PRICE

Seawater Flooding Adaptation Pathways for Yorke Peninsula Settlements

Stage 1: State of Play

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Photograph of Price seafront supplied by Coast Protection Branch.

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Project stage	Version	Date	Reviewed	Approved
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CONTENTS

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

1.1 Background and scope

In February 2015 the Yorke Peninsula Council commissioned Mutual Projects Pty Ltd 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:

Price.

Figure 1:1 Location Map: Price, Yorke Peninsula[1]

[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.

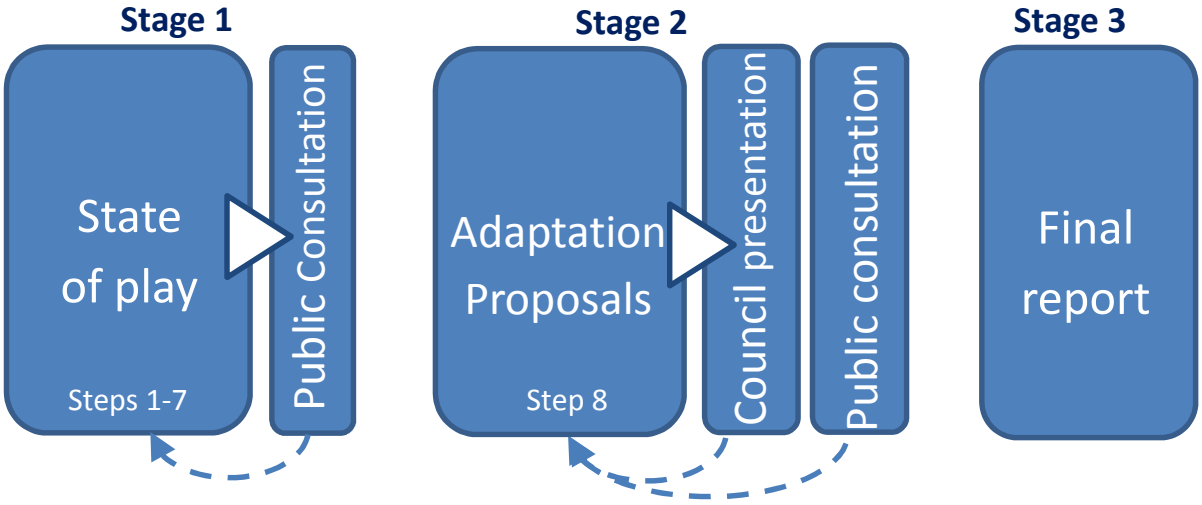
1.3 Methodology and staging

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?
- 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.

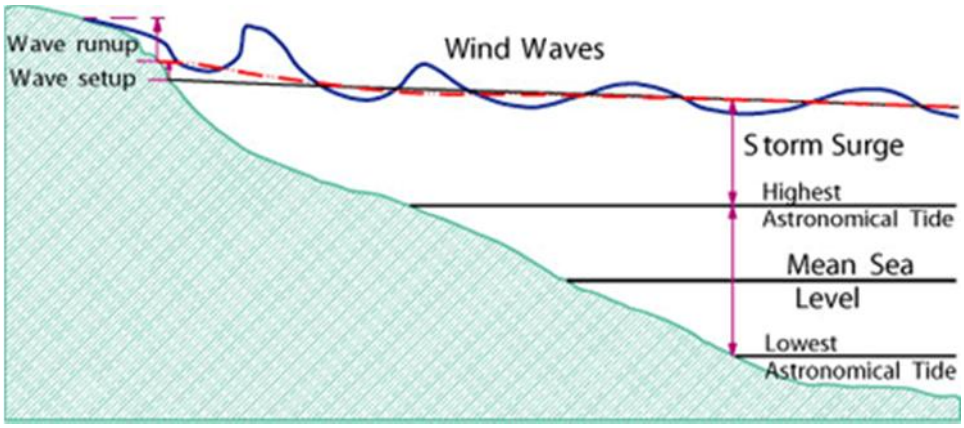
2.3 Analyse the impact of the sea upon the coast.

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 (now currently resides within Department of Environment and Natural Resources) has utilised the following inputs to calculate the 1 in 100 ARI event for Price (See Table 2:1).

Table 2:1 Price - 1 in 100 ARI storm event –Price (current since 1994)

Storm surge (at king tide)	2.9m AHD
Wave set up	0.2m AHD
Wave run up	0.2m AHD
Total Risk (total)	**3.3m 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 (at king tide)	2.7m AHD
Wave set up	0.1m AHD
Wave run up	0.0m AHD
Total Risk (total)	**2.8m 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 Price with Coast Protection Board policy sea level rise rates, the following table depicts the sea-flood risk for Price.

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

	1990	2050	2100
Storm surge (at king tide)	2.6m	2.6m	2.6m
Wave set up	0.1m	0.1m	0.1m
Wave run up	0.0m	0.0m	0.0m
Sea level rise	0.0m	0.3m	1.0m
Totals (AHD)	**2.7m**	**3.0m**	**3.7m**

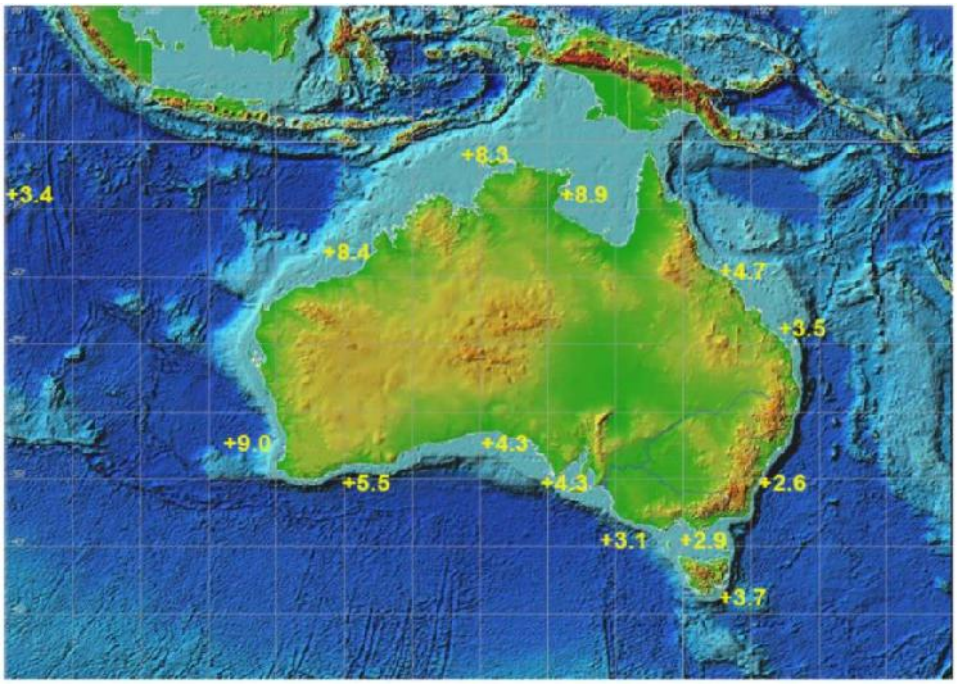
2.3.3 Actual sea level rise

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 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 300mm (0.3m) rise that SA Coast Protection Board has incorporated into its policy framework.

Figure 2:2 Tidal gauges at Thevernard and Pt Stanvac have recorded an average rise of 4.3mm[4]



Recognising that the sea has been rising since 1990 levels the current risk levels for 2015 are calculated by including a 0.1m rise[5] (Table 2:3).

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

	1990	2015	2050	2100
Storm surge (at king tide)	2.6m	2.6m	2.6m	2.6m
Wave set up	0.1m	0.1m	0.1m	0.1m
Wave run up	0.0m	0.0m	0.0m	0.0m
Sea level rise	0.0m	0.1m	0.3m	1.0m
Totals (AHD)	**2.7m**	**2.8m**	**3.0m**	**3.7m**

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

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 for a 2.8 m AHD event (2015)?
- What is the likely impact on the settlement for a 3.0 m AHD event (2050)?
- What is the likely impact on the settlement of a 3.7m AHD event (2100)?

2.4 Analyse emergency access and egress.

Historically sea-flood events in Price 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 3.0 m AHD (2050) flood event, are emergency services able to access the settlement?
- In the event of a 3.0 m AHD (2050) flood event, are people able to move directly away from the place where flooding is occurring (egress)?

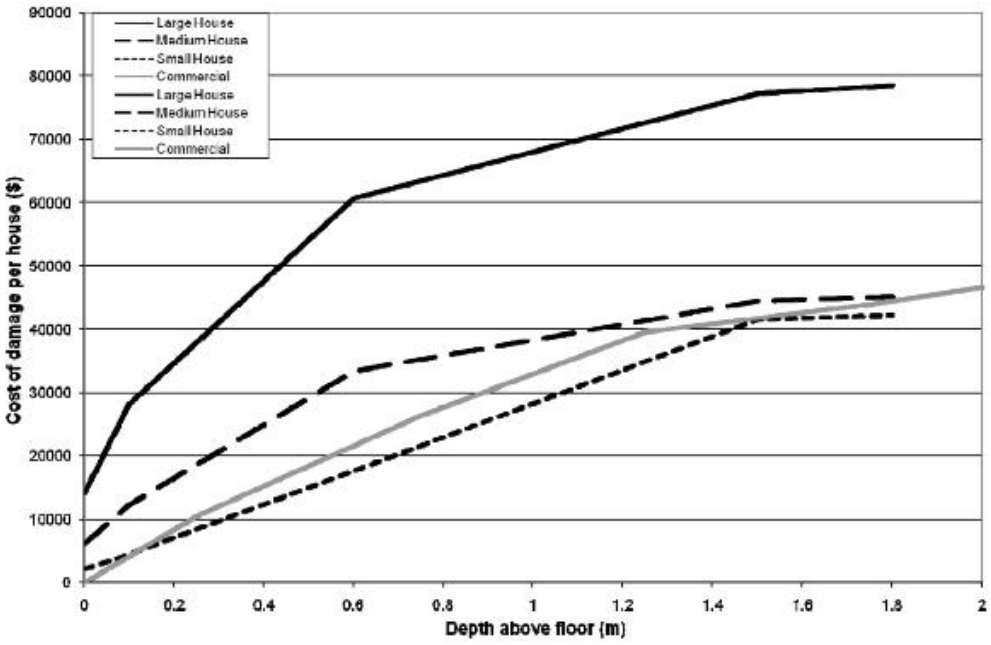
2.5 Establish profile of assets at risk

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[6].

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[7]. The 'small house' scenario has been chosen for the curve for Price.

Figure 2:3 Flood/damage curve utilised in the study (adapted from ANUFLOOD,2008[8]).



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

[7] This flood/damage curve was used in a flood study in a small Victorian town of Barmah. 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.

[8] 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[9].

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.

[9] 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.

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?
- 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 – Price (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 Price 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 (See Appendix A).
- Two ABC regional radio interviews were conducted with the 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 Price 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 three residents from Price attended. 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[10] encouraged participants to answer prepared questions and to provide marks and comments on the provided map of Price (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 community consultation process, these contributors are noted as *Price 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 community 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.

[10] 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 (Price)

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 that the 'Price settlement is located in a flat area. The Council owned caravan park is subject to seawater flooding causing damage to assets and emergency response and the causeway is showing signs of erosion'[11].

4.1 Settlement History

4.1.1 When was the settlement established?

Price was proclaimed on 3rd August 1882 and although not immediately on the coast is connected to the Wills Creek tidal creek by a causeway that stretches 1.4 km over a mangrove habitat. Originally railway lines were laid on the causeway as a means of transporting bagged salt and grain to the ketches for export. For many years Price was part of the District Council of Clinton but was amalgamated with Central Yorke Peninsula Council. 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. Wills Creek Conservation Park situated east of Price was proclaimed in 2006 under the National Parks and Wildlife Act 1972 and is considered to be a significant coastal estuary supporting mangrove and intertidal habitats as well as being important fish nursery areas. The park contains two creeks within its boundaries Wills Creek and Shag Creek.

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

Price 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 Price to take into account actions of the sea.

4.1.2 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 Price notes that the causeway is 'quite often flooded' (p. 14) but there was no mention of any flooding issues in the field notes of 2nd – 4th June 1986[12].

[11] Yorke Peninsula Council (2015) Request for Quote, p.17
[12] Coast Protection Board, briefing and field notes for site visit conducted in 1986

- *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. Price was assigned twelfth position out of fourteen towns in accordance with the table below (Table 4:1).

Table 4:1 Price – Risk assignment given by the Sea Flood Risk Mapping project

Price	Development pressure	Designated growth area	Land levels	Known flood risk	Total risk
Risk assignment	2	1	3	1	7
Explanation	A moderate number of dwellings constructed	No expansion beyond the existing township	Land levels lower than 5m AHD	Known flood history, inadequate protection measures.	

- *Yorke Peninsula Coastal Issues Scoping Study Price, 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 and foreshore reserve assets are at risk from coastal inundation from sea level rise'[13]. 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 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.

[13] Civil and Environmental Solutions (2014), Scoping study report, p. 5

4.2 Analysis of existing 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, potential for inland flooding is also reviewed where these factors are known.

4.2.1 What natural coastal protection exists?

Coastal environment

Figures 4:1 and 4:2 show that Price is situated inland from the open waters of Gulf St Vincent and separated by a 2.2 km wide samphire and mangrove intertidal zone.

Figure 4:1 The nature of Price coastal region

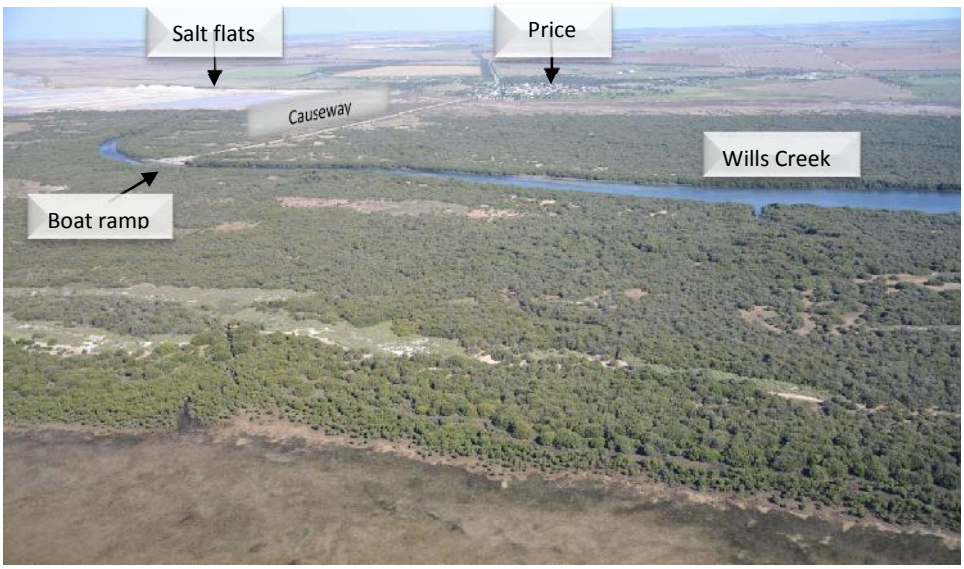


Figure 4:2 The nature of Price coastal region

Photographs: Coast Protection Board (2014 & 1997)

Natural topography of Price settlement

- West of Fowler Road

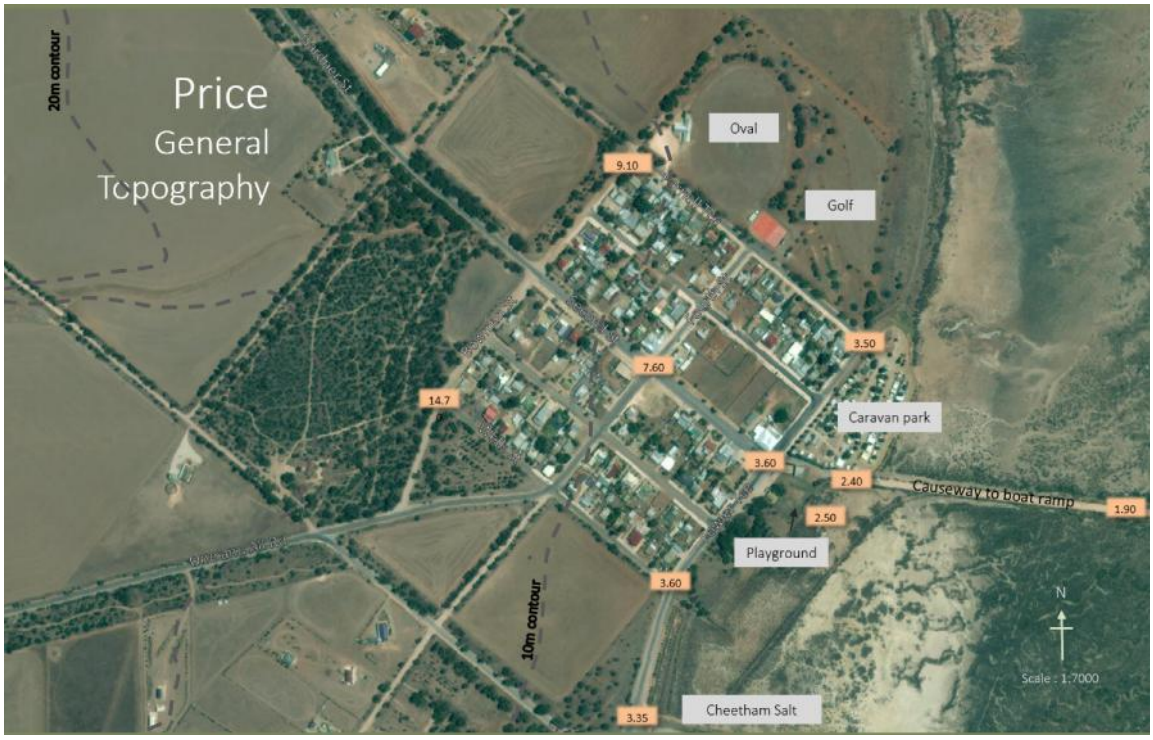
Fowler Road at the general height of 3.50m to 3.60m AHD acts as the esplanade road to Price with the entire residential settlement situated to the west of this road. Land to the west of Fowler Road rises quite quickly to a height of 10m as seen by the contour line on the map below (Figure 4:3). The land between Price and Cheetham Salt works is equally elevated while the general topography on the northern end of Price adjacent the oval and golf course is lower.

The general topography of Price would indicate that the majority of dwellings are not likely to be vulnerable to flooding over the duration of this century based on current projections.

- East of Fowler Road

Between Fowler Road and the samphire and mangrove intertidal zone is the community sector of Price. A grassed playground and BBQ area, and two sheds are situated on the southern side of the causeway entrance with lowest points being adjacent the samphire habitat at 2.4m AHD. The council caravan park is situated on the northern side of the causeway at elevations 2.20m AHD in the lower portions of the park and 2.70m AHD in areas closer to Fowler Road.

Figure 4:3 The general topography of Price coastal region



Aerial photograph: Google Earth, 2015

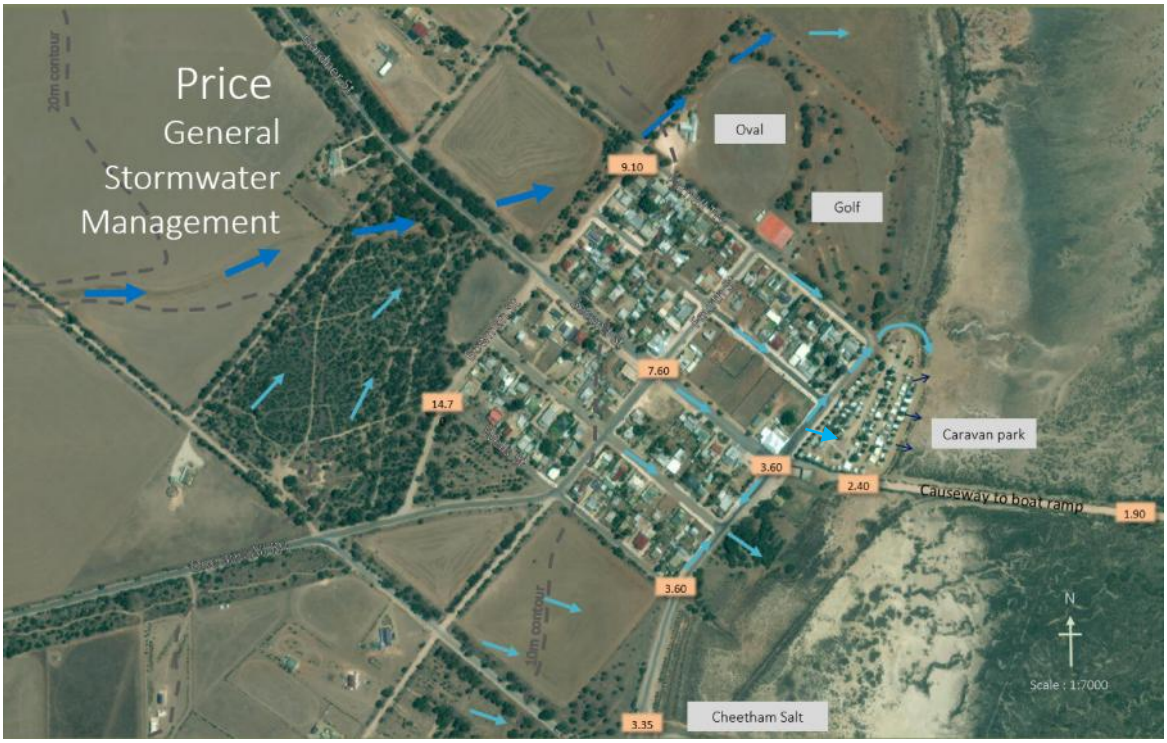
4.2.2 What existing man-made protection has been installed?

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 Price.

Storm water management: General Scheme

To cater for the potential for flooding from inland, the natural contours of the land have been utilised to create a storm water management system that diverts water around the north eastern side of Price (Figure 4:4). This includes a bank installed by the Price Progress Association to the northern side of the oval. Therefore, any water that flows to Fowler Street before emptying into the samphire coastal flat is only that which comes from within Price itself. The outlet around the top side of the caravan park is an open channel which is likely to be adequate at current sea levels, but a review should be undertaken to ascertain the system is adequate over the longer term. The outlet for stormwater on the southern end of Price is by way of a pipe under Fowler Street and empties into the samphire to the front of Price.

Figure 4:4 General scheme of storm water management for Price



Aerial photograph: Google Earth, 2015

To cater for rain water or flood water that might enter the caravan park, storm water drainage pipes with tidal flaps have been installed (by Price Progress Association) through the earthen bund that drain water to the samphire flat.

Sea flooding management: General Scheme

Only one sea-flood protection work has been installed to Price, an earthen bund that encircles the caravan park and joins with the more highly elevated Fowler Road. This bund was installed in two stages. The first stage is a wide earthen bund and was installed in 2001 at the time the caravan park was expanded. After the 25th April, 2009 flood event, a narrow top to the inside edge of the wider bund to create an extra 0.2 to 0.3m height of protection (Figure 4:5 and 4:6).

Figure 4:5 Existing sea-flood protection – earthen bund encircling caravan park

The original lower level bund is well vegetated with vegetation providing a natural wind break for the park as well as increasing the integrity of the bund.

Figure 4:6 Existing sea-flood protection – earthen bund encircling caravan park

Photograph: M. Western (2015)

Alongside the golf course, and adjacent the samphire flat, a wide earthen mound at heights 3.90m to 4.10m AHD is situated and effectively prevents any seawater from entering the settlement (Figure 4:7). This mound represents the consolidation and covering of the old Price rubbish dump and was not specifically installed as a flood protection measure.

Figure 4:7 Existing sea-flood protection – earthen bund adjacent golf course

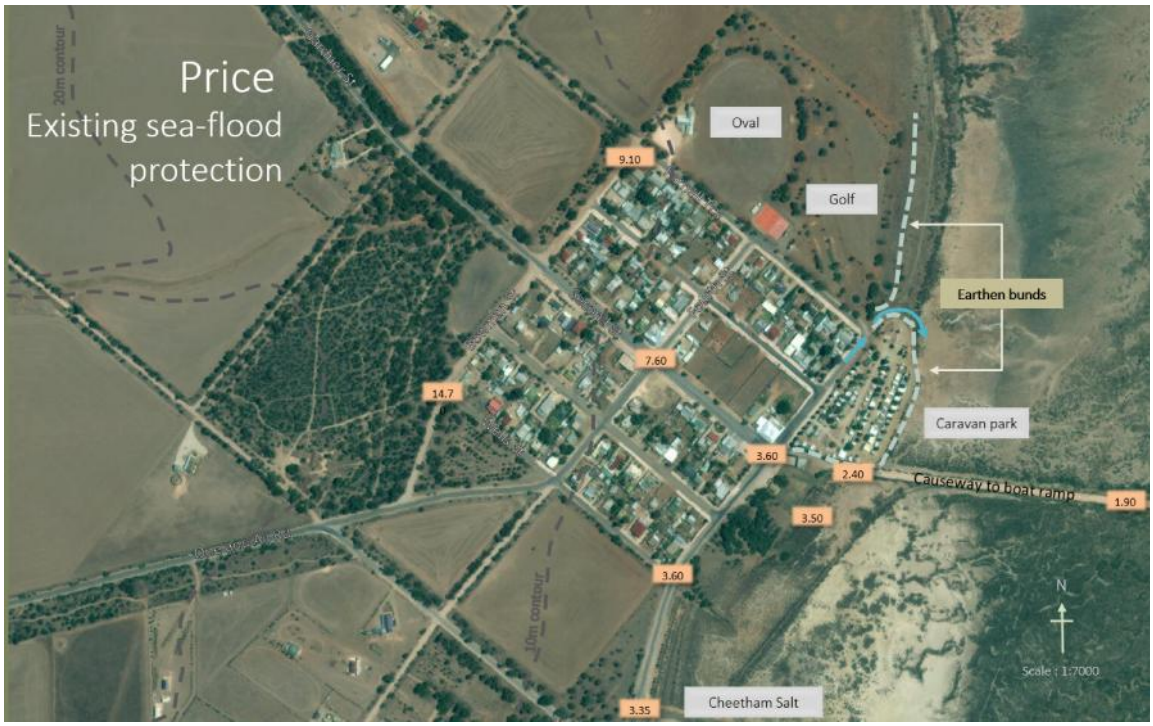
Photograph : M Western (2015)

The key factor here is that due to the natural topography of Price and the placement of the mound adjacent the golf course, Price is very unlikely to be vulnerable to lateral erosion where the viability of the settlement is undermined from the sides of the settlement, or from behind the settlement.

The existing sea-flood protection is depicted in Figure 4.8 below[14].

[14] Cheetham's salt pans are contained within a bund approximately 2.80m AHD and located directly south of Price provides increased protection of the settlement (not pictured).

Figure 4:8 Existing sea-flood protection of Price



Aerial photograph: Google Earth (2015)

General condition of protection

Earthen bund encircling caravan park

- The lower level bund is in sound condition covered with significant amounts of vegetation (installed 2001).
- The upper level addition to the bund is much narrower and of a looser constituency and its integrity unknown (installed 2009).
- The earthen bunds show no signs of seawater erosion, but some minor erosion is occurring adjacent the causeway due to storm water running from the upper level of the causeway and from Fowler Terrace (Figure 4:9 and figure 4:10).

Earthen bund adjacent golf course

- The earthen bund adjacent the golf course was constructed with a very wide profile and is well vegetated, and showing no evidence of deterioration or erosion.

Figure 4:9 Evidence of stormwater erosion at the causeway entrance adjacent the caravan park bund

Photograph: M. Western (2015)

Figure 4:10 Minor erosion of the caravan park bund due to stormwater flows

Photograph: M. Western (2015)

*Note the example of the storm water pipe with tidal flap to allow rain water to drain from within the caravan park.

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

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

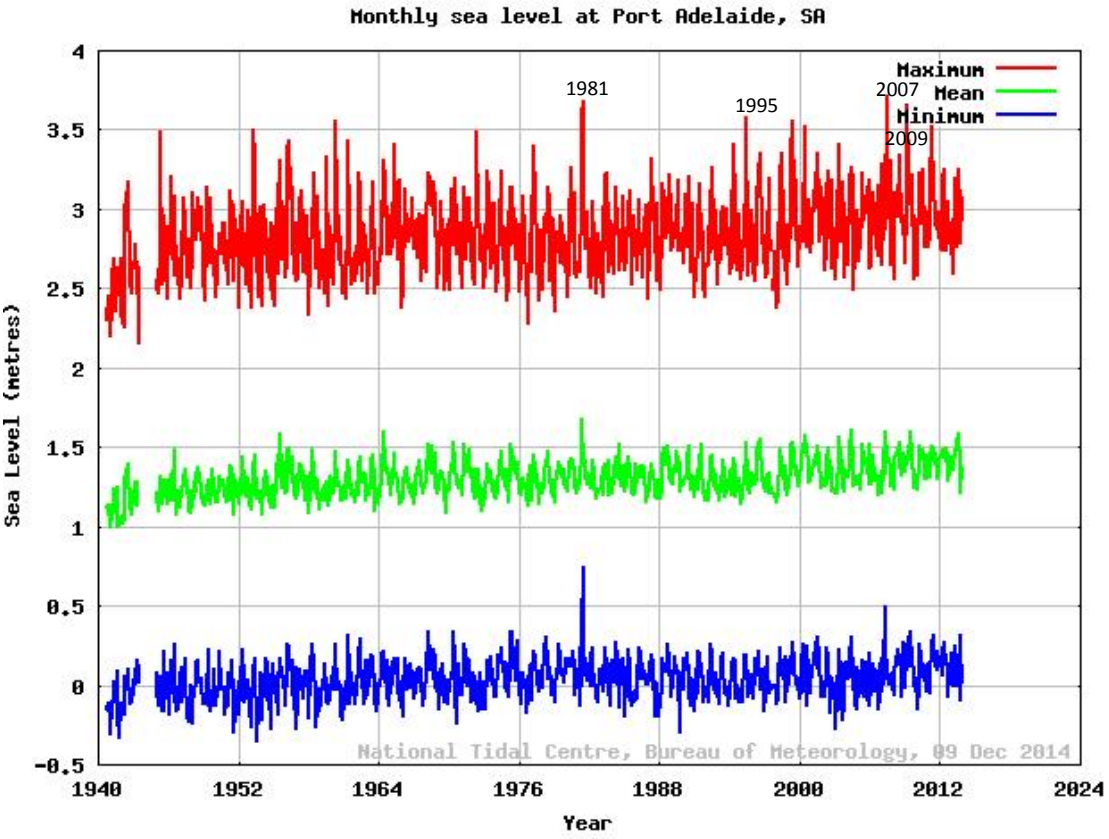
- What sea-flood events have occurred in the past?
- What is the nature of the wave action in sea-flood events?
- What wind direction accompanies high water events?

What sea-flood events have occurred in the past?

The request for quote for this study states, 'Price settlement is located in a flat area. The Council owned caravan park is subject to seawater flooding causing damage to assets and emergency response and the causeway is showing signs of erosion'. The scoping study undertaken by Civil and Environmental Solutions notes that 'Council officers have observed that the high tide inundates the causeway approximately 10-12 times a year by up to 300mm and during these time the tide extends up to the existing playground on the foreshore reserve within 50 m of Fowler Tce'[15].

Flood events in Gulf St Vincent

The tidal record at Port Adelaide since 1940 is represented by Figure 4:11:



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

[15] Civil and Environmental Solutions (2014).

The four highest recorded flood levels at Port Adelaide since 1940 are:

- 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 location of Price 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 Price 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 Price region.

Flood events in the Price region

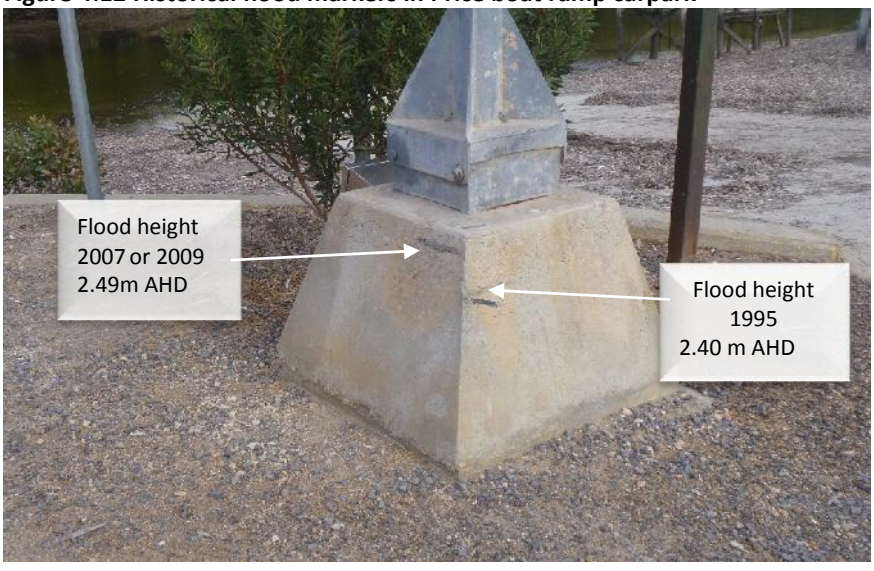
David Carty[16] has recorded the two highest flood levels that he has witnessed in Price on a light pole at the boat ramp (Figure 4:12):

- Highest water mark – his recollection was 2007 (but it may have been 2009)
- Second highest water mark - 1995[17].

These two marks have been surveyed using a surveyor and Digital Elevation Model and using the average of these two calculations[18] are likely to represent heights of:

- 2007 or 2009 event : 2.49m AHD
- 1995 event: 2.40m AHD

Figure 4:12 Historical flood markers in Price boat ramp carpark



[16] Informal interview conducted at Price boat ramp on 28th March 2015.

[17] Mr Carty recalls this was the same event that flooded Port Adelaide and that he travelled to Clinton to assist with sandbagging in that location (See Port Clinton report and pictures associated with this event).

[18] Highest marker: surveyor 2.516m & DTM 1.99m + 0.46 (measured) = 2.45m. Second marker: surveyor 2.445 & DTM 1.99 + 0.37 (measured) = 2.36m.

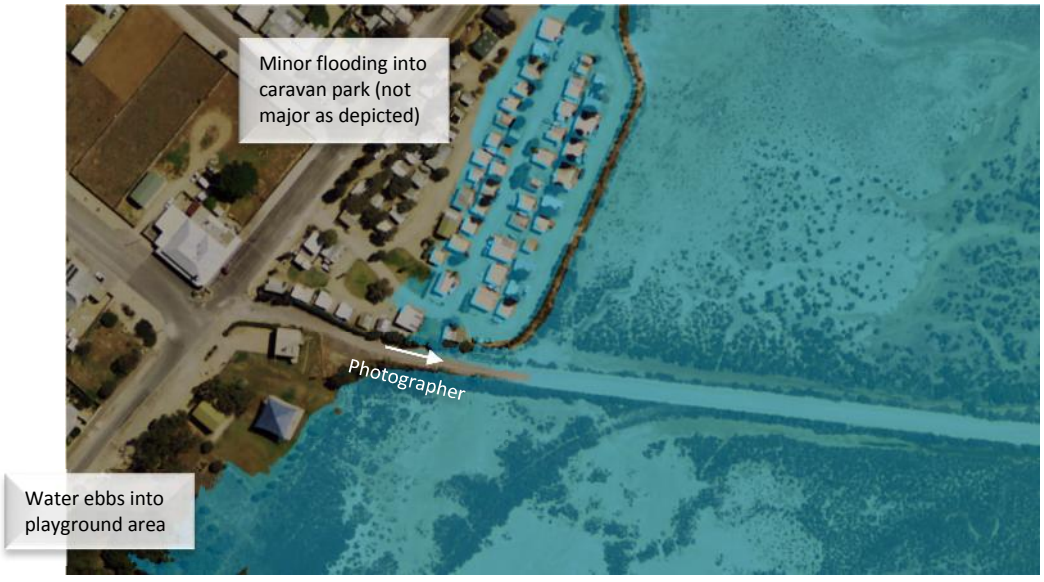
A scanned photograph provided by resident Fred Pinnington gives a visual record of the sea-water flooding event of 25th April 2009 in Price (Figure 4:13). Using the sea-flood level of 2.50m AHD, the Digital Elevation Model produces the flood pattern shown in Figure 4:14.

Figure 4:13 Sea-flooding event at Price (25th April, 2009)

Photograph: Fred Pinnington, Price Resident (2009)

A comparison between the photograph (Figure 4:13), and a description by Stephen Goldsworthy (Yorke Peninsula Council) as to how the flood waters flow into the playground area (Yorke Peninsula Council), provides some solid congruence between the recorded level and how the flood behaved on 25th April, 2009.

Figure 4:14 Depiction by DEM of sea-flood event 2.50m AHD



Digital Elevation Model flood mapping: M. Western (2015)

In the 2009 event there was minor flooding along the sides of the caravan park[19] (not major flooding as depicted using 'bucket fill' flood mapping methodology). The road has not been recently paved, although a small bund has been added to the side of the causeway road to prevent water from entering the caravan park in this location.

The community recorded no memory of any impact in the Price region of the event 4th July, 2007 nor the flood event of June 1981 (and this was true of Clinton residents as well).

Causeway flooding

The general reflection of all residents in informal interviews and in formal consultation is that the causeway floods regularly with high tides (once or twice a month). Those in informal interviews suggested that the flooding has become more regular while those in formal consultation suggested that there has been 'no change in over 50 yrs' to the causeway. On 5th May, 2015, such an event occurred and is depicted in Figure 4:15.

Figure 4:15 Flooding of the Price boat ramp causeway on 5th May, 2015

Photograph: Stephen Goldsworthy (Yorke Peninsula Council) 2015

David Carty[20] suggested that this perceived increase in tidal flooding events of the causeway may be due to the ongoing dust erosion that has decreased the height of the road rather than this being related to rising sea levels. Both of these factors may be contributing to increasing inundation of the causeway.

Mr. Carty also informed that in times past the water rose evenly on either side of the causeway, whereas subsequent to the closing up of channels to the west of the causeway, the eastern side

[19] Robert Hill (Price Progress Association) email 8th June, 2015
[20] Informal interview with David Carty on 28th March 2015.

now fills up first at a level which has been measured at 300mm higher than the western side. Once the water reaches the level of the causeway it moves to equalise.

This action of the water is beginning to scour the western side of the causeway (whereas no erosion exists on the eastern side) and over time may undermine the integrity of the road.

Figure 4:16 Example of erosion on west side of Price boat ramp causeway

Photograph: M. Western (2015)

One letter exists in Council records that addresses the flooding of the causeway. Mr. Ian Fraser (Letter 6621-2010-2) requests that a feasibility study be carried out to upgrade the causeway. He also suggests that people are deterred from using the facility due to the flooding and muddy condition of the causeway after rain. Mr. Carty was of the opinion that the boat ramp facility at Price was more important in the context of the Gulf after the classification of the waters as a marine park around Port Wakefield as it was now first boat ramp on the Yorke Peninsula that provided a good launching facility from a motor vehicle. Residents in formal consultation concurred, stating that the causeway and boat ramp facility is 'frequent and well used' (SIC).

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

The flood photographs all show that there is no wave action in the vicinity of the Price settlement. Residents in formal consultation confirmed that the water is 'always calm' in the Samphire flat region of Price but that it 'can be rough out at sea'.

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'.

4.2.4 What rain flooding events that have occurred in Price?

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)[21]. 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.

Residents in formal consultation did recall that a large rain storm event occurred in Price in 1989 which resulted in flooding of houses in the lower portion of Price (see example Figure 4:17). Subsequent to this event the Price Progress Association installed a bank to Bowden Street to divert water to the north east and there has been no significant storm water event since 1989.

The view of residents in formal consultation was that water does pool in the lower areas of Price after significant ran events at either end of Fowler St (which acts as the esplanade road). Water collects adjacent the caravan park before flowing out between two bunds to the samphire flat (Figure 9), and collects at the corner of First St and Fowler Tce before flowing under the road to empty into the samphire flat. Residents also confirmed that water pools on the road between the Price township and Cheetham Salt.

Rain water also accumulates within the caravan park but flows out to the samphire flat through pipes that have tidal flaps fitted.

Figure 4:17 Rain storm event caused flooding adjacent Fowler Tce in 1989.

Photograph: Bruce, Resident of Price (1989)

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

4.2.5 Conclusions

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

- The general topography of Price would indicate that the majority of dwellings and infrastructure are not likely to be vulnerable to flooding over the duration of this century.
- Price is not likely to be vulnerable to lateral erosion which would undermine the integrity of the settlement over longer periods of time.
- The highest level of flood water in the last 15 years is likely to have been 2.50m AHD on 25th April, 2009. This correlates with the third highest flood event that occurred in the Gulf St Vincent since 1940 (and only 5cms short of the highest event on 4th July, 2007.
- The caravan park levee was installed in 2001 at a height of 2.60m to 2.7m and increased in height in 2009 with a narrow top to 2.8m to 2.9m. The levee had never been overtopped in either form but water had entered through the sides of the caravan park.
- The causeway floods two or three times a month in winter time and appears be scouring to the western side upon equalisation between the two sides.
- There is anecdotal evidence that lower sections of the playground become inundated although the DEM modelling of the flood height 2.50m AHD demonstrates that this may be a rare event, such as the 25th April, 2009 event.
- Significant over-land flooding is unlikely due to the installation of a diversion system to the north of Price and there is no correlation between rain events and sea-flooding events which may compound the flooding problem.
- In rain events water some water accumulates on the eastern end of Fowler Tce, and within the caravan park, and also on the road between Price and Cheetham Salt.

4.3 Analyse the impact of sea-flood scenarios

4.3.1 Coastal Processes

The location of Price 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 Price 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[22] 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 in the Port Adelaide region). 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[23]:

> 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[24] 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.

[22] 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.
[23] http://www.flindersports.com.au/pdf/PtUserGuideGeneralInfo.pdf
[24] Note: the context here is Spencer Gulf, but the weather pattern described is also related to Gulf St Vincent region.

In the Price region

In the weather conditions described above, either the north-west or a west wind blows off-shore from Price. A south-west wind would blow obliquely across the region, but certainly wouldn't be 'on-shore' and therefore the storm surge events described above are always accompanied by calm water, a factor supported by residents in community consultation[25].

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 Price are shown in Table 4.2

Table 4:2 Sea flood characteristics for Price coastal region.

Flood characteristic	Price 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 friction of 2.2kms of mangrove and samphire
Direction of water	From the east (water fills the area on the northern side of the causeway first)
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[26]

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

[25] 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.

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

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 Price region in dealing with potential flooding from the sea.

4.3.3 Likely impacts in selected sea-flood scenarios

What is the likely impact on Price of a 2.8m 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 2.8m AHD flood to Price, 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 4:18 Flood mapping for sea-flood scenario 1 in 100 ARI event of 2.8m AHD (2015 scenario).

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 2.8m AHD are listed in Table 4:4 below.

Table 4:4 Location and nature of breaches (Sea-flood scenario 2.8m AHD, 2015)

Location	Location and nature of breaches	Notes	Depth Of water over defences	Depth At foreshore (or inside defences)	Depth Over road (Fowler Tce)	Depth Northern side of Fowler Tce
Golf and Oval Section	Water unlikely to over-top the existing bund adjacent golf course.		0 m	NA	NA	NA
Caravan Park Section	The bund protecting the caravan park would be overtopped in places. The integrity of the upper bund may be also called into question.		0.0-0.1 m	0.7 m At deepest adjacent bund	0 m	0 m
Community facilities Section	The grassed community area would be inundated with water that would almost circle the existing play equipment at low depths of water.		NA	0.3–0.4m At edge of grassed area	0 m	0 m
Road between Price and Cheetham	Unlikely to be flooded		NA	0 m	0 m	0 m
Cheetham Salt	Unlikely to be flooded		0 m	0 m	0 m	0 m

Causeway and boat ramp area.

Location	Height AHD	Depth of water
Causeway (at line of caravan park bund)	2.50	0.3m
Causeway - centre	1.90	0.9m
At boat ramp	2.00	0.8m

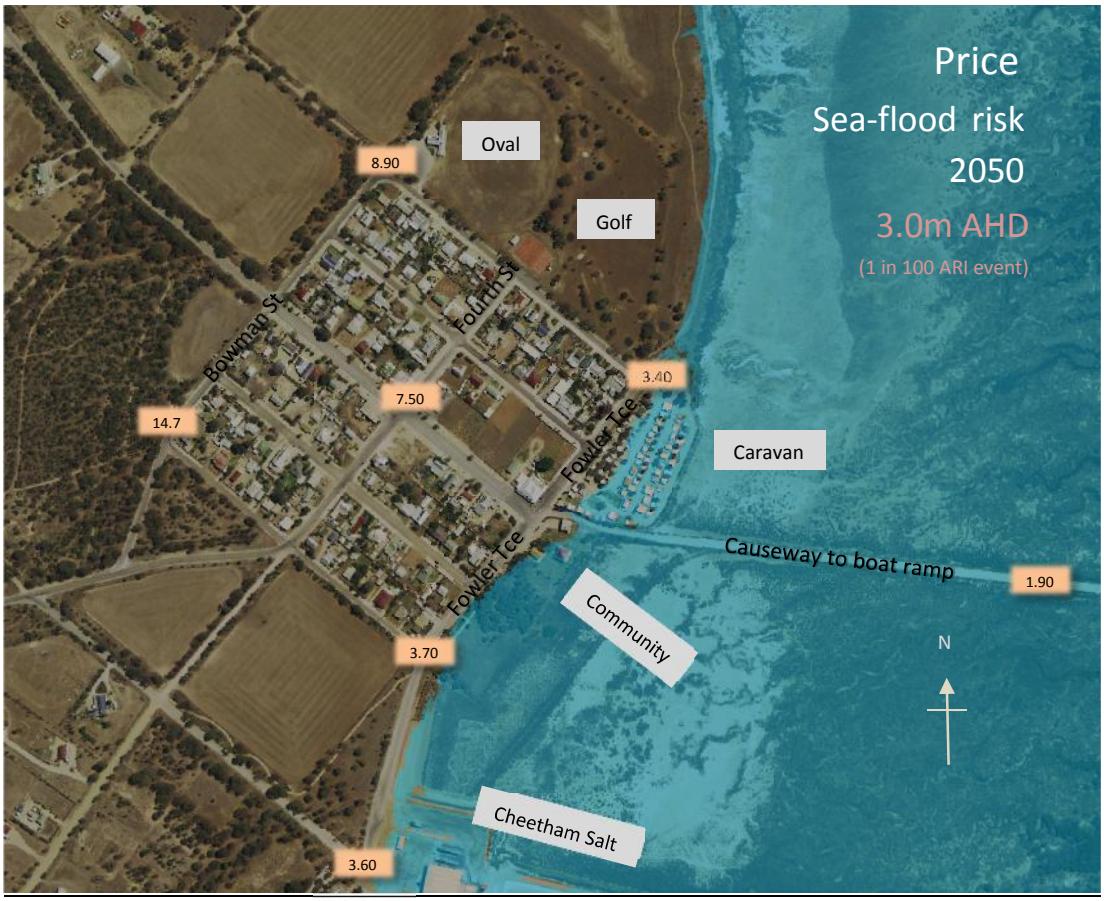
Note: The areas of main breaches have been identified above, but water traverses quickly in all directions and would inundate entire areas uniformly, irrespective of the location of the breach.

What is the likely impact on Price of a 3.0m 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 3.0m AHD flood to Price, 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 4:19 Flood mapping for sea-flood scenario 1 in 100 ARI event of 3.0m AHD (2050 scenario).



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 3.0m AHD are listed in Table 4:5 below.

Table 4.5: Location and nature of breaches (Sea-flood scenario 3.0m AHD, 2050)

Location	Location and nature of breaches	Notes	Depth Of water over defences	Depth At foreshore (or inside defences)	Depth Over road (Fowler Tce)	Depth Northern side of Fowler Tce
Golf and Oval Section	Water unlikely to over-top the existing bund adjacent golf course.		0 m	NA	NA	NA
Caravan Park Section	The bund protecting the caravan park would be overtopped along its entire length. The integrity of the upper bund may be also called into question.		0.1-0.3m	0.9 m At deepest adjacent bund	0 m	0 m
Community facilities Section	The grassed community area would be inundated with water that would almost reach Fowler Tce. Depth of water around the play equipment <0.3m		NA	0.5–0.6m At edge of grassed area	0 m	0 m
Road between Price and Cheetham	Unlikely to be flooded	However car and truck parking area would be flooded	NA	0 m	0 m	0 m
Cheetham Salt	The Cheetham Salt bund on north side would be overtopped in places.		0-0.2 m	1.1 m in salt pan area. Up to 0.9m adjacent building	0 m	0 m

Causeway and boat ramp area.

Location	Height AHD	Depth of water
Causeway (at line of caravan park bund)	2.50	0.5m
Causeway - centre	1.90	1.2m
At boat ramp	2.00	1.0m

Note: The areas of main breaches have been identified above, but water traverses quickly in all directions and would inundate entire areas uniformly, irrespective of the location of the breach.

What is the likely impact on Price of a 3.7m 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 3.7m AHD flood to Price, 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 4:20 Flood mapping for sea-flood scenario 1 in 100 ARI event of 3.7m AHD (2100 scenario).

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 Price is depicted in Table 4:6.

Table 4.6: Location and nature of breaches (Sea-flood scenario 3.7m AHD, 2100)

Location	Location and nature of breaches	Notes	Depth Of water over defences	Depth At foreshore (or inside defences)	Depth Over road (Fowler Tce)	Depth Northern side of Fowler Tce
Golf and Oval Section	Water would over-top the bund on the north end but unlikely to flow back into Price settlement.		Varies: 0.1m - 0.6 m	Varies: < 0.5m	NA	NA
Caravan Park Section	The bund protecting the caravan park would be overtopped along its entire length. The integrity of the upper bund may be also called into question.		0.8- 1.0m	1.6 m At deepest adjacent bund	0.2 m – 0.3m	0 m
Community facilities Section	The grassed community area would be completely inundated with water which would flow over Fowler Rd. Depth of water around the play equipment <1.0m		NA	1.2–1.3m At edge of grassed area	0.2 m	0.2m – 0.6m
Road between Price and Cheetham	Flooded for its entire length		NA	1.0 m	0.2m – 0.4m	0.3 m
Cheetham Salt	The Cheetham Salt bund on north side would be overtopped for its entire length.		0.7m - 0.9 m	1.8 m in salt pan area. Up to 1.6m adjacent building	0.3m - 0.4m (at entrance to Cheetham)	0.1 m

Causeway and boat ramp area.

Location	Height AHD	Depth of water
Causeway (at line of caravan park bund)	2.50	1.2m
Causeway - centre	1.90	1.9m
At boat ramp	2.00	1.7m

Note: The areas of main breaches have been identified above, but water traverses quickly in all directions and would inundate entire areas uniformly, irrespective of the location of the breach.

4.4 Analysis of emergency egress and access

For reasons outlined in the introduction (p. 10) an analysis of emergency egress and access issues for the 3.0 m 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 Price area (Table 4:7).

Table 4:7 Sea flood characteristics for Price coastal region.

Flood characteristic	Price region
Depth of water	Over Fowler Tce : 0.0
Velocity of water	Low, due to tidal action and ocean terrain
Wave action	Minimal due to depth of water and friction of samphire and mangrove habitats
Direction of water	From the east
Duration of flood	Short 1-2 hours
Warning	Predictable as the flood will relate to tide.

In 3.0 m AHD flood event (Scenario 2050) could residents move away from the source of flood and move to a safe place?

The combined factors of the grid pattern of streets in Price and the elevation of Fowler Tce (which acts as the esplanade road) will allow easy movement away from the flood source. Fowler Tce (which acts as the esplanade road) is unlikely to suffer any inundation. Anyone residing in the caravan park will only have a short walk to reach higher ground on Fowler Tce. However, anyone who remains at the boat ramp through the duration of the flood will find it difficult to move back across the causeway with water at depths of 1.2m. However, this is an unlikely scenario and any rescue would need to take place by boat.

In a 3.0 m AHD flood event (Scenario 2050) could emergency vehicles access Price?

The combined factors of the grid pattern of streets in Price and the elevation of Fowler Tce will allow easy movement of emergency service vehicles into close proximity to all locations within Price. The nature of the flood being of low velocity and duration should allow movement of personnel over the remaining short distances that cannot be accessed by vehicles. Areas most problematic would be adjacent to caravan park bund which would be at a likely depth of 1.3m. However in this flood scenario vehicle access would not be possible to the boat ramp and any rescue would need to take place by boat to that region.

4.5 A 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 Privately owned assets:

Impact of sea-flood scenarios upon assets

- Sea-flood scenarios - 2015 and 2050

Due to the elevated nature of the residential sector of Price there are no private assets deemed to be at risk from inundation in the 2015 and 2050 sea-flood scenarios, including the Wheatsheaf Hotel that has a floor level of 3.88m AHD. Privately owned caravans within the caravan park could be at risk from both sea-flood scenarios, but it is assumed that these would be removed prior to flooding.

- Sea-flood scenario - 2100

Only one building has a floor levels that would be affected by the 2100 sea-flood scenario and this building is approximately 70 years old.

Address	Depth	Age of building
3 Fowler Street	0.60m	70

Conclusions:

Due to the natural topography of Price it is concluded that the existing residential sector is not vulnerable to sea-flood inundation over the coming century.

4.5.2 Council owned assets:

Yorke Peninsula Council's assets in Price 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 Price region (see p. 45) and that these flood events are tidal and therefore short lived, qualifications are added to contextualise the risk appropriately.

Buildings (Council owned)

Table 4:8 Council owned buildings (and inundation risk assessment)

Council Assets - Buildings				**Subject to inundation**		
Specific Item	**Location**	**Street**	**Total Value**	**2015 2.8 m**	**2050 3.0 m**	**2100 3.7 m**
Price Boat Club	Pinnington Reserve	Fowler	$36,701	No	No	Minor 0.2m
Price Tramway Shed	Pinnington Reserve	Fowler	$26,714	No	No	Moderate 0.7m
Ablution Block (north)	Caravan Park	Fowler	$59,887	No	No	Moderate 0.6m
Ablution Block (south)	Caravan Park	Fowler	Not listed	No	Moderate: 0.6m	Significant 1.3m
Caretaker's office	Caravan Park	Fowler	Not listed	No	Moderate: 0.5m	Significant 1.2m
Cabin (north)	Caravan Park	Fowler	Not listed	No	No	No

Contextualisation notes:

The outlook for Council owned buildings 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 in a sea-flood event of short duration and the caretaker's residence could be easily located.

It is acknowledged that all building assets would be obsolete by 2100 and the risk assessment is given to assist with forward planning of the Price settlement.

Structures (Council owned)

Table 4:9 Council owned structures (and inundation risk assessment)

Council Assets - Structures				Subject to inundation		
Specific Item	**Location**	**Street**	**Total Value $**	**2015 2.8m**	**2050 3.0m**	**2100 3.7m**
Playground equipment	Pinnington Reserve	Fowler	$30,525	No	Minor 0.1 -0.2	Major 0.8 – 0.9
Playground Shelter	Pinnington Reserve	Fowler	$40,915	No	No	No
BBQ shelter	Pinnington Reserve	Fowler	$5,671	No	No	Moderate 0.6m
Jetty	Wills Creek boat ramp		$29,500	Yes	Yes	Yes
Shelter 1	Wills Creek boat ramp		$3,832	Yes	Yes	Yes
Shelter 2	Wills Creek boat ramp		$5372	Yes	Yes	Yes

Contextualisation notes:

The outlook for Council owned structures in the foreshore region is positive to 2050 with only minor inundation likely of the playground area.

The structures in the boat ramp area will suffer major inundation. However, the jetty has been constructed as a floating structure and is unlikely to suffer any damage in the short term.

It is acknowledged that all structures would be obsolete by 2100 and the risk assessment is given to assist with forward planning of the Price settlement.

Items not on asset register (Council owned))

Table 4:10 Items not on asset register (and inundation risk assessment)

Council asset profile				Subject to inundation		
Specific Item	**Location**	**Street**	**Total Value $**	**2015 2.8m**	**2050 3.0m**	**2100 3.7m**
Flood protection levee	Caravan Park	Fowler	-	Not	relevant	
Wharf infrastructure	Boat ramp area		-	Not	relevant	

The concrete ramp and wharf structure are not likely to be damaged by flooding, but should the area become unusable due to increase in water levels, the asset may become obsolete.

Roads and associated infrastructure (Council owned)

The DEM indicates that there will be no flooding risk to roads and associated infrastructure within the Price settlement over the next 50-60 years. The one exception is the causeway road to the boat ramp area known as Wills Creek Road on the asset register.

The value of this 1.4km stretch of 'township sheeted surface is valued at: $74,950.

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.

As previously noted (p. 31,32), due to water rising more rapidly on the eastern side of the causeway than the western side, scouring is occurring on the western side when the water overtops the road and seeks to equalise its level.

Land (Council owned)

The Council owns two pieces of foreshore land – the caravan park and Pinnington Reserve. Taking into account the nature of flooding in the area, flood damage or erosion damage is unlikely to be severe, but long term planning will need to assess the viability of assets in these locations.

Council asset profile			
Specific Item	**Location**	**Street**	**Total Value $**
Land	Caravan Park	Fowler	$340,740
Land	Pinnington Reserve	Fowler	$46,299

4.5.3 Summary:

This section provides an overall picture of the assets adjacent in the Price settlement area 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 appears to be zero. No damage is likely to Council road infrastructure in these two scenarios, and only minor inundation is likely to council buildings and structures.

However, if a 3.7m AHD event were to occur as predicted in the latter part of this century, the impact would be significant Council owned infrastructure in the foreshore region. 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 The current policy framework

Yorke Peninsula Council makes planning decisions regarding Price 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 planning 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).

Price is not designated for significant expansion in the plan and the township is not expected to experience significant population growth.

- *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 in Price?

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 Price are (Figure 4:20):

- Settlement Zone
- Community Zone (surrounding the Settlement Zone)
- Coastal Conservation Zone (in oval and golf course region)
- Mineral Extraction (in the samphire flat to the front of Price)

With this current zoning arrangement, there is no requirement for development applications to be referred to Coast Protection Board for advice (Schedule 8, Development Regulations). 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…'The policy heights recorded in the Development Plan for Price are 3.4m AHD for sites, and 3.65m AHD for floor levels.

Note: as part of this study, these policy levels have been reviewed and new policy levels adopted (see p.7)

Figure 4:20 Current land use zoning for Price overlay (Map YoP/67)

The Yorke Peninsula Council Development Plan also contains *Table YoP/4 – Design Guidelines for Coastal Dwellings* which is a six page policy document to which applicants must have regard, including those applications which are proposed for the Settlement Zone.

4.6.3 How has Yorke Peninsula Council been operating within the statutory planning environment?

Department of Environment Water and Natural Resources (CPB) reported that Yorke Peninsula Council referred one development application for review from period of 2003 to 2015, an application for a shed. Due to the fact that Council has incorporated site and building levels into its Development Plan, no referrals are required to CPB and the Council ensures that the levels are adhered to in the planning approval processes. As noted prior, the general elevation of Price means that very few sites would require any raising to comply with the requirements of the Development Plan.

4.6.4 Conclusions

The broader strategic policy outlook for Price is that it is not designated for future expansion and not expected to come under any significant population pressure. Even if population growth were to occur, there are ample vacant allotments and any future expansion is expected to be contained within the existing settlement borders. Further, and based on current sea level rise projects, the general elevation of Price indicates that it will not be threatened by actions of the sea over the coming century.

The Yorke Peninsula Council Development Plan does contain current Coast Protection Board policy and utilises the current site and building floor levels for the Price region. As part of this study, it is important to recall that these levels have now been amended in July, 2015.

Only one Development Application was referred to Coast Protection Board for advice.

4.7 Exploration of liability issues

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

Price was established in 1882 almost 100 years before there was any formal planning legislation. There was no overarching statutory requirement for those who established Price to take into account actions of the sea. Furthermore, there has been no expansion of the residential section of the settlement since its founding.

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

Table 4:11: Implementation of protection works

Works	Implemented by:	Installation Date	Planning Approvals	Responsibility
Bund to caravan park (Stage 1 – lower portion)	Progress Association	2001, when the caravan park was expanded.	Not on Development Register	Whose property? May be Council's responsibility.
Bund to caravan park (Stage 2 – upper portion)	Progress Association	2009	Not on Development Register	Whose property? May be Council's responsibility.
Mound adjacent golf course	Unknown. This location is old rubbish dump consolidated and covered over with earth.	Unknown	No.	This mound is not a coastal protection work.

Further work is required to ascertain who legally owns the bund, and whose responsibility it is to maintain.

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

Council has no records of any breaches of its protection works to the caravan park or the earthen bund adjacent to the golf course. Robert Hill (Progress Association) informs that only one incursion has occurred into the caravan park. On 25th April, 2009, water flowed into the caravan park from the sides of the park. A small mound has been implemented in these places and overall the height of the protection bund raised by 0.3m by the Progress Association.

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

There is no requirement to refer residential developments from Price to Coast Protection Board as the residential section of Price is further away than 100m from the coast measured mean high water mark on the sea shore at spring tide (Schedule 8. 1 (1) (b)). The findings of Step 5 would indicate that there is no imperative for dwellings to be referred to Coast Protection Board apart from those situated on Fowler Tce.

- **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. Note: the findings of Step 5 indicate that the residential section of Price is well protected from sea level rise inundation over the next century apart from a few sites on Fowler Tce.

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

No, and recommendations will be made in the second half of this study, but taking into account the elevated nature of Price, these may not be necessary.

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:

- Price was founded in the 1800s so the Council has no liability stemming from the founding of the settlement.
- 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. Further clarification is required as to whether planning approvals were required and obtained when the bund to the caravan park was installed (in two stages), who owns the bund, and who is responsible for its maintenance.
- 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. There are currently no plans to expand Price.

5. Community consultation report – Price (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 14th April, at which three members from Price 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.
- Water has never gone over the old train line mound (it can go through the culvert)

In relation to rainwater flooding:

- Lower area of Price is frequently affected by storm water but Council says it is the lowest section and therefore nothing can be done.
- Resident's Identified water capture and reuse potential where storm water drains from the community adjacent the caravan park.

6. Summary and Conclusion

6.1 Summary Table – Price

Stage	Question	Summary comment
1. Site history	When was the settlement founded?	1882, and no expansion of residential sectors since.
	Were climate change and sea level rise issues relevant?	No
2. Existing protection	What existing natural protection exists?	General topography of Price is elevated above sea-flood risk for residential sections.
	What breaches have occurred?	No major breaches have been recorded apart from flooding into the caravan park on 25th April, 2009.
	What man-made protection works have been installed into the settlement?	A bund (implemented in two stages by the Price Progress Association) to the caravan park. An earthen bund is located adjacent the golf course but was not implemented as a coastal protection measure and represents the location of the old rubbish dump.
3. Impact of storm events	What is the likely impact for a 2.8 m AHD event (2015 scenario)?	The defences of the caravan park would suffer minor overtopping and the park inundated. Minor inundation to community park. No roads within the settlement would suffer inundation (apart from the causeway).
	What is the likely impact for a 3.0 m AHD event (2050 scenario)?	The defences of the caravan park would be overtopped and the park inundated. Minor inundation to the community park. No roads within the settlement would suffer inundation (the causeway is the exception).
	What is the likely impact of a 3.7m AHD event (2100)?	Significant flooding of caravan park and community park. Fowler Road would likely be inundated to 0.2m.
4. Emergency access and egress	Egress issues in a 3.0 AHD event	Egress satisfactory, apart from egressing from the boat ramp area.
	Emergency vehicle access in a 3.0m AHD event.	Emergency access satisfactory, apart from accessing the boat ramp area.
5. Profile of assets at risk	How many buildings are likely to be affected in 2.8m event (2015)?	None
	How many buildings are likely to be affected in 3.0m event (2050)?	None, perhaps minor inundation of shed on western side of park.
	How many buildings are likely to be affected in 3.7m event (2100)?	1 dwelling, 1 Council owned shed, and most buildings in the caravan park.
6. Statutory policy framework	What are key development polices?	Development Plan incorporates current Coast Protection Board polices. Site and building heights for Price 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 flood risks?	A newspaper article and mail out to all residents have begun this process. Public consultation meetings will also be occasions where residents will be informed of the sea-flood risks.
	Have emergency procedures been implemented?	No, and may not be necessary.
	Were planning approvals obtained for the caravan park bund?	Further checking required.
	Is there a formal maintenance regime of protection works?	No, but staff review protection works as part of general duties as required.

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 Price 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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Yorke Peninsula Council Development Plan

Yorke Peninsula Council Strategic Plan 2012-2015

8. Appendices:

Appendix A – Community Sea Level Rise Fact Sheet

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

Appendices

Appendix A: Community Fact Sheet

Fact Sheet

Yorke Peninsula Council - **Seawater Flooding Study**

Introduction - Coastal Change

Many Australians choose to live near the sea.
Our coastline is constantly changing in ways that affect people who live near it. In some coastal areas we need to find ways of managing the risk of coastal flooding that may affect homes and properties.

Facts about rising sea levels

Evidence suggests that sea levels have been gradually rising and are predicted to rise further. Tide gauges on our coast have provided more than 100 years of information about tides and storms.

In South Australia, sea levels are estimated to have risen an average of 1.5mm per year during the 20th Century. Since 1990, sophisticated measurement stations have recorded an average rise of 4.3mm per year.

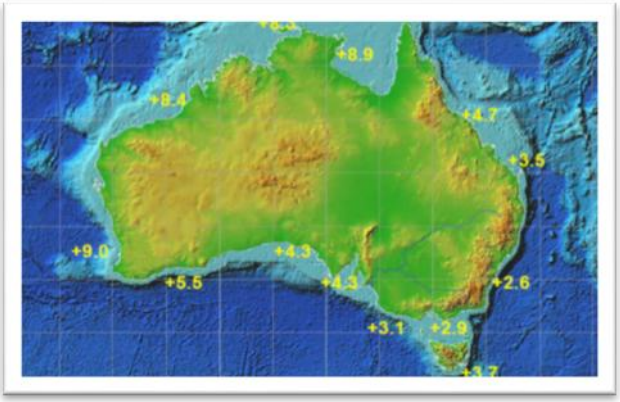
In 1991, the Coast Protection Board predicted that the sea may rise 300mm by 2050.

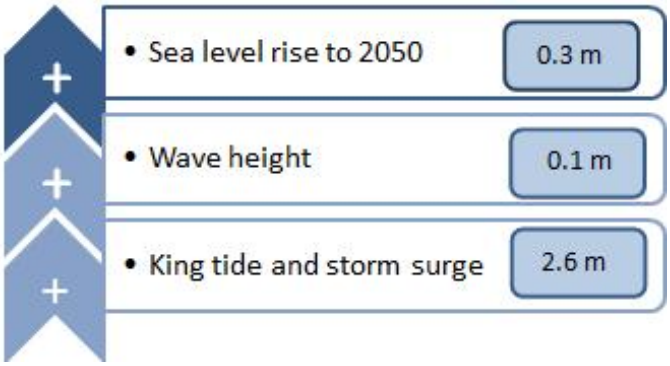
Actual sea level records suggest this prediction is likely to be realised.

Identifying the Risks

Council is leading a study jointly funded by the Commonwealth Government, Coast Protection Board and Council under the Natural Disaster Resilience Program to identify and map coastal flooding risks to local communities.

The study will identify which properties may be at risk of future flood events and will help Council and the community to plan for and manage these future risks.





There have been incidents in recent years where water threatened to overtop the levees and dunes around the gulf. One of the highest flooding events of the last thirty years occurred on Anzac Day, 2009.

Do you recall what happened in your town on that day?

Do you recall other flooding events prior to this?

But what if these flooding events had been higher as predicted may be the case by 2050? The flood map (right) shows how Coobowie may be affected in such an event. In these worst case scenarios properties are likely to be flooded. Roads into some parts of the settlements may also be flooded and emergency vehicles may not be able to access all areas.

Adapting to rising sea levels

In the Yorke Peninsula coastal region, flood defences have been designed for past conditions. In the future we may need to plan for flood levels that may be higher than they are now. Some settlements have more natural protection from flood, while others have less. Some newer coastal houses have floor levels above predicted flood levels. Some older houses may be lower than the predicted level.

Council is developing an Adaptation Plan, in consultation with the community, to respond to the risks from rising sea levels.

Find out more. Have your say. Come to a Workshop.

You are invited to participate in Council's planning for sea level rise. To help us plan, you can attend any workshop to share your knowledge of living in the area, discuss the current risks of coastal flooding, and find out about future flood risks.

Please bring your flood photos and videos!

Workshop 1 Date: 13 April 2015 Time: 1:30 PM
Venue: Port Clinton Community Hall

Workshop 2 Date: 14 April 2015 Time: 2:30 PM
Venue: Pine Point Town Hall

Workshop 3 Date: 14 April 2015 Time: 7:00 PM
Venue: Coobowie Community Hall

For more information, enquiries or feedback please contact Yorke Peninsula Council:

Telephone: 08 8832 0000
Fax: 08 8853 2494 e-mail: admin@yorke.sa.gov.au
Postal Address: PO Box 88, Minlaton SA 5575

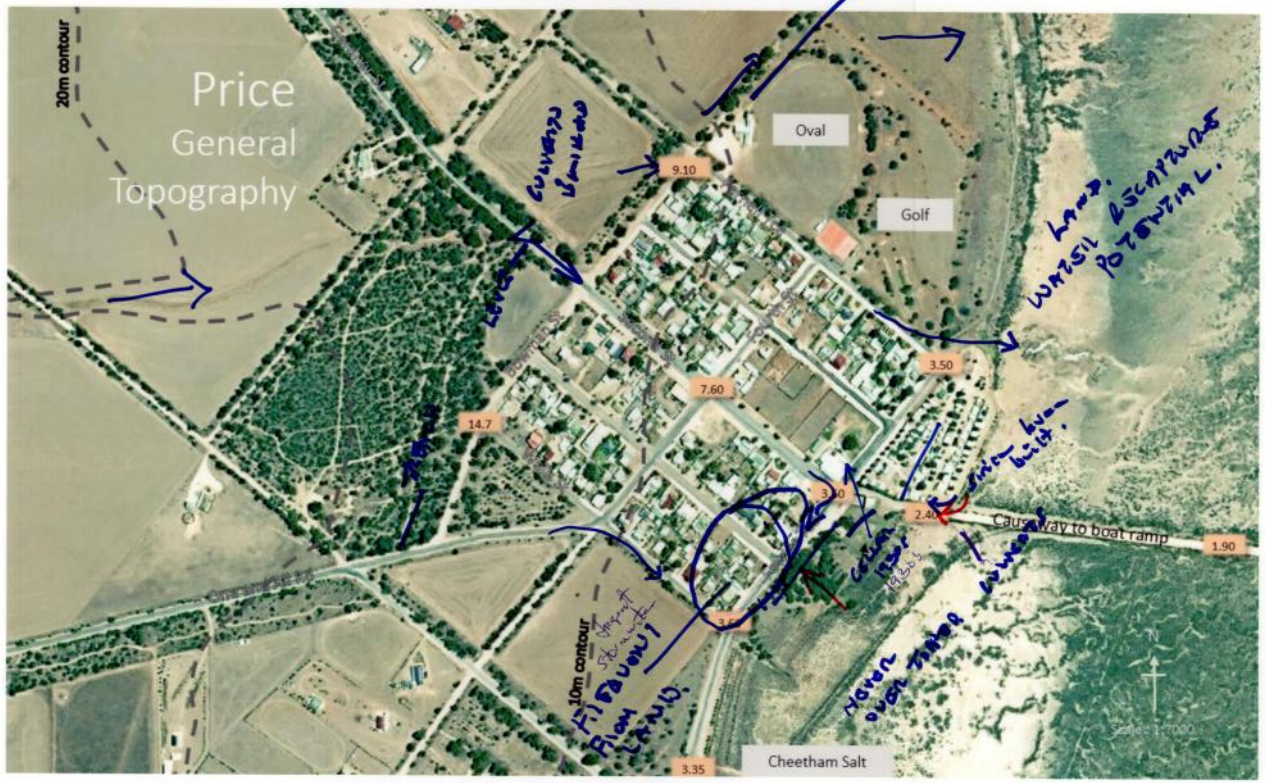
Government of South Australia
Coast Protection Board

DISASTER RESILIENT AUSTRALIA

Appendix B: Price community consultation feedback- maps with mark up from residents 13th May, 2015.

Price: 'Flood Feedback'

12th May 2015, Port Clinton Community Hall



Starter questions:

1. Where have flooding or erosion incidents occurred in the past? (Use blue pen)
2. Where do you feel your settlement is going to be most vulnerable in the future? (Use red pen)

Write any other comments on the map or use the reverse side for more room