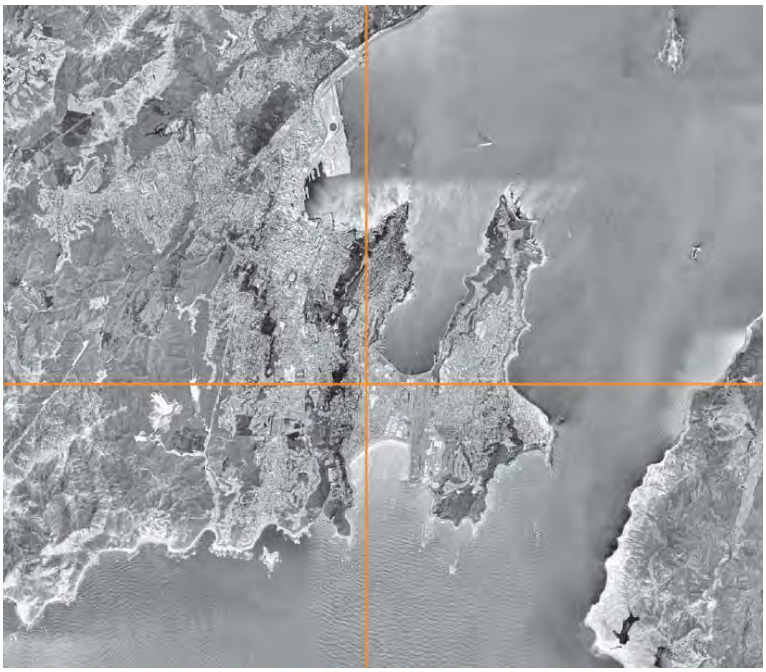
Kilbirnie Town Centre Plan

Working Paper



Assessing the implications of sea level rise

Kilbirnie Town Centre

September 2009

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1. Introduction

Kilbirnie town centre and its surrounds is currently the subject of a comprehensive planning process under the Kilbirnie town centre plan.

The focus of the town centre plan process is on the commercial area but includes a small area immediately surrounding the town centre that has been identified as being suitable for intensification and higher density residential living. New rules are proposed for the Wellington District Plan to enable higher density development to occur.

While a citywide assessment of constraints and opportunities was carried out as part of the overall analysis for the long term spatial plan, the issue of sea level rise was identified as requiring further study due to the low lying nature of the area.

This paper responds to this information gap by considering in more detail the implications of a series of sea level rise in the Kilbirnie area. It does so by recording the findings of an infrastructure focused interdisciplinary workshop held at WCC offices in late August 2009.

2. Objectives of the Study

There are two overarching objectives of the study.

Firstly – to better understand the resilience of the infrastructural systems in the Kilbirnie in response to expected and potential sea level rise scenario. More specifically:

- To better understand the risks for the Kilbirnie area around sea level rise and storm surge
- To identify the physical and social infrastructure that will be affected by sea level rise and storm surge and to better understand what is at most risk
- To determine what extent can we adapt to various sea level rise scenario and to determine thresholds where we may need to consider other options (ie retreat)
- If we engineer, to identify what the key physical works (and costs) required to future proof the area and over what time frames (eg short, medium, long)
- To identify opportunities to reduce risk through future planned upgrades and renewals.

Secondly - to use the Kilbirnie sea level rise project as a case study to test the appropriateness of the methodology for wider use in other low lying area of the city.

3. Methodology – strategic level scenario assessment

Sea level rise was viewed as one of the most critical climate change impacts on the study area, because it lies between only 1m and 3m elevation.

The latest New Zealand guidance on coastal hazards[1] associated with climate change recommends that councils consider the impacts of a 0.8m increase in sea level by 2090. However, given the considerable uncertainty in projections and the possibility of catastrophic events, an approach was taken based on testing infrastructure resilience and response via a range of scenarios. This will allow the development of strategies to manage the expected risk.

Three core scenarios were examined (0.5m, 1m and 2m) with each having an additional 0.5m storm surge component within the harbour and a 1m component on the exposed southern coast. These scenarios reflect the most recent scientific probabilities in the short term (50-100 yrs), while allowing for possible higher levels in the longer term.

Evaluation of the scenarios was carried out in an interdisciplinary cross-council workshop including water, drainage, roading, hazards, transport, coastal and recreational, and urban planning experts.

While the focus of the workshop was initially on the stormwater asset, it soon became clear that there was a close interrelationship with other infrastructure assets and utilities. The resulting inter-connected nature of discussion provided a sufficient basis for report back.

The following information was gathered: description, ownership, criticality, condition, relocatability, economic value, proposed upgrades. Assets were then tested against each sea level rise scenario to determine potential risks and impacts. Feasible response options were then proposed. The results are set out in following sections.

While a general storm surge aspect is included into the methodology, it was identified that future assessments should consider in more detail the susceptibility of wave action and increasing wave height.

[1] See http://www.mfe.govt.nz/publications/climate/preparing-for-coastal-change-guide-for-local-govt/index.html

4. The Study Area

5. Mapping the Scenarios

Sea level rise scenarios were mapped based on ground elevation data from LiDAR (Light Detection and Ranging). The LiDAR data was captured at 1cm vertical intervals with +/-10cm accuracy and was verified by field survey. The data was then used to create a digital terrain model. A local vertical datum was developed based on mean high water springs. This allowed for assessment of the highest likely sea level that includes mean tidal elements.

Infrastructure and key existing community facilities were mapped against the sea level rise scenarios so the impacts could be evaluated holistically.

Results are discussed under each of the three sea level rise scenario. This is followed by a more general discussion, bringing together common themes and recommendations for consideration.

5.1. Scenario 1 – 0.5m sea level rise plus storm surge (0.5m at Evans bay, 1m at Lyall Bay)

Scenario 1 – 0.5m sea level rise plus storm surge (0.5m at Evans bay, 1m at Lyall Bay)

Statement of probability

Almost given – there is a strong probability that sea level will rise by 0.5m by the end of the century.

Risk Assessment (likelihood/consequence)

A significant issue for this area is that storm surge and rainfall are likely to occur at the same time – exacerbating existing flooding problems in this area. The areas mostly affected are the coastal areas around Evan Bay marina (there is evidence already of some inundation around the marina) and the original waterfront areas along Kilbirnie Crescent and Rongotai Road. Areas on the coastal side of the road in Lyall Bay (surf clubs and housing in west Lyall Bay) are also likely to experience some inundation.

From an infrastructural perspective, the following conditions are likely under this scenario:

- Increased saltwater intrusion into drainage pipes
- More flooding in rain events and a lower level of discharge capacity in stormwater due to tidal influence on pipes
- Less capacity to move stormwater – with consequences further up the pipes – may need to consider open/shut valves to remove excess water
- Flooding in roadways (Evans Bay parade, Kilbirnie Cres, Rongotai Road and Kemp Street).

Response

Drainage infrastructure has an average life of 80 years. The likelihood of 0.5-1m of sea level rise is within the Councils infrastructure planning horizon of 100 years.

The most appropriate response under this scenario is to continue to consider climate change effects and sea level rise in all engineering design.

Under the current CAPEX programme, significant wastewater and stormwater renewals are planned for 2009/10-11, including a pumping station at Tacy Street. Water supply renewals are also planned for Rongotai/Wellington Road areas. The ongoing renewals programme will continue to renew pipes as priority dictates. Mitigation and adaption measures will be considered in forward planning and design.

Council officers will keep abreast of new theories and predictions and integrate this information into practice when necessary.

Heavily engineered efforts to protect roads and property will interfere with the basic processes necessary for coastal evolution in response to ongoing sea-level rise so where possible works that are more aligned to natural processes will be explored.

Overall statement of risk/resilience

With on-going and reasonable long term planning the area will cope with modest levels of growth expected over this time period.

5.2. Scenario 2 – 1m sea level rise plus storm surge (0.5m at Evans bay, 1m at Lyall Bay)

Scenario 2 – 1m sea level rise plus storm surge (0.5m at Evans bay, 1m at Lyall Bay)

Statement of probability

Less likely scenario – it is possible that sea level could rise by 1m by the end of the century, though this is not by any means certain. The probabilities of a 1m rise will increase over a longer period – current science suggests that this could potentially become a reality sometime in the 22nd century.

Risk Assessment (likelihood/consequence)

The issues stated in Scenario 1 are exacerbated under Scenario 2 – having significant impact on key roads and residential and commercial areas around Evan Bay marina and the original waterfront areas along Kilbirnie Crescent and Rongotai Road. Areas affected would expand to include most of the playing fields and community hub, residential areas just south of Rongotai Road and between Rongotai Road and Kemp Street, the northern part of Bay Road and parts of Cobham Drive including the roundabout.

Areas on the coastal side of the road in Lyall Bay (surf clubs and housing in west Lyall Bay) will experience serious inundation with some likely overtopping of Lyall Bay Parade near Queens Drive. Problems will be exacerbated with the expected rise in the water table.

The combination of higher sea levels, storm surge and rising water table with rain events means that without engineering solutions, there will be NO capacity to move stormwater – leading to significant flooding and inundation. This could result in significant downstream impacts on other lifeline infrastructure such as electricity, telecommunications, roading and emergency management.

Response

The most appropriate responses under this scenario are still likely to be engineering based, including the following:

- Making roads higher via on-going maintenance upgrades (Cobham Drive and Lyall Bay Parade) in order to enhance defences against sea level rise and stormsurge
- Introduction of stormwater pumping stations to remove excess water and
- Consideration of open/shut valve solutions to expel excess stormwater.

For the Lyall Bay, further consideration would need to be made regarding the effectiveness of the sea-wall defences and the implications of buildings and assets on the coastal side of the road (including the existing residential area and surf buildings- which are currently proposing redevelopment through demolition of existing building and replacing with a new clubhouse). Retreat options would have to be given serious consideration under this scenario.

With an 80 year forward planning timeframe for major infrastructure, this scenario is just outside the current AMP planning cycle. As there are multiple benefits of dealing with flooding, storm surge and sea level rise, it would be wise to start considering how we could mitigate the impacts of this scenario through future AMP's.

Overall statement of risk/resilience

With out carefully considered infrastructural improvements, the risks for the entire area would be unacceptable. There are significant downstream impacts with this scenario which could impact on wider area, including the Airport and the Eastern Suburbs.

The resilience of the coastal edge (partucularly in Lyall Bay and Greta Point) is problematic under this scenario – indicating that it may be necessary to consider alternative adaption techniques more in line with natural processes.

5.3. Scenario 3 – 2m sea level rise plus storm surge (0.5m at Evans bay, 1m at Lyall Bay)

Scenario 3 – 2m sea level rise plus storm surge (0.5m at Evans bay, 1m at Lyall Bay)

Statement of probability

This is a much less likely scenario – only for consideration of very long term expectations beyond 23rd century (or if predictions increase significantly from current scientific understanding).

Risk Assessment (likelihood/consequence)

Significant impacts are likely under this scenario, not only due to on-going inundation but also likely impacts of significant wave action on the coastal edge. Key consequences include:

- A rising water table
- Serious inundation throughout the northern part of Kilbirnie covering residential, commercial and recreational areas
- Major roads closed and undermined, with constrained access to the Airport and Eastern Suburbs
- Sea wall overlapped and dunes undermined in Lyall Bay
- Inundation in residential areas in Lyall Bay.

Wave action becomes a significant issue in Lyall Bay under this scenario.

Response

A combination of serious engineering solutions and retreat actions would likely be necessary for this scenario.

Engineering solutions would build on those identified in Scenario 2 (raising road levels and additional pumping stations); however greater consideration would need to be given to the implications of a rising water table on a largely sand based foundation.

Questions to be answered include:

- Is it necessary or possible to pump large areas on a continuous basis?
- If widespread pumping is not a viable option, would a barrier holding back the water table need to be considered?

Requiring a minimum floor level may need to be considered if removing water proves problematic.

The ability to engineer solutions is likely to be more problematic in the Lyall Bay Parade area due to the impacts of wave action and storm surge. Retreat and reliance on natural coastal defence options may need to be considered under this scenario.

Overall statement of risk/resilience

The entire study area is at risk under this long term scenario. As stated above, a combination of engineering solutions and retreat actions (particularly Lyall Bay) would be likely under this scenario.

A better understanding of the implications of a rising water table is necessary to determine how best to respond.

6. Summary Statement for the Kilbirnie/Lyall Bay/Rongotai Area

Subject to existing flooding issues (original coastline area) and overlapping in Evans Bay Marina, the area is considered to be resilient over the short term.

Given the existing investment associated to the urban infrastructural foundations, defend and engineer is considered generally as the most appropriate aim for the study area – particularly for the short to medium term (o.5m sea level rise plus storm surge).

Targeted improvements (particularly to stormwater infrastructure) in existing low lying areas will improve the resilience of the area in the short and medium term (o.5m sea level rise plus storm surge)

More significant engineering solutions will be required over the longer term (1m sea level rise plus storm surge and greater) to ensure resilience of the majority of the area is maintained. However, the success of these solutions depends whether ground water issues can be adequately dealt with. Minimum floor levels may need to be introduced if ground water cannot be dealt with.

Ground water is the greatest risk over the medium to long term. A better understanding of ground water issues is required as a matter of priority.

The future of low lying areas on the coastal edge (particularly Lyall Bay Parade and Evans Bay Marina) need to be considered carefully with significant increases in wave height and reduced natural beach defence. Engineering solutions will become less effective over time and retreat may need to be considered as a possible option in the longer term (1m sea level rise plus storm surge and greater).

With a current AMP planning cycle of approximately 100yrs, the Council should be designing the future AMP to fit Scenario 1 (0.5m sea level rise plus storm surge) and Scenario 2 (1m sea level rise plus storm surge).

APPENDIX 1 – ASSESSMENT TABLE

Proposed Workshop Method

The approach proposed is designed to be simple but effective. The approach is based on graphically illustrating a series of sea level rise scenario over key infrastructure foundations, and then discussing and reporting on what the implications are.

The following matrix is proposed to guide discussion and help to tease out what areas/infrastructures are at risk, and what possible responses are available to manage that risk. The first step of the workshop will be to confirm/adjust the questions and scenario and determine what infrastructure/assets will be considered.

General Questions about the asset							Scenario Analysis			
Description of the Infrastructure/asset	Who owns?	How critical is the asset?	Any quality concerns?	Ease of relocation?	Asset Lifetime	Any upgrades proposed? Value?	Scenario 1 – 0.5m sea level rise	Scenario 2 – 0.5m sea level rise with storm surge (0.5m Evans Bay, 1m Lyall Bay)	Scenario 3 – 1m sea level rise with storm surge	Scenario 4 – 2m sea level rise with storm surge
Eg Water Supply							Risk assessment - Likelihood of effect? - Consequence of effect?			
							Response assessment - What could you do to mitigate? - When would you respond?			
							Overall statement of risk and resilience			