University of South Australia

School of Natural and Built Environments

Institute for Urban Renewal

Coastal Settlements Adaptation Study

Draft Report – Stage 1 (State of Play)

Contact details:

Mark Western

mutualprojects@bigpond.com

Associate Professor Jon Kellett

Jon.kellett@unisa.edu.au

Ph: 83021701

August 2013

CONTENTS

GLOSSARY

ADAPTATION

Adaptations are actions taken to help communities and ecosystems moderate, cope with, or take advantage of actual or expected changes in climate conditions.

AHD

AHD is an acronym for Australian Height Datum. When a measurement is put with the letters AHD it indicates a height above mean sea level. For example, 3.2m AHD is 3.2 metres above mean sea level. Mean sea level was adopted in 1971 by the National Mapping Council of Australia. 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 Annual 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 on Monday, and then another one on Thursday!

DEM

DEM is an acronym for Digital Elevation Model. The digital elevation model used in this study was created from a light aircraft that sent millions of beams of light (usually infra-red) to the ground and then created a digital topographical map. This digital map is combined with aerial photography and an operator can use a computer to check the height of land features.

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 size of the waves, and the height the water is raised when pushed up the beach especially when driven by a South Westerly gale.

Introduction

1.1 Background and aim

The University of South Australia (UniSA), School of Natural & Built Environments (NBE) was commissioned by DC Mallala to undertake work on a Coastal Settlements Adaptation Study in May 2013. The aim of the study is to identify and evaluate potential sea level rise adaptation strategies for the coastal settlements of DC Mallala. The intent is to clearly define the benefits, risks and estimated costs associated with realistic and achievable adaptation options.

1.2 Focus

Previous study has been undertaken in relation to the natural ecology of the DC Mallala region (for example, Caton et al 2009; Clarke B., Simpson 2010) and some analysis has been completed of the policy framework in which DC Mallala operates to deal with coastal adaptation (Clare B., Simpson 2010; Balston JM et al (2012). However no investigation has been completed to date that relates specifically to the impact of rising sea levels on human settlements. Therefore the prime focus of this study is to evaluate how rising sea levels, will impact the human settlements of Parham, Webb Beach, Thompson Beach and Middle Beach and to suggest adaptation strategies to cope with changes in sea level. This focus does not negate the importance of how rising sea levels may impact the ecology of the region and thus the companion report, *Overview of the ecology and heritage of Parham, Webb Beach, Thompson Beach and Middle Beach,* has been completed by Robyn Rawlings as part of this study, should be read in conjunction with this report.

1.4 Investigative framework

This study uses an adaptation of the Coastal Adaptation Pathways Decision Map developed by the Local Government Association of SA and UniSA for the Department of Climate Change and Energy Efficiency (Balston et al, 2012) to identify and analyse the threats posed by sea level rise. Each settlement is reviewed within the following framework:

1. Site history and existing policy framework.
2. Existing protection – natural and manmade
3. Analysis of the impact of sea level rise.
4. Analysis of emergency access and egress.
5. Profile of the assets at risk.
6. Exploration of liability issues.
7. Determination of monetary value of assets and adaptive solutions.
8. Analysis of possible adaptation actions.

1.5 Methodology and staging

The study is conducted in three main stages:

<u>Stage 1: Evaluate the impact of rising sea levels</u> (Steps 1-6)

In this stage site the data and analysis is to be completed by:

- consultation with staff at DC Mallala Council and Coast Protection Board,
- review of existing reports and correspondence at DC Mallala and Coast Protection Board,
- review of minutes of Coastal Management Advisory Committee / Environmental Management Committee,
- inspections of the settlements and surrounds,
- analysis of flood mapping and evaluation of settlement topography,
- collection of housing and infrastructure data,
- physical survey to validate data.

The findings of Stage 1 are within this report.

Stage 2: Consultation phase

Subsequent to completion of the 'State of Play' report is the consultation phase where others are invited to contribute to the report. Members of the community serve as a valuable source of information about the history of interaction between the ocean and the settlements that cannot be found in any other place. Long standing Council workers or those who have served on committees such as the Coastal Management Advisory Committee or residents who have lived in the coastal settlements will be able to add to this report, as well as offer corrections to the findings where appropriate. Therefore this report should be viewed as a work in progress and a starting point for the collection of a repository of local knowledge.

Stage 3: Adaptive solutions proposed (Steps 7,8)

The findings of the consultation phase will be used to inform the 'State of Play' report as well as the formulation of adaptive solutions. There are five broad ways a Council 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, 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.

Keeping this framework in mind may assist the reader in understanding why certain data is collected and analysed in this first stage of the project.

2. Investigative Framework

The purpose of this section is to explain the rationale and methodology for the investigation. A fuller explanation is found within the PowerPoint© presentation, *Dealing with the impacts of sea level rise on coastal assets* (Western, Kellett 2013).

2.1 Site history

2.1.1 Rationale

The first step is to evaluate the history of the settlement and how the settlement is currently protected from actions of the sea. A history of the founding of the 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 over time. An older settlement such as Parham will have less available documentation than Thompson Beach which was settled more recently.

2.1.2 Assessment questions

- When was the settlement established?
- What account was taken in relation to potential impacts from the sea?

2.1.2 Methodology

- Document review of DC Mallala and Coast Protection Board records relating to the founding of the settlements.
- Review policies relating to climate change, in particular, rising sea levels.

2.2 Analysis of existing protection - natural and man-made

2.2.1 Rationale

Protection can be afforded a settlement in two ways: natural land forms and man-made protection works, such as a levee. There are two reasons for paying particular attention to manmade protection works:

<u>Reason 1:</u>

The original development application and conditions of approval for the settlement and/or the implementation of protection works will provide information on the science that was utilised, the options considered, the rationale for the adopted approach, and the engineering specifications used in the construction of the works. Additionally, any conditions of approval relating to the ongoing maintenance of the protection works will be more easily identified. A review of subsequent Council records and correspondence will inform whether the protection works have been breached or repaired, or whether the council has fulfilled its maintenance obligations over time.

Reason 2:

A review of policies and cases around the world (Balston et al, 2012) found that there was the potential for increased liability for Councils where protection works have been implemented. Therefore, to review the circumstances of the implementation and historical performance of the existing protection works, and whether any maintenance obligations have been fulfilled will help inform the question of current and future responsibilities for council and landowners. .

2.2.2 Assessment questions

- What existing natural protection exists in the settlement?
- Have the protection works ever been breached?
- Have any man-made protection works have been installed?

2.2.2 Methodology

- Document review of DC Mallala and Coast Protection Board records relating to implementation of protection works.
- Site inspection to review protection to the West and East of the settlements, and dune protection approximately 1km North and South of the settlements.
- Evaluation of topography using a digital elevation map (DEM) to ascertain heights of existing natural land forms and manmade protection works.

2.3 Analysis of impact of predicted sea level rise.

2.3.1 The problem with climate change predictions

Much has been written at an international, national, and state level about the predicted effects of climate change upon human settlements. These predictions range more broadly from decreased rainfall overall, increased incidents and intensity of storm events, and increased incidents and intensity of heatwaves. In coastal regions, there are predictions of increased sea level, increased coastal flooding, beach and dune erosion, changes to ground water, changes to run-off patterns (Caton 2007), and possibly altered wave climates (Caton et al 2009: p. 119). All of these factors will impact the ecology of the coastal environment and long term viability of coastal settlements. For example, decreased rainfall may deplete vegetation growing within a dune system, with the result that the dune becomes more vulnerable to erosion from the sea. While all of these predictions are based upon current science the 'level of uncertainty of climate change projections makes it difficult for Local Governments to prioritise their commitment to adaptation' (Department of Climate Change, 2009a; p.1). Therefore, in this study the main criterion to evaluate each settlement is, predicted sea level rise, and as a secondary factor, erosion. The review of the erosion factor is assessed primarily by identifying places where erosion is already taking place.

This does not infer that other matters are less important but confining the study to one main criterion provides the ability to apply a more simple and certain filter that may then inform where further evaluation of other factors is required. For example, the Environmental Impact Assessment for the Thompson Beach approval process identified the possibility of flooding from the Light River in a major rain event. While there hasn't been any event where rain has

been a significant factor in 25 years, this does not mean this factor should be completely discounted in a future study.

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

Historically planners have evaluated potential threats to infrastructure from 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, this being unique to each coastal location due to differing sea floor level formations and wind intensity and direction. This calculation is illustrated in Figure 1:

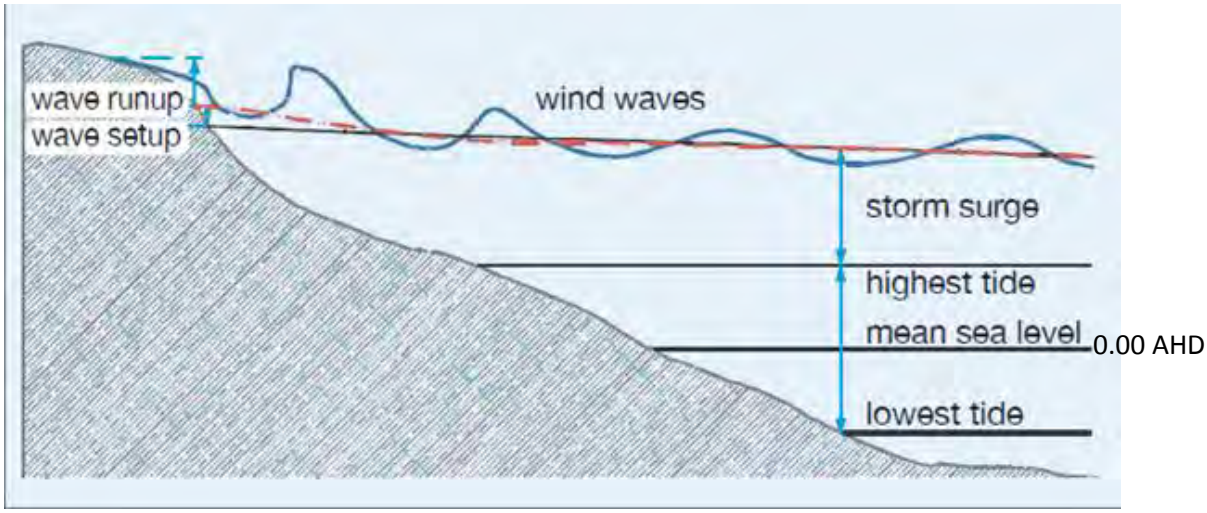


Figure 1: A storm surge at highest tide will produce increased wave setup and will wash further up the beach creating a higher tidal action on the coast.

Water levels are expressed in terms of Australian Height Datum (AHD) which is 1.45m lower than predicted tide charts (Chart Datum). The following diagram further explains the established methodology that planners utilise to ascertain appropriate planning heights for development in coastal regions (Figure 2):

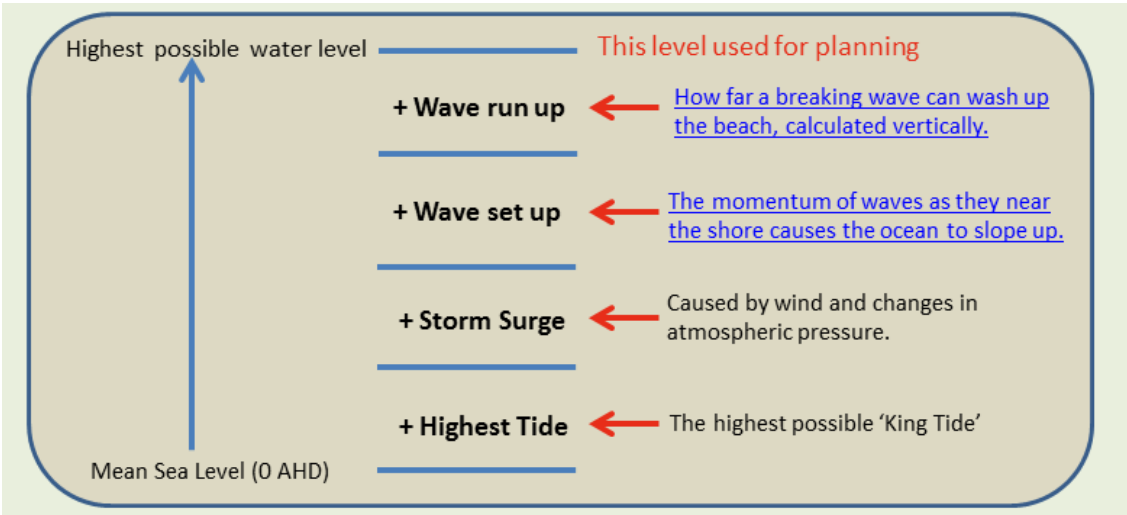


Figure 2: Adding up the height of each component of the storm tide gives the highest probable water level.

Specifically in relation to DC Mallala coastal regions South Australian Coast Protection Board utilises the following calculations for the 1 in 100 Annual Return Event[1]. Acting under the Development Act 1993, the Council is required to refer any development to the Coast Protection Board and can rely on the SA Coast Protection Board's advice.

Table 1: 1 in 100 ARI storm event – DC Mallala Coastal region

Storm surge (at king tide)	2.6m AHD
Wave set up	0.1m AHD
Wave run up	0.0 m AHD
Total	**2.7m AHD**

Wave set up and wave run up is low in the DC Mallala coastal region due to the very slow incline of the sea floor. In places where the incline is sharper, the wave set up and run up is usually higher.

2.3.3 Predicted sea level rise

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

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

Therefore taking into account the specifics of the coastal region of DC Mallala the planning benchmarks are:

Table 2: 1 in 100 annual return event, with sea level rise predictions provide the planning benchmarks for DC Mallala.

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

2.3.4 Actual sea level rise

Since 1990, two sophisticated gauges at Port Stanvac south of Adelaide, and at Severnade 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

[1] ARI is an acronym for Annual 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 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 remember that the ARI calculation is a probably event based on historical observations and there is nothing preventing two or even three 1 in 100 ARI events within days or weeks of each other. However, this factor does not negate that utilising ARI calculations is the standard method of calculating risk.

has been 4.3mm per year (Figure 3). 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 1.5mm per year.

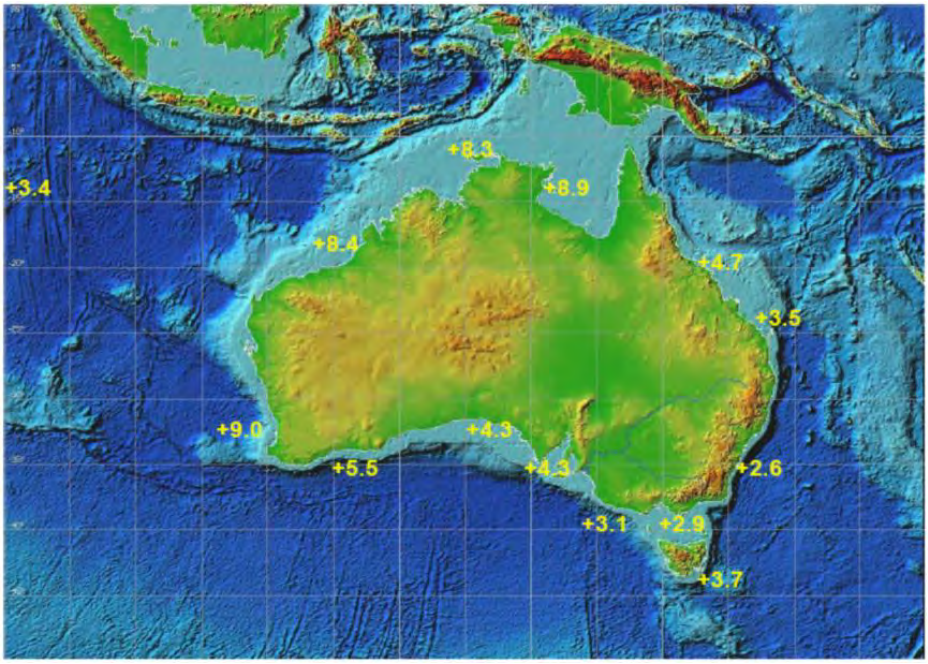


Figure 3 – Sophisticated gauges at Severnade and Pt Stanvac have recorded an average of 4.3mm per year since 1990 (Bureau of Meteorology, 2013)

Assuming that the rate of sea level rise remains reasonably constant until 2050, a simple multiplication of 4.3mm x 60 years suggests an increase in mean sea level of 258mm which is not too far away from the SA Coast Protection Board's prediction of 300 mm (0.3m). In the longer term, the prediction of 1.0 m sea level rise by 2100 assumes that the sea level will rise more rapidly in the second half of this century.

2.3.5 Which sea level rise scenario?

It is proposed in this study to primarily utilise the storm surge and sea level rise event calculated for year 2050 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 good degree of confidence in the predictions 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.
- 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.
- Logically, it makes sense that if a settlement is under threat at 2050 then it will be under greater threat at 2100. Conversely, by using the 2050 yard stick it may be ascertained that a settlement is manageable until 2050 but there may be problems thereafter, so, planning mechanisms could be employed to cater for those threats.

In summary, using 2050 as the main focus of this study will provide a pivotal point upon which to assess settlements against both the shorter term and longer term. There are three possible outlooks for a settlement using predicted sea level rises at 2050:

(1) Settlements that are not threatened at 2050 and have minimal threat at 2100.
(2) Settlements that have minimal threat at 2050 but face increased threats by 2100.
(3) Settlements that are threatened at 2050 and therefore face severe threat by 2100.

In the case of outlooks (1) and (2) time is a 'friend' because planning mechanisms can be instituted to cater for new dwellings and replacement dwellings. Settlements with outlook number (3) may require more immediate attention.

Finally, the one in hundred ARI event to be utilised in 2013 may be calculated by incorporating the amount the sea has risen since 1990.[2]

Table 3: Sea flood scenarios for DC Mallala coastal region.

	2013	**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	0.1m	0.3m	1.0m
Totals	2.8m AHD	3.0m AHD	3.7m AHD

Recent storm events on 25th April, 2009 and 4th July, 2007 provide some context to the assessment. The storm event of both of these events was at an approximate height of 2.4 to 2.50m AHD[3]. On the annual return interval (ARI) scale, this event represents a 1 in 20 ARI event (Rob Tucker, Coast Protection Board, interview 13.08.13).

2.2.2 Assessment questions

- What is the likely impact on the settlement for a 2.8 m AHD event (2013)?
- 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)?

2.2.2 Methodology

- Use bath tub flood mapping and analysis taking in to account the natural and manmade protection systems within and around the settlements.

[2] Sea level rise since 1990 level is calculated by 4.3 average rise per year x 22 years = 95mm (0.1m)
[3] A resident in Middle Beach has a flood marker that has been surveyed at 2.48m AHD. Video of 25/04/09 shows water over the road on the Southern end by about 200mm. A check on the digital elevation map reveals an approximate flood height of 2.4m AHD. Tide height at Port Adelaide was 3.68 CD less 1.45 = 2.23m AHD event, but expected to be higher further up the gulf (M. Townsend, CPB, 13.08.13).

2.4 Analysis of emergency access and egress.

2.4.1 Rationale

The purpose of this investigation is to provide a filter through which a preliminary assessment can be made of each settlement in relation to two basic criteria:

- In the event of 3.0 m AHD flood event can emergency services access the settlement (access).
- In the event of a 3.0 m AHD flood event, can residents move directly away from the place where flooding is occurring (egress).

It is pertinent to note that due to the slow incline of the sea floor in the region that SA Coast Protection Board does not expect any flood to contain a significant velocity of water or large wave height but anticipates that the movement of water would be more tidal. Video in the flood event of 25th April, 2009 at Middle Beach (John Kneuitt, 2009), provides an example of how flood water may act in a storm event. Furthermore, the fact that any significant inundation will be related to tidal action means that potential flooding events are very predictable. In terms of managing emergency access and egress this is a positive aspect because ample warning can be given and evacuation procedures employed if necessary.

Figure 5: Screen print from Video at 29:53 by John Kneuitt, Middle Beach Resident

However, the anticipated low velocity and height of water in a flood does not imply that these events are without risk. The vulnerable of the community, the aged, disabled, or young, may be in danger, especially if an event was to occur at night. Furthermore, more damage is done to houses, roads and infrastructure as the tide recedes since the water naturally finds the easiest way back to the ocean. This factor means that the velocity may increase in unpredictable places, and also that roads near the foreshore may be eroded making them dangerous to traverse by foot or in a vehicle. 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. Emergency service vehicles are bound by operating protocols and are unable to enter flood waters. (Protocols under research)

2.2.2 Assessment questions

- In a 3.0m AHD flood event could residents move directly away from the place where flooding is occurring and move to a safe place?
- In a 3.0m flood event could emergency vehicles access the settlements?

2.4.2 Methodology

- Review each settlement to ascertain if residents are able to move away from the head of the flood to ground that is at least 3.0 m height AHD.
- Review each settlement to ascertain if main access roads into the settlements are at 3.0 m AHD or above.
- Review the road network of each settlement to ascertain which roads are at 3.0m AHD or higher.

Due to the fact that anticipated flood events will be related to tidal movements and therefore of a predictable duration, such events may not reach inland at 3.0m AHD and therefore some leeway to the heights of access roads may be acceptable. On the other hand, the immense volume of water in the sea would mean that a prolonged event would probably inundate most areas indicated on the flood maps.

2.5 Establish profile of assets at risk

2.5.1 Rationale

The purpose of this step is to identify all the assets at risk from sea level rise and categorise them as:

- Privately owned – eg. Houses, land.
- Council owned – Roads, shelters, public toilets, playgrounds and equipment.
- Owned by others – eg. Telstra, SA Power Networks, SA Water.

In relation to infrastructure such as houses, depth of water over floor levels 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 to estimate potential flood damage utilised by the insurance industry. This estimation is undertaken using a flood/damage curve such as the one illustrated below. How the flood damage curve is utilised will be incorporated into the Stage 2 report.

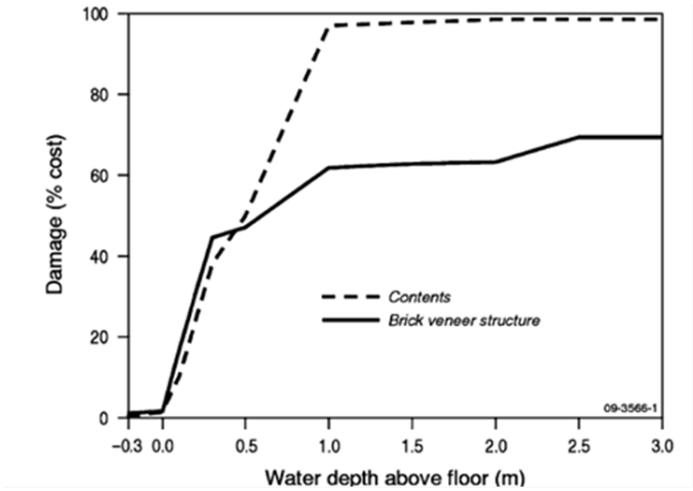


Figure 6: Flood / damage curve (Source: Dale, K et al,2004).

2.5.2 Methodology

In relation to privately owned assets the methodology was to:

- Use a cadastral map and record whether the site is vacant or occupied.
- Use a digital elevation map (DEM) to pinpoint the land in front of the building to ascertain how high it is above mean sea level (AHD).
- Conduct a site survey of all dwellings and record into a spread sheet
    - Estimated height of finished floor above ground level in front of house.
    - Single or double storey
    - Type of construction – brick, lightweight construction, transportable.
    - Type of foundation – concrete, stumps, poles.
- Assess finished floor levels against 3.0m AHD flood height to ascertain potential flood depth over finished floor levels.
- Use data from the DEM to provide elevation data of the road in front of all allotments within settlements.
- Validate these data using surveyed measurements carried out by qualified professional surveyors on a sample of sites.

In relation to Council assets:

- The Council provided a list of assets.

In relation to other owned assets:

- Infrastructure maps were obtained from relevant authorities.

2.6 Exploration of liability issues.

It is important to recognise that this section is designated an 'exploration' rather than as definitive legal advice (See Appendix 1 for further explanation). Where there is any doubt about particular circumstances, these should be referred to the Council's legal advisors[4].

2.5.1 Rationale

The following questions are relevant:

- **In what way can councils 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 to that asset from its owners. If liability has not been clearly established such claims may result in legal action where both the Council and the land owner 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 or not. 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.

- **In what ways can 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.

<u>Administrative Appeals</u>

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 are not properly catered for; or when Councils make amendments to the Development Plan that may restrict the types of development 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 to date are administrative appeals (Australian Local Government Association, 2011).

<u>Tort based claims</u>

There are two types of tort based claims where Council can be liable to pay damages: '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'. The only case to date is Byron Shire Council v Vaughan in NSW.

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

Legal defences

In common law, the defence of 'voluntary assumption of risk' provides that there will be no liability of the defendant 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.

In relation the allocation of resources, a council's resources are limited and the allocation of resources cannot be challenged in court. Therefore, while there might be protection works that may be implemented in theory, in the disbursement of the council budget, they may not be able to be implemented and the fact of limited resources is not capable of being challenged.

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

- It is unlikely that an action might 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 factor. 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 have a defence that they have upheld a duty of care.
- Finally Councils that have emergency action plans for their residents accomplish two things: 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.

At what points is the council weak 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 they have not advised their residents of the risk or do not have emergency action plans to deal with possible risk.

Summary

In 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, having no legal liability does not mean that the Council does not necessarily take any action to implement protection works and strategies. However, these actions need to be implemented carefully with public awareness strategies that do not impede the Council with new sets of liabilities.

2.6.2 Assessment Questions

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

2.6.2 Methodology

- Review site history and documents relating to the establishment of settlements (where available).
- Ascertain under which Act of Parliament the settlement was approved and what obligations were placed upon Council at the time (if available).
- Review documents relating to the implementation of any protection works.
- Analyse whether legal liability exists (get external advice)
- Analyse the potential for political liability.
- Analyse the nature and extent of warnings which Council has given to residents in relation to any potential threats from actions of the sea.

3. Existing policy context

The broader environmental policy context is described in Robyn Rawlings (2013), *Coastal Settlements Adaptation Study– Overview of ecology and heritage of Parham, Webb Beach, Thompson Beach and Middle Beach* (p. 8,9). Clarke and Simpson (2010, p. 186-197) have reviewed the policy and decision making context of District Council of Mallala and produced a summary table. The table notes that two committees support the decision making of the Council: Coastal Advisory Committee and Mallala Greening Committee (now Environmental Advisory Committee).

Table 18.1 List of Interrogated Documents from the District Council of Mallala

	Type of Document
Policy 3.1 Vegetation Management 2007	Policy (B)
DC of Mallala Development Plan	Policy (SLR)
Draft Samphire Coast Conservation Strategy	Strategy
Uncategorised Documents	
Coastal Advisory Committee Terms of Reference 18 Feb 2008	ToR
Greening Committee Terms of Reference	
Coastal Advisory Committee Agenda 19 January 2010	Agenda
Greening Committee Minutes 12 October 2009	Minutes

Annotation for the list of interrogated documents from Mallala Council:
(B- Biodiversity, SLR- Sea Level Rise, ToR – Terms of Reference).

The main overarching policy document that deals with environmental issues as well as development issues is the DC of Mallala Development Plan. The existing policy context is detailed in Table 4:

Table 4: Policy context for coastal development within DC Mallala Development Plan

Objective or Development PDC	Mallala District Council Development Plan
Council Wide	
Development to be located and designed that can be reasonably protected against tidal and/or stormwater flooding and probably sea level rise.	Objective 58 (p.51)
Development that can accommodate anticipated changes in sea level due to natural subsidence and probable climate change during first 100 years of development.	Objective 73 (p. 33)

Development which will not require public expenditure on protection of the development of the environment.	Objective 74 (p. 33)
Development not located in environmentally sensitive coastal features such as sand dunes, cliff tops, wetlands, or important native vegetation.	Control 259 (p.71)
Development should not be undertaken where it will create or aggravate coastal erosion, or where it will require coast protection works which cause or aggravate coastal erosion.	Control 261 (p.71)
Development should not preclude the natural geomorphological and ecological adjustment to changing climate, sea level or other conditions (e.g. the landward migration of wetlands, dune drift).	Control 268 (p. 72)

Hazard Minimisation	**Mallala District Council**
Development should be protected against the standard sea-flood risk level which is defined as the 1 in 100 year average return interval flood extreme sea level (tide, stormwater, wave effects combined) plus an allowance for land subsidence for 50 years.	Control 284 (p. 75)
Commercial, industrial, or residential development and associated roads and parking should be protected from sea level rise by ensuring that the following levels are maintained above the standard sea-flood risk level:	Control 286 (p. 75): (a) building floor-levels are at least 0.25 m above and 0.55 m above the standard sea-flood risk level), unless the development is or can be protected in accordance with control 288.
Buildings to be sited over tidal water or which are not capable of being raised or protected by flood measures in future, should have a floor level of at least 1.25 metres above the standard sea-flood risk level.	Control 287 (p.75)
Development that requires, now or in the future, protection measures against coastal erosion, sea or storm water flooding, sand drift etc. should only be undertaken if all of the following apply: (a) the measures will not have an adverse effect on coastal processes, public access, and amenity. (b) the measures will not require community resources. (c) the risk of failure of the protection	Control 288 (p.75)

measures is acceptable relative to the potential hazard resulting from their failure. (d) binding agreements are in place to cover future construction, operation, maintenance and management of the protection measures.	

The Council operates under the Development Act 1993 and Development Regulations 2008 which requires the it to refer new development in coastal zones to Coast Protection Board for 'regard' or 'direction'. Usually matters referred to for 'regard' are to do with the height 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.

Prior to January 1994, the Council operated under the Planning Act 1982 and associated regulations. The system of referral was different than the current system with matters referred to external bodies being limited to 'consideration' only.

4. Investigation of Settlements

4.1 Parham

4.1.1 Site history

- **When was Parham established?**

Parham was proclaimed a township on 27 July 1876 by the Governor, Sir Anthony Musgrave. The main reason it was founded was to act as a port. It was named after Mr John Parham who transported the first load of wool by ship from Port Parham to Port Adelaide (Now & Then – Mallala, 2013).

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

It is unknown what account was taken of impacts from the sea in the decision making process but there are no legal liabilities related to the establishment of this settlement.

4.1.2 Analysis of existing protection - natural and manmade

The following assessment of natural and man-made land forms that provide Parham with protection from the sea is to be read while viewing the companion set of maps that append this report. Heights are expressed in metres AHD but normally the acronym AHD is assumed in the context of the report.

Parham North (North of First Street)

What existing natural protection exists in Parham?

To the West:

Map 1.a Parham North- shows that this part of the settlement has the following natural landforms:

- The Esplanade Road is at a height in this location of approximately 2.20m AHD to 2.5m AHD.
- Protection from the West is provided by a dune having a maximum height of 2.4m to 2.7m between Main Street and North Tce., and a little higher between Main and First Street at 2.8m to 3.0m. Low points are noted where the dune may be no higher than 2.0m. It is likely the dune is a combination of natural and manmade features built up over generations. The levee is sparsely vegetated (See Figure 6)

Figure 6: Foreshore Parham (North) (Google Maps, 11.08.13)

- The settlement rises uniformly to the East to Driscoll Tce that is approximately at height 2.80m to 3.30m. The green band on the *Map 1.a* indicates land levels are above 3.0m AHD in these locations.

<u>To the East:</u>

- To the East of the settlement is a significant band of scrubland on a ridge of sandy soil which is well vegetated with trees and shrubs (see Figure 7).

Figure 7: Terrain to the East of Driscoll Tce in Parham (Photo: M Western, 2013)

<u>To the North (*See Map 1.c*):</u>

- *Map 1.c* shows that a dune of approximately 20-40m wide dune exists along the foreshore. The green band of colour indicates that some of the ridgeline is at 3.0m or above but some locations are at 2.5m height.

- A gully which is likely to have been mined for shell grit in the past is between the dune and the Esplanade.
- The Esplanade road is at height 2.80m in the North to 2.40m adjacent the camping ground.
- Small acre rural allotments are situated to the East generally at 3.0m and above but there is also a small ridge line of 4.0m AHD.
- There is no evidence that sea water traverses from the North to the South behind the settlement and the mudflats are likely to contain rainwater only (*See Map 1.c*).

What flooding or erosion incidents have occurred?

The following incidents have been reported to Council Depot. There may be more incidents that public consultation will add for the final report.

- On 25th April, 2009, sea water entered between the dune and the Esplanade road and travelled South to towards the camping ground. The water lay in the area for a number of weeks and vegetation was damaged, and has not recovered as yet (*See Map 1.c* and Figure 8). (Source: Keith Earl).

Figure 8: Sea water decimated vegetation in April, 2009 (Photo: M.Western, 2013)

- On 25th April 2009, sea water just overtopped the dune between North Tce and Main Street.
- On date unknown, sea water entered the camping ground. It is unknown if the water came over the walkway to the sea, or if it entered around the existing levee. (Source: Keith Earl).
- On 25th April 2009, the king tide eroded about 3m of vegetation from the coastline and this has not returned to date (See Figure 9).

Figure 9: Vegetation line receded 3m and did not return after 25/04/09 event (M Western, 2013)

While not specifically a marine flood, rain water tends to collect in the road reserves.

What man-made protection works have been installed in Parham?

Two man-made protection works exist in Parham (North):

- A shell grit levee to approximately 1m high (and at 2.80m AHD approx.) was installed between the dune and the Esplanade to halt any future sea water moving south. There have been no further incidents since 2009 (See Figure 10). Work was installed in an emergency mode but no retrospective development approval was obtained.

Figure 10: Shell grit levee on Northern end of Esplanade (Photo: M. Western, 2013)

- An existing levee joins the Dune and the Esplanade on the Northern boundary of the camping ground. This levee has been in place longer than 27 years and presumably installed to stop sea water moving from the South into the camping ground (Figure 11).

Figure 11: Levee on northern boundary of camp ground (M. Western, 2013)

Parham South (South of First Street)

What existing natural protection exists in Parham (South)?

To the West:

Map 1b - Parham South shows that this part of the settlement has the following natural landforms:

- The Esplanade Road is at a height of approximately 2.50m AHD at the corner of First Street and descends to 1.80 m AHD at the roundabout at the southern end of Parham.
- Protection from the West is provided by a dune having a maximum height of 2.7m to 3.0m. The green band of colour indicates where the dune is likely to be at height 3.0m or over. Low points are noted with some spots of the dune likely to be no higher than 2.4m. The levee is densely vegetated, especially on the southern end. Access ways to the beach are controlled by fencing (Figure 12).

Figure 12: Well-vegetated dune on Southern end of Esplanade (M.Western, 2013)

- The settlement behind the Esplanade to the East is generally low with Prime Street at heights 2.11m in the North to 1.80m in the South.
- The Esplanade culminates in a roundabout at level 1.80m (Figure 13).

Figure 13: Southern end of Parham culminates in a roundabout (M Western, 2013)

<u>To the East of Parham:</u>

- Behind the settlement to the East is a sandy ridge which is well vegetated and generally at height of 2.80m (Figure 14).

Figure 14: Well-vegetated ridge to the East behind Parham (M Western, 2013)

<u>To the South of Parham (See *Map 1.d*):</u>

- *Map 1.d* shows that between Parham and Webb Beach is a narrow foreshore dune at heights between 2.0m and 3.0m AHD and intersected by two tidal creeks (1st and 2nd Creek are their local names).
- Behind the foreshore dunes are two more substantial dunes in excess of 3m AHD.
- Behind these dunes are mudflats which are fed by the tidal creeks.
- The mudflats are enclosed by Parham settlement, Parham Point Road, and the ridge upon which Webb Beach road runs. The only point where water can exit the area is in the South East corner through a culvert under the road (*Map 1.d* and Figure 15).

Figure 15: Culvert under Webb Beach Road (M. Western, 2013)

What flooding incidents have occurred?

The following incidents have been reported to Council Depot. There may be more incidents that public consultation will add to be included in the final report.

- On 25th April, 2009, sea water broke through the shell grit levee on the roundabout at the Southern end of Parham and travelled north along the Esplanade (Figure 18).

Figure 18: Location of levee break, water entered southern roundabout (M.Western, 2013)

- On 25th April, 2009, the tide broke through the dune system about 50m to the South of the roundabout (Figure 19,20) and water travelled North East alongside the shell grit levee. Water entered rabbit boroughs in the levee at the end of Prime Street and the levee collapsed allowing water to flow down Prime at low levels with no damage recorded (Figure 21). Water entered to the rear of the two or three houses at the end of Prime Street once the water had travelled past the former levee (Source: K. Earl).

Figure 19: The tide broke through dune 50m South of Parham (M Western, 2013)

Figure 20: The tide broke through dune 50m South of Parham (M Western, 2013)

Figure 21: Water broke through levee weakened by rabbit boroughs (M. Western, 2013)

What manmade protection works exist in Parham?

Two man-made protection works exist in Parham (South):

- A shell grit levee has been installed around the southern roundabout. However, this is only 1-3 metres thick and unlikely to withstand flood events. There is a large height difference from the road (1.80m) within the roundabout to the top of the levee (3.0m approx.). There levee has no record of development approval.

- The shell grit levee at approx. 3.0m high continues from the roundabout around the rear of Parham (South) (Figure 22).

Figure 22:Shellgrit levee around roundabout, continues to rear of Parham (M Western, 2013)

- A new clay levee has been installed to the rear of Parham (South) in April 2013 at heights 3.25 to 3.15 AHD (Figure 23). Development approval was obtained.

Figure 23: New clay levee installed to rear of Parham April 2013 (Mark Western, 2013)

- The new clay levee joins the natural ridgeline to the East of Parham (South) which provides a significant degree of protection to the South and East of Parham (see Figure 24).

Figure 24: Natural ridgeline to East of Parham joins newly installed levee (M. Western, 2013).

4.1.3 Analyse the impact of sea level rise

<u>What is the likely impact on the settlement for a 2.8m AHD event (2013)?</u>

The following issues would be likely in Parham if such an event were to occur for a significant length of time (See concept at Figure 25):

- The dune/levee system to the West of the Esplanade (North of First Street) would be severely overtopped and inundate the Esplanade and properties to the East.

Figure 25: Possible flooding pattern of Parham North in 2.8m event of significant duration

- The dune/levee system to the West of the Esplanade (South of First Street) may withstand a 2.8m event as this area is well vegetated and generally at heights 2.8m to 3.0m.
- The shell grit levee on the southern roundabout is likely to be high enough but may not be thick enough to withstand the pressure of water.
- The newly constructed clay levee from the south of Parham that joins with the natural ridge to the East of Parham would withstand this event.
- The shell grit levee at the Northern end of the Esplanade may be vulnerable due to its loose constituency.

What is the likely impact on the settlement for a 3.0m AHD event (2050)?

The flood maps (See *Maps 1.a to 1.d*) illustrate the impact of a 3.0m flood event. The methodology utilised is known as 'bathtub' modelling and takes no account of land forms, man-made or otherwise. Bathtub modelling also does not take into account that the water is tidal and moves in from the West and then recedes within a time frame of about 2 hours. Therefore, while some roads and properties may be lower than the 3.0m event, the water may not encroach this far into the settlement especially if the time of inundation is short.

Irrespective of these factors, the following assessment can be made about Parham's vulnerability in a 3m event (See concept at Figure 26):

Within the Parham settlement:

- The shell grit levee on the North end of the Esplanade is likely to be overtopped and water travel towards the camping ground.
- The dune/levee system to the West of the Esplanade (on the North side of Parham) would be severely overtopped and inundate the Esplanade and properties.

Figure 26 : Possible flooding pattern of Parham North in 3.0m event of significant duration.

- The dune/levee system to the West of the Esplanade (on the South side of Parham) is higher and well vegetated would fare better, but due to the low points in the dune, water would be likely to enter the settlement in places. If the event was for a significant duration the following flooding is possible (Figure 27):

Figure 27: Possible flooding pattern of Parham South if storm event was of significant duration (assumes southern levees and dunes hold).

- The Southern point of the settlement is well protected with a shell grit levee but the levee is quite narrow (less than 2 metres in places) and vulnerable to giving way.
- The Eastern side of the settlement is very well protected with a shell grit levee/ clay levee that adjoin a natural ridge line with significant height and vegetation, all of which are at 3.15AHD or higher.

<u>Greater North and South of the Settlement:</u>

It appears unlikely that a 3m event would threaten the settlement further to the North or from behind the settlement to the East anywhere North of Point Parham Road (see *Map 1.c*).

In the South it is likely that increased sea level will also increase incursion into the sand dunes between Parham and Webb Beach. This has already been observed (See *Map 1.d*) and it is predicted that without any remediation work, the recent incursions through the dunes 50m south of the roundabout may become a new permanent inlet. If this was to occur other inlets would also eventuate and in time much of the existing dune system to the West may erode away. This would change the nature of the ecology between the sea and the ridgeline to the East from being a Samphire mudflat region to being a tidal flat. Further

research is required to ascertain what long term effects might occur to the human settlement if sea water was to enter this area more regularly and for longer periods of time.

What is the likely impact on the settlement for a 3.7m AHD event (2100)?

It is not possible to predict whether the dune systems to the North and South of the Parham settlement would survive to 2100. However, if a 3.7m event were to occur with the existing defences and dune system, Parham would be significantly affected as there are no defences around the town higher than 3.0 m and a significant portion of the foreshore is at 2.0m to 2.5m AHD. Port Parham road would also be overtopped in a 3.7 m event.

4.1.4 Analyse emergency egress and access

In 3.0m AHD flood could residents move directly away from the energy head of the flood and move to a safe place?

Parham (North of First Street)

The grid pattern of streets would provide easy movement away from the sea front. Driscoll Crescent on the East side of the settlement is at 3.00 AHD and this street runs south to the community centre and where Port Parham Road enters the settlement. Thus emergency egress appears suitable in this area (Figure).

Figure 28: Potential emergency routes away from place of flood in Parham North

Parham (South of First Street)

The Southern side of Parham is more problematic as Prime Street, which is the only street parallel to the Esplanade to the East, has an AHD height of 1.80m AHD to 2.00m AHD. However, Good Street provides an access point to the ridgeline to the East of Parham. Residents could also walk along the newly constructed levee to reach the ridge behind the Parham settlement. However, if an event were to occur at night, navigating through the bushland towards the community centre would be difficult (Figure 29).

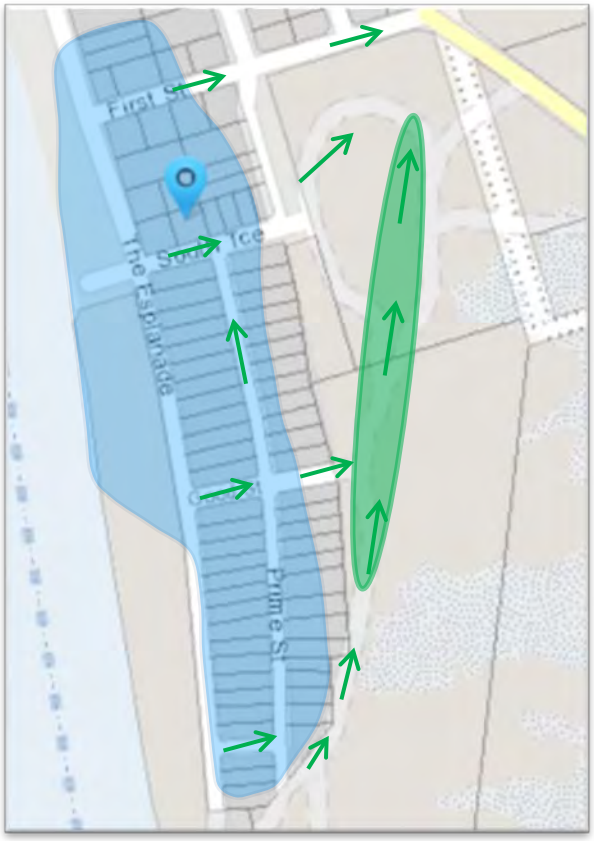


Figure 29: Potential emergency egress away from storm head (Note that new levee on eastern side of Parham could be utilised)

In a 3.0m flood event could emergency vehicles access Parham?

Parham (North of First Street)

Access along Driscoll at 3.00AHD or even Richardson at 2.80AHD is predicted to be free of obstacles in a flood event which would put vehicles in close proximity to all of the houses and therefore emergency access is possible to Parham (North of First Street).

Parham (South of First Street)

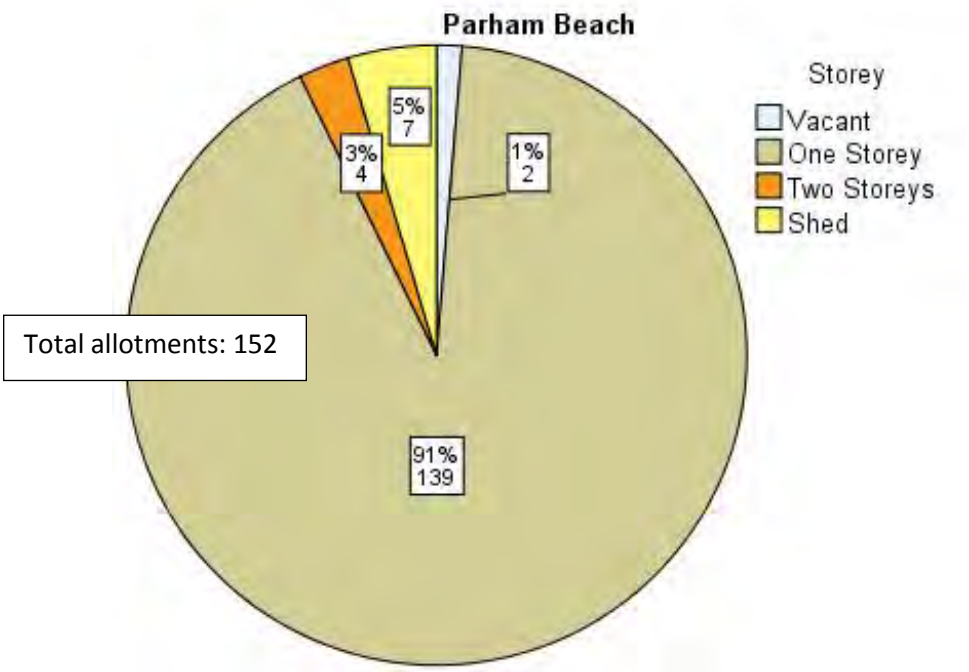
The Southern side of Parham is more problematic but access could be gained across the ridgeline to the rear of the settlement by way of Good Street which would put emergency vehicles in close proximity of most houses. However, clear navigation will be required rather than the bush tracks that currently criss-cross this area.

3.1.5 Establish profile of assets at risk

This section profiles the range of assets at risk in three main categories: privately owned assets, council owned assets, other owned assets. An accurate profile of assets will assist in decision making when considering adaptation solutions in the second part of this project.

Privately owned assets:

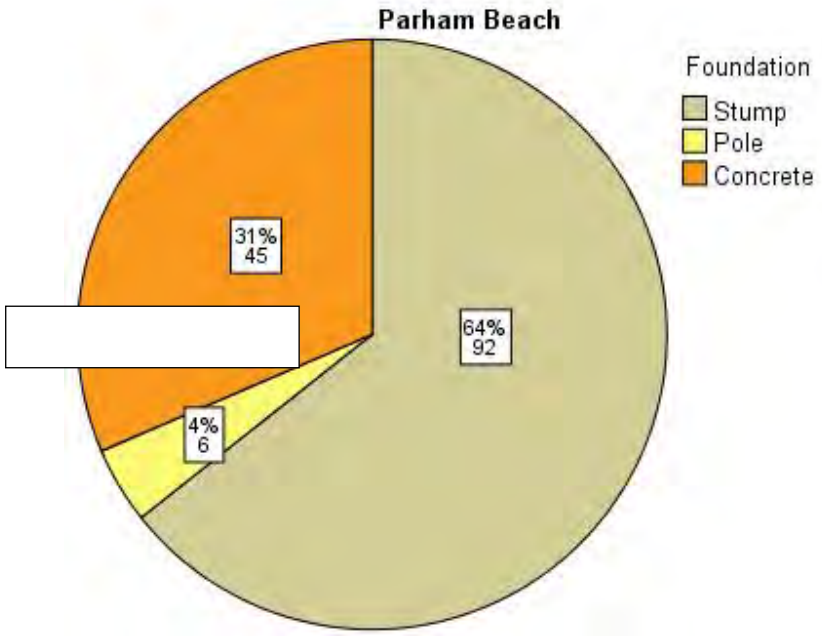
1. Total number of allotments and profile of improvements (Figure 30).



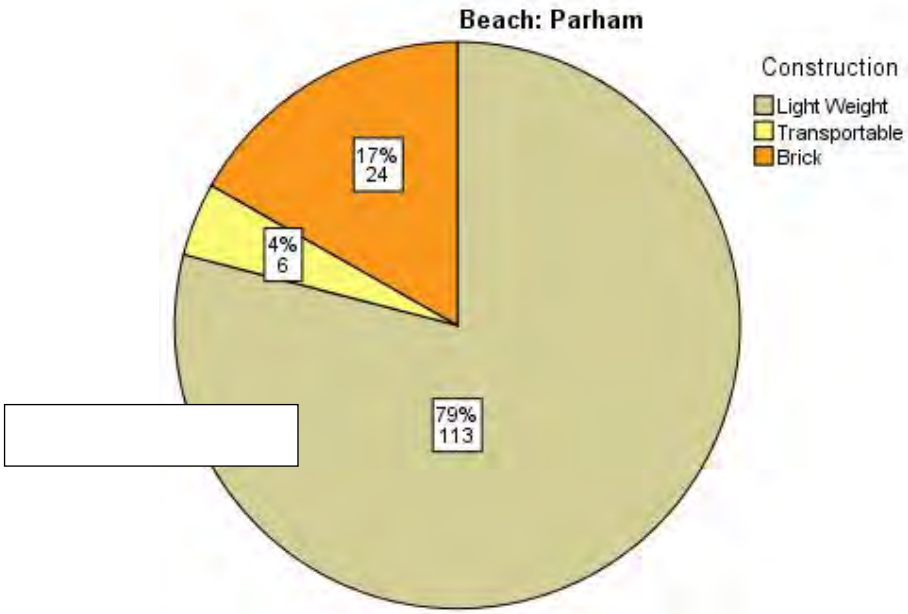
DC Mallala valuation records for 2013 show that the land and buildings are valued at:

Parham – value of residential assets	
Land	To be advised
Improvements	To be advised
Total capital value	$36,722,500

2. Foundation types – stump, pole, or concrete (Figure 31)

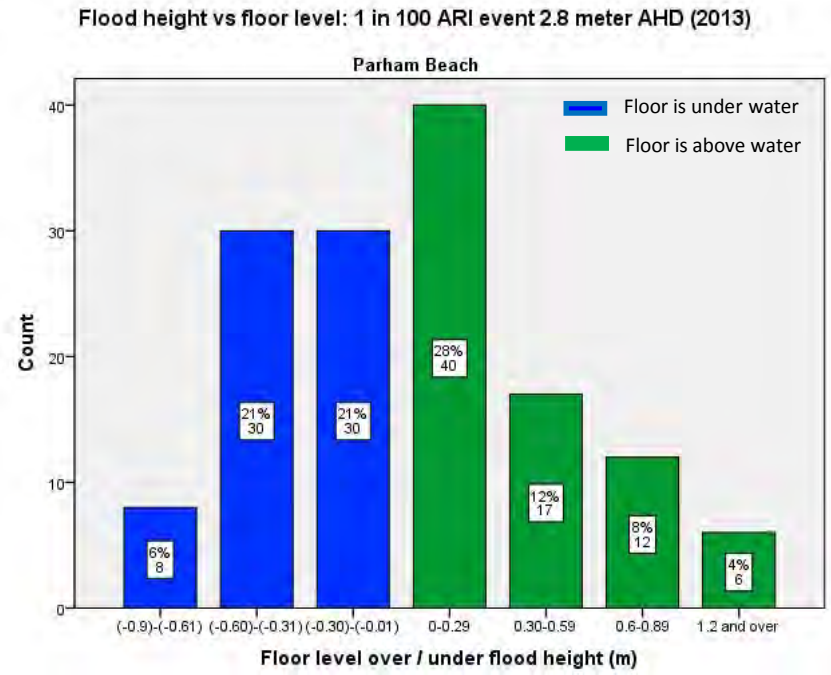


3. Construction types* (Figure 32)

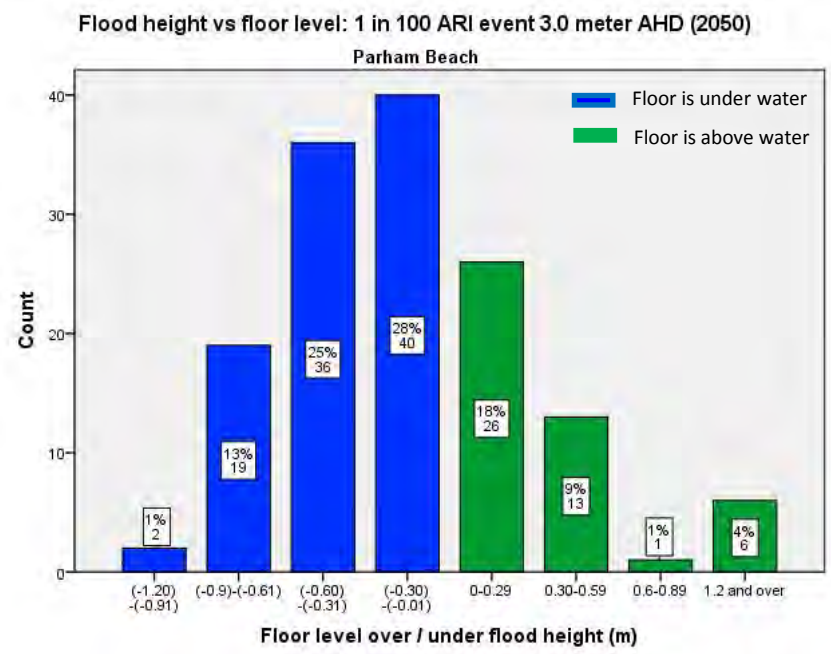


*Note: Transportable homes may have been over categorised as light weight construction. However, the main point here is that generally light weight construction and transportable houses are on stumps or poles.

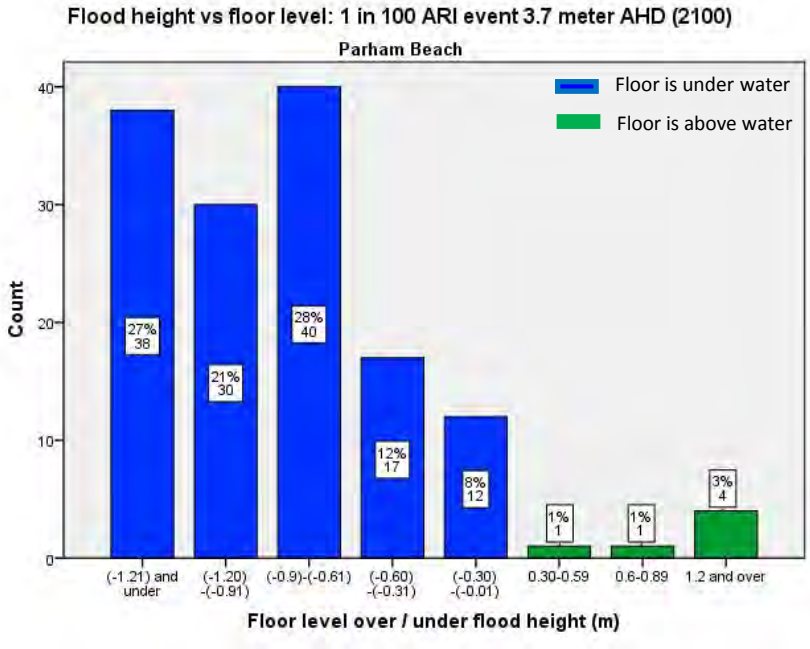
4. Impact on dwellings in selected inundation events (Figure 33):



If the predicted one in one hundred year flood event occurred in 2013, and it lasted for a significant duration of time (in other words not just a brief overtopping of the dunes), 68 dwellings are likely to be inundated, with 38 of these with water level over floor in excess of 0.3m.



If the predicted one in one hundred year flood event occurred in 2050, and it lasted for a significant duration of time (in other words not just a brief overtopping of the dunes), 97 dwellings are likely to be inundated, with 57 of these with water level over floor in excess of 0.3m.



If the predicted one in one hundred year flood event occurred for 2100, and it lasted for a significant duration of time (in other words not just a brief overtopping of the dunes), only 6 dwellings would remain unaffected.

Council owned assets:

DC Mallala's valuation records for 2013 show that infrastructure assets at Parham are valued at $1,822,000 and roads are valued at $1,881,939 (See Appendix 2 – Council infrastructure).

Other owned assets:

Telstra, SA Water, and SA Power Networks have infrastructure in Parham and maps of these are included in Appendix 3.

Summary

This section provides an overall picture of the assets that are likely to be under threat, especially at the 3.0m inundation event. Such an event may not just occur once, but could occur several times. Remember, the one in one hundred year ARI methodology is just a statistical method used in the face of risk. Parham could expect that these events would result in significant damage to houses, roads and infrastructure. However, there are a range of strategies that could be employed to reduce the risk and in the next stage of the investigation this data will be utilised to ascertain what strategies might be employed to reduce the potential threat from impacts of the sea.

4.1.6 Discuss liability issues.

- **What obligations did Council have at the time the settlements were founded in relation to assessing impacts from the sea?**

Parham was subdivided in the late 1876 and therefore nothing is known about the initial site assessment. There are very unlikely to be any obligations for the Council arising from the establishment of Parham.

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

Levee	Implementation Date	Responsibility and liability
Foreshore levee and dune (at various places)	Unknown	Unlikely to have any maintenance responsibility or liability in relation to Parham foreshore as levee works are largely indistinguishable from the natural dunes.
North of camping ground	Unknown	Possible maintenance responsibility due to its obvious proximity to the camping ground.
Shell grit levee at North of Esplanade	2009	Works were implemented in emergency mode but no retrospective approval was sought. There may be some liability to Council if these fail in the future.
Shell grit levee at southern end of roundabout	Unknown	Possible maintenance responsibility as it protects the roundabout.
From roundabout to ridgeline behind Parham	2013	Development Application approved but no conditions in relation to maintenance obligations. However, maintenance is likely inferred.

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

Yes, see incidents recorded above. There may be potential liability where protection works prove not to have been maintained, not necessarily just because they were breached. A regular inspection regime (even annually) assists Council in fulfilling a duty of care.

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

Council advises that it has been policy to apply the heights of sites and buildings in accordance with Coast Protection Board advice.

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

No, but upcoming community consultation will begin this process.

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

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

Summary

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

- Parham was subdivided and settled in the late 1876 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 responsible to implement protection works per se.
- 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 particular to protection works, the Council is likely to have a responsibility to ensure that protection works are adequately maintained in integrity and height, especially for the more recent works.
- However, while there is no legal responsibility to implement protection works, Councils are likely to have a responsibility to warn their constituents of any danger. Therefore, the Council should make the findings and mapping from studies such as this one available to the public.
- 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.

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, recent trend in Court decisions indicates that the Court will take into account climate change related facets to a case.

4.1.7 Summary Table - Parham

Stage	Question	Summary comment
1. Site history	When was the settlement established?	1876
	Were climate change and sea level rise issues relevant?	No, there was no requirement to take into account sea level rise.
2. Existing protection	What existing natural protection exists?	Dunes to the foreshore, ridgelines to the rear of the settlement.
	What breaches have occurred?	Four breaches occurred in 2009.
	What manmade protection works have been installed into the settlement?	A shell grit levee on the far north of the Esplanade (no record of DA). A shell grit levee to the north boundary of the camping ground (no record of DA). A shell grit levee to the Southern roundabout (No record of DA). A clay levee to the rear of Parham connects to the natural ridge (DA approved 2013).
3. Impact of storm events	What is the likely impact for a 2.8 m AHD event?	Front dune overtopped on northern end of Parham. Some flooding expected of roads and residential properties.
	What is the likely impact for a 3.0 m AHD event?	Front dune overtopped, especially on northern end, but some likely in the south as well. Some flooding expected of roads and residential properties.
	What is the likely impact of a 3.7m AHD event?	Front dune, northern levee, severely overtopped. Extensive flooding of roads and properties.
4. Emergency access and egress	Egress issues in a 3.00AHD event	Egress is clear in North Parham, more impeded in the South.
	Emergency vehicle access in a 3.0m AHD event.	Access is clear in North Parham but more impeded in the South.
5. Profile of assets at risk	How many residents are likely to be affected in 3.0m event?	In 2050 flood scenario 97 dwellings may be affected, 57 of these with depths over 300mm over floor level.
6. Liability issues	Does liability exist if Council fails to implement protection?	Unlikely to be any general liability, check liability relating to protection works, especially those installed in recent years without any development approval.
	Have residents been warned?	Not yet.
	Have emergency procedures been implemented?	Not yet.
	Are there conditions relating to the maintenance of protection works	Not yet.
	Is there a maintenance regime of protection works?	Unknown.

4.2 Webb Beach

4.2.1 Site history

- **When was the settlement established?**

There are no records relating to the establishment of Webb Beach but it can be safely assumed it was at similar time to Parham.

- **What obligations does Council have in relation to the establishment of the settlement?**

Due to the age of Webb Beach no liability is expected to DC Mallala relating to any issues of settlement.

4.2.2 Analysis of existing protection - natural and manmade

The following assessment of natural and man-made land forms that provide Webb Beach with protection from the sea is to be read while viewing the companion maps that append this report. Heights are expressed in metres AHD but normally the acronym AHD is assumed in the context of the report.

What existing natural protection exists in Webb?

<u>To the West:</u>

Map 2a Webb Beach (Settlement) shows the following natural landforms:

- The Collins Road at the front of Webb Beach is at a height of approximately 2.00m AHD to 2.45m AHD.
- Protection from the West is provided by a dune having a height of 3.0m to 3.8m and the dune is heavily vegetated (See Figure 34). The height of the ramp is 2.90m AHD.
- The settlement rises uniformly to the East to Jury Street that is predominantly at height 2.70m to 3.00m. Green bands on the plan indicate areas 3.00m and above.

Figure 34: Vegetated Dune (Source: Google Maps Street view 11.08.13)

To the East:

- The East of Webb Beach has a significant portion of land at 3.00m AHD that protects it from inundation from behind the settlement.

To the North:

- To the North of George Street is a band of scrubland of varying heights along which the tidal flows from the inlet. Areas adjacent George Street are generally low but two ridgelines are likely to exist within the scrub (See *Map 2.a*) (Figure 35).

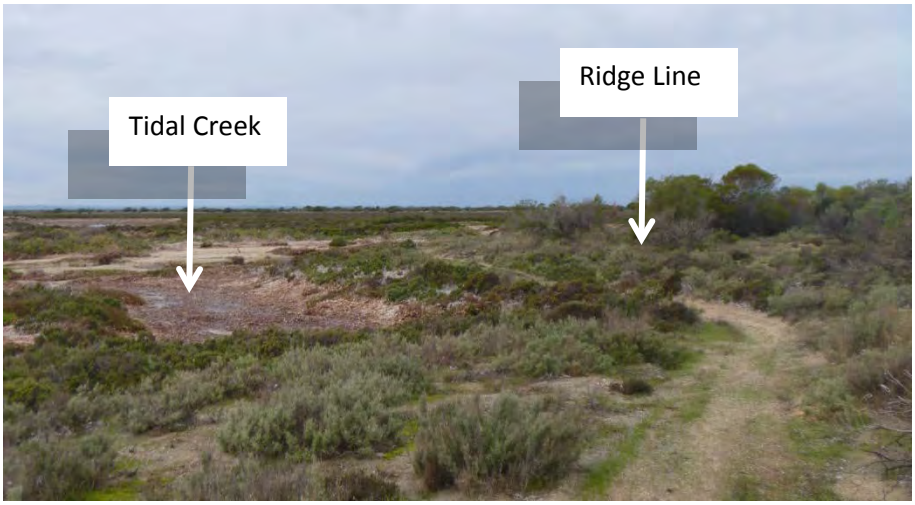


Figure 35: Dune North of Webb Beach Settlement (M.Western, 2013)

To the South:

- Jarmyn Street runs along the Southern border of Webb Beach at a height of 2.45 m at the front to 2.53m at the rear (with a hump in the middle at 2.80m). Extensive vegetation exists to the South of Jarmyn Street. However a gully runs from the South

East corner of the settlement and may be susceptible to inundation in the future. A small levee may be situated at the bottom end of this gully (to be confirmed).

What flooding incidents have occurred?

The following incidents have been reported to Council Depot. There may be more incidents that public consultation will bring to light.

- On 25th April, 2009, sea water entered Webb Beach settlement from behind the public toilets and travelled up George Street as far as Jones Street.
- On this same day, the shell grit levee that wraps around the North West corner eroded back a distance of 2-3m.
- On the same day, sea water entered through Second Creek as well as through a new inlet South of Webb Beach and crossed the causeway (one report suggests from the South not the North).

While not specifically a marine flood, rain water tends to collect in the road reserves after downpours.

What man-made protection works have been installed in Webb Beach?

Two man-made protection works exist in Webb Beach:

- A shell grit levee has been installed to the North West corner of the settlement and protects the public toilets and tanks as well as the settlement itself from inundation (Figure 36). The shell grit levee has a life of about 4-5 years before needing remedial work (Opinion: Keith Earl, DC Mallala). Development approval was not obtained for these works.

Figure 36: Shell grit levee protects North West corner of Webb Beach (M. Western, 2013)

- Subsequent to the event of 25th April 2009, a shell grit levee at height 3.00m to 2.80m was joined to the aforementioned levee to protect Webb Beach from further inundation (See Figure 37). Development approval was not obtained for these works.

Figure 37: Levee installed in 2009 subsequent to flood event (Photo: M. Western, 2013)

4.2.3 Analyse the impact of sea level rise

<u>What is the likely impact on the settlement for a 2.8m AHD event (2013)?</u>

By way of comparison, the flood event of 25th April, 2009 was at height of approximately 2.50m AHD. The following issues would be likely in Webb Beach if such an event were to occur:

- The dune/levee system to the West would likely defend the settlement. However, the ramp at 2.90m AHD would be susceptible to overtopping due to its hard surface and less resistance to water flow.
- The East of Webb Beach is elevated at 3.00m or above and no inundation is likely here. However, the access road into Webb Beach would be overtopped by 0.5 to 0.6m cutting off egress and access to the settlement (See *Map 1.d*).
- The Northern side of Webb Beach is susceptible to flooding with some portions of natural defences at 2.4 or even lower. The shell grit levee would likely impede some water flow but may not be of sufficient compaction to withstand a large event.
- The Southern side of Webb Beach is well vegetated but a 2.8m event may enter the gully on the South East corner of the settlement (see *Map 2.b*), although water would have had to travel from further South and therefore there may be little impact.

Figure 38: Possible impact of 2.8m AHD event if of event (Water may overtop the ramp)

<u>What is the likely impact on the settlement for a 3.0m AHD event (2050)?</u>

The flood maps (See *Maps 2.a and 2.b*) illustrate the impact of a 3.0m flood event. The methodology utilised is known as 'bathtub' modelling and takes no account of land forms, manmade or otherwise. Bathtub modelling also does not take into account that the water is tidal and moves in from the West and then recedes within a time frame of about 2 hours. Therefore, while some roads and properties may be lower than the 3.0m event, the water may not encroach this far into the settlement.

Irrespective of these factors, the following assessment can be made about Webb Beach's vulnerability in a 3m event:

<u>Within the Webb Beach settlement:</u>

- The dune/levee system to the West would likely defend the settlement. However, the ramp at 2.90m AHD would be susceptible to overtopping due to its hard surface and less resistance to water flow.
- The East of Webb Beach is elevated at 3.00m or above and no inundation is likely here. However, the access road into Webb Beach would be overtopped by 0.8m and Webb Beach would be cut off (See *Map 1d*).
- The Northern side of Webb Beach is susceptible to flooding with some portions of natural defences at 2.4 or lower. The shell grit levee would likely impede some water flow but may not be of sufficient compaction to withstand a large event.
- The Southern side of Webb Beach is well vegetated but a 3.0 m event may enter the gully on the South East corner of the settlement (although water would have had to travel from further South and therefore the impact may be lessor).

Figure 39: Possible impact of 3.0m AHD event if of significant duration

Greater South of the Settlement:

The area between Webb Beach and Parham has been addressed in the Parham section of the report. To the South it is likely that increased sea level will also bring increased incursion into the sand dunes between Webb Beach and Baker's Inlet (Third Creek). This has already been observed (See *Map 2.b*) and it could be predicted that without any remediation work, the recent incursion may become a new permanent inlet. If this was to occur other inlets may develop and in time begin to erode the dune.

What is the likely impact on the settlement for a 3.7m AHD event (2100)?

It is not possible to predict whether the dune systems to the South of the Webb Beach would survive to 2100. However, if a 3.7m event were to occur with the existing defences and dune system, Webb Beach would be significantly affected as there are no defences around the town higher than 3.0 m and therefore the whole settlement would be inundated.

4.2.4 Analyse emergency egress and access

In 3.0m AHD flood could residents move directly away from the place of flood and move to a safe place?

The grid pattern of streets would provide easy movement away from the sea front. Jury Street on the East side of the settlement is at 3.00 AHD and thus residents could retreat to this location. However, egress from the settlement may be cut off for a period of a few hours. Therefore emergency egress is suitable to move away from the threat but residents would be cut off from the mainland.

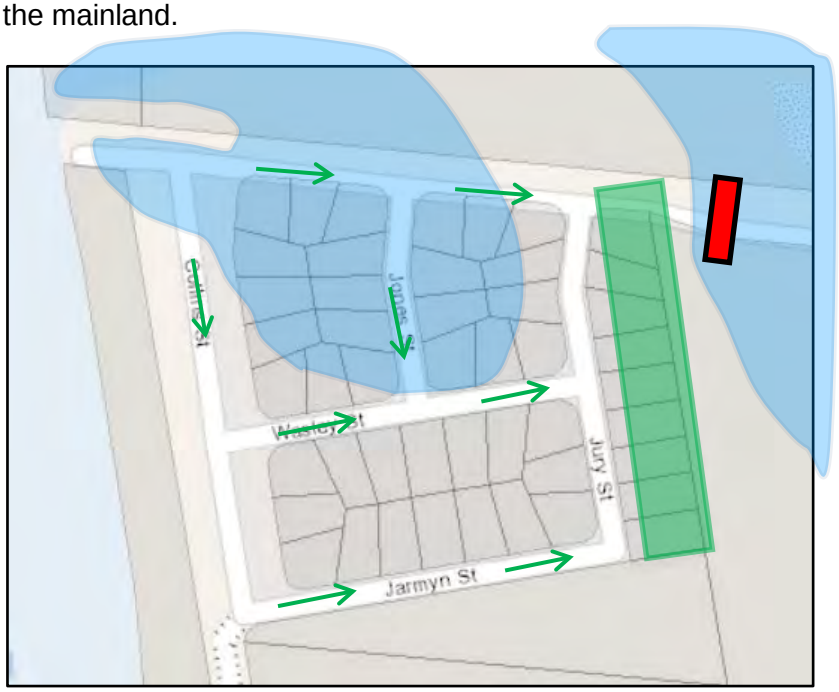


Figure 40: Potential emergency egress pattern of residents

In a 3.0m flood event could emergency vehicles access Parham?

Emergency access via road would be impossible in a 3.0m AHD event as the causeway is generally at height 2.20m AHD and road would be under by 0.8m (See *Map 1.d* and Fig 41).

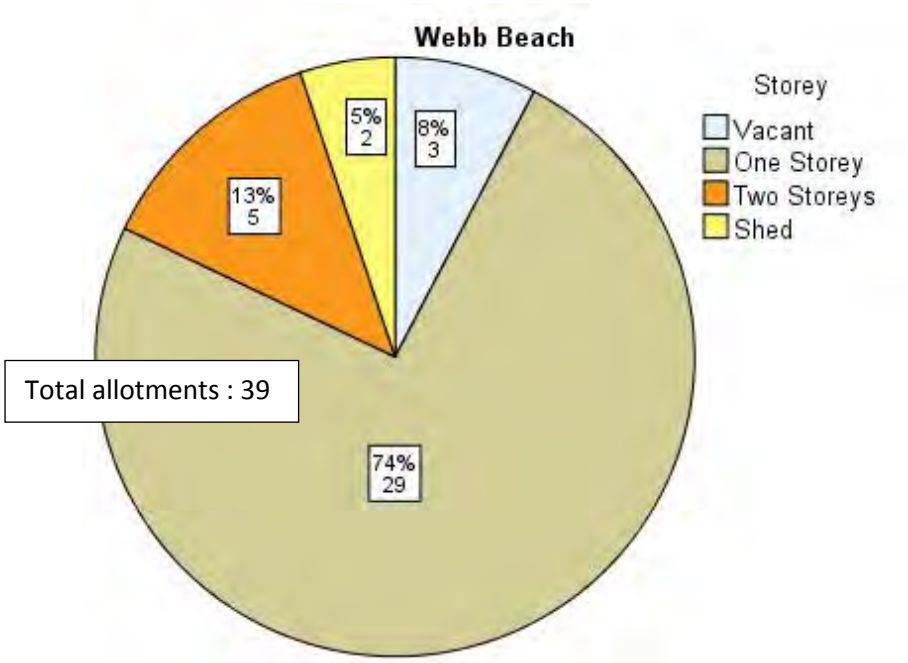
Figure 41: Access road into Webb Beach is at 2.20m AHD (J. Kellett, 2013)

4.2.5 Establish profile of assets at risk

Using the methodology reported in Section 1, this section profiles the range of assets at risk in three main categories: privately owned assets, council owned assets, other owned assets. Identifying the different construction types provides appropriate data from which to offer some solutions for adaptation should these be required.

Privately owned assets:

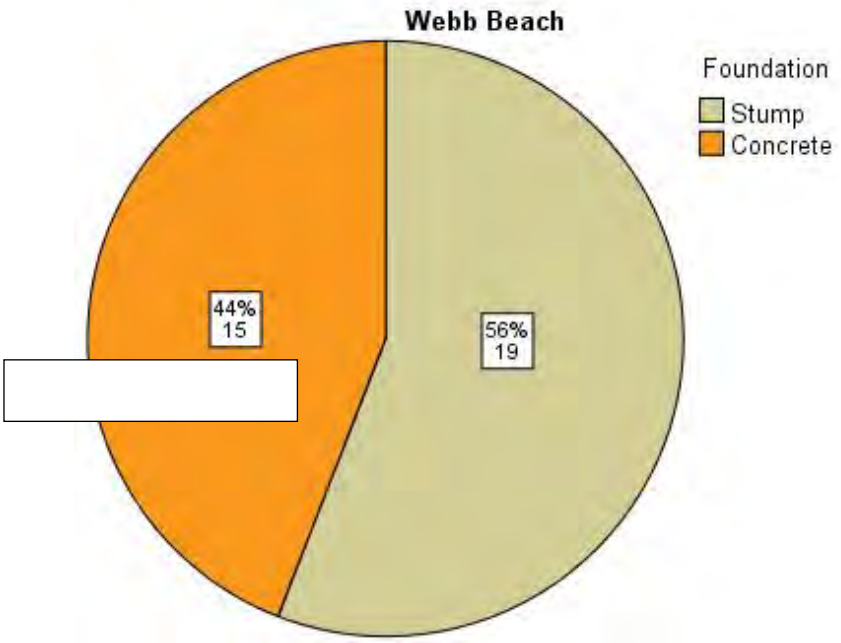
1. Total number of allotments and profile of improvements (Figure 42).



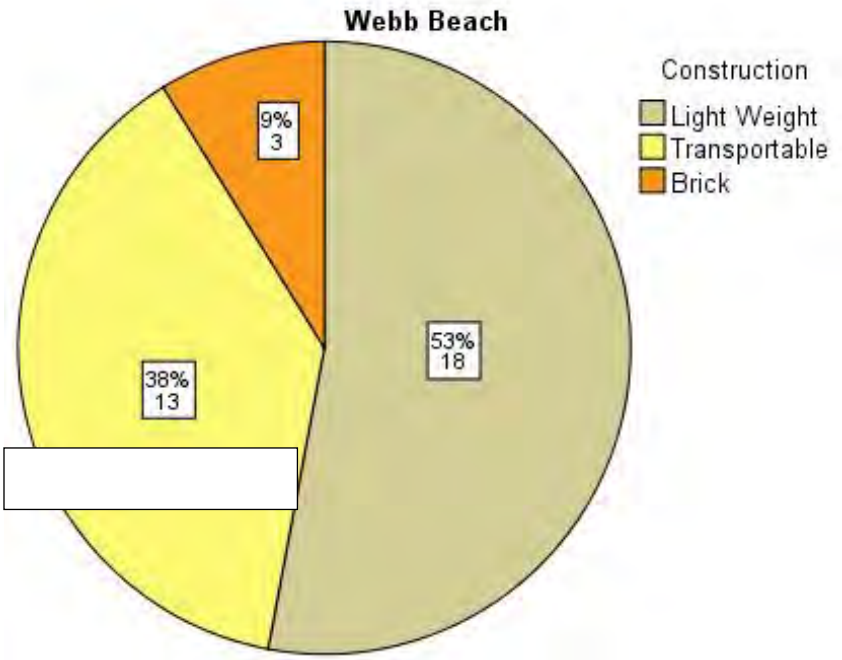
DC Mallala valuation records for 2013 show that the land and buildings are valued at:

Webb Beach – value of residential assets	
Land	To be advised
Improvements	To be advised
Total capital value	$8,064,000

2. Foundation types – stump, pole, or concrete (Figure 43)

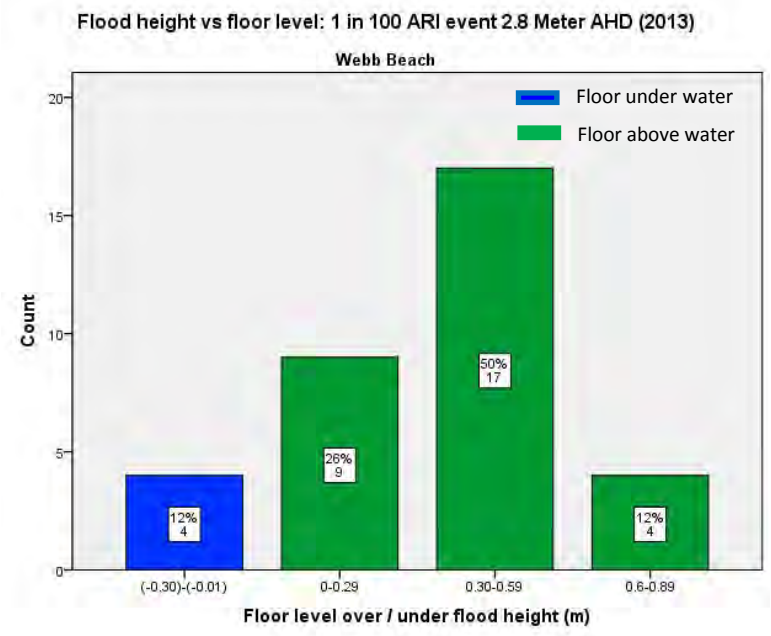


3. Construction types – light weight, transportable, and brick (Figure 44)

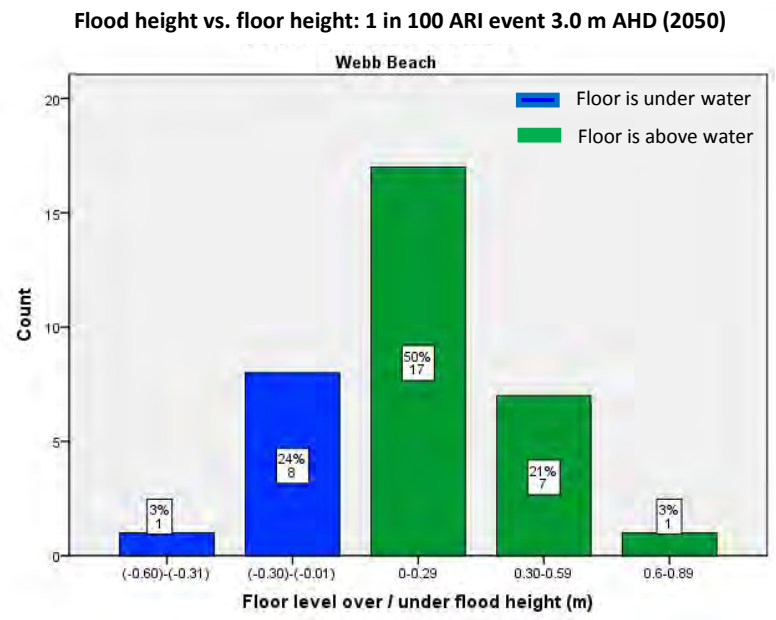


*Note: The categorisation of transportable to light weight construction may be interchangeable.

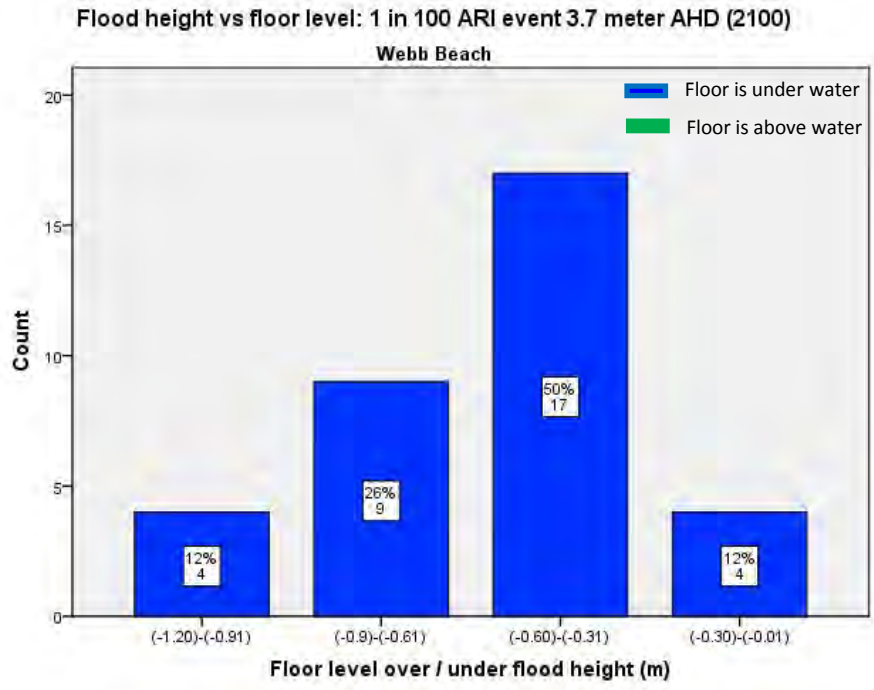
4. Impact on dwellings in selected inundation events (Figure 45):



If the predicted 1 in 100 ARI flood event occurred in 2013, only 4 dwellings in Webb Beach are likely to have water above their floor levels. This assessment assumes an event of significant duration, not just a short duration of overtopping of dunes or defences.



If the predicted 1 in 100 ARI flood event for 2050 occurred, 7 dwellings would be likely to have water level over their floor levels, with only 1 of these with a level higher than 0.3m. This assessment assumes that the flood duration is significant and not just a short duration of overtopping of dunes or defences.



If the predicted 1 in 100 ARI flood event for 2100 occurred, all dwellings would be likely to have water level over their floor levels, most of these at significant levels. This assessment assumes that the flood duration is significant and not just a short duration of overtopping of dunes or defences.

Council owned assets:

DC Mallala's records show that infrastructure assets at Webb Beach are valued at $114,000 and roads are valued at $409,137 (See Appendix 2 – Council infrastructure).

Other owned assets:

Telstra, SA Water, and SA Power Networks have infrastructure in Webb Beach and maps of these are included in Appendix 3.

Summary:

This section provides an overall picture of the assets that are likely to be under threat at Webb Beach. The threat in the events of 2.8m and 3.0m inundation height are predominantly from the North and only result in 4-9 houses having flood over floor levels and these levels are all less than 300mm. However, roads and other infrastructure may be damaged in these events also. There are a range of strategies that could be employed to reduce the risk and in the next stage of the investigation this data will be utilised to ascertain what strategies might be employed to reduce the potential threat from impacts of the sea upon Webb Beach.

4.2.6 Discuss liability issues.

- **What obligations did Council have at the time the settlements were established in relation to assessing impacts from the sea?**

Webb Beach was subdivided in the late 1800's and therefore nothing is known about what information was assessed. There are very unlikely to be any obligations for the Council arising from the establishment of Webb Beach.

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

Levee	Implementation Date	Responsibility and liability
Levee to North West corner	Unknown	Council staff monitor and top up as necessary.
Shell grit levee to adjoin abovementioned levee	2009	Levee was implemented under emergency conditions but no Development Application was sought retrospectively. A possible liability to Council may exist if another event caused the levee to fail.

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

Yes, see incidents recorded above. There may be potential liability where protection works prove not to have been maintained, not necessarily just because they were breached. A regular inspection regime (even annually) assists Council in fulfilling a duty of care.

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

It has been Council policy to apply the heights of sites and buildings in accordance with Coast Protection Board advice.

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

No, but upcoming community consultation will begin this process.

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

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

Summary

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

- Webb Beach was subdivided and settled in the late 1880s 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 responsible to implement protection works per se.
- 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 particular to protection works, the Council is likely to have a responsibility to ensure that protection works are adequately maintained in integrity and height
- However, while there is no legal responsibility to implement protection works, Councils are likely to have a responsibility to warn their constituents of any danger. Therefore, the Council should make the findings and mapping from studies such as this one available to the public.
- 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.

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, recent trend in Court decisions indicates that the Court will take into account climate change related facets to a case.

4.2.7 Summary Table – Webb Beach

Stage	Question	Summary comment
1. Site history	When was the settlement founded?	Late 1800's.
	Were climate change and sea level rise issues relevant?	No, there was no requirement to take into account sea level rise.
2. Existing protection	What existing natural protection exists?	Dunes to the foreshore, ridgelines to the rear of the settlement.
	What breaches have occurred?	Several – one in 2009.
	What manmade protection works have been installed into the settlement?	A shell grit levee to protect the North West corner. A shell grit levee running South of the aforementioned levee.
3. Impact of storm events	What is the likely impact for a 2.8 m AHD event?	Northern dunes overtopped. Flooding expected of roads and residential properties. Settlement cut off from mainland.
	What is the likely impact for a 3.0 m AHD event?	Northern dune overtopped. Flooding expected of roads and residential properties. Settlement cut off from mainland.
	What is the likely impact of a 3.7m AHD event?	Front dune, northern dune severely overtopped. Extensive flooding of roads and properties. Settlement cut off.
4. Emergency access and egress	Egress issues in a 3.00AHD event	A safe place exists on the Eastern side but egress to the mainland cut off.
	Emergency vehicle access in a 3.0m AHD event.	No access.
5. Profile of assets at risk	How many residents are likely to be affected in 3.0m event?	Minimal effect on dwellings in 2050 scenario (7 dwellings, but only 1 of these with water over 300mm).
6. Liability issues	Does liability exist if Council fails to implement protection?	Unlikely to be any general liability
	Have residents been warned?	No.
	Have emergency procedures been implemented?	No.
	Are there conditions relating to the maintenance of protection works	No.
	Are there any possible liability issues relating to protection works	Development Approval has not been obtained for emergency works.
	Is there a maintenance regime of protection works?	Yes, council staff monitor but regularity unknown.

4.3 Thompson Beach

4.3.1 Site history

- **When was Thompson Beach established?**

Thompson Beach was founded in the late 1980's. Development Applications 312/162/83 and 312/D033/85 were considered under the Planning Act 1982 and against the provisions of the DC Mallala Development Plan.

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

The planning authority was the DC Mallala[5]. An Environmental Impact Study (EIS) was completed in two stages, the first on 8th May 1985, and in response to the submissions received in the consultation process, the developer issued a supplement to the original EIS dated 29th November 1985. Flooding issues were addressed in both of these documents and a system of flood mitigation was detailed in the second one. As part of the process, the EIS was referred to the Coast Protection Board. The Planning Act 1982 in Section 49 (7) states that the planning authority must have 'regard' to any EIS that is officially recognised by the Minister before giving consent. There were powers for the Minister to make amendments to the EIS but this right was not exercised. A submission by Bone and Tonkin Planners dated 1st August 1985 explains how the EIS and approval system operated at the time and conclude 'the planning authority then having regard to the EIS, is to determine whether consent should be granted to the development and if consented to, what conditions should be applicable to that consent'. An interview with Rob Tucker (Coast Protection Board, 13th August, 2013) affirmed that the Council had a responsibility to take 'advice' only. He also confirmed that planning authorities did not need to take account of sea level rise until 1994 under Development Act 1993.

In summary, the Council did need to take into account flooding potential as part of the EIS process but had the authority to make its own determination. There was no statutory requirement to take sea level rise into consideration in the Mallala Development Plan of the time. This matter is explored further under Section 4.3.6 below.

4.3.2 Analysis of existing protection - natural and manmade

The following assessment of natural and man-made land forms that provide Thompson Beach with protection from the sea is to be read while viewing the companion maps that append this report. Heights are expressed in metres AHD but normally the acronym AHD is assumed in the context of the report.

[5] This is despite the Planning Act 1982 stating that in the case where an Environmental Impact Study was commissioned then the SA Planning Commission would be the planning authority. (It is possible that due to the original application being lodged in 1983 that the Planning Act 1982 did not have this rule at the time).

Thompson North (North of Ruskin Road)

What existing natural and man-made protection exists in Thompson Beach North ?

To the West:

Map 3.a Thompson (North) - shows that Thompson (North) has the following landforms:

- The Esplanade Road North of Ruskin Road is generally at height of 3.00m AHD to 3.4m AHD with one section on the Northern end being at 2.80m AHD.
- Protection from the West is provided by a substantial natural dune having a maximum height in excess of 4m in the North and 3.0m or over near Ruskin Road in the South. The levee is well vegetated (See Figure 46)

Figure 46: Esplanade and dune (Thompson North) (Google Maps Street view 15.08.13)

- Traversing inland, the level of land remains above 3.0m AHD, but declines in height East of Kestrel Ave (See *Map 3.a*). The green colour on the map below shows elevations of 2.80m AHD and above and gives a picture of the general topography of the settlement (Figure 47).

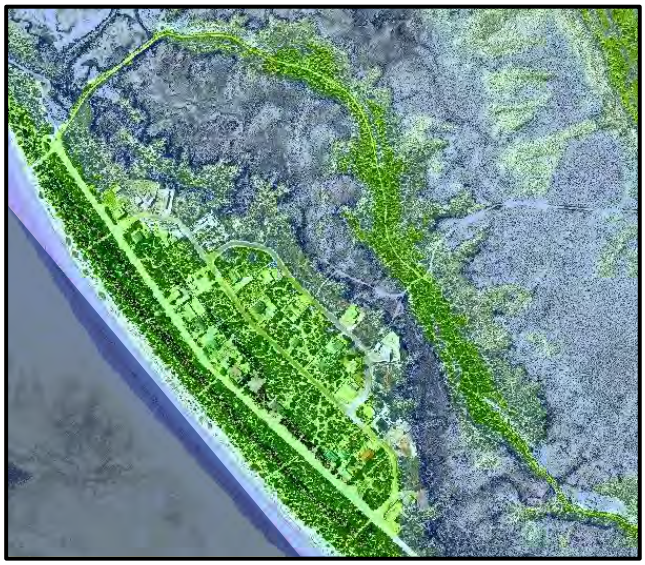


Figure 47: General topography Thompson Beach (North). Settlement is at 2.8m or above apart from houses to the Eastern side

To the East (See *Map 3.d*):

- To the East of the Thompson Beach (North) are samphire mudflats generally at 1.6m AHD. Across the mudflats to the East of Thompson Beach North is a natural dune system generally at heights 3.00AHD but with some lower spots.
  .
- *Map 3.d -Thompson Beach (Levee system North)* shows the man-made levee that connects the Thompson Beach settlement with the natural dune to the East (See Figure 48) . The plans for the settlement show that some sections of the natural dune were to be raised so as to ensure that protection was at a constant height of 3.0m AHD but some of these sections appear to be lower than this at 2.70m AHD or 2.60m AHD.

Figure 48: Man-,made levee connects Thompson Beach with natural dune system to the East.

- Ruskin Road to the South encloses the levee system so that the rear of Thompson Beach (North) is generally protected at 3.0m AHD. This system protects the rear of Thompson Beach settlement and although dwellings appear to be inundated by the bath tub flood modelling, they are not likely to be subject to inundation.

To the North (See *Map 3.f*):

- *Map 3.f -Thompson Beach (Greater North)* shows that approximately 400m north of the Northern levee the dune on the coast narrows and is less vegetated. Generally the height of the dune is at 2.5m but there is one opening at 1.7m through which king tides may be entering (in excess of 3.0m Chart Datum).

<u>Thompson Beach South (South of Ruskin Road)</u>

What existing natural and man-made protection exists in Parham (South)?

<u>To the West:</u>

Map 3.b and 3.c Thompson (Settlement -South) show that:

- The Esplanade Road declines from 2.93 at the corner of Ruskin Road to a height of 2.47 at the southern end.
- Protection from the West is provided by a dune. At Ruskin Road the dune is 30m wide and this fans out to 50m and then recedes back to 20m wide near Petrel Crescent. The dune is generally well-vegetated but becomes more sparse as it approaches the Petrel corner (Figure 49 and 50). The band of green colour indicates where the dune is 3.0m or over.

Figure 49: Dune at corner of Esplanade and Plover (Google Maps, 16.08.13).

Figure 50: Dune at corner of Petrel and Esplanade (Google Maps, 16.08.13)

- From the corner of Petrel to the southern end of the Esplanade the dune height varies between 2.60AHD and 3.00AHD. See also Appendix X for copy of survey data compiled by DC Mallala.
- The settlement has a general height of 2.80m AHD but towards the South the height is less. The green colour on the map below showing at height 2.80m and above gives a general picture of the topography of the settlement (Figure 51).
- Houses that back onto the mudflats on the Eastern side are situated on sites that have portions as low as 2.20m AHD.

Figure 51: General topography of Thompson Beach (South). Green colour depicts levels at 2.80m AHD or above.

- The plans held at DC Mallala show that the developer was to install a levee to the front dune at a height of 3.0m AHD. The man-made portion of this is now largely indistinguishable from the natural form. The plans detailed how the levee was to be engineered but it is not known if these specifications were followed. The levee is not at height 3.0m AHD at the southern end of the dune and it is now known whether this relates to slumping over time or whether the levee was not originally installed to the correct height.

<u>To the East (*Map 3.e – Thompson Beach (Levee system South)*):</u>

- Behind the settlement is similar ecology and topography to the Northern side of Ruskin Road but the distance back to the natural dune to the East is 600m.

- Ruskin Road acts as a levee to the North. The natural dune system South of Ruskin Road and 600m east of the settlement is mostly at height 3.0m with some spots a little lower at 2.60m AHD (See *Map 3.e)*. The original plans show that this dune system was to be elevated in places. A levee on the Southern end of Thompson Beach connects the settlement with the natural dune to the East. The levee is at 2.5m AHD, despite the plans detailing a height of 3.0m AHD (Figure 52).

Picture 52: Man-made levee at 2.5 m AHD connects end of Thompson Road with natural dune system to the East (M. Western, 2013)

To the South (*Map 3.g – Thompson Beach (Greater South)):*

- *Map 3.g* shows that an extensive dune of approximately 150m wide is situated directly to the South of the settlement at heights between 2.60m and 2.80m AHD. About 800m further south the dune narrows a little but is still at a height of 2.60 to 2.70m AHD.
- A man-made levee connects Thompson Road (continuation of Esplanade) and the natural dune to the East at height of 2.50m AHD (See *Map 3.e and 3.g* and Figure 52).

What flooding incidents have occurred?

There have been no reports of any breaches of the defences since the establishment of the settlement. However, some incidents may come to light in the public consultation process. There also have been no reports of any water moving from the sea from the South of Thompson through the pipes under the southern levee to the East of Thompson Beach.

4.3.3 Analyse the impact of sea level rise

<u>What is the likely impact on the settlement for a 2.8m AHD event (2013)?</u>

By way of comparison, the flood event of 25th April, 2009 was at height of approximately 2.4m -2.50m AHD at which time there were no reported flooding incidents at Thompson Beach. The following issues would be likely in Thompson if such an event were to occur:

- The settlement North of Ruskin Road (Thompson North) would be unlikely to be affected.
- The section of dune between Ruskin and Petrel to the South is predominantly at 2.8m or above and provided that the levee didn't fail, would provide protection.
- The section of dune between Petrel and the end of the Esplanade may be overtopped in places. Due to the low AHD height of the Esplanade road and development behind it, once the water began to flow over, it would likely scour the dune, and this may give rise to greater flooding.
- While some of the dwellings to the East are well below 2.8m AHD these would be unlikely to be inundated as this area is protected by levees at 2.5m or above, unless the inundation was for an extended period.

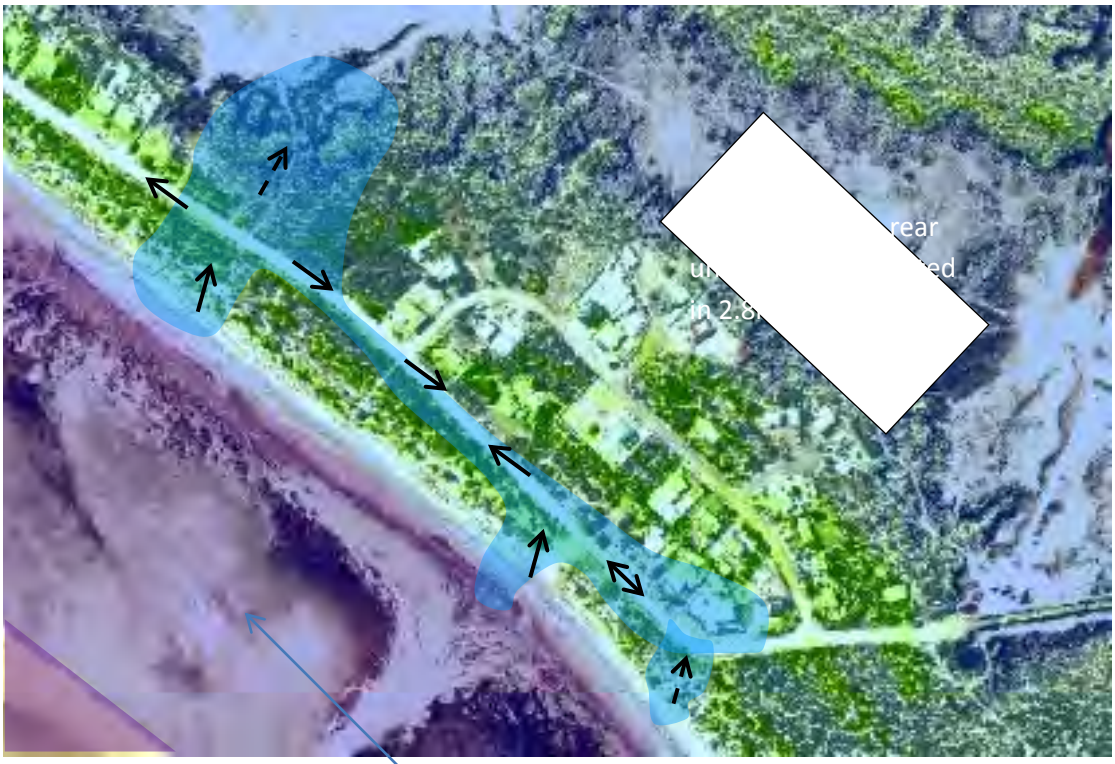


Figure 53: Possible inundation points and flow path of water inThompson Beach (South) in 2.8m AHD storm event of significant duration.

What is the likely impact on the settlement for a 3.0m AHD event (2050)?

The flood *Maps 3.a to 3.d* illustrate the impact of a 3.0m flood event. The methodology utilised is known as 'bathtub' modelling and takes no account of land forms, man-made or otherwise. Bathtub modelling also does not take into account that the water is tidal and moves in from the West and then recedes within a time frame of about 2 hours. Therefore, while some roads and properties may be lower than the 3.0m event, the water may not encroach this far into the settlement. Irrespective of these factors, the following assessment can be made about Thompson Beach's vulnerability in a 3m event:

Within the Thompson Beach settlement:

- Thompson Beach North of Ruskin Road would be unlikely to be affected as the dune system in this area is 3.0m AHD to over 4.0m AHD. Even if sea water entered from the North (See *Map 3.f*) the levee system would protect the settlement.
- As with the 2.8m event the southern end of Thompson Beach is the most vulnerable from the West. The dune would likely be overtopped and inundate the lower lying areas. However, even though the 3.0m AHD scenario map shows that the topography of this section is under the 3.0m AHD level, the 2.8m AHD map demonstrates that the level of water would be very low at the top of the ridge and therefore may not cross over to the rear with any volume.
- Some water may pass over the ridge between the two street areas shown on the map. However, it is unlikely that water would traverse from the South across the dune and then across the man-made levee at 2.5m high due to the distance from the sea front. Therefore, it is unlikely that the rear of Thompson Beach would be significantly affected by a 3.0m AHD event. An exception to this assessment may occur where the inundation is for an extended period of time.

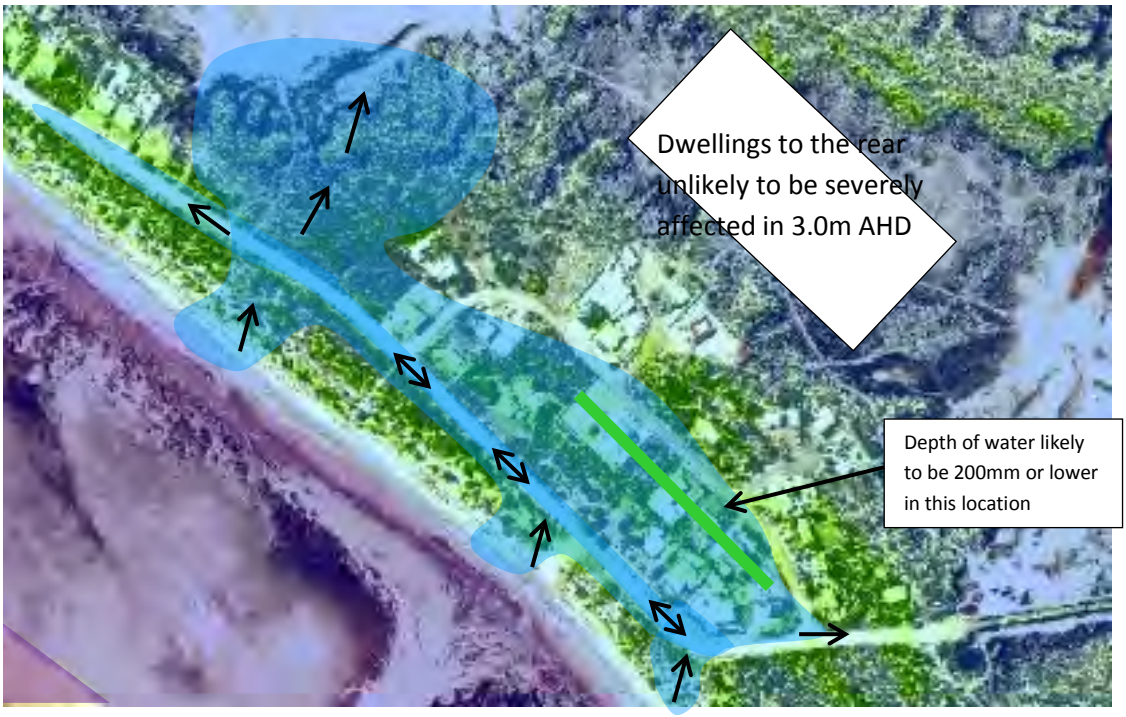


Figure 53: Possible inundation points and flowpath of water inThompson Beach (South) in 2.8m AHD storm event of significant duration.

Greater North and South of the Settlement:

It appears unlikely that a 3m event would threaten the settlement from the North or South (see *Maps 3.c to f*). However the dune to the North of the settlement appears low, is more sparsely vegetated, and has an existing incursion for sea water to enter in high tides. Over the next 30 to 80 years this dune may erode away and this could leave Thompson as a headland protected only by its levee system. The same issue exists in the South although this dune system is higher, is more densely vegetated and has no evidence of incursions by the sea.

What is the likely impact on the settlement for a 3.7m AHD event (2100)?

It is not possible to predict whether the dune systems to the North and South of the Thompson Beach settlement would survive to 2100. However, if a 3.7m event were to occur with the existing defences and dune system, Thompson Beach would be significantly affected as there are virtually no defences around the town higher than 3.7 m and the topography of the entire internal part of the settlement is less than 3.7m AHD (See *Map 3.h*).

4.3.4 Analyse emergency egress and access

In 3.0m AHD flood could residents move directly away from the place of flood and move to a safe place?

Thompson (North)

Thompson Beach north of Ruskin Road is not likely to be affected with a 3.0m AHD flood event and the Esplanade Road is generally at 2.80m to 3.0m AHD in this location. Ruskin Road is generally at 3.0m AHD or above.

Thompson (South)

There are two main problems with egress from the Southern end of Thompson Beach. The first is that the flood map of the 3.0m AHD event shows that almost the entire Esplanade is lower than this height, in some places as low as 2.35m AHD. This suggests that a storm event of any duration will inundate the Esplanade for a considerable length. The second problem is that there is only one way to exit the settlement, and that is along the Esplanade to Ruskin Road (See Figure 54). Residents will be able to move away from the place of inundation to higher ground but unable to egress the settlement.

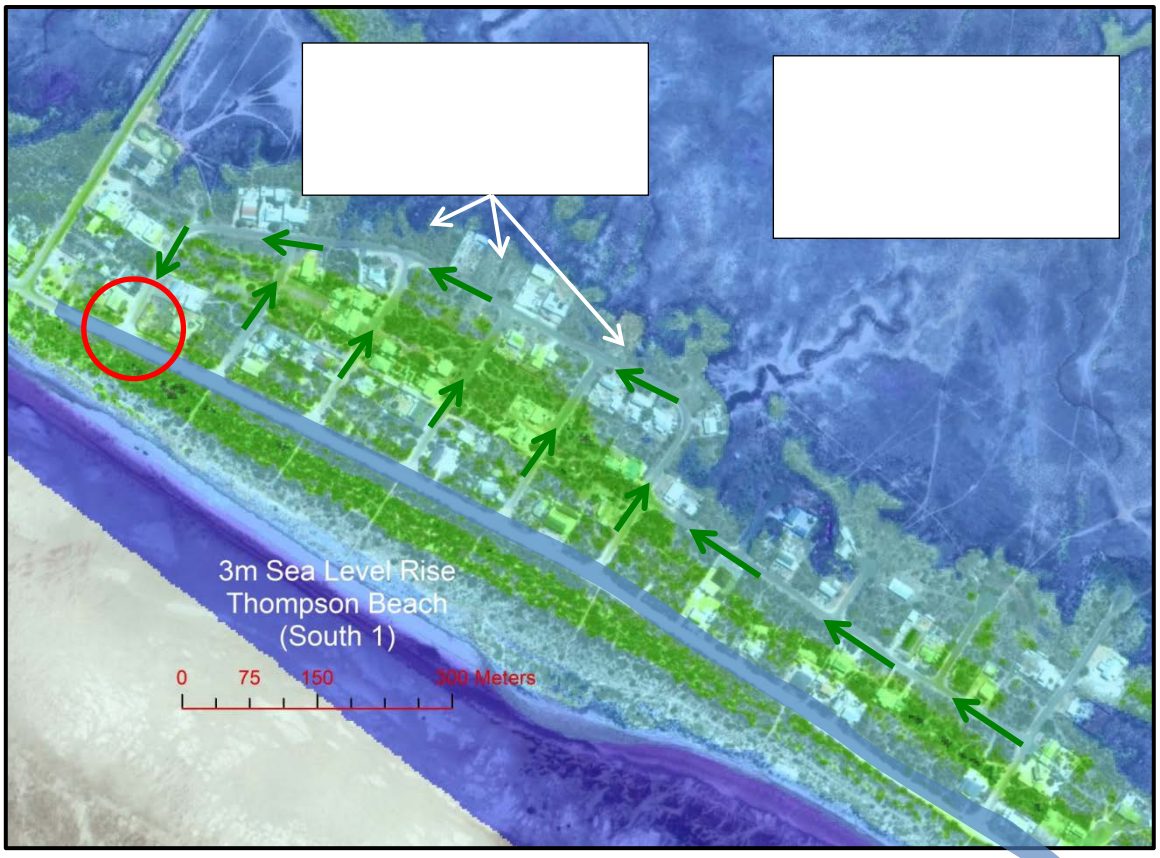


Figure 54: Emergency exit pattern from 3.0m AHD flood event at Thompson Beach South (1). Red circle indicates possible bottleneck which residents cannot pass to egress the settlement.

Those residents from the southern end would fair even worse as there is no way to access land further north that are naturally higher than by traversing the Esplanade (See Figure 55).

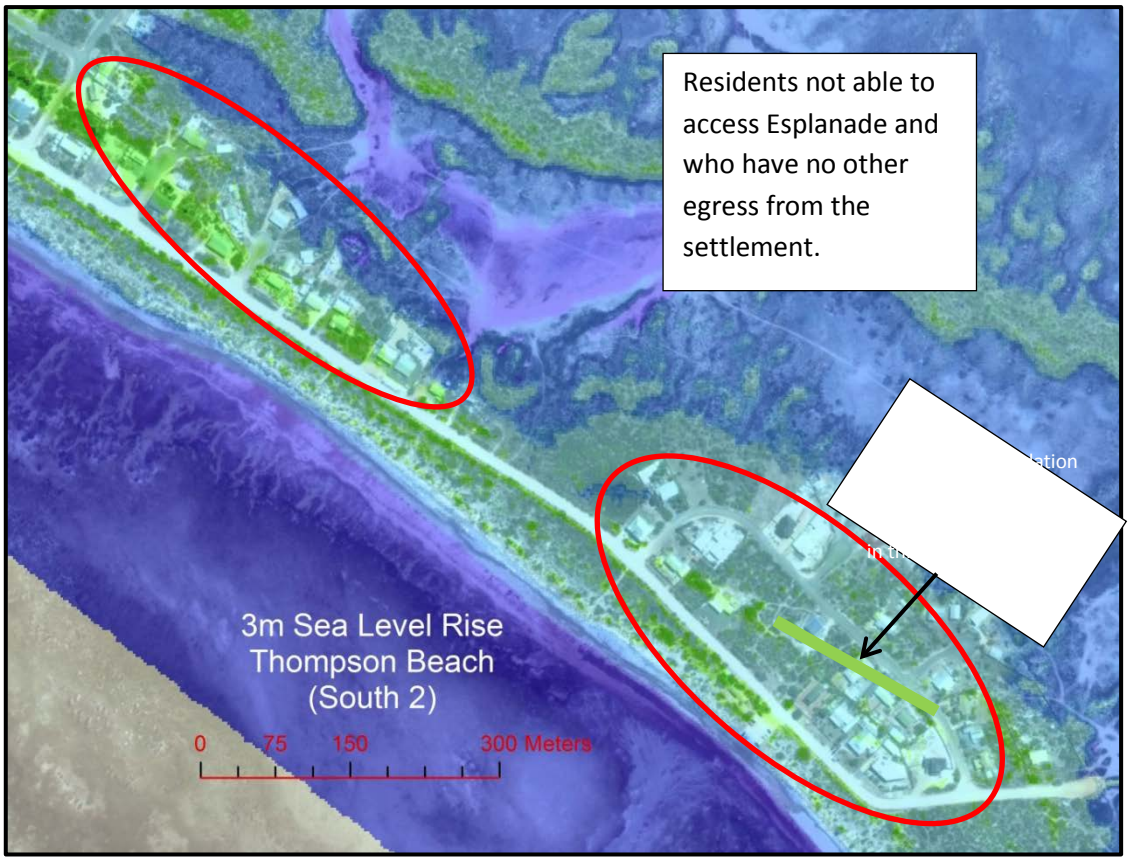


Figure 55: Emergency exit pattern from 3.0m AHD flood event at Thompson Beach South (2). Red circles indicate that residents cannot egress the settlement without traversing the Esplanade that is likely to be flooded.

In a 3.0m flood event could emergency vehicles access Thompson Beach?

<u>Thompson Beach (North of Ruskin Road)</u>

Ruskin Road which is the main entrance into Thompson Beach is at 3.00AHD or higher and as described previously, Thompson Beach North is not likely to be subject to inundation in a 3.0m AHD event and therefore access would be available.

<u>Thompson Beach (South of Ruskin Road)</u>

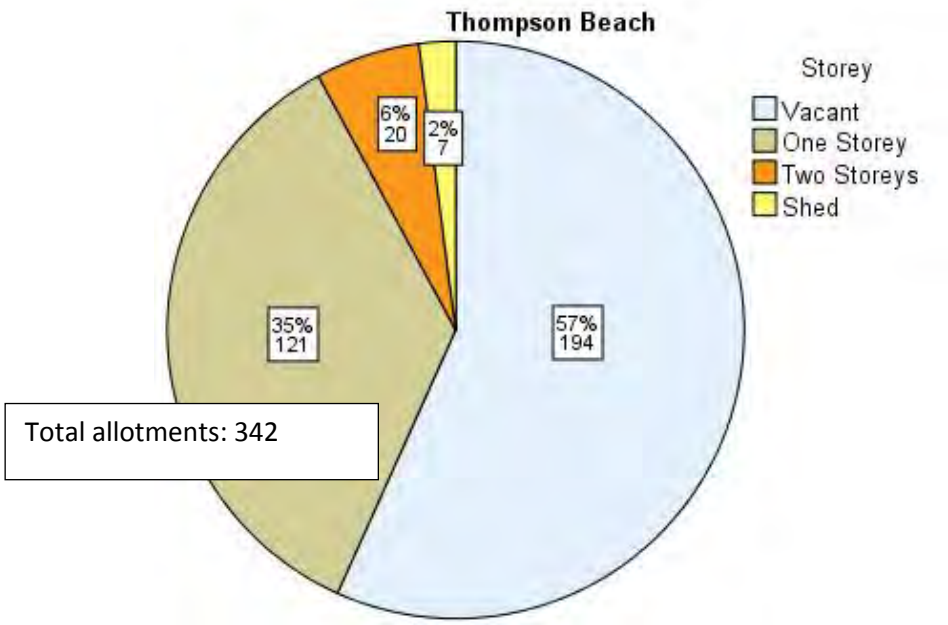
Depending on the duration of the flood event will dictate how far the Esplanade is flooded. In a worse case, emergency vehicles will not be able to access any further South than Ruskin Road. In a best case, they will be unlikely to access past Petrel Crescent meaning that no access will be available to residents on the southern end of Thompson Beach.

4.3.5 Establish profile of assets at risk

This section profiles the range of assets at risk in three main categories: privately owned assets, council owned assets, other owned assets. An accurate profile of assets will assist in decision making in the solutions stage of the project.

Privately owned assets:

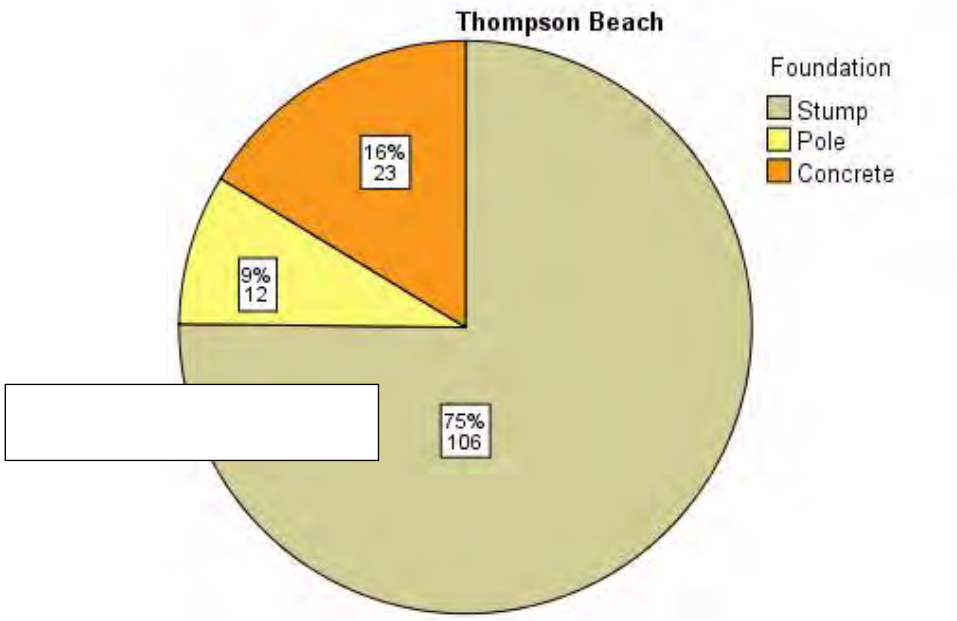
1. Total number of allotments and profile of improvements (Figure 56).



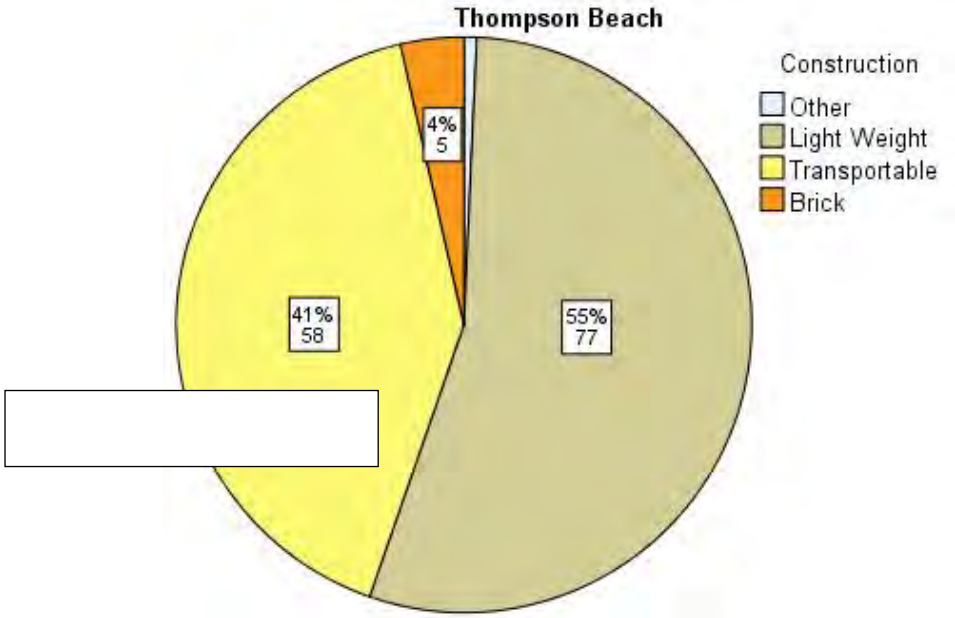
DC Mallala Council valuation data for 2013 show that the land and buildings are valued at:

Thompson Beach – value of residential assets	
Land	$23,197,000
Improvements	$13,133,500
Total capital value	$36,330,500

2. Foundation types – stump, pole, or concrete (Figure 57)

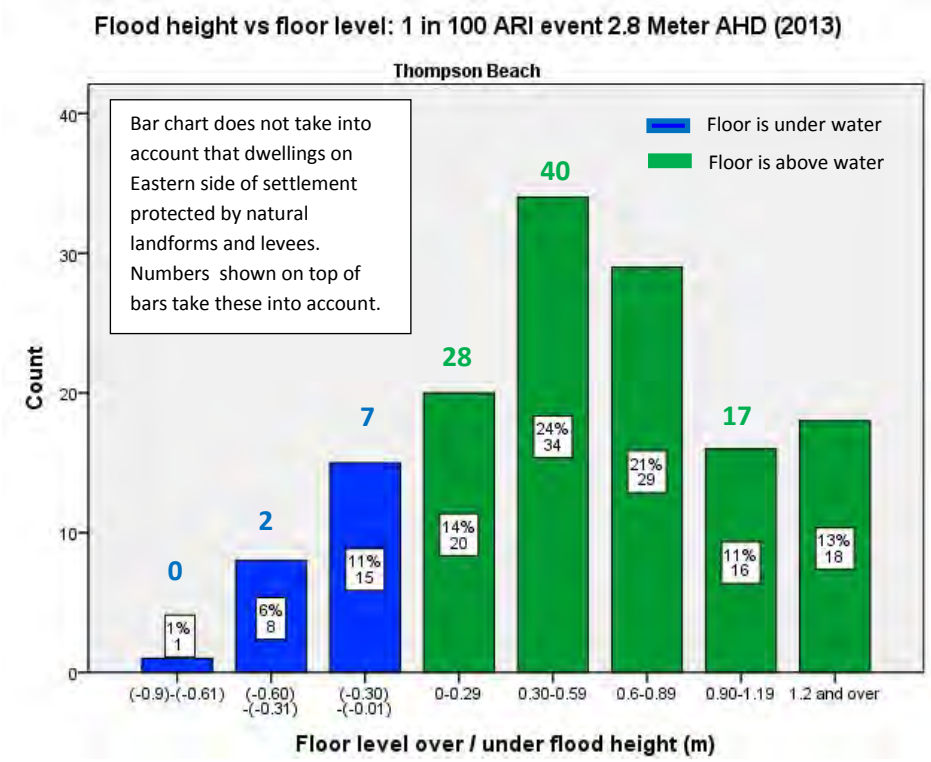


3. Construction types* (Figure 58)

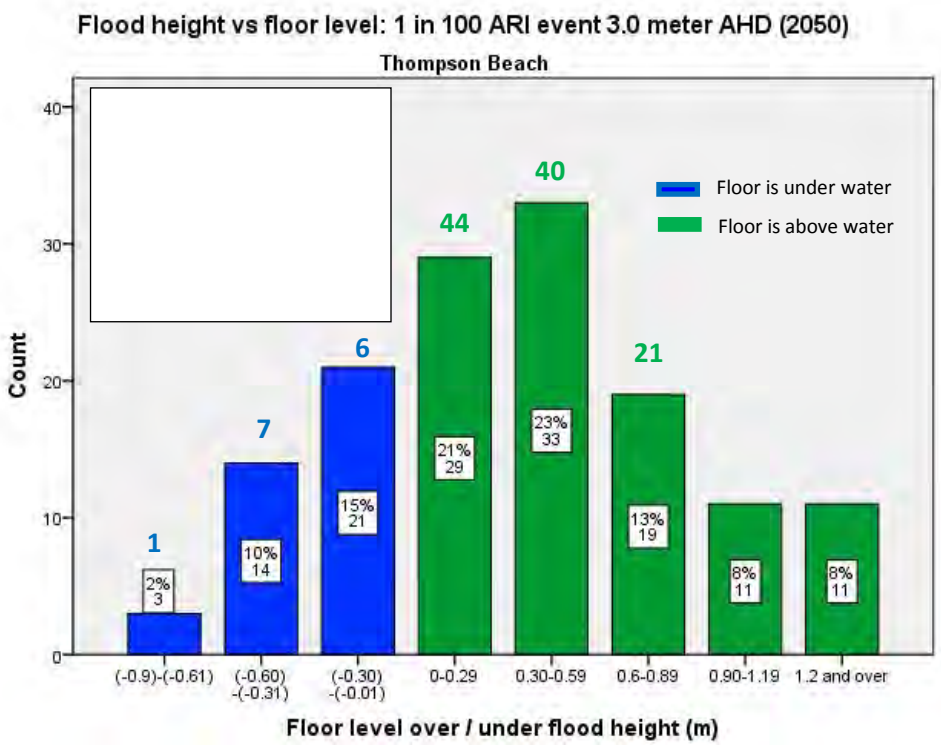


*Note: The categorisation of so many light weight construction versus transportable is likely to be in error. However, the main point here is that generally light weight construction and transportable houses are on stumps or poles.

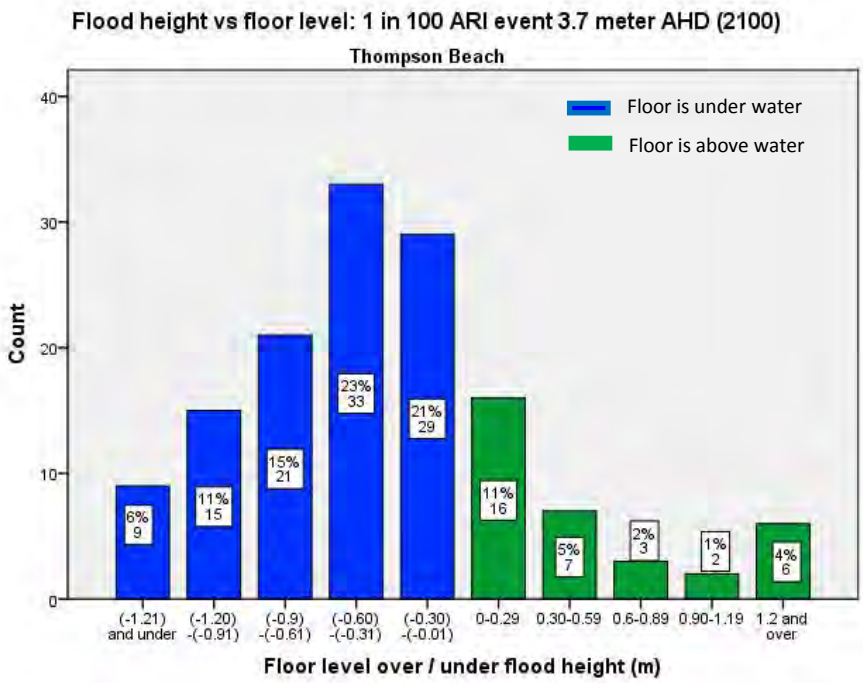
4. Impact on dwellings in selected inundation events (Figure 59)



If the predicted 1 in 100 ARI flood event occurred for 2013, the spread sheet calculation indicates that 24 dwellings in Thompson Beach, are likely to have water above their floor levels. However, this calculation includes dwellings on the Eastern side of the settlement. Therefore using the flood map those dwellings that were unlikely to be affected were removed from the calculation and the actual number of dwellings affected drops to 9.



If the predicted 1 in 100 ARI flood event occurred for 2050, the spread sheet calculation indicates that 38 dwellings in Thompson Beach, are likely to have water above their floor levels. However, this calculation includes dwellings on the Eastern side of the settlement. Therefore using the flood map those dwellings that were unlikely to be affected were removed from the calculation and the actual number of dwellings affected drops to 14.



If the predicted 1 in 100 ARI flood event for 2100 occurred, most dwellings would be likely to have water level over their floor levels as the defences and topography of the settlement is generally less than 3.7m AHD. This assessment assumes that the flood duration is significant and not just a short duration of overtopping of dunes or defences.

Council owned assets:

DC Mallala's records show that infrastructure assets at Thompson Beach are valued at $409,000 and roads are valued at $1,482,042 (See Appendix 2 – Council infrastructure).

Other owned assets:

Telstra, SA Water, and SA Power Networks have infrastructure in Thompson Beach and maps of these are included in Appendix 3.

Summary:

This section provides an overall picture of the assets that are likely to be under threat at Thompson Beach. The threat in the events of 2.8m and 3.0m inundation height are predominantly in the Southern section of the settlement with a likely result in 9-14 dwellings having water over floor level. However, roads and other infrastructure may be damaged in these events also. There are a range of strategies that could be employed to reduce the risk and in the next stage of the investigation this data will be utilised to ascertain what strategies might be employed to reduce the potential threat from impacts of the sea upon Thompson Beach.

4.3.6 Discuss liability issues.

- **What obligations did Council have at the time the settlement was established in relation to assessing impacts from the sea?**

As the development was established in the late 1980's the application was assessed through the Environmental Impact Assessment process of Planning Act 1982. A review of correspondence and reports at DC Mallala and at Coast Protection Branch was undertaken and the findings of that investigation included at Appendix 4. The following summary points explore the issues relating to the approval of the settlement:

- Coast Protection Board initially recommended that the application be refused because the EIS did not sufficiently address inundation issues. However, it also stated that should appropriate engineering solutions be devised that this position was to be reviewed.

- Coast Protection Board did give advice that the height of the front levee at 3.0m was approaching 'safe levels' but that it was preferable to add 0.2m or 0.3m to that level to allow for subsidence and/or deficient construction.

- Coast Protection Board conceded that subsequent to the production of the EIS supplement, that protection measures were adequate. However, Coast Protection Branch did eventually recommend to refuse the application but on other grounds, such as the application being at odds with the provisions of the Development Plan.

- In the supplement to the EIS the developer volunteered protection measures for the front dune at 3.4 and for the rear levees at 3.0m.

- SA Planning Commission also conceded that the engineering proposals would satisfactorily reduce the risk of flooding but also recommended that the Minister refuse the application mainly because of its noncompliance with the Development Plan .

- DC Mallala had a responsibility to have 'regard' to the submissions from all parties and as designated planning authority under the Act it had the power to make the decision. It could be argued that DC Mallala did approve an application that may have been outside the provisions of its own Development Plan but that issue is of no consequence here. It could also be argued that it did take advice and that the proposal in the EIS supplement was generally accepted by Coast Protection Board and others as adequate protection from flooding.

- No written advice can be sourced that states the CPB said that rising sea levels were to be taken into account but this was likely to be incorporated into the CPBs advice for 3.0m with an extra 0.2 or 0.3m. The assessment by SA Planning Commission does note that CPB gave advice on this issue.

- Irrespective of whether this advice was given, DC Mallala had no statutory responsibility to incorporate sea level rise. To also provide a contextual point, the International Panel on Climate Change first met in 1988 so it could be reasonably deduced that sea level rise was unlikely to be a matter considered at local government level. Coast Protection Board is regarded as a world leader in the matter of rising sea levels (Balston et al. 2012)

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

The following points explore the issues surrounding the implementation of the protection works:

- The reports and correspondence indicate that the Coast Protection Board (and possibly other agencies) was under the assumption that the protection works were going to be installed as per the EIS supplement.

- Late in December 1989, Coast Protection Branch sent a letter to the Council seemingly coinciding with the installation of the protection works. In that letter Coast Protection Branch reminded the Council of the construction details of the levees.

- However, it appears that the developer was planning to install the levees differently than the construction details in the EIS for a considerable length of time. This is evidenced to the numbers of times correspondence from the developer to the Council referred to the 3.0m AHD height for the front levee. In a transcript of a meeting with Council members in November 1989, the developer states while referring to the whole process, including the EIS, 'it was agreed that 3m should be the level'.

- Plans held at DC Mallala show levees to be constructed at 3.0m to the frontal and rear levees. The plans relate to Stage 2 of the subdivision but are unstamped as being received or approved.

- A letter from the Council to the developer circa 1989 indicates that the Council was aware that the levees were being implemented at 3.0m but Council may not have been aware that the southern levee was being installed at a lower level.

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

No.

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

The question here is, did the Coast Protection Board advise site and floor levels based on the understanding that protection works were at 3.4m AHD. Further research is required to understand the ramifications of this possibility.

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

No, but upcoming community consultation will begin this process.

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

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

Summary

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

- Thompson Beach was subdivided in the late 1980s and impacts of the sea had to be considered as part of the establishment 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 responsible to implement protection works at ever increasing heights.
- 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 of the implementation of the protection works, it appears that the developer worked on a different installation height than they volunteered in the EIS supplement. The Council was aware of the height the developer was utilising. The question of who knew at Council of the discrepancy between the two heights is unknown. There was a gap of 3 years between the EIS process and the installation of the levees.
- On the positive side, the Council did get and heed advice about the necessity for the implementation of protection works. In the adaptation solutions section of this study, an exploration of how the Council could now take new advice in the light of this study may be a way forward to resolving this issue.
- A secondary positive aspect is that there have been no reports of inundation and there are few houses that are affected by 2.8m or 3.0m AHD storm events (unless an event is of significant duration). Further confirmation of the floor heights of houses in areas susceptible to inundation may confirm the serious or otherwise of the situation.
- Councils are likely to have a responsibility to warn their constituents of any danger. Therefore, the Council should make the findings and mapping from studies such as this one available to the public.
- 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.

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, recent trend in Court decisions indicates that the Court will take into account climate change related facets to a case.

4.3.7 Summary Table – Thompson Beach

Stage	Question	Summary comment
1. Site history	When was the settlement founded?	Late 1980s
	Were climate change and sea level rise issues relevant?	No, there was no requirement to take into account sea level rise.
2. Existing protection	What existing natural protection exists?	Dunes to the foreshore, dunes to the rear of the settlement.
	What breaches have occurred?	None.
	What manmade protection works have been installed into the settlement?	Around 1990, a levee was installed to the foreshore, a levee on each end of the settlement to join with natural dune systems to the East and the natural dune system to the East was elevated in places.
3. Impact of storm events	What is the likely impact for a 2.8 m AHD event?	The front dune may be overtopped on the southern end of the settlement and the Esplanade inundated.
	What is the likely impact for a 3.0 m AHD event?	The front is likely to be overtopped on the southern end resulting in significant inundation.
	What is the likely impact of a 3.7m AHD event?	All defence systems overtopped and the vast majority of the settlement inundated.
4. Emergency access and egress	Egress issues in a 3.00AHD event	Egress is ok in the North, impeded in the South.
	Emergency vehicle access in a 3.0m AHD event.	Access is clear in North but could be severely impeded in the South.
5. Profile of assets at risk	How many residents are likely to be affected in 3.0m event?	14 dwellings.
6. Liability issues	Does liability exist if Council fails to implement protection?	Unlikely to be any general liability
	Have residents been warned?	Not yet.
	Have emergency procedures been implemented?	Not yet.
	Are there conditions relating to the maintenance or upgrade of protection works	Yes, levees may be too low. Legal advice is required.
	Is there a maintenance regime of protection works?	Unknown.

4.2 Middle Beach

4.4.1 Site history

- **When was the settlement established?**

Nothing is known as yet about the establishment of Middle Beach. The land on the foreshore was originally leasehold to the State Government, so the establishment may not have been overseen by DC Mallala.

- **What obligations did Council have in relation to the establishment of the settlement?**

It is very unlikely that there are any obligations arising out of the establishment.

4.4.2 Analysis of existing protection - natural and man-made

The following assessment of natural and man-made land forms that provide Middle Beach with protection from the sea is to be read while viewing the State of Play (Maps) that append this report. Heights are expressed in metres AHD but normally the acronym AHD is assumed in the context of the report.

What existing natural protection exists in Middle Beach?

<u>To the West</u>

The Esplanade forms the spine around which the settlement is structured. On the West side are houses and shacks that have direct frontage to the shoreline and thus have no engineered system of protection (see Figure 60). Further West a substantial mangrove colony is growing in the shallow water that may provide some buffer from the sea in relation to wave height and velocity of water. The only visible gap in the mangroves is for the tidal inlet of Salt Creek (See *Map 4.a*).

Figure 60: Middle Beach shore line looking South (J. Kellett, 2013)

To the South

Salt Creek forms the southernmost border of Middle Beach on which a boat ramp has been installed (Figure 61).

Figure 61: Middle Beach boat ramp on the southernmost end of Middle Beach Road

To the East:

Access to the shacks and houses on the front row is from Esplanade at the rear. On the Eastern side of the Esplanade is a second row of eleven houses (Figure 62).

Figure 62: Middle Beach road is the spine around which the settlement is structured.

The Salt Creek inlet swings around behind the Middle Beach settlement allowing water to enter to the East of the settlement (See *Map 4.a,b)*.

<u>To the North</u>

On the Northern most tip of Middle Beach is the privately owned Middle Beach Education and Recreation Centre. Another tidal creek passes close by this centre to the North and water flows into the flats to the East of the settlement (See *Map 4.a,b*).

Figure 63: Northern end - Middle Beach Education and Recreation Centre and tidal creek.

What flooding incidents have occurred?

There have been numerous incidents reported to the Council Depot but only 4th July 2007 and 25th April 2009 are covered in this report. Screen captures from video taken on 4th July 2007 (pictures from 29.53) by John Kneuitt provide a valuable insight to the flow of water:

Figure 64: Water flowed into the car park over the front levee (looking South-West towards boat ramp).

Figure 65: Looking West toward the car ramp to Beach

Figure 66: Looking North-West towards the southernmost house on the shoreline.

Figure 67: Water flowed north along Middle Beach Road and joined flood waters coming between the houses on the shore front.

A large volume of water also travelled up the tidal creek and filled up the area behind the settlement and entered into the resident's back yards on the second row.

Figure 68: Looking East behind the settlement – water entered through Salt Creek.

Figure 69: Water entered the backyards of houses on second row with minor inundation of some sheds.

Figure 70: Video taken from the same location as Figure 69 but now facing West demonstrates that water almost covered the peninsula.

Figure 71: Markers such as these suggest the AHD height of the water was 2.4 -2.5m

Damage in this event included the ripping out of stumps under a house at Lot 1785 as the tide receded. The receding tide also eroded a gully which took two semitrailer loads of sand to refill (Source: Keith Earl, DC Mallala).

Figure 72: Location where water flowed between houses (Keith Earl, 5.07.07)

Figure 73: The filling of sand almost completed (Keith Earl, 5.7.07)

Water also cut across Middle Beach Road further inland possibly from both the North and the South (*See Map 4.c*)

What man-made protection works have been installed in Middle Beach?

Working from South to North, man-made protection works include:

- Loose rock armament to the southern tip, adjacent the boat ramp, installation date unknown (Figure 74).

Figure 74: Rock armament to southern tip of settlement.

- Subsequent to the events of 2007 and 2009, a concrete block wall was installed along the Western side of the car park (Figure 75).

Figure 75: Concrete block wall to Western side of car park.

- Further South protection is entirely an individual matter and the following photographs illustrate the range of measures utilised (Figures 76-80).

Figure 76: Car park block wall joins the wall of the southernmost house (pictured).

Figure 77: Double concrete block retaining with elevated stump floor.

Figure 78: Concrete block, rock armament, stilts

Figure 79: Elevated floor – no protection

Figure 80: Earthen levee – common along the frontage of varying heights.

- On the East side at the rear of the second row of houses some dirt levees/ mounds have been installed (date unknown).
- To the South of the second row of houses is a ridge of land with some points with height above 3.0m AHD (See *Map 4.a*). This ridge may be a combination of natural ridge and man-made structure with the installation date unknown.

Figure 81: On top of ridgeline to East of Middle Beach Road looking South West.

- On the Northern end of the settlement Middle Beach Education and Recreation Centre is surrounded by levees approximately 2.80 m to 2.90 m high (*See Map 4.b*)

4.4.3 Analyse the impact of sea level rise

<u>What is the likely impact on the settlement for a 2.8m AHD event (2013)?</u>

By way of comparison, the flood event of 4th July, 2007 was at height of approximately 2.4m-2.5m AHD. The following issues would be likely in Middle Beach if such an event were to occur:

- While the new concrete block wall and levee at height 2.80m AHD approx may not be overtopped, water would enter the car park over the top of the boat ramp.
- Knowing that the access road (unsealed) at the rear of the front row of dwellings is generally at 2.0m, and in some places lower, it is logical to assume that water would flow between buildings where protection works were lower than 2.80m.
- Water would enter behind the settlement by way of Salt Creek and the tidal creek north of the recreation centre and inundate the entire settlement. The levee system to the East (and North of 'Row 2) has numerous entry points lower than 2.8m, with one main one at 1.6m AHD (See Map 4.a).
- The access road into Middle Beach would be overtopped by 0.8m water (See Map 4.c).
- The recreation centre at the Northern end would be unlikely to be overtopped.

What is the likely impact on the settlement for a 3.0m AHD event (2050)?

The flood maps (*Maps 4.a, 4.b, 4.c*) illustrate the impact of a 3.0m flood event. The methodology utilised is known as 'bathtub' modelling and takes no account of water flow in relation to land forms, manmade or otherwise. Bathtub modelling also does not take into account that the water is tidal and moves in from the West and then recedes within a time frame of a few hours. Irrespective of these factors, the following assessment can be made about Middle Beach's vulnerability in a 3m event:

- The concrete blocks and levee system to the Western side of the car park would be overtopped.
- Knowing that the access road (unsealed) at the rear of the front row of dwellings is generally at 2.0m, and in some places lower, it is logical to assume that water would flow between buildings where protection works were lower than 3.0m.
- Water would enter behind the settlement by way of Salt Creek and the tidal creek north of the recreation centre and inundate the entire settlement. The levee system to the East (and North of 'Row 2) has numerous entry points lower than 2.8m, with one main one at 1.6m AHD.
- The access road into Middle Beach would be overtopped by 1.0m water.
- The levee system around the recreation centre at the Northern end would be overtopped.

Greater South of the Settlement:

No review has been undertaken of topography further south as the Salt Creek inlet is the extremity of the flood mapping.

Greater North of the Settlement:

The mangrove colony and inlets are substantially lower than the Middle Beach settlement and it could be expected that increased amounts of water will encroach further inland causing the farmland to recede.

What is the likely impact on the settlement for a 3.7m AHD event (2100)?

As Middle Beach has very low topography a 3.7m AHD event would completely submerge all land forms. Some dwellings on stilts may be higher than 3.7m but they would be cut off from all contact with land.

In relation to Salt Creek

A review of Coast Protection Board records and reports on 13th August, 2013 found that there has been some concern that Salt Creek is increasing in silt levels. This issue was first raised in 1982, at which time Coast Protection Board stated, 'inward growth of mangroves has had no effect on siltation process occurring at Middle Beach but is a consequence of it'. He notes that the work of Penrice Soda was 'accelerating' the process but the silting was mainly due to a 'long term natural process'. A further report (source needed) that the main cause of siltation was the die back of seagrass meadows south west of Middle Beach with a large 'slug' of sand gradually moving northwards. The mangrove colonies thrive in water that has little movement and this would account for the increase in mangrove colonies in the area.

In relation to this study, further research is required to ascertain whether this is in fact a process of 'coastal accretion' and what bearing this has on the flooding issues at Middle Beach.

4.4.4 Analyse emergency egress and access

In 3.0m AHD flood could residents move directly away from the place of the flood and move to a safe place?

The only land form higher than 3.0m AHD is the ridgeline to the South of 'Row 2'. However, it is unlikely that access to the ridge in flood conditions is available because of a ditch that runs between the road and the ridge. Secondarily, history shows that the water is likely to first enter the car park and the Council drainage easement, and therefore cut off access to any residents south of this point.

In a 3.0m flood event could emergency vehicles access Parham?

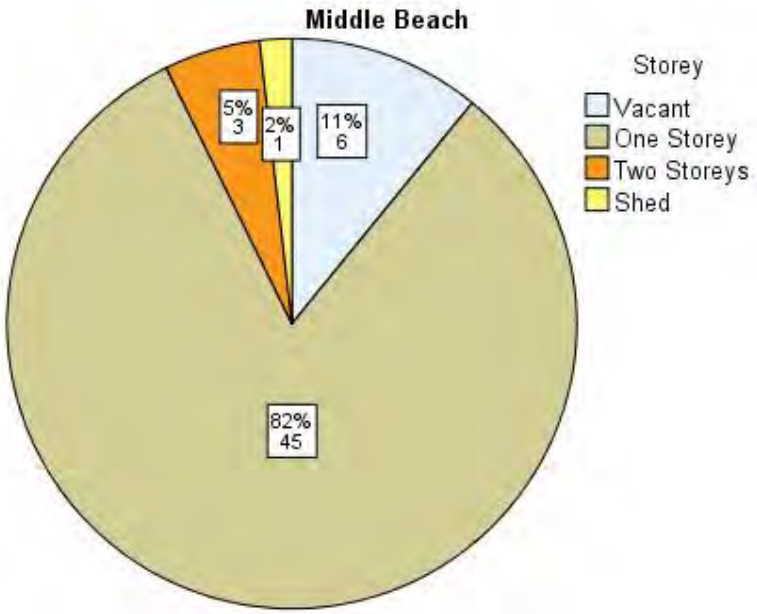
Emergency access via road would be impossible in a 3.0m AHD event as the causeway is generally at height 2.00m AHD and such an event would cover the road by 1.0m (See *Map 4.c*).

4.4.5 Establish profile of assets at risk

Using the methodology reported in Section 1, this section profiles the range of assets at risk in three main categories: privately owned assets, council owned assets, other owned assets. Identifying the different construction types provides appropriate data from which to offer some solutions for adaptation should these be required.

Privately owned assets:

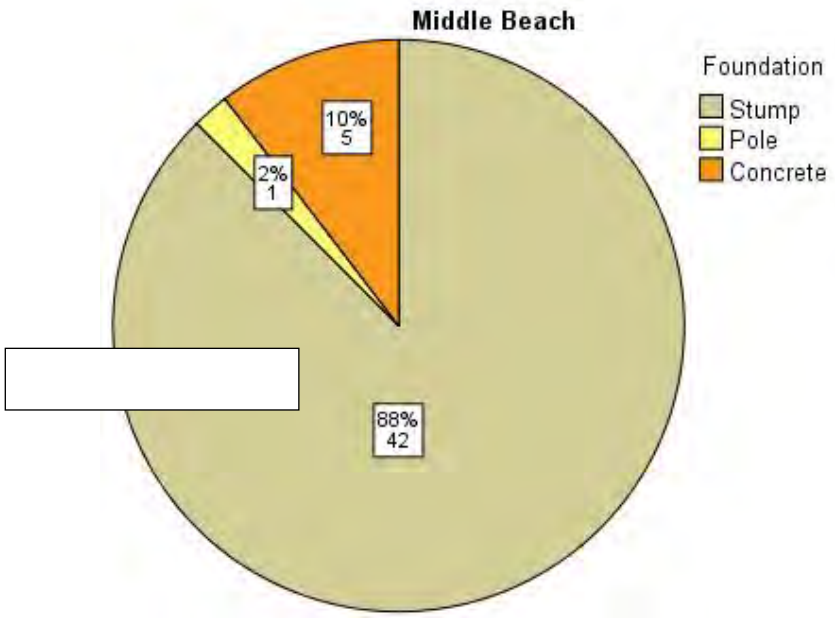
1. Total number of allotments and profile of improvements (Figure 82).



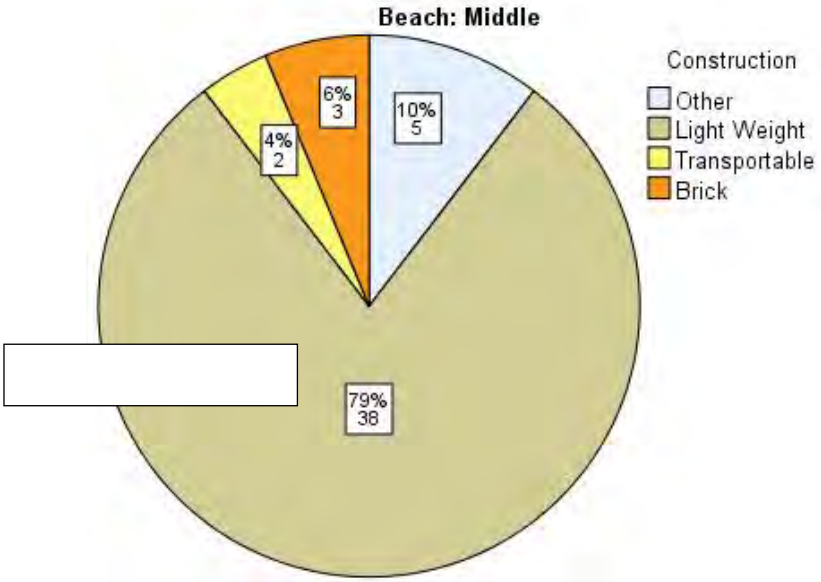
DC Mallala valuation records for 2013 show that the land and buildings are valued at:

Middle Beach – value of residential assets	
Land	To be advised
Improvements	To be advised
Total capital value	$20,668,000

2. Foundation types – stump, pole, or concrete (Figure 83)

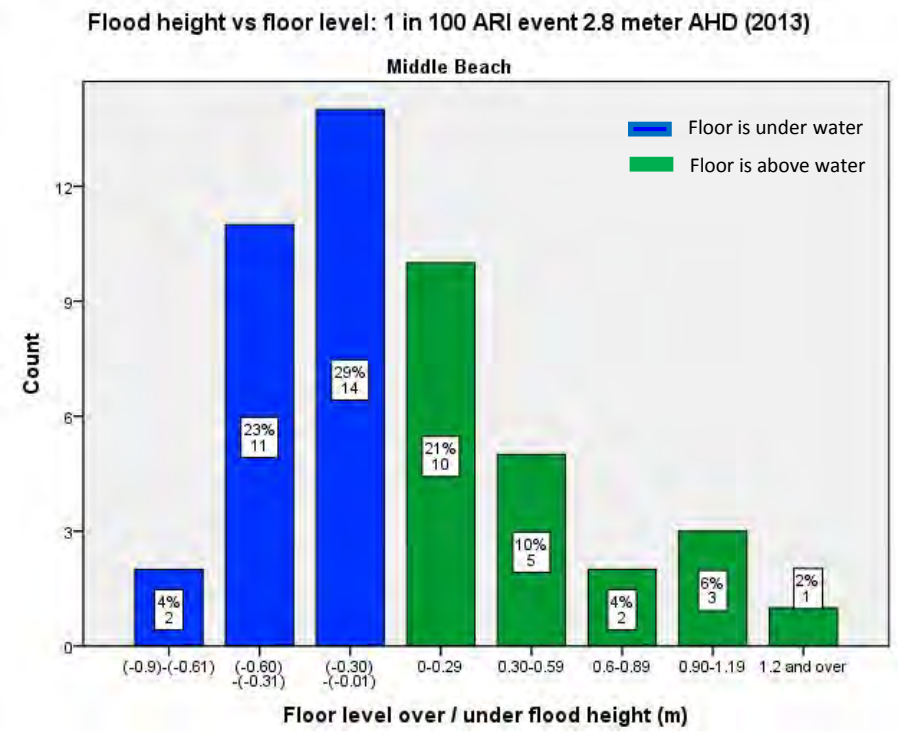


3. Construction types* - lightweight, transportable, brick (Figure 84)

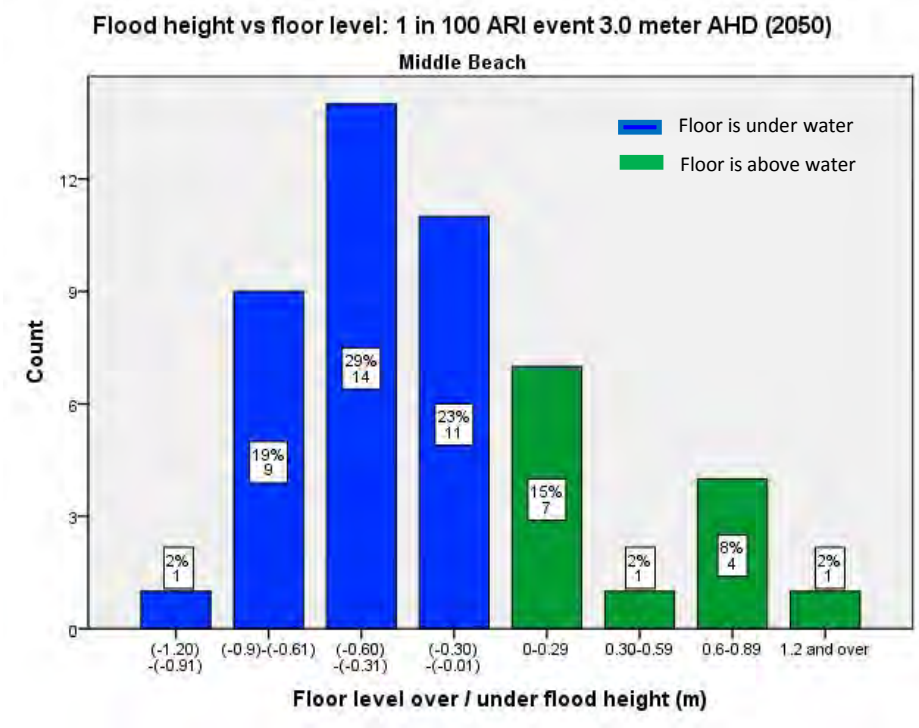


***The 'lightweight' category has likely been over applied and 'transportable' under applied. The basic issue is whether the dwelling could be raised.

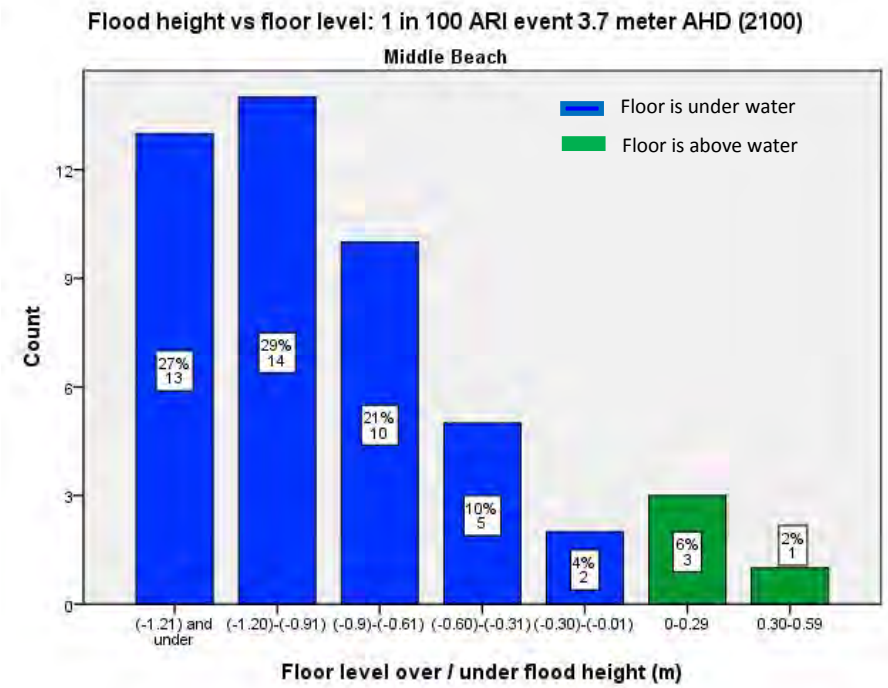
4. Impact on dwellings of selected inundation events (Figure 85)



If the predicted 1 in 100 ARI flood event occurred for 2013, the spread sheet calculation indicates that the floor of 27 dwellings in Middle Beach would be underwater.



If the predicted 1 in 100 ARI flood event occurred for 2050, the spread sheet calculation indicates that 35 dwellings in Middle Beach would have water over floor level, with 24 of these having over 300mm water over floor level.



If the predicted 1 in 100 ARI flood event occurred for 2100, the spread sheet calculation indicates that only 4 dwellings would have floor levels higher than 2.7m AHD.

Council owned assets:

DC Mallala's records show that infrastructure assets at Middle Beach are valued at $895,000 and roads are valued at $812,092 (See Appendix 2 – Council infrastructure).

Other owned assets:

Telstra, SA Water, and SA Power Networks have infrastructure in Middle Beach and maps of these are included in Appendix 3.

Summary:

This section provides an overall picture of the assets that are likely to be under threat at Middle Beach. The threat in the events of 2.8m and 3.0m inundation height will inundate most of Middle Beach. However, roads and other infrastructure may be damaged in these events also. There are a range of strategies that could be employed to reduce the risk and in the next stage of the investigation this data will be utilised to ascertain what strategies might be employed to reduce the potential threat from impacts of the sea upon Middle Beach.

4.2.6 Discuss liability issues.

- **What obligations did Council have at the time the settlements were established in relation to assessing impacts from the sea?**

Middle Beach was subdivided in (to be advised) and therefore nothing is known about what information was assessed. There are very unlikely to be any obligations for the Council arising from the establishment of Middle Beach.

In 2002, the entire front row of dwellings were transferred from leasehold to free hold Torrens Title. Land management agreements were enacted for each owner that moved liability entirely to the owners to mitigate their own risks.

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

Levee	Implementation Date	Responsibility and liability
Concrete block wall to car park	2011	No development application but general responsibility to maintain. Possible liability if the concrete wall was to fail in a storm event.
Levee to South of Row 2 dwellings (North East of settlement)	Unknown	Unknown when or how this levee was installed, or even if it was intended to act as a levee. No responsibility or liability likely for council.
Levees and protection works to the front of Row 1	Various	No responsibility and no liability to Council.
Levees around the recreation centre	Unknown	Likely no responsibility and no liability to Council as the park is privately owned.

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

Yes, see activities recorded above. There may be potential liability where protection works are shown not to have been maintained, not necessarily just because they are breached. A regular inspection regime (even annually) assists Council in fulfilling a duty of care.

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

Council has had a policy of applying the heights of sites and buildings in accordance with Coast Protection Board advice.

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

No, but upcoming community consultation will begin this process.

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

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

Summary

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

- Middle Beach was subdivided and settled in (to be advised) so the Council has no liability stemming from the establishment 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 responsible to implement protection works per se, and have no responsibility in relation to those allotments under a land management agreement enacted in 2002.
- 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 particular to protection works, the Council is likely to have a responsibility to ensure that protection works that have been installed more recently are adequately maintained in integrity and height.
- However, while there is no legal responsibility to implement protection works, Councils are likely to have a responsibility to warn their constituents of any danger. Therefore, the Council should make the findings and mapping from studies such as this one available to the public.
- 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.

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, recent trend in Court decisions indicates that the Court will take into account climate change related facets to a case.

4.2.7 Summary Table – Middle Beach

Stage	Question	Summary comment
1. Site history	When was the settlement founded?	To be advised
	Were climate change and sea level rise issues relevant?	No, there was no requirement to take into account sea level rise.
2. Existing protection	What existing natural protection exists?	None.
	What breaches have occurred?	Several – eg. 2007, 2009.
	What manmade protection works have been installed into the settlement?	Levees to the recreation park but not Council responsibility. Possible levee to South of Row 2 but this is likely a combination of natural and man-made. Not likely to be any responsibility or liability relating to this levee.
3. Impact of storm events	What is the likely impact for a 2.8 m AHD event?	Flooding expected for roads, and dwellings (27 affected). Settlement cut off from mainland at depth 0.8m
	What is the likely impact for a 3.0 m AHD event?	Flooding expected for roads, and dwellings (35 affected). Settlement cut off from mainland at 1m.
	What is the likely impact of a 3.7m AHD event?	All land forms to be overtopped. Settlement cut off from mainland at depth 1.7m. All dwellings to be affected apart from 4.
4. Emergency access and egress	Egress issues in a 3.00AHD event	No egress from settlement and no safe land to which to retreat.
	Emergency vehicle access in a 3.0m AHD event.	No access.
5. Profile of assets at risk	How many residents are likely to be affected in 3.0m event?	35 affected.
6. Liability issues	Does liability exist if Council fails to implement protection?	Unlikely to be any general liability
	Have residents been warned?	No.
	Have emergency procedures been implemented?	No.
	Are there conditions relating to the maintenance of protection works	No.
	Is there a maintenance regime of protection works?	Unknown.

- Further research is required to ascertain the long term impact of the siltation processes underway at Middle Beach in relation to flooding.

5. Conclusion

The conclusion of the first stage of the project is really a bridge into the next phase – consultation. This report is a work in progress and the public, the DC Mallala Council, and other agencies will contribute to the knowledge base that is assembled here. Further research is required to ascertain:

- In relation to Middle Beach and Webb Beach, the circumstances when they were settled.
- In relation to levees: when some of the levees were installed and what maintenance procedures the Council employs in overseeing them (if any).
- This report has largely drawn on two flood events – 4th July, 2007 and 25th April, 2009. The public is likely to be a repository of knowledge about other events that could build an important data base about the levels that waters have reached as well as how the water acts (an example of this is the video for Middle Beach event in 2007).

All four settlements were passed through an eight stage investigation process for two main purposes:

- To identify where the settlements are vulnerable to future flooding and how settlements might be affected by rising sea levels,
- To form a profile of the existing infrastructure: privately owned, council owned, and owned by others.

The overarching purpose of collecting the data is to provide a basis to make recommendations for adapative solutions that will fall into the following categories:

- **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.

It is now hoped that the consultation phase will add to this repository of knowledge so that adaptation solutions can be applied in the third stage of the project.

6. References

Australian Government, 2010, Developing a National Adaptation Agenda, Report from National Coastal Adaptation Agenda conference, 18-20 February, 2010. Adelaide, South Australia.

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.

Balston, J.M., Kellett, J., Wells, G. Li, S., Gray, A., Western, M. (2012). Climate change decision support framework and software for coastal Councils, Local Government Association of South Australia, Adelaide, SA. pp.139.

Caton, B., Fotheringham, D., Krahnert, E., Pearson, J., Royl, M. & Sandercock, R. 2009, Metropolitan Adelaide and Northern Coastal Action Plan (MANCAP), Prepared for the Adelaide and Mount Lofty NRM Board and Department for Enviroment and Heritage, Adelaide.

Clarke B and Simpson, N, 2010, *Climate Change Vulnerability – identification of threatened coastal habitat in the Adeaide and Mount Lofty Ranges Region* prepared for Adelaide and Mount Lofty Ranges Natural Resources Management Board (p. 186-197)

Dale, K., Edwards, M., Middelmann, M. and Zopou, C. (2004) Structural Flood Vulnerability and the Australianisation of Black's Curves, Risk 2004 conference proceedings, Risk engineering society, Melbourne. http://www.ga.gov.au/image_cache/GA19290.pdf accessed 21/03/2012

Planning Act (SA) 1982

Rawlings, R., 2013, *Overview of the ecology and heritage of Parham, Webb Beach, Thompson Beach and Middle Beach,* prepared for DC Mallala

Western M., & Kellett, J. 2013, *Dealing with the impacts of sea level rise on coastal assets, a* Powerpoint developed for SA Local Government Association.

Appendices:

Appendix 1 – Exploration of general legal issues.

Appendix 2 – Council infrastructure records.

Appendix 3- Other infrastructure maps (SA Water, SA Power Networks, Telstra)

Appendix 4 – Thompson beach review.

Appendix 1 – Exploration of legal issues

Feedback from participants at the National Coastal Adaptation Agenda conference held in Adelaide in 2010 found that legal liability was one of the key concerns of local councils.

It is understood that you are not a solicitor and that external advice will need to be sought to make final decisions. However, as this is an emerging field it is unlikely that your local solicitor will be well versed with the issues at law and therefore it is recommended that you inform yourself about some of the key issues. When legal advice is sought you will have the key facts and issues distilled ready for analysis.

The information provided here is for educational purposes and is not to be relied upon as legal advice. The source of information in this section is entirely taken from the report, *Local Council Risk of Liability in the Face of Climate Change - Resolving Uncertainties* by law firm Baker and McKenzie (2011). Some key principles are distilled for you on the following slides but a greater understanding of the issues are found in Appendix 3 by pressing on the icon of the report below, or to review the entire report by Baker and McKenzie press the icon below.

A Council that accepts legal liability for an asset may face claims for future damage to that asset from its owners. If liability has not been clearly established such claims may result in legal action where the Council may have to spend time and money to defend itself in court, and then pay damages if it loses the case. It makes sense to establish who is liable for the assets in the event of an action of the sea that results in damage. A determination that the Council is not liable for an asset does not necessarily mean that the Council will take no action, but allows the Council to deal with the matter from a position of strength, or react more quickly if it is perceived that its position is weak.

This determination will need to be made by a properly qualified legal personnel. However, the collection of data you have made in the previous steps will greatly assist in making this determination. While all councils care about the wellbeing of their constituents, the way that legal liability impacts a council is financial. There are two main ways a council may have financial costs in relation to legal liability.

1. <u>Administrative appeals</u>.

Administrative appeals relate to challenges made at law to decisions the council has made. For example, a developer may challenge the council decision to refuse an application for a development based on the risk of rising sea levels to that development. Conversely, third parties such as environmental groups may appeal decisions made in favour of a development and cite rising sea levels as a reason not to proceed with the development. The cost in an administrative appeal is confined to the cost of time and resources in defending the action. Because these generally relate to new development no further attention is given to this matter here apart from noting that the vast majority of legal action in Australia relating to climate change and sea level rise has been administrative appeals.

2. Tort based claims.

A tort based claim is sought for a perceived breach of duty other than under contract. There are two main types that that might be brought against a Council:

- ❖ Claims of negligence
- ❖ Claims of nuisance.

❖ Elements of a negligence claim:

Negligence is a failure to exercise care or skill. An action of negligence 'will not succeed if the defendant can establish a defence' (p.27). Assuming the Council is the defendant the elements are:

- The defendant owed the plaintiff a duty of care;
- The defendant breached that duty of care;
- The plaintiff suffered loss or damage as a result of the breach of duty;
- The loss or damage is not too remote.

<u>Duty of Care</u>

In common law, a Council that is under no statutory obligation does not generally owe a common law duty of care. 'Therefore at common law, there are only limited circumstances in which a Council is liable for failure to exercise a statutory function' (p. 28). Each State and Territory (apart from SA and NT) has legislation to further limit the liability of statutory and public authorities that also includes Councils (p. 28).

<u>Breach of duty</u>

A plaintiff must show that a reasonable person in the defendant's position, would take certain reasonable precautions against a reasonably foreseeable risk of injury. In determining this a court will consider the following factors:

- The likelihood of the risk occurring;
- The magnitude of the risk and the seriousness of the potential harm;
- The difficulty, expense and inconvenience of taking the precautions;
- The social utility of the defendant's conduct.

<u>Causation</u>

The plaintiff must prove that the defendant's negligence cause or materially contributed to the injury or damage suffered by the plaintiff.

❖ Elements of Nuisance Actions

In common law there are two types of nuisance tort claims: private and public. Private nuisance is an interference with an individual's rights in relation to the use of the land that

may occur by material damage to land or property upon which the interference occurred. In some cases a person may be liable in private nuisance even if the damage results from natural causes, if the defendant knew of the cause but did nothing to prevent it. The following elements must be proven (p. 28,29):

- The defendant is vested with management and control of the premises or asset;
- As a result of interference, material damage is caused to the property;
- The interference arose as a result of the defendant's actions or inactions;
- The defendant had knowledge of the risk of harm.

Public nuisance is an interference with the rights of the public at large and must be deemed as substantial and unreasonable. Activities that cause unreasonable interference to another person's land for which a local government may be liable include landslides, bushfires, flooding and coastal erosion. However, a local government will only be liable if it was in control (either as the landowner or the principal manager) of the premises, or the resources from which the nuisance emanated.

Legal defences

In common law, the defence of 'voluntary assumption of risk' provides that there will be no liability of the defendant 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 (p. 29).

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 (p. 30).

In relation the allocation of resources. A council's resources are limited and the allocation of resources cannot be challenged in court. Therefore, while there might be protection works that may be implemented in theory, in the practice of the council budget, they may not be able to be implemented and the fact of limited resources is not able to be challenged.

Finally, in most jurisdictions, legislation prescribes that litigation must be commenced within six years of the cause of action accruing - either a decision, action or inaction of the council which led to the damage.

What are the defences of a council against tort based claims? The following may apply:

- It is unlikely that an action might 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 aware of the issue of rising sea levels.
- Councils have limited resources and have to make decisions based on this factor. 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 have a defence that they have upheld a duty of care.
- Finally Councils that have emergency action plans for their residents accomplish two things: 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.

At what points is the council weak in relation to tort based claims?

- Where the council has approved settlements against the science or advice of the time. For example if the coast protection board advised that a settlement be installed at 4m AHD in a location and it was installed at 3m AHD then the council could be liable for damages.
- Where they have installed protection works 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 hasn't done so, or even in the absence of written obligations, where the works fail because they have not been maintained or repaired.
- Where they have not advised their residents of the risk or have emergency action plans to deal with possible risk.

What are the particular issues relating to protection works?

Where a resident purchases an allotment near the open sea the potential risk is apparent. Assuming that the settlement was installed in accordance with the available science of the time and in accordance with its conditions of consent it is unlikely the council will be held liable because of an action of the sea that overtops the dunes and damages assets.

However, when protection works are installed, there may be the assumption that these should function effectively against an action of the sea. When they fail or are breached it might be possible for claims to be made.

Therefore a decision to implement new protection works brings with it a new range of liabilities and requires careful consideration.

Political backlash

Council members are democratically elected and therefore councils are vulnerable to political pressure. In the age of instant media and twitter, issues that once took a long time to ferment can become frontline agendas in a very short space of time.

Because the matters of climate change and rising sea levels are not precise, and there are opposing views and different vested interests, decisions a council makes or doesn't make can result in a hostile political climate. For example, there may be differing views on climate change and rising sea levels among the elected members and these matters need to be resolved carefully.

Case study

The vast majority of the legal cases in Australia have been administrative appeals rather than tort claims. There has only been one case at law as at January 2013 which has dealt directly with an action of the sea. This was as a result of a storm that hammered the coast of Byron Bay in May 2011 and resulted in a loss of council installed protection works. Intense political pressure was applied and brought the council undone in the end. Therefore this case study provides an excellent example of where legal liability and political liabilities were played out together and it is recommended that the reader review this case study in Appendix 3 of the report below.

Key points from the case study:

- The court did not find that the council owed a duty of care in protecting residents from action of the sea.
- The matter related to protection works the council had installed and not maintained.
- The court considered that protection works installed in one place may exacerbate problems in other places.
- The NSW Government enacted legislation that clarified the legal rights of the council and the property owners wishing to defend their properties. It also exempted government from any liability relating to protection works.

Appendix 2 – Privately owned infrastructure

Valuation data to be inserted.

Appendix 3 – Infrastructure owned by others

To be inserted.

Appendix 4 – Review of Thompson Beach establishment

See separate file.

Appendix 5 – Data validation by surveyor

See separate file.