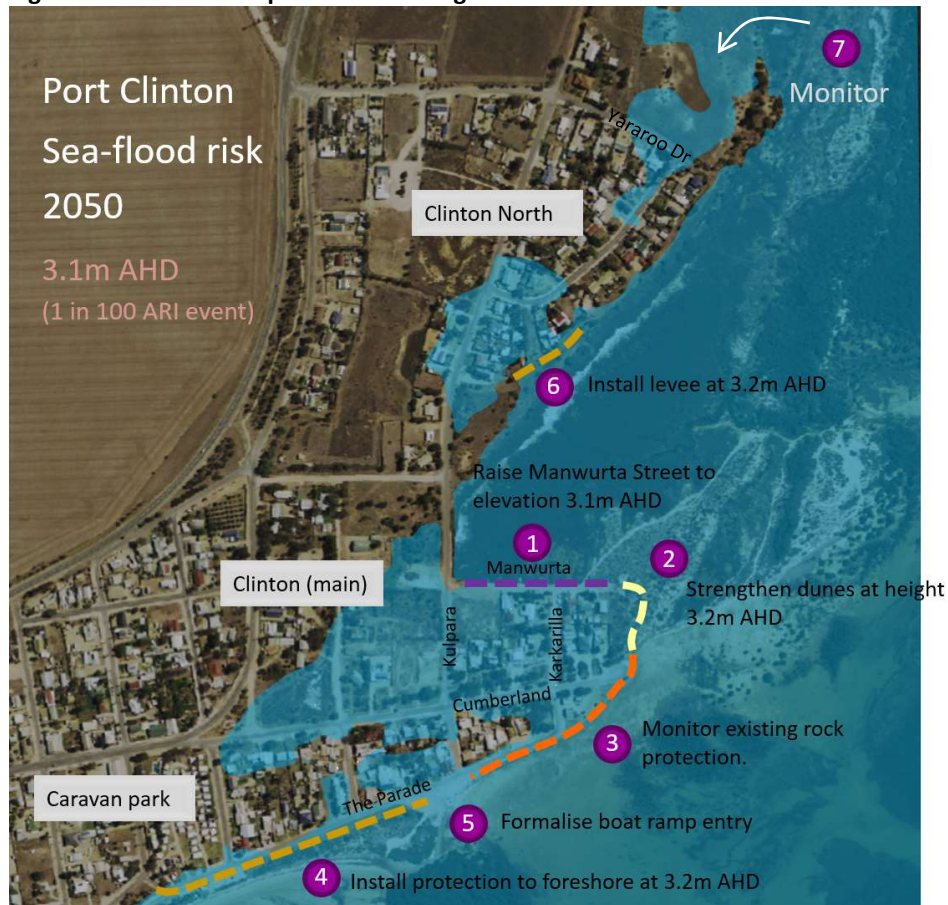
Yorke Peninsula Council estimated the costs for Adaptation Option 6 at \$5750.

## 7. Monitor dune system to the north of Clinton

### Background:

Some residents in community consultation suggested that the area noted as (7) on Figure 2.27 had suffered sea-flood inundation. Resident of 23-25 Yararoo Drive and owner of the land adjacent the dune system north of Clinton confirmed that sea-water has not flowed through the dune system from north of Yararoo Drive but that the flooding observed by residents related to rain inundation.

**Figure 2:27 Location of potential flooding north of Clinton**



### Proposal

Due to sections of the dune system north of Clinton being lower than 3.10m AHD it is possible that water may circumnavigate the natural dune system north of Clinton and flow back into the settlement. However, currently, the volume of water travelling north is likely to be low due to the necessity of travelling into the estuary through the narrow channels of the frontal dune system. But if this dune system were to erode away, then water may flow more readily into the northern areas of Clinton.

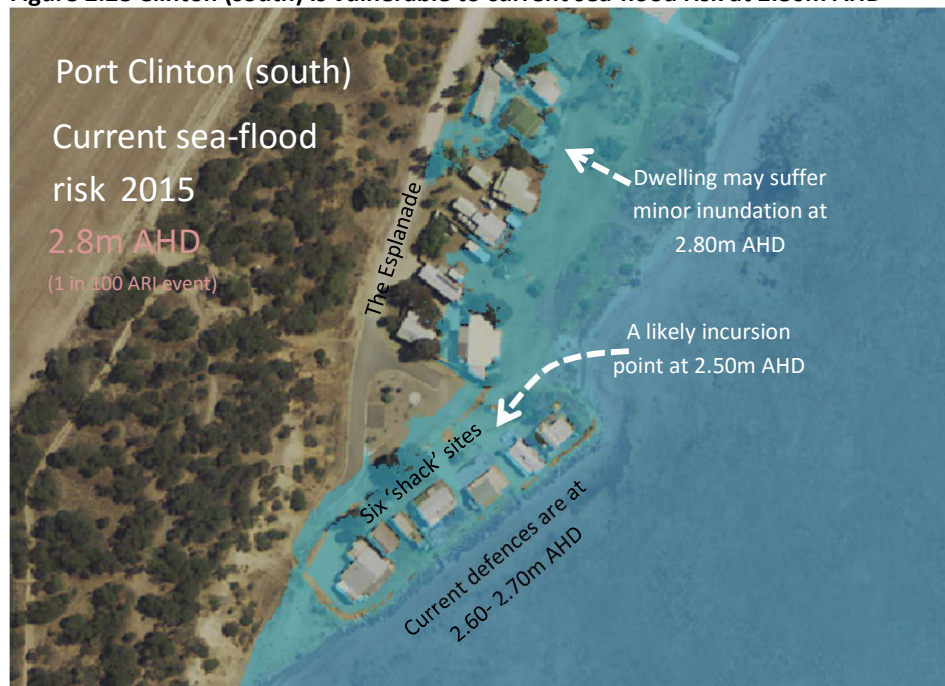
The proposal is for residents of Clinton to monitor the action of the water in high tide events and report any increasing threat of inundation to Council.

### 2.3.2 Clinton (South)

Analysis of the flood risk to the dwellings in Clinton (south) found that only 7 dwellings were likely to be subject to flooding from the current risk of 2.80m AHD. Currently, six of these dwellings are protected by rock revetment at 2.60 to 2.70m AHD and therefore if the current risk event occurred, water would flow over these defences. (One section of the defences is shown to be at lower height at 2.50m AHD and is indicated on Figure 2.21). One dwelling situated further north, may also suffer minor inundation over floor level (Figure 2.21).

The flood mapping also indicates that the some additional property sites would also be inundated at low depths (0.1m to 0.2m).

**Figure 2:28 Clinton (south) is vulnerable to current sea-flood risk at 2.80m AHD**



Analysis of the flood risk to the dwellings in the sea-flood risk of 3.2m AHD (2050) found that only 10 or 11 dwellings were likely to be subject to flooding in Clinton (south). However, substantially more properties would be inundated at depths up to 0.5m, and the six 'shack' dwellings at depths up to 0.8m.

A low height earthen bund could be installed to the front of properties where these are identified as vulnerable (Figure 2.22). The six 'shack' dwellings in the southern section would not be protected by this bund and would require their defences to be raised by 0.6m to 0.7m to cater for the 2050 sea-flood scenario of 3.2m AHD.



**Figure 2:29 Adaptation option to cater for 3.20m AHD sea-flood risk (2050)**

#### **8. Raise existing rock revetment defences by 0.5m to 0.6m.**

The six sites in the southern 'shack' area are under land management agreements (2002) and therefore the owners are responsible to manage their own protection at their own cost.

Council has notified the owners of this study and that the reports for the study can be obtained from the Council website.

#### **9. Install low height bund (s) where properties are likely to be inundated at 3.20m AHD**

In relation to properties in Clinton (south) (other than those mentioned at 8 above):

- The long standing policy<sup>8</sup> of the Coast Protection Board has been to not provide funding to protect private property unless certain conditions are met (such as there being simultaneous protection of public property, or where large numbers of dwellings may obtain a benefit).

<sup>8</sup> Since 1980, See Coast Protection Board Policy Document, revised 22 May, 2012.



- Where settlements were founded prior to Councils being required to take into account rising sea levels (pre 1990s), there is not likely to be any legal responsibility for Councils to implement protection to protect private properties.
- Councils may make decisions to protect esplanade roads and associated infrastructure and these protection strategies may provide a dual benefit of protecting private properties. However, in the case of Clinton (south) any inundation of the road shown on the flood mapping is at very low levels and the event very infrequent.

To provide some context, only four or five dwellings are likely to be at any risk of inundation at the 2050 sea-flood risk. A preliminary review of these dwellings suggest that they are all of advanced age and would likely be replaced by 2050.

The works associated with protecting Clinton (south) have not been costed as they are likely to be at the property owners cost, or at least a shared cost.

Council has notified the owners of this study and that the reports for the study can be obtained from the Council website.

Important Note:

The greater problem facing Clinton (south) is increasing erosion. Anecdotal accounts by residents suggest that the rate of erosion may be in the vicinity of 0.7 to 0.8m per year over the last nine years. Due to the distance of the row of dwellings from the sea-shore, erosion is unlikely to affect any properties in the near future, but this factor should be taken into consideration in longer term decision making.

To provide some immediate context, one anecdotal account placed the rate of erosion over the last nine years at 0.6 to 0.7m per year (approximate)<sup>9</sup>.

**Figure 2:30 Example of eroding coast line (2006 to 2015)**



Photograph: M. Western (2015)

<sup>9</sup> Based on anecdotal account from owner of 32 The Parade.

### 3. Port Clinton Accommodation Options

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Accommodation options are necessary when sites and buildings are not able to be protected by reasonably practical means to cater for the 1 in 100 ARI event for the 2100 sea-flood scenario. Infrastructure and buildings implemented now will have life spans in excess of eighty years and thus are likely to be in existence around 2100. This study has found that protection options are only viable to cater for the 2050 sea-flood scenario and therefore, other accommodation options should be implemented.

#### 3.1 Accommodation option - prepare the community to be 'flood ready'.

As noted above (see p. 5), a community that is prepared to deal with a flood is likely to suffer much less in financial terms, and also less likely to suffer risk to humans. Further, a prudent community prepares for emergency events that may fall outside of its historical context as 'mother nature' does not necessarily adhere to ARI tables. The following are ways in which the community could prepare itself to be 'flood-ready':

##### 3.1.1 Implement general warnings of general flood risk.

Yorke Peninsula Council to implement general warnings to residents about the general risk of flood. These warnings may include:

- Flood mapping and floor levels of dwellings made available to residents to allow them to more fully evaluate the flood risk to their property. It is noted here that two community work shops have been held, and the State of Play reports containing flood mapping have been posted on the Council website. All land owners were notified of the meetings and where to find the State of Play report.
- New residents made aware of the risk of flooding in the Form 1 required as part of a real estate contract at time of purchase within the settlement.

##### 3.1.2 Implement warning systems for possible flood events.

Port Clinton Progress Association (or other appropriate community organisation) to implement flood warning systems such as:

- Community run warning systems to inform residents of upcoming king tides. Examples of warning systems include: sending tide charts to all residents, and/or utilising SMS or email to send messages to community members with king tide information.
- Implement systems to warn residents of predicted storms. For example, SMS and email storm warnings are available from the Bureau of Meteorology and could be forwarded to residents. The SES or CFS may also have other ways in which to warn residents.
- Install flood depth markers to where required<sup>10</sup>.

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<sup>10</sup> Unit cost \$150, approximate labour cost \$250, installation \$400 per flood depth marker.

Generally the depth of flood over road levels in a sea-flood of 3.10m to 3.20m AHD would be reasonably low throughout the settlement (less than 0.3m). However at two places the depth of flood would exceed this depth:

#### Cumberland Road (Clinton – main)

Cumberland Road would be a logical choice for residents to use when moving away from the flooding in the lower sections of Clinton. However, flooding in vicinity of the intersection of Kurilla Street and Cumberland region would be as high as 0.8m – 0.9m if the sea-flood scenario for 2050 occurred and a flood depth marker should be installed in this location.

#### The Esplanade (Clinton – south)

The section of The Esplanade that connects Clinton (south) to Clinton (main) would be largely inundated as shown on Figure 2:26.

**Figure 3:1 Access road from Clinton (south) to Clinton (main)**



Taking into account that the current risk is 2.80m AHD flood depth markers should be immediately installed now in the area where the stormwater egresses from the upper levels of the Clinton area and warning signs installed that warn of the potential for storm water and sea water flooding.

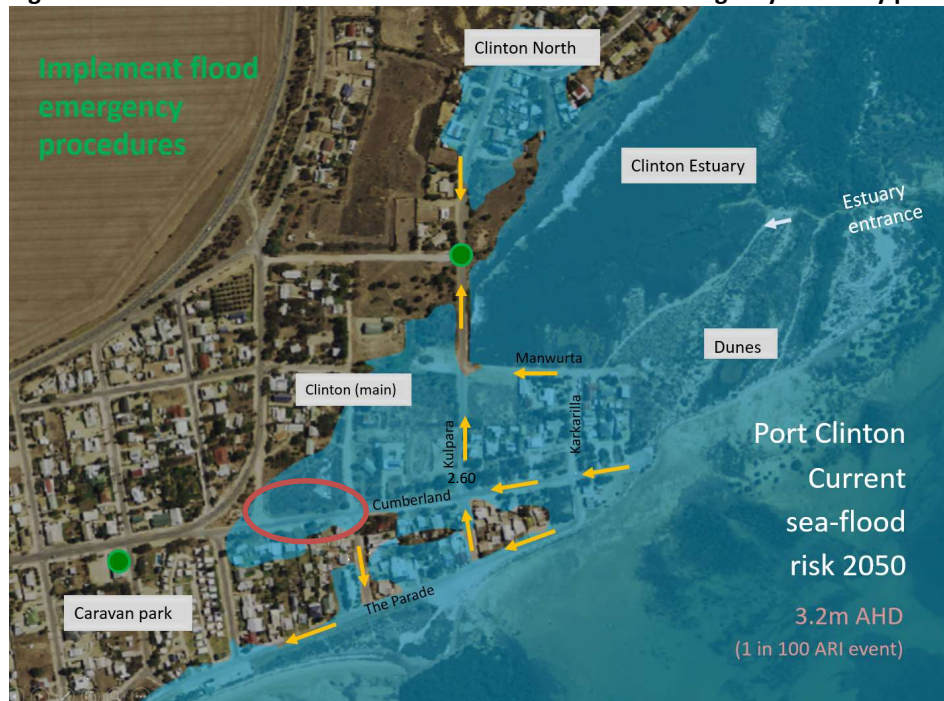
Other flood depth markers could be installed now or installed at a later date when the higher sea-flood risk is more likely.

### 3.1.3 Implement flood emergency procedures.

Port Clinton Progress Association (or similar community body) to establish flood emergency procedures such as:

- Establish an emergency assembly point (s) within the Port Clinton settlement. A logical point of assembly would be the Port Clinton Community Hall. Residents may wish to identify other points that may be closer to their places of residence.
- Establish emergency evacuation routes that residents can use on foot that lead away from the source of the flood and to the emergency assembly point. For example, residents who have not planned a route may instinctively adopt Cumberland Rd as the preferred route, but in fact this would be one of the deepest points to traverse.

**Figure 3:2 Routes that residents can utilise to move to the emergency assembly point (Example Only)**



Flood mapping from DTM: M. Western (2015)

Emergency service vehicles would be able to enter most areas of Port Clinton but may have some difficulty on the eastern end of the settlement in the Karkarilla St region<sup>11</sup>. The greatest area of difficulty for emergency vehicles to enter would be to Clinton (south). If the current risk of 2.80m AHD flood event occurred then most emergency vehicles would not be able to enter this area. The issue here is not one of 'rescue' but more if a flood event was concurrent with another emergency, such as in the case where medical assistance was required and access (or egress) was not possible.

<sup>11</sup> Note: the height of Kulpara Road near the Cumberland intersection is 2.60m AHD. In the longer term if this section of road was raised by 0.3m then access to most areas could be obtained via Kulpara Road which would then only have depth of flood at less than 0.3m



### 3.1.4 Prepare written Flood Emergency Action Plans.

Port Clinton Progress Association in partnership with Council to prepare a guide to assist residents to prepare Flood Emergency Action Plans and to educate new and existing residents of its contents. The Guide should include evacuation policies based on the level of warning, what each member of the household should do if flood waters enter the dwelling, and describe how each member will access the emergency assembly point.

### 3.2 Accommodation Option- amend Development Plan policy.

Planning policy should ensure that:

- All new buildings (apart from minor structures such as sheds) are capable of being raised to 4.15m AHD (and not that they are capable of being raised to 1.25m above the standard sea-flood level in accordance with current policy);
- Site levels no longer required to be 'protected' from standard sea-flood risk level, sites should no longer be required to be 0.3m above the standard sea-flood risk, substitute clauses should have the sense of 'managing' the site in relation to sea-flood risk;
- The requirement that practical measures are available to 'protect' new development against additional sea level rise of 0.7 metres is removed and replaced with clauses that have the sense of 'accommodating' additional sea level rise.

Review the specifications of septic systems to be installed with new dwellings at Port Clinton to ensure that these are adequate to cater for potential sea flood scenarios later in the century.

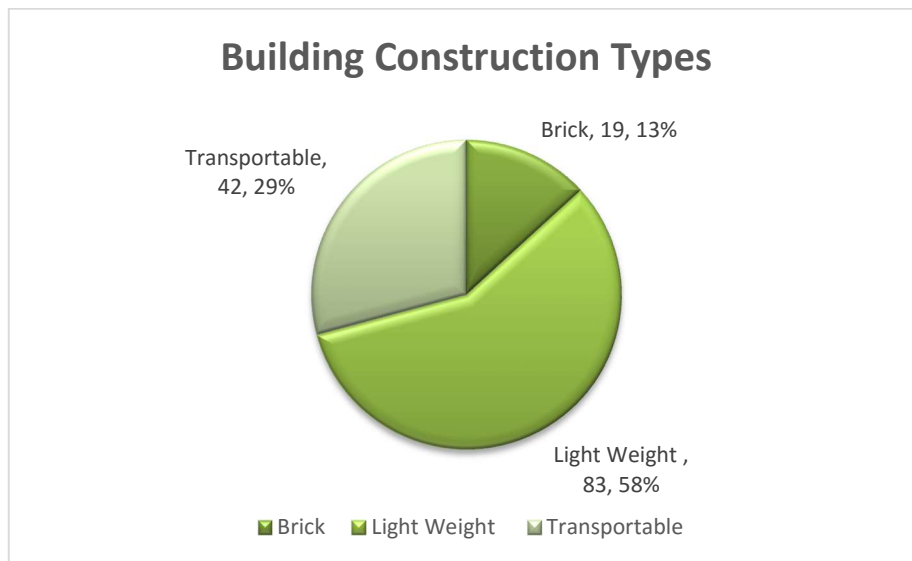
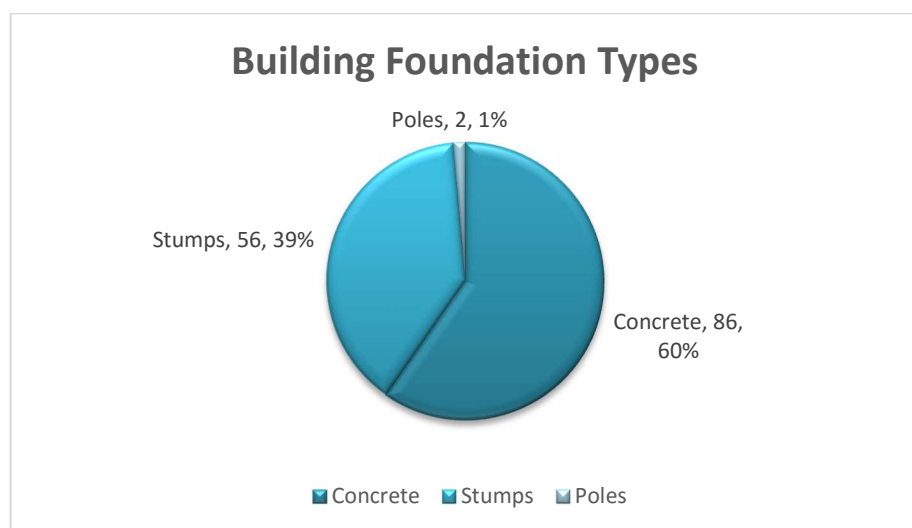
### 3.3 Accommodation Option - adapt existing buildings

#### 3.3.1. Raise the floor level of dwellings.

The number of existing dwellings subject to inundation at the current predicted 1 in 100 ARI event of 2.8m AHD is 27, with a likely damage bill to private property in current dollars at \$282,000 (SOP, p. 51). The predominant housing construction in Port Clinton is either light weight or transportable<sup>12</sup> but foundation types are evenly split between concrete and stumps or poles. Dwellings on stumps could be raised if required, but these tend to be newer dwellings and are likely to have been installed at appropriate heights. If a decision is made to 'do nothing' about the protection options outlined above (p.12-21) or a decision is made to defer for any length of time, then residents may choose to raise their dwellings if the frequency and heights of inundation increase<sup>13</sup>.

<sup>12</sup> It is likely that in collection of data that 'lightweight' has been over applied rather than the 'transportable' category but this is of little consequence to the accommodation strategy proposed here.

<sup>13</sup> Note: Any dwelling constructed over the last decade or so is likely to be at sufficient height to cope with 2050 sea-flood scenario.

**Figure 3:3 Building construction types (Port Clinton)****Figure 3:4 Foundation construction types (Port Clinton)**

It is anticipated that over the next 30-40 years many of the existing older dwellings in Port Clinton will be replaced. If the proposed protection options outlined above (p. 12-21) are implemented then it is conceivable that a number will still remain with floor levels lower than the sea-flood risk. Residents could raise their dwellings to deal with the sea-flood threat subsequent to 2050 when the proposed protection options may not always protect the settlement.

### 3.3.2 Water proof dwellings

Other flood accommodation options that residents could employ should the threat of inundation increase are:

- To internally water proof buildings and raise electrical outlets above the predicted flood levels.
- To provide temporary flood barriers to the outside of dwellings when tides are predicted to be high<sup>14</sup>.

**Figure 3:5 Flood diversion/ protection method for dwellings**



**Figure 3:6 Flood diversion/ protection method for dwellings**



<sup>14</sup> Examples from Blobel Flood Protections Systems (Blobel Environmental Engineering, 2013)

## 4. Port Clinton Retreat Options

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The data from tide gauges at Port Stanvac and Thevernard have shown that sea level in the region has been rising at an average of 4.3mm per year over the past 20 years. For the sea to rise 0.7m in the second half of this century as predicted would require an average rate of rise at 14mm per year. In reality this rate would be much lower than 14mm at 2050, and a much higher rate at 2100. Therefore, from now until 2050-2060 it should be possible to monitor the rate of increase and adjust predictions accordingly. There are two possible scenarios that will emerge from the monitoring in this time frame:

- If the rate of change of sea level rise does not increase and the predictions for 2100 are proven to be inaccurate, then at the very least as a result of implementing the adaptation strategies above, Port Clinton would have become a far more resilient community and prepared for any unforeseen flood event.
- If the rate of change of sea level rise does accelerate and the predictions prove accurate, then Port Clinton can expect to be inundated far more frequently as the century approaches its close and the associated increased erosion may also remove the entire dune system. Even though planning changes foreshadowed above mean that the floor levels of dwellings will be above the flood levels, roads are likely to be more frequently cut off and damaged, emergency vehicles may not be able to enter the settlement, and the safety of people may be increasingly at risk.

Therefore, if future monitoring of sea level rise indicates that the rate of change is accelerating, then planning policy should be devised and implemented to ensure that all new buildings are capable of being removed. Policy should be developed so that a predetermined event triggers the removal of buildings, for example, when a certain sea level height is reached, residents may have 5 years (for example) to remove dwellings. It is important to note that this study is not recommending that such a change be made now, but that sea level rise be monitored over the coming decades and the change made when:

- It is recognised that the rate of sea level rise is accelerating<sup>15</sup>
- Dwellings constructed now will be reaching the end of their life span and sea levels reach a point that may not be properly accommodated.

In summary, such a policy would allow residents the liberty to continue to develop their properties, but with the knowledge that the development may have a limited life span and plan accordingly. Additionally, within this strategy is the assumption that should sea level rise as predicted and coastal properties become increasingly threatened by inundation or erosion, people's attitudes will change to living in certain coastal areas. It is also likely that this changing attitude will be reflected as reduced values of some coastal properties.

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<sup>15</sup> Caution: the rate of sea level rise is not constant and thus longer term trends should be employed to ascertain whether the rate of change is accelerating.



In regard to Council owned infrastructure it is anticipated that:

- Any new buildings or infrastructure would be implemented taking into account the flood mapping provided by this study,
- Council will increasingly make decision not to upgrade infrastructure if it has become obvious that in the longer term a settlement cannot be protected,
- Should a retreat strategy be implemented, Council would need to implement its own retreat strategy for its own assets.

In conclusion, using the strategy outlined above, the Council will not be in the position of needing to implement a retreat strategy until it is obvious that such a strategy is required, and that fair warning had been given to all residents with the establishment of a pre-determined trigger a few decades prior.

## 5. Port Clinton Adaptation Costs (preliminary)

The cost estimates provided below are based on very limited data and without engineering design calculations. They are therefore indicative only and have been prepared to assist council with the priority setting processes. They should not be relied on for budgeting or construction cost management purposes. **Table 5:1** is a summary of the adaptation options for Port Clinton grouped according to the categories of *protect*, *accommodate*, or *retreat*.

**Table 5:1 Summary of adaptation options for Port Clinton**

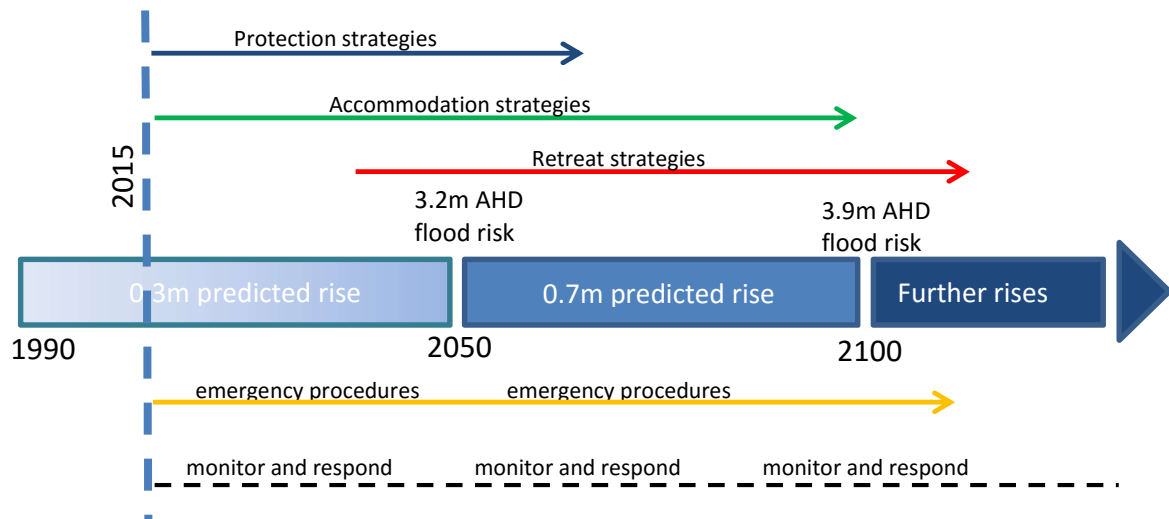
	Adaptation options	Approximate cost	Reference pp.
Protect	Raise Manwurta St to 3.1m AHD.	\$53,600	12-13
	Install flood minimisation measures to dunes at 3.2m AHD	\$6,100	14-15
	Review existing rock revetment (and install minor works where required). Monitor performance.	\$2500 (not costed)	16-17
	Install flood protection works to foreshore at 3.2m AHD	\$46,500	18-24
	Formalise boat ramp entry point and provide temporary flood protection strategy.	\$10,000 (not costed)	25
	Install low height earthen bund to ridgeline	\$5750	26
	Raise existing defences by 0.6m to 3.2m AHD (these properties under land management agreements)	By owners	29
	Install low height bund to front of properties (as required)	By owners	29
Accommodate	Implement emergency procedures – establish warning systems; establish emergency assembly point; establish evacuation policies; establish community emergency action plans.	Council & Progress Association	31-34
	Install flood depth markers to Cumberland Road (Clinton main) and the Esplanade (Clinton south).	\$2000	32
	Devise and implement planning policy that ensures: new dwellings are capable of being raised to 3.95m AHD; and site levels are not required to be raised.	Not costed	34
	Adapt existing dwellings (if required) – residents to raise floor levels; utilise internal waterproofing; or temporary protection mechanisms.	By owners	34-36
Retreat	Subject to monitoring that demonstrates that the rate of sea level rise is accelerating, devise and implement planning policy that ensures that new dwellings are capable of being removed (once a predetermined trigger point has been reached, for example a particular AHD height).	Not costed.	37-38

Within all of these adaptation options is the option to 'defer' or 'do nothing'. For example, cost may prohibit the implementation of a protection measure and therefore the project is deferred. In other cases, the risk might be deemed so minor that 'do nothing' is adopted.

## 6. Port Clinton – Timing and prioritisation

### 6.1 Timing of adaptation options

In general, **Figure 6:1** illustrates how the different protection, accommodation, and retreat options interrelate over time. Sea level rise and erosion are monitored over time and responses made accordingly. Emergency procedures are always in place and amended according to the conditions. When protection measures become inadequate, accommodation options mitigate the risk. Subject to ongoing monitoring longer term decisions are made in relation to the viability of the settlement itself.








### 6.2 Prioritisation of adaptation options

The prioritisation of adaptation options is based on the following criteria:

- First, warning and emergency procedures to ensure people are safe.
- Second, implement monitoring systems because these are not onerous, and the Council may be liable without them.
- Third, begin changes to planning policy as this process takes time, and the life span of infrastructure is long.
- Fourth, install protection works to protect Port Clinton for the current sea-flood risk.
- Fifth, install protection works to protect Port Clinton for the sea-flood risk for 2050.

Subject to Council and community input the following prioritisation in **Table 6:1** is recommended for Port Clinton.

**Table 6:1 Prioritisation and responsible entities for adaptations at Port Clinton**

	Adaptation response	Risk rating and other priority factors	Response time	Map reference
1.	Implement emergency procedures – establish warning systems; establish emergency assembly point; establish evacuation policies; establish community emergency action plans.	Such procedures are a wise response to living adjacent to an unpredictable threat.	Within 1 year	NA
2.	Implement monitoring systems (annual) to assess the state of protection bunds	A duty of care exists for the condition of bunds/ levees	Within 1 year	NA
3.	Install flood depth markers to Cumberland Road and The Esplanade.	Flood depth markers will increase awareness and safety of drivers.	Within 1 year	NA
4.	Devise and implement planning policy that ensures: new dwellings are capable of being raised to 4.15m; and site levels are not required to be raised.	Some dwellings constructed now may still be in use in 2080-90 when the 1 in 100 ARI flood risk is 3.8m AHD.	1-2 years	NA
5.	Raise Manwurtia Street to 3.10m AHD (note, Manwurtia Street may also require remedial works)	Should the 2.80m AHD current risk sea-flood occur, water will flow over Manwurtia Street and cause significant inundation to eastern area	1-2 years	
6.	Strengthen dunes to height AHD 3.2m AHD	Should the 2.80m AHD current risk sea-flood occur, water will flow through the dunes and cause significant inundation to eastern area	1-2 years	
7.	Raise any low points in the rock revetment system, and monitor performance in flood conditions.	Should the 2.80m AHD current risk sea-flood occur, water may flow through protection work at low points.	1-2 years	
8.	Install flood protection works to foreshore	Should the 2.80m AHD current risk sea-flood occur, water would be unlikely to flow over The Parade, but the threat will increase over time.	3-5 years	
9.	Formalise access to boat ramp area and provide temporary protection system	Should the 2.80m AHD current risk sea-flood occur, water would be unlikely to flow over The Parade, but the threat will increase over time.	3-5 years.	

10.	Install low height bund to ridgeline	Should the 2.80m AHD current risk sea-flood occur, water would be unlikely to flow over the ridgeline, but the threat will increase over time.	3-5 years	6
11.	Monitor flood flows north of Clinton (residents)	Portions of the dune system north of Clinton are at heights less than 2.80m AHD and it isn't known if flood waters can penetrate this far north.	3-10 years	7
12.	Subject to monitoring from the present until the 2020s- 2030s, should sea level rise accelerate to indicate more rapid rise, devise and implement planning policy that ensures new dwellings are capable of being removed once predetermined triggers have been realised.		30-40 years	NA
13.	Adapt existing dwellings (if required) – residents to raise floor levels; utilise internal waterproofing; or temporary protection mechanisms.	Residents responsibility	30-40 years	NA

Note: Items relating to Map reference 8 and 9 have not been included in the list of actions to be prioritised as these items are likely to be at the land owners' expense.



## 7. Port Clinton - Community consultation

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### 7.1 Consultation methodology

All land owners were mailed an invitation to attend a community workshop on 19<sup>th</sup> August 2015 at 1.30pm. The invitation included the summary table from the State of Play Report (p. 61) and notification that the State of Play report had been uploaded to the Council website.

Mark Western gave a formal presentation in which a review was undertaken of the State of Play report and the adaptation options presented.

At the conclusion of the formal presentation, maps showing the location of the proposed adaptation options and a feedback sheet were provided for participants to record responses (See Appendix A). Participants were asked to give responses as to how to be 'flood ready' on 'post it notes' to questions left on the screen:

- Do you think it necessary to be flood ready?
- What type of warning systems could be implemented?
- What emergency procedures could be implemented?

The facilitators of the meeting were Mark Western (Integrated Coastal Management), Natasha Hall (Central Region Climate Change Officer), Stephen Goldsworthy (Yorke Peninsula Council).

Twenty six people attended the meeting.

### 7.2 Community feedback

#### **Feedback on the proposal for the community to be 'flood ready':**

Q1. Do you think it necessary to be flood ready?

*All facilitators reported that the general feedback from participants was that the idea of being 'flood ready' was treated with neutrality (apart from being 'flood ready' with practical means).*

Q2. What type of warning systems could be implemented?

*No suggestions were given by participants.*

Q3. What emergency procedures could be implemented?

*No suggestions were given by participants.*

#### **Observation:**

The fact that the majority of Port Clinton is elevated and that there has been no flood event that has overtopped The Parade (it has encroached upon it), nor flowed over Manwurtta Street since its installation in the 1990s may be reasons that the residents do not feel 'exposed' to the threat of major inundation and therefore felt these measures unwarranted. Note: The 'post it note' methodology of feedback may also have contributed to the low response.

**Feedback on the proposed adaptation options:**

Generally the feedback was positive about the adaptation proposals. Specific feedback is recorded below:

## 1. Raise Manwurtta Street to 3.1m AHD.

*Several participants recommended that the 'soakage' problem be addressed.*

*One participant recommended an alternative strategy of installing a new levee to the north of Manwurtta Street within the existing samphire flat.<sup>16</sup>*

*One participant that the section from Karkarilla Street to the dune section be 'built up to match'<sup>17</sup>.*

## 2. Strengthen the dunes at height 3.2m AHD

*No comments*

## 3. Monitor existing rock revetment.

*One comment: 'needs to be raised as it will be the weak link after lifting the dunes area'<sup>18</sup>.*

## 4. Install protection structures to foreshore at 3.2m AHD.

*One comment: 'vegetate the mound'.*

## 5. Formalise the boat ramp entry and provide protection measures to 3.2m AHD.

*'Raise the whole boat ramp – better than having to block the entry' [refers to boat ramp traffic access area, not the boat ramp per se].*

*'Move the boat ramp? Yelta Street alternative'*

## 6. Install low height levee at elevation 3.2m AHD.

*One comment: [install] levee from 7 down past 6 to Kulpara<sup>19</sup>*

## 7. Monitor flood flows to the north of Clinton

*One comment: 'levee north'. (This may suggest a recommendation for a levee in this location).*

**Other comments:**

*'Reducing mangroves/ channel between mangroves and beach could help'<sup>20</sup>*

*'Extend study to consider shacks to the south'<sup>21</sup>*

<sup>16</sup> The samphire flat is likely to be at elevation 1.30m AHD and would require a levee at 1.80m high to cater for 3.10m event. This option was reviewed by AWE engineer (Geoff Fisher) and discounted because of the likely cost.

<sup>17</sup> The whole of Manwurtta Street is to be raised (perhaps a misunderstanding?).

<sup>18</sup> This option has been modified to include a 'review' of the rock revetment and to 'raise low points' where necessary (see p. 16).

<sup>19</sup> This comment a little unclear – perhaps suggesting that the levee should be extended westwards to Kulpara. However, the DTM indicates that this area is not at risk in 3.2m AHD event.

<sup>20</sup> This comment reflects a view that the mangroves in front of the boat ramp are increasing the flood threat to this area. This matter was reviewed by the coastal engineer (AWE) and discounted.

<sup>21</sup> In August the study was extended to include Clinton (south).

## **Appendix A: Community consultation feedback sheets**

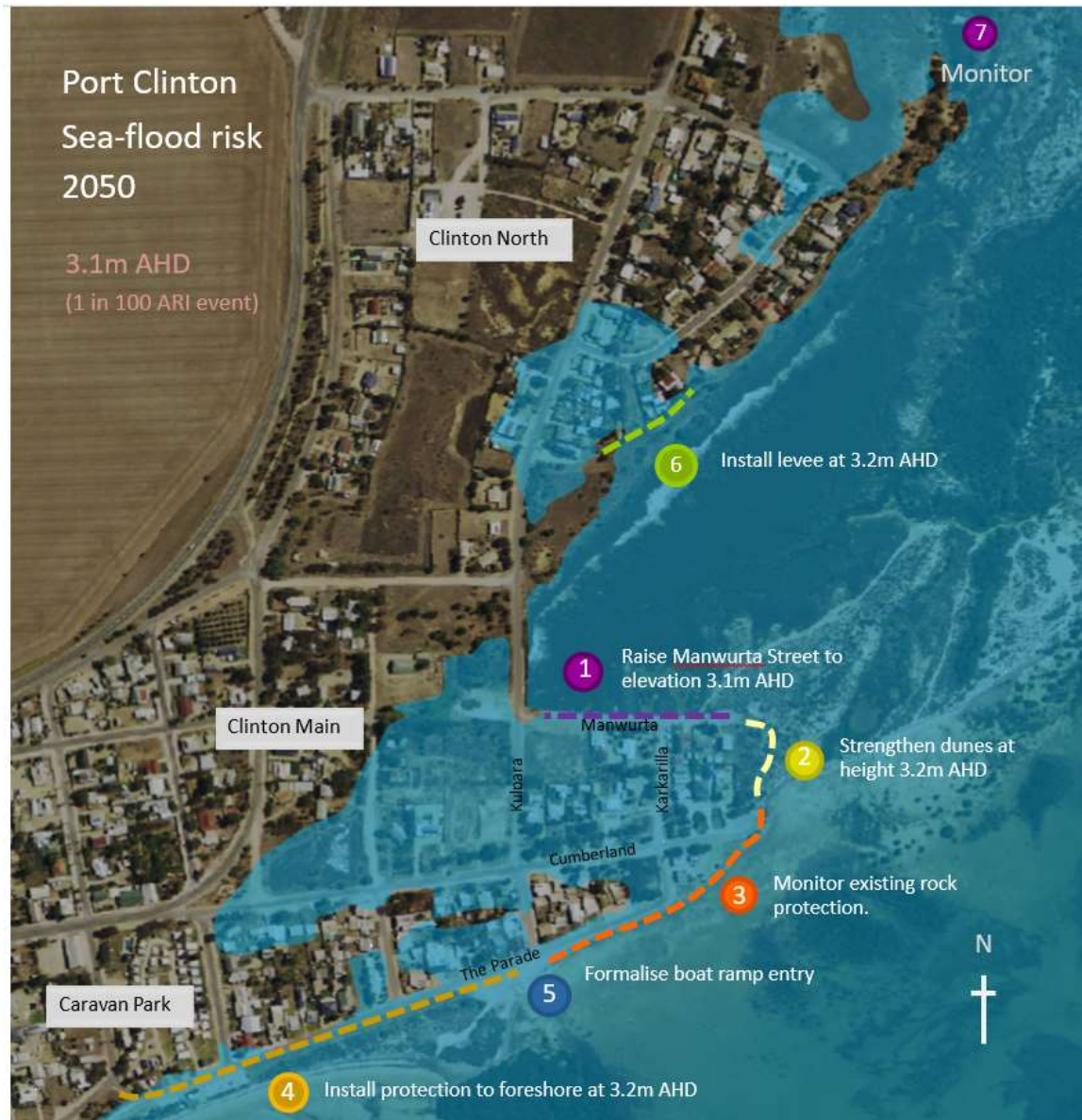
(Samples – originals in A3)

## Community Feedback – Adaptation Options for Port Clinton

	Adaptation option	Reason	Feedback
1	Raise Manwurtta Street to elevation 3.1m AHD	Raising Manwurtta Street to 3.1m AHD is likely to prevent flood waters entering Clinton from the north and should cater for anticipated sea-flood risk for 2050.	
2	Strengthen the dunes at height 3.2m AHD (not a flood protection measure)	If the flood event 3.1m AHD were to occur, the dunes would be overtopped and water may enter Clinton from the east.	
3	Monitor existing rock revetment	The elevation of the existing rock revetment is likely to be adequate for a 3.0m AHD event. Ongoing monitoring will assist in further decision making.	
4	Install protection structures to foreshore at 3.2m AHD	Previous flood events have already inundated the foreshore area. Installing protection measures at 3.2m AHD should be adequate to give protection at levels anticipated for 2050.	
5	Formalise boat ramp entry, and provide protection measures at 3.2m AHD.	The methodology to be employed is still under review.	
6	Install low height levee at elevation 3.2m AHD	This strategy is to prevent water entering the Clinton North area through the vacant allotment.	
7	Monitor flood flows to the north of Clinton	It is unknown if water may swing back into Clinton from the North. Residents in the area can monitor flood flows and report to Council.	



# Adaptation Options



## How can our community be flood ready?

Do you think it is necessary to be flood ready?

What type of warning systems could be implemented?

What emergency procedures could be implemented?

WRITE YOUR COMMENTS HERE: