



climate change actions
for Manly LGA

2008 > 2038



innovate | adapt | reduce | combat



Released in the Public Interest By Manly Council
Subject to Qualifications

8002 | *april 2008*

Executive Summary

Manly Council is seeking to pro-actively address the impacts and causes of climate change upon the LGA. Manly is taking a significant leadership role in taking actions towards addressing climate change in proposing a significant, levy funded, schedule of works in response to predicted climate change related impacts.

To assist Manly Council in the determination of this forward planning program Cardno identified and mapped preliminary predictions of specific climate change impacts upon the LGA with respect to Sea Level Rise, Catchment Flooding, and Oceanic Inundation. In addition to this, potential effects of broader-scale climate change environmental impacts (eg temperature increases, wind velocity, storm frequency increases) were considered.

Following on from the identification of the potential impacts, a variety of mitigation measures (actions to limit the unavoidable impacts of climate change) and preventative measures (actions to limit Manly LGA contributions to on-going climate change) were proposed for inclusion in the schedule of works. For each mitigative action a costing of implementation and economic valuation of resultant benefit was determined. For each preventative action a costing of implementation and estimate of resultant greenhouse gas emission reduction was determined.

The action list was prioritised in terms of Benefit:Cost Ratio and Greenhouse Gas Emissions and assigned inclusion into the schedule of works on the basis of either exceeding a BCR of unity, or leading to a net reduction in Greenhouse Gas. Some actions in the action list were identified to require partnership between Council and other agencies. These actions were transferred to a partnership list for further consideration.

The resultant forward planning program represents a comprehensive, economic, and effective strategy to adapt to a changing environment.

Released in the Public Interest By Manly Council
Subject to Qualifications

Table of Contents

1.	Introduction	1
1.1	Overview	1
1.2	Document Structure	1
2.	Predicted Effects of Climate Change on the Manly LGA	3
2.1	Climate Change Predictions Relevant to the Manly LGA	3
2.2	Probabilistic Approach	15
3.	Identification Process for Mitigation Actions	16
4.	Identification Process for Preventative Actions	17
5.	Preliminary Lifecycle Costing of Options	18
6.	Preliminary Benefit:Cost Analysis for Mitigative Actions	19
6.1	Overview	19
6.2	Identification and Calculation of Benefits	19
6.3	Identification of Costs	21
6.4	Application of Benefit Calculation Method	21
7.	Preliminary Greenhouse Gas (GHG) Emissions Analysis for Preventative Actions	22
7.1	Overview	22
7.2	Method of Calculation	22
7.3	Assumptions and Outcome	23
8.	Preliminary Forward Program for Implementation	24
8.1	Prioritisation of Actions	24
8.2	Forward Program	24
9.	Recommendations and Conclusions	26
10.	References	27
11.	Qualifications	28
	Appendix A	29
	Appendix B	30
	Appendix C	31

Released in the Public Interest By Manly Council
Subject to Qualifications

Subject to Qualifications

1. Introduction

1.1 Overview

Climate Change, one of the defining challenges of our time, is an issue that Manly Council is seeking to address through two primary approaches:

- Mitigation of, or adaptation to the effects of climate change
- Prevention of further emissions contributing to climate change.

The consequences of climate change considered for this assessment are described with respect to their projected effects on the Manly LGA in Section 2.

Mitigation of the effects lies in the realms of property, infrastructure and natural resource management.

Prevention of further emissions lies principally in the realms of reducing carbon-related energy demands and reducing carbon-related transport demands.

Cardno has assisted with the identification and prioritisation of actions to address climate change, over and above Council's 'Business as Usual' program of funding for general services, infrastructure, stormwater and the environment. This approach ensures that Council prepares now for the conditions expected to occur in the next 30 – 100 years (with the best available projections of the effects of climate change).

Given Council's budget is fully committed for the delivery of existing services, including delivering programs of environmental, stormwater and infrastructure improvements to meet the current conditions, these additional works and strategies to address climate change are expected to require a specific levy. The nexus for the levy being the link between past and present emissions of greenhouse gases (GHG) from the LGA and the overall consequent response to the cumulative effect of all GHG emissions.

1.2 Document Structure

This report seeks to address the manner in which the action program was development and the underlying assumptions. The document takes the following form:

- Predicted Effects of Climate Change on the Manly LGA (Section 2)
- Identification Process for Mitigation Actions (Section 3)
- Identification Process for Preventative Actions (Section 4)
- Preliminary Lifecycle Costing of Options (Section 5)
- Preliminary Benefit:Cost Analysis for Mitigative Actions (Section 6)
- Preliminary Greenhouse Gas (GHG) Emissions Analysis for Preventative Actions (Section 7)
- Preliminary Forward Program for Implementation (Section 8)
- Recommendations and Conclusions (Section 9).



Appendix A contains the spreadsheets of the preliminary action lists for mitigative actions and preventative actions. Appendix B contains the preliminary forward program for implementation. Appendix C contains the list of those actions not included in the forward program at this time, but to be considered separately for implementation.

Released in the Public Interest By Manly Council Subject to Qualifications

Subject to Qualifications

2. Predicted Effects of Climate Change on the Manly LGA

2.1 Climate Change Predictions Relevant to the Manly LGA

Predicted changes associated with climate change include:

- Sea level rise (DECC, 2007)
- Increase in intensity of regular and rare catchment flood events (DECC, 2007)
- Increase in the number of ocean wave storm events (IPCC, 2007)
- Increase in oceanic inundation associated with ocean wave events (Ransinghe et al, 2007)
- Decreases in annual average rainfall (CSIRO/BoM/AGO, 2007, 2007)
- Increases in temperature and solar radiation (CSIRO/BoM/AGO, 2007, 2007)
- Increase in sea surface temperature (CSIRO/BoM/AGO, 2007, 2007)
- Increases in evapotranspiration (CSIRO/BoM/AGO, 2007, 2007), and
- Increases in wind speeds (CSIRO/BoM/AGO, 2007, 2007).

The associated effects of sea level rise in the coastal zone may manifest as responses including (for example):

- Coastal groundwater level rise
- Changes to coastal groundwater chemistry (increased salinity)
- Increased tidal dominance of estuaries (and associated marinisation of estuaries).

It is important to acknowledge that the science of climate change is relatively inexact in some areas. However, those estimates that are available in a numerical form have been used for this assessment to define the likely effects of climate change in terms of the plan extent of the LGA that could potentially be altered.

These estimates commonly project out to either 2070 (CSIRO/BoM/AGO, 2007) or 2090-2100 (DECC, 2007). For the purposes of this assessment, which is related to the design life of many of the actions proposed (eg infrastructure), the time scale used for planning is the furthest projection available (ie 60 – 90 years from now). It is important to note that the effects of climate change are not expected to cease at 2100 and will be dependent on decisions made over time with regard to factors affecting climate change (eg reduction on carbon emissions achieved by legislation or other mechanisms). However, for the purposes of this assessment, the line has been drawn with the information available.

Three key greenhouse gas emission scenarios are commonly considered for planning. These are:

- Low Level Emissions (also referred to as Scenario B1 by IPCC, 2007)
- Medium Level Emissions (also referred to as Scenario A1B by IPCC, 2007)
- High Level Emissions (also referred to as Scenario A1FL by IPCC, 2007).

For this assessment, the low and high emissions levels have been considered, with a conservative emphasis on planning for high level emissions (referred to in this document as CCHigh).

In the cases of sea level rise, catchment flooding, and oceanic inundation preliminary mapping has been prepared based on digital terrain information (a digital elevation model or DEM) to provide a broad indication of the likely spatial effects of climate change.

While the above discussion is focused on the gradual changes postulated up to 2100, it is also important to note that some scientists see the potential for what is referred to as 'abrupt' climate change (Gagosian, 2003). In this situation, rather than a slow shift in environmental conditions, a major shift is hypothesised, consistent with other recorded major climatic shifts, which rather than occur over a gradual process, occur rapidly (eg within a decade). The consequences of these rapid type changes are not well understood at present. However, understanding that change may occur sooner rather than later and faster than expected is critical in the event that these types of abrupt changes are observed in our climate.

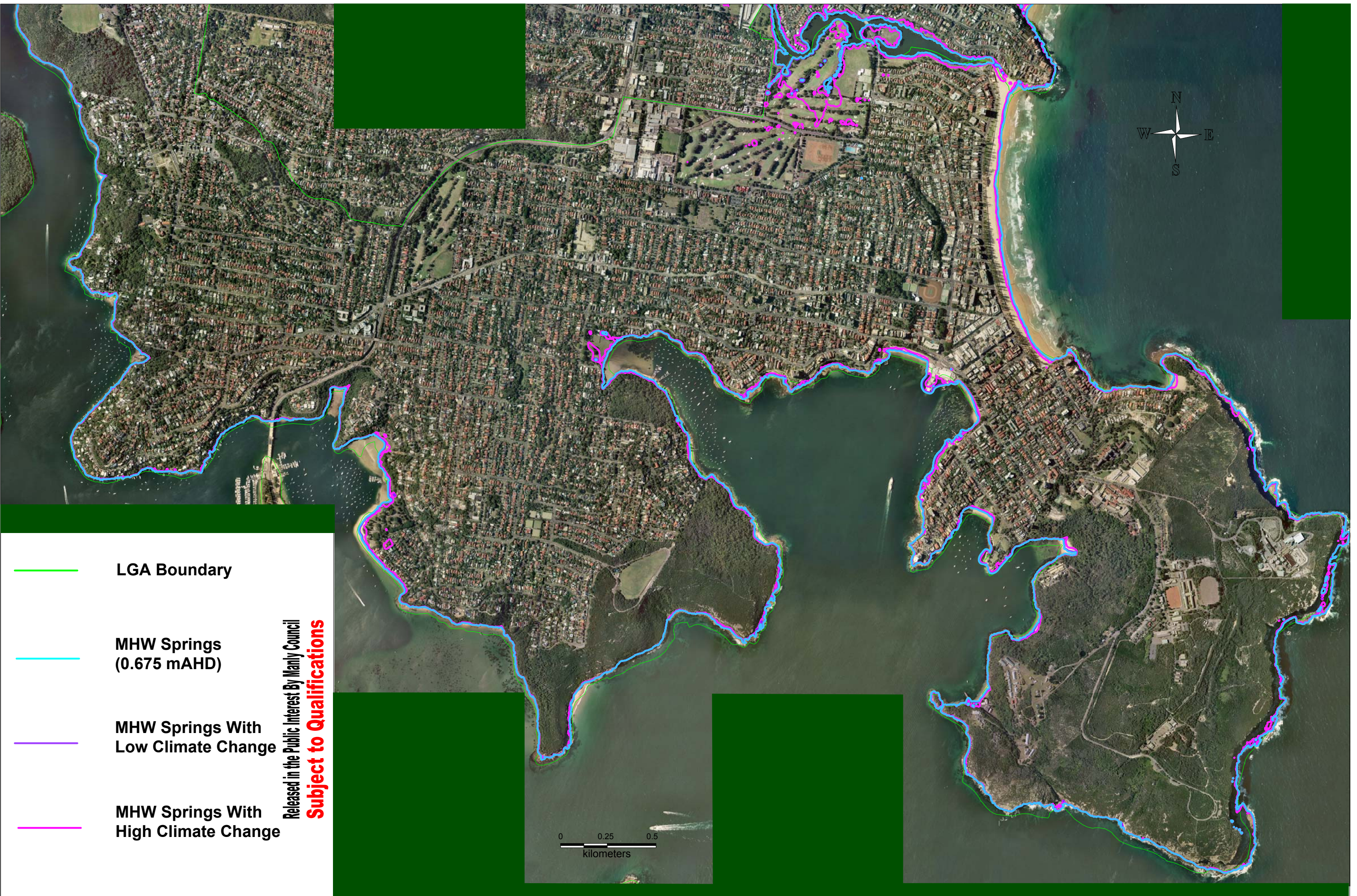
Sea Level Rise

In the case of sea level rise, the effects can be considered with regard to a range of conditions. These conditions include:

- Fortnightly 'spring' tides
 - under the current conditions, the mean high water spring (MHWS) tide level is 0.68 mAHD (RAN, 2007)
 - under a low level climate change scenario, the mean high water spring tide level is $0.68 + 0.18 = 0.86$ mAHD
 - under a high level climate change scenario, the mean high water spring tide level is $0.68 + 0.91 = 1.59$ mAHD
- Annually Exceeded Water Levels (referred to as the 100% Annual Exceedance Probability Water Level – being the level that has been statistically calculated from tidal records at Fort Denison of 1.25 mAHD – it can be expected that the water level in the ocean and in the Harbour would reach this level approximately once a year)
 - under the current conditions the 100%AEP is 1.25 mAHD
 - under a low level climate change scenario, the 100%AEP level is $1.25 + 0.18 = 1.44$ mAHD
 - under a high level climate change scenario, the 100%AEP level is $1.25 + 0.91 = 2.16$ mAHD
- Rarely Exceeded Water Levels (referred to as the 1%AEP Water Level – being the level that has been statistically calculated from tidal records at Fort Denison of 1.48 mAHD – the probability of this level being exceeded every year is 1%)
 - under the current conditions the 1%AEP is 1.475 mAHD
 - under a low level climate change scenario, the 1%AEP level is $1.48 + 0.18 = 1.66$ mAHD
 - under a high level climate change scenario, the 1%AEP level is $1.48 + 0.91 = 2.39$ mAHD.

Figure 2.1 shows the spatial extent of the mean high springs under current and climate change scenarios. Figure 2.2 shows the spatial extent of the 100%AEP under current and climate change scenarios. Figure 2.3 shows the spatial extent of the 1%AEP under current and climate change scenarios.

Released in the Public Interest By Manly Council
Subject to Qualifications

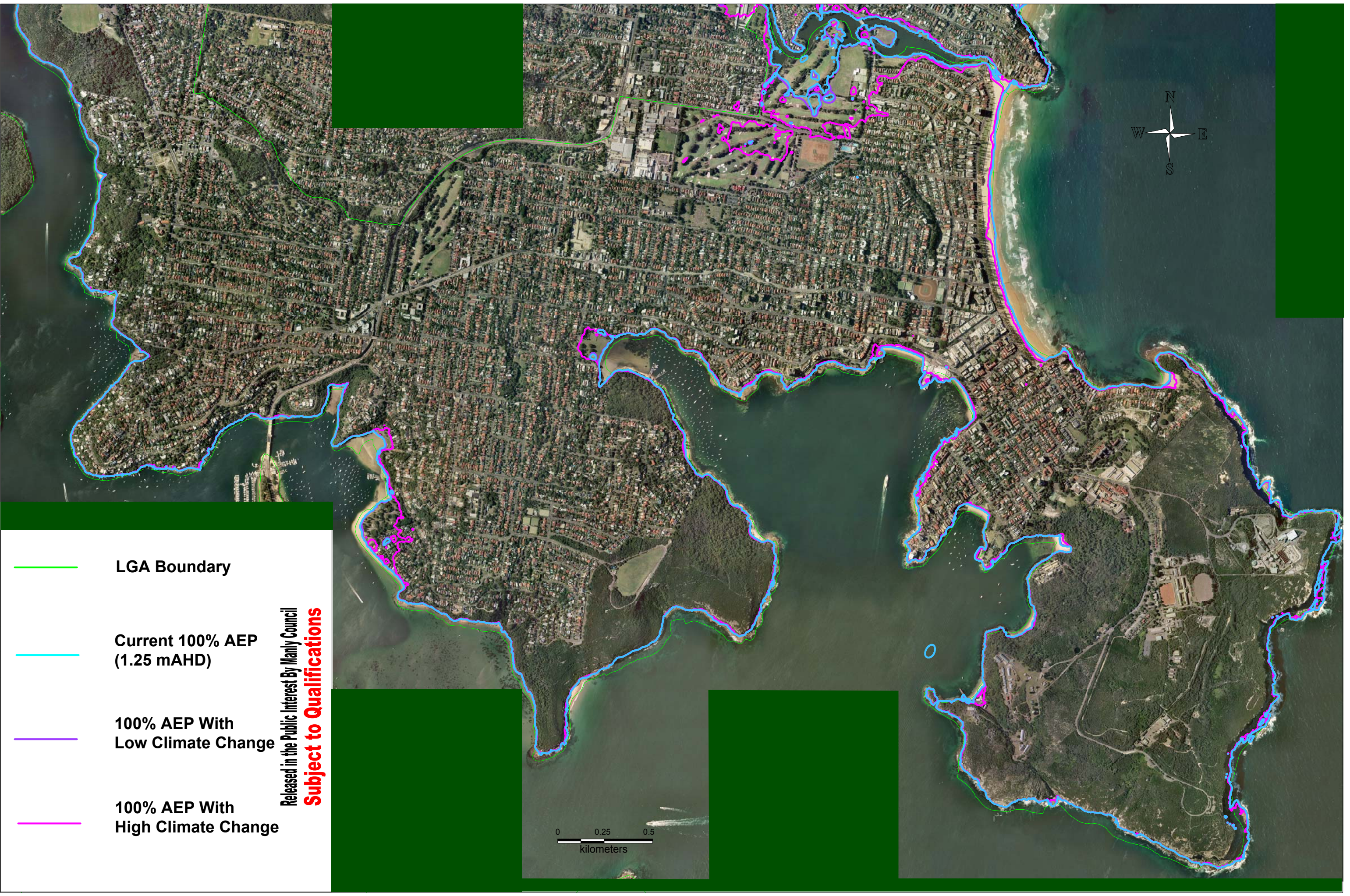


- LGA Boundary
- MHW Springs (0.675 mAHD)
- MHW Springs With Low Climate Change
- MHW Springs With High Climate Change

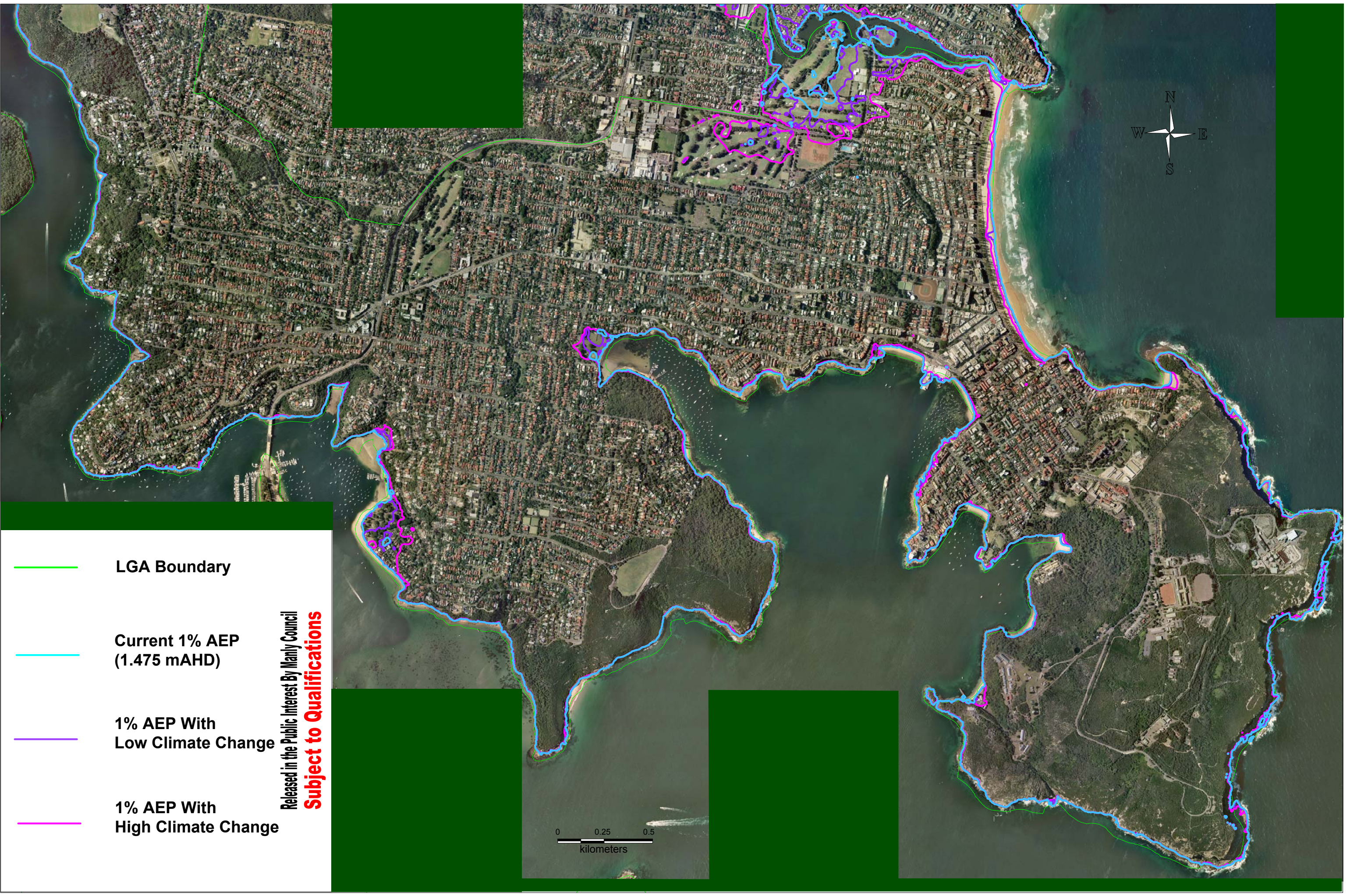
Released in the Public Interest By Manly Council
Subject to Qualifications





0 0.25 0.5
kilometers





Released in the Public Interest By Manly Council
Subject to Qualifications



-  LGA Boundary
-  Current 1% AEP (1.475 mAHD)
-  1% AEP With Low Climate Change
-  1% AEP With High Climate Change

Released in the Public Interest By Manly Council
Subject to Qualifications

Figure 2.3 - 1% AEP Levels
 Manly Climate Change
 Manly Council

Catchment Flooding

For catchment flooding, the current worst case estimate on expected changes to rainfall intensities is an additional 30% on top of rainfall intensities for a region reported in *Australian Rainfall and Runoff* (ARR) (Engineers Australia, 1999). Manly LGA has experienced several severe flood events over the last 50 years at high cost to the residents (Figures 2.4 – 2.6). The expected increase in severity of flood events under a climate change scenario will significantly increase the damage and costs associated with these events.

To assist with defining the spatial extent changes of the additional 30%, a preliminary two-dimensional, rainfall on grid modeling approach flood model was created for the entire LGA and associated adjacent catchment areas that flow into the LGA. This model was created using the SOBEK software (WL | Delft Hydraulics) and data inputs included Council's DEM (with a 10 m rectilinear grid) to assist with identifying the potential effects of changes to rainfall intensities. This model was run under four separate conditions:

- 100 year ARI Catchment Flood (using intensities derived from ARR) and a 0 mAHD ocean boundary
- 100 year ARI Catchment Flood ARR + 30% and a 0 mAHD ocean boundary
- 100 year ARI Catchment Flood (ARR) and a 1.25 mAHD (current 100% AEP) ocean boundary
- 100 year ARI Catchment Flood ARR + 30% and a 2.16 mAHD (high climate change scenario 100% AEP) ocean boundary.

Figure 2.7 shows the spatial extent and depth of the catchment flooding (including overland flows) under the current scenario. Figure 2.8 shows the spatial extent and depth of catchment flood with an additional 30% rainfall on the current scenario. Figure 2.9 shows the spatial extent and depth of catchment flood with the additional 30% rainfall and a 2.16m ocean boundary.



Figure 2.4: Flooding in Manly – Pittwater Road (1977) (courtesy of MHL, 2008)

Released in the Public Interest By Manly Council
climate change actions
for Manly LGA

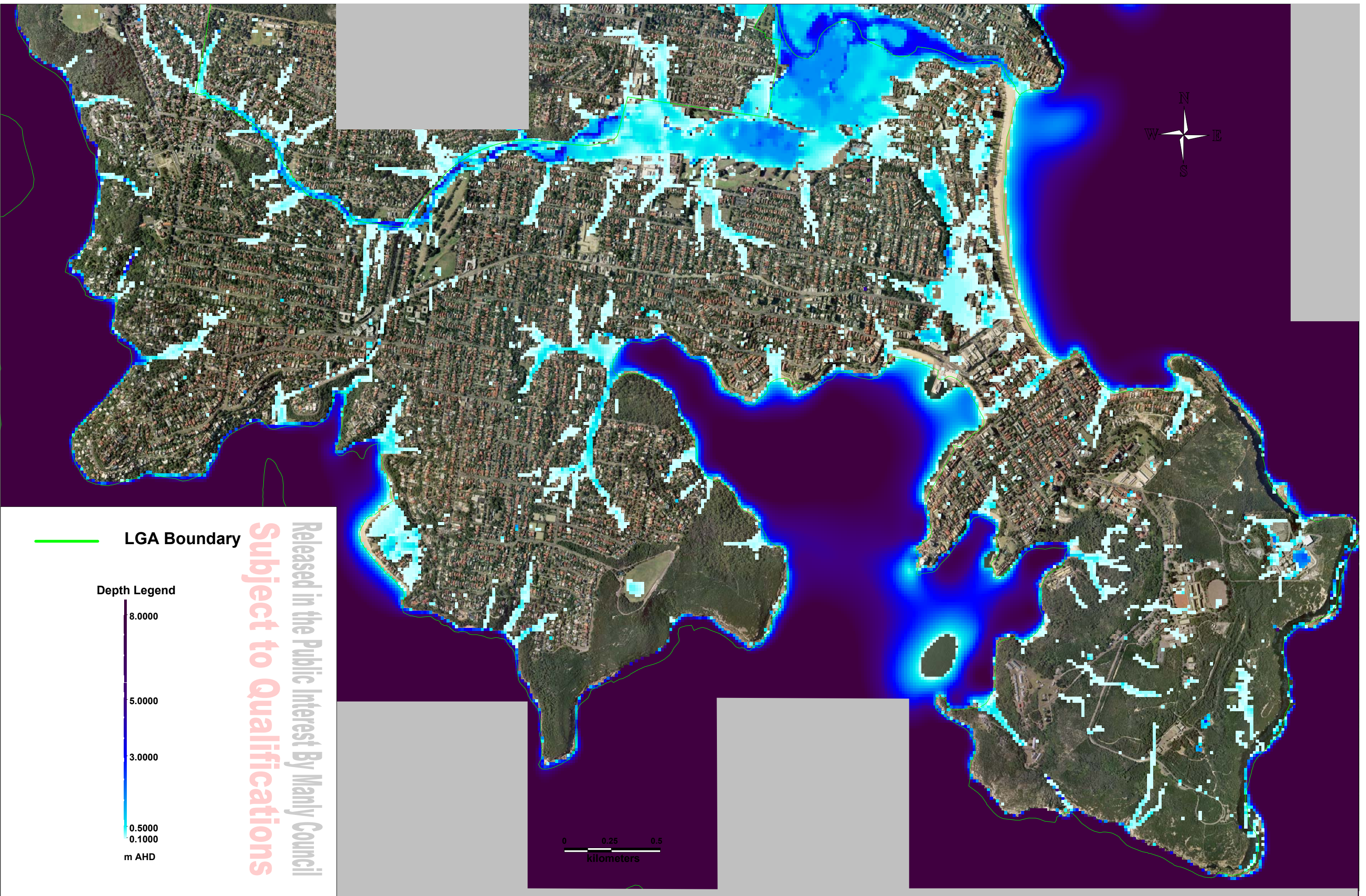
Subject to Qualifications



Figure 2.5 : Flooding at Manly Lagoon Entrance (1996) (courtesy of MHL, 2008)

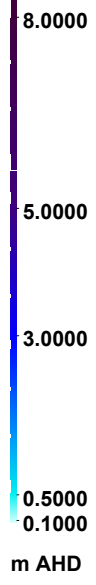


Figure 2.6: Flooding at Manly Golf Course (1987) (courtesy of The Manly Daily – 12/11/1987)

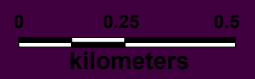


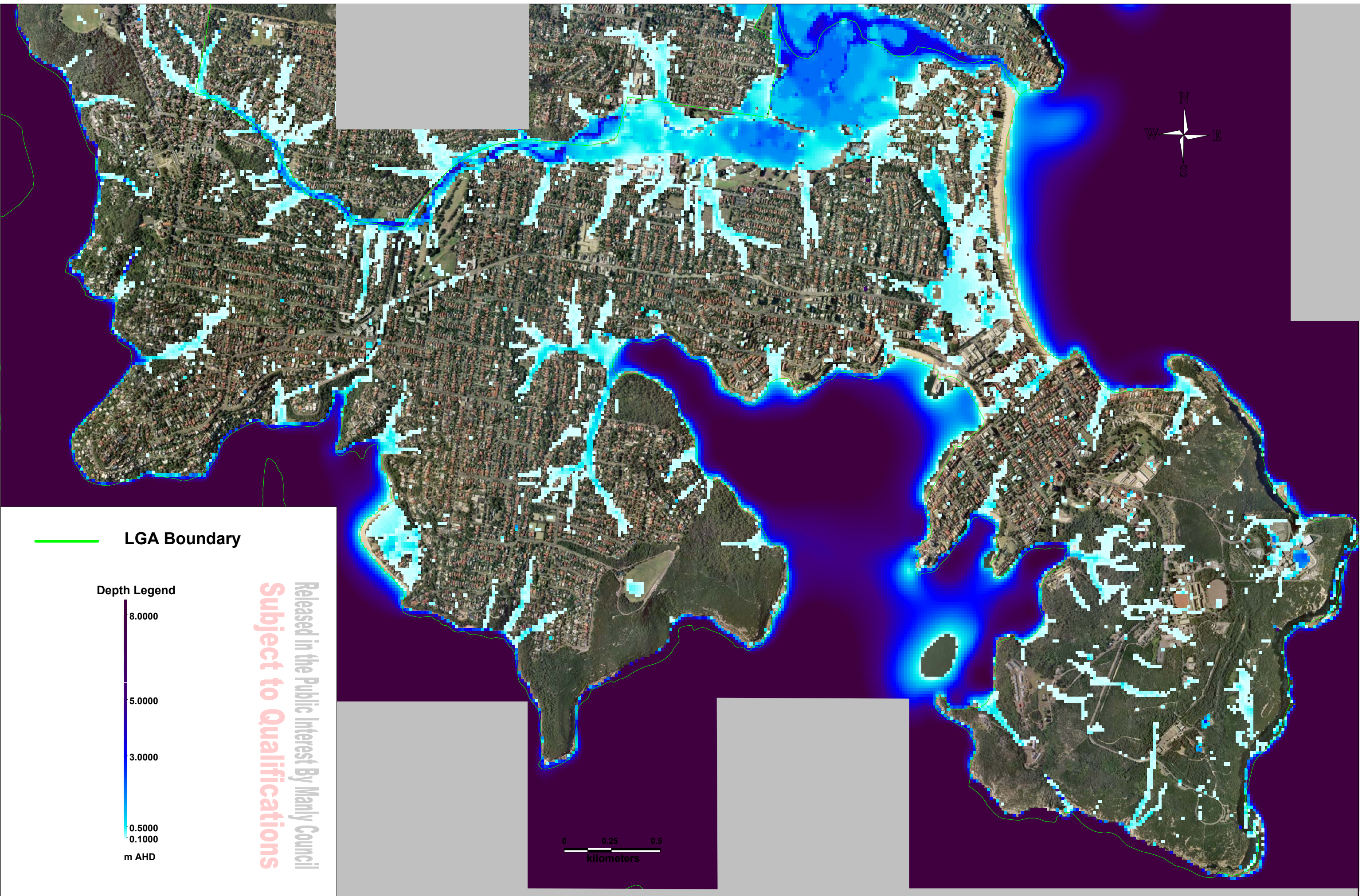
— LGA Boundary

Depth Legend



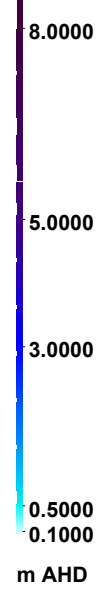
Released in the Public Interest By Manly Council
 Subject to Qualifications





— LGA Boundary

Depth Legend



Released in the Public Interest By Manly Council
Subject to Qualifications

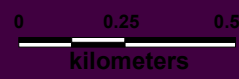
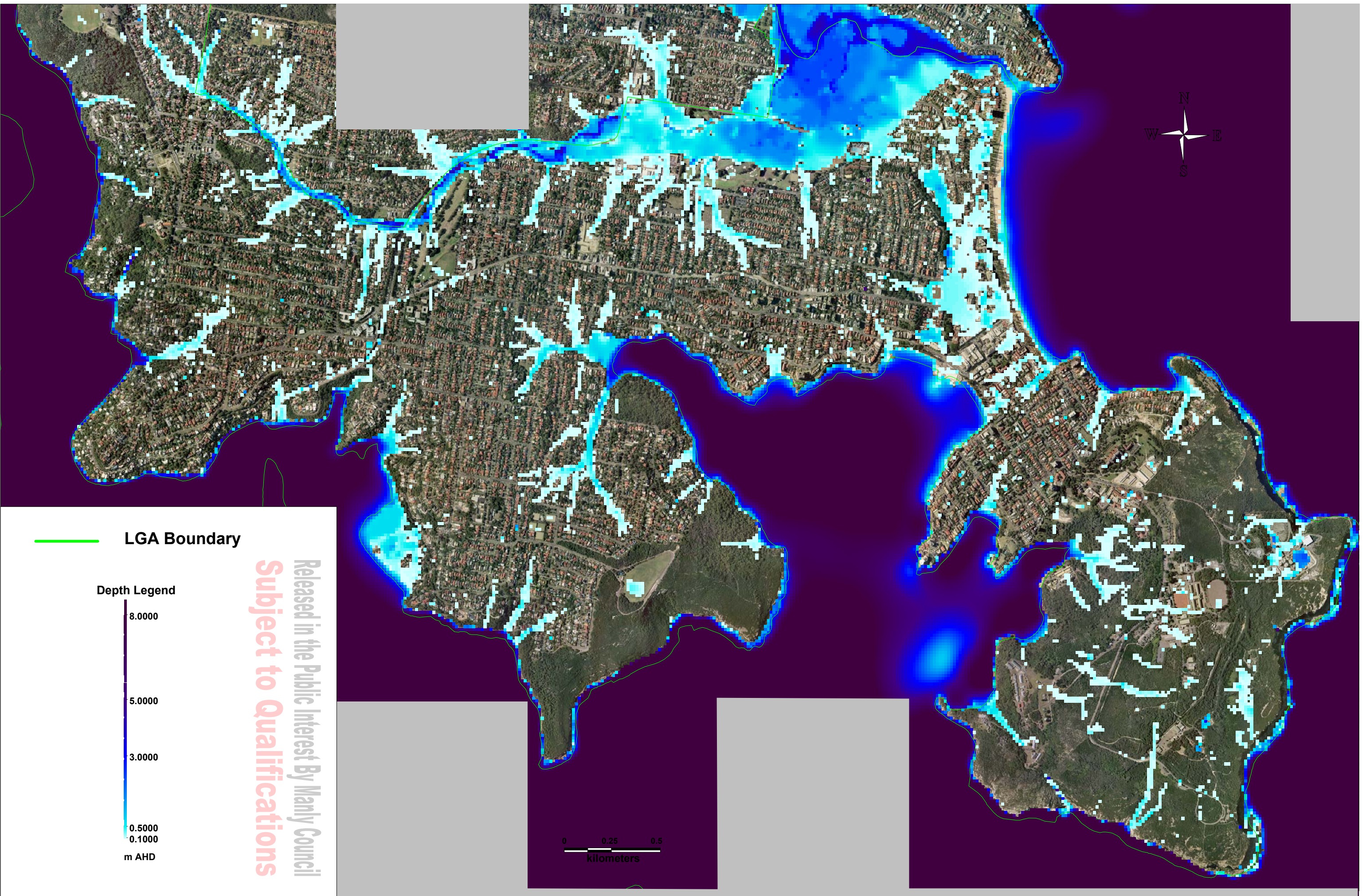
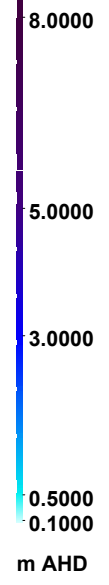


Figure 2.8 - 100yr Flood Depth with 30% Rainfall Increase, No Sea Level Rise.
 Manly Climate Change
 Manly Council



— LGA Boundary

Depth Legend



Released in the Public Interest By Manly Council
Subject to Qualifications

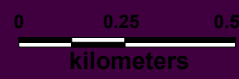


Figure 2.9 - 100yr Flood Depth with 30% Rainfall Increase and a 100% AEP High Climate Change Scenario
 Manly Climate Change
 Manly Council



Oceanic Inundation Associated with Major Ocean Storm

Oceanic inundation is a major source of damage during storm events, resulting in a severe loss of beachfront (Figure 2.10) and potentially intruding into residential and commercial areas. Preliminary mapping has been prepared for the oceanic inundation associated with a major ocean storm event of a magnitude of 100 years Average Recurrence Interval. This preliminary mapping (Figure 2.11) for the ocean beach, referred to as a 'potential' extent has been prepared based on information contained in the *Manly Coastline Management Plan* (PBP, 2007) and engineering judgment to create an inferred extent of likely inundation that may occur associated with oceanic inundation (eg. the process of wave run-up after waves break over the sea wall). The mapping is based on an 8.5 mAHD level for runup at the seawall crest (100 year ARI= 8 mAHD + 0.5 m sea level rise, factored down from the 0.91 mAHD in the case of wave breaking). It has been assumed that for every 50 m plan distance from the sea wall that a 1 m reduction in potential runup occurs (to account for factors such as friction associated with the numerous buildings in the area but does not explicitly account of building obstacles having a 'shielding' effect for other properties). This mapping has only been prepared to assist with understanding of the possible range of inundation and should not be used for any other purposes other than as a guide for this climate change actions assessment.

It is not expected that the additional 0.5 m accounted for in sea level rise will result in a quantifiable change in the inundation as the change in level will be most observable at the ocean sea wall and then the effect will be less noticeable with distance with the sea wall.

A similar map of inundation for the harbour-side beaches has not been prepared as data is even less reliable than for the ocean beach area and inundation is not expected to extend a substantial distance from the seawall (say no more than 20 – 30 m).

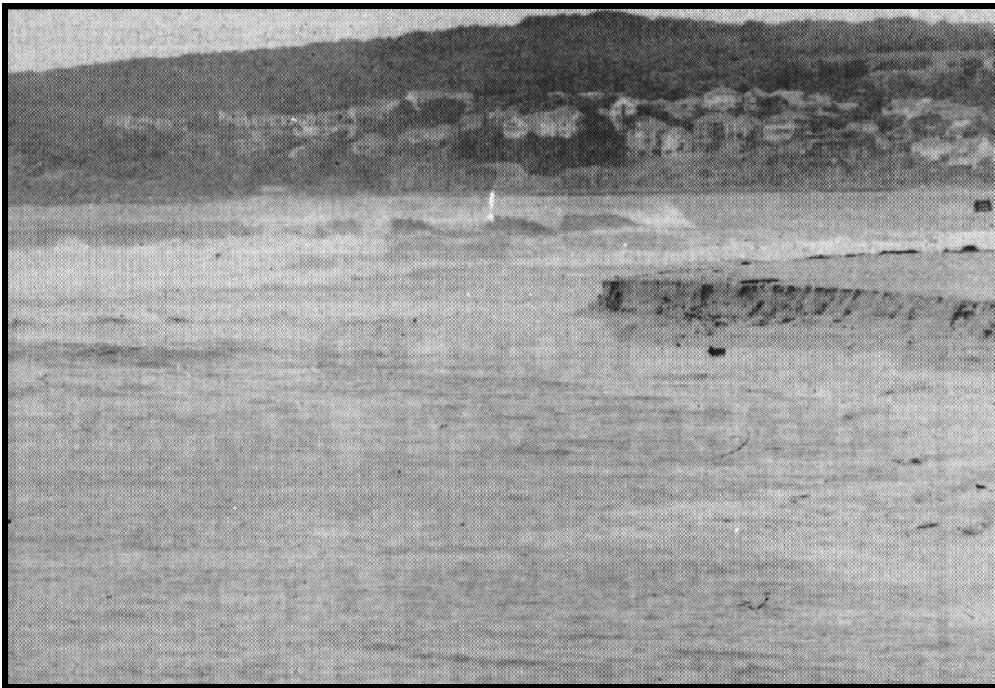
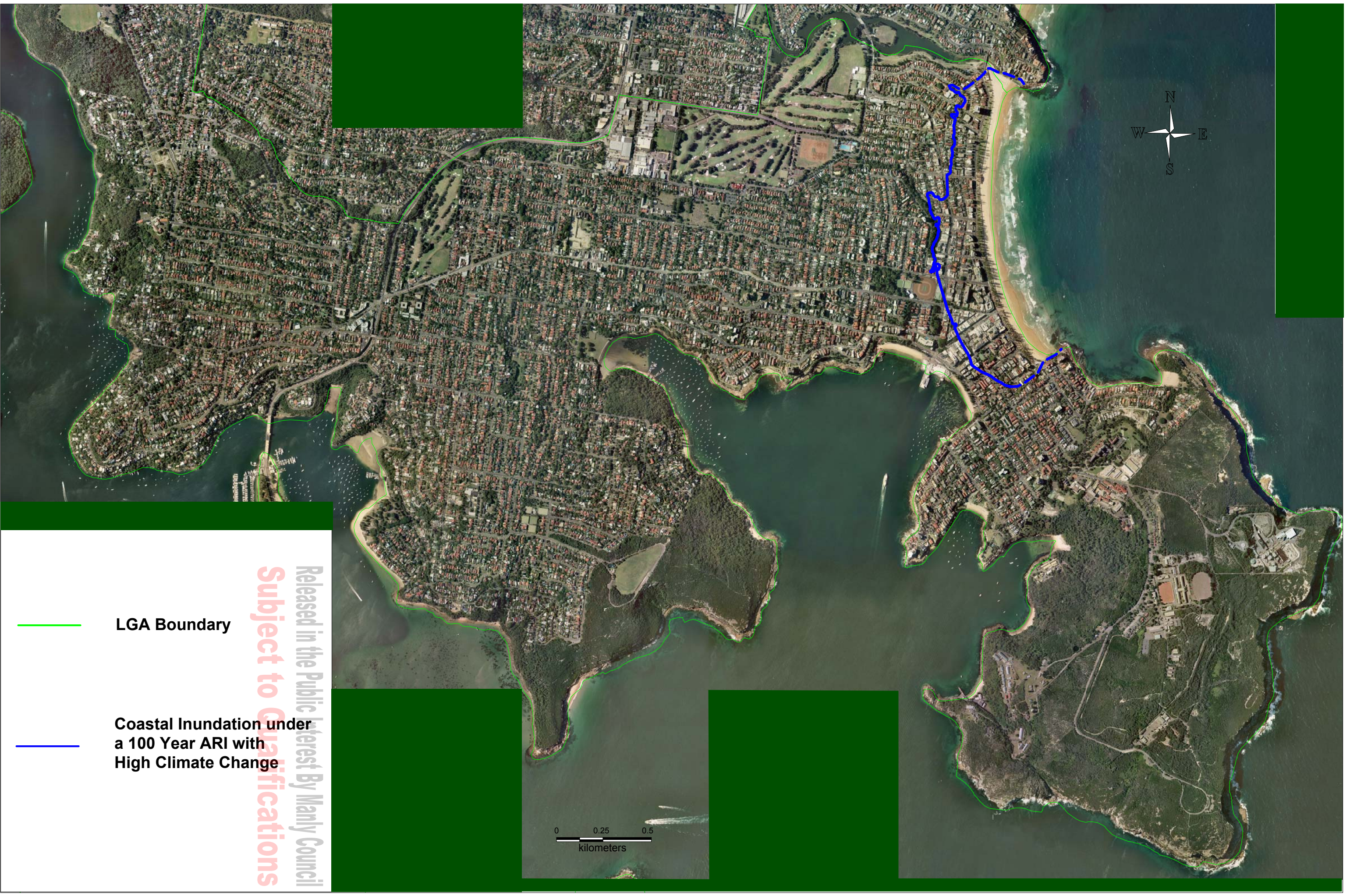


Figure 2.10: Erosion of Queenscliff Beach following a large storm (courtesy of *The Manly Daily* – 19/01/1988)



0 0.25 0.5
kilometers

Released in the Public Interest By Manly Council
Subject to Qualifications



-  LGA Boundary
-  Coastal Inundation under a 100 Year ARI with High Climate Change



Figure 2.11 - 100 yr ARI Ocean Inundation with High Climate Change
Manly Climate Change
Manly Council

2.2 Probabilistic Approach

In order to ensure that actions are prioritised against those effects of climate change which can be expected to occur most frequently, a series of timeframes of when effects could be expected to occur has been developed. The time scales and events are shown below.

Time Scale	Event
Daily	2070 Average Annual Temperature Change - High Emissions (+ve 3 - 4 °C), 2070 Annual Average Rainfall Change - High Emissions -ve 5-10%, 2070 Average Evapotranspiration +ve 12-18%, Mean sea level + 0.91 mAHD (2090/2100)
Fortnightly	Normal Spring Tides with change in sea level (1.59 mAHD)
Quarterly	Wind speed increase by 10 -15% in summer under 2070 High Emissions
Annually	100%AEP Ocean Level with change in sea level
50% Chance each year	5 year ARI flood which with climate change may become a 2 year ARI flood
1% Chance each Year	1%AEP Ocean Level, 100 year ARI Flood, 100 year ARI ocean storm
Less than 1% Chance each Year	100 year ARI Flood and 100 year ARI ocean storm

Released in the Public Interest By Manly Council
Subject to Qualifications

3. Identification Process for Mitigation Actions

The identification process for mitigation actions took the following path:

- Internal meeting of a team of infrastructure and natural resource management experts from Cardno
- Preliminary mapping of those areas which are expected to be vulnerable to climate change (on a probabilistic basis) (see Section 2)
- Evaluation of the predicted spatial extent of effects on known assets (as identified in Council's geographic information system, GIS, dataset)
- Meeting with Council asset managers and senior management team to discuss preliminary mapping and concepts
- Liaison with a wide range of Council officers by telephone and transfer of information to assist with assessments
- Identification and preliminary evaluation of potential actions to mitigate the effects on a range of assets or otherwise including:
 - Roads and Road Furniture
 - Traffic Lights and signs
 - Footpaths and Cycleways
 - Walking trails/scenic trails and associated bridges
 - Bus shelters
 - Car parking (at-grade and multi-storey)
 - Sporting fields and related infrastructure (including public amenities)
 - Playgrounds
 - Stormwater pipes and pits
 - Stormwater/runoff capture and recycling systems (eg rainwater tanks)
 - Stormwater quality improvement devices
 - Building structures (eg Council Administration Building, Scout/Guide Halls, Community Centres, Public Swimming Pools)
 - Marine structures and coastal management (eg Sea walls, beach nourishment, boat ramps, jetties and related infrastructure, ocean swimming pools and swimming enclosures)
 - Known contaminated land
 - Known Heritage items (Aboriginal and Non-indigenous)
 - Biodiversity (eg critical habitat, seed collection locations, wetlands, weeds)
 - Hazards (eg flood risks and mitigation, risk of dam failure of Manly Dam).
- Review of initial actions list by Council
- Finalisation of actions list.

It is important to acknowledge that some actions may rely on approvals or considerations outside of the control of Manly Council.

The actions identified are listed in Appendix A.

Released in the Public Interest By Manly Council

Subject to Qualifications

4. Identification Process for Preventative Actions

The identification process for preventative actions took the following path:

- Internal meeting of a team of infrastructure and natural resource management experts
- Evaluation of existing emissions sources within the LGA
- Evaluation of opportunities to reduce emissions within the LGA
- Meeting with Council asset managers and senior management team to discuss possible action items
- Liaison with a Council officers by telephone and transfer of information to assist with assessments
- Identification and preliminary evaluation of potential actions to prevent emissions including:
 - Strategic Planning (controls on land use)
 - Transport Planning (local and regional)
 - Energy Alternatives
 - Opportunities to sequester Carbon (eg in Bushland, through growth and use of renewable resources that capture carbon)
- Review of initial actions list by Council
- Finalisation of actions list.

It is important to acknowledge that some actions may rely on approvals or other considerations outside of the control of Manly Council.

As government policy changes and new products are developed, it would be expected that a significant range of alternative solutions may become available that are not listed in the option list.

The actions identified are listed in Appendix A. Where an action is expected to be the responsibility of another organisation, or as a partnership process, this has been shown against the specific option.

Released in the Public Interest By Manly Council
Subject to Qualifications

5. Preliminary Lifecycle Costing of Options

Given the preliminary nature of the option identification process, both capital and recurrent costing of each option has been undertaken using engineering and natural resource management judgment.

Capital costing is an estimate of that cost which would be expended in actually implementing the option. The recurrent costing is an estimate of the expected annual cost of retaining the option (for example maintenance costs or operational costs of running a facility).

Lifecycle costing (as a net present value of each option) has been generated from the capital and recurrent costing, using a period of 30 years and a discount rate of 7% (in accordance with NSW Treasury Guidelines).

The lifecycle costing has endeavoured to be a first pass estimate of the full implementation of an option (ie it covers the costs of investigations and studies, concept and detailed design and construction).

The lifecycle costing was used for the initial evaluation of the options. The proposed implementation schedule outlined in Section 8 uses the capital and recurrent costs in a program planned for the next 30 years of implementation of selected actions based on the outcome of benefit:cost analysis (Section 6) and greenhouse gas emission and reduction analysis (Section 7).

The lifecycle costing is shown for each option in Appendix A.

Released in the Public Interest By Manly Council
Subject to Qualifications

6. Preliminary Benefit:Cost Analysis for Mitigative Actions

6.1 Overview

A preliminary Benefit:Cost analysis (BCA) was undertaken for 'mitigative actions' (ie those actions identified in Section 3). Given the short time frame available for the assessment, a 'cut-down' or 'rapid' Benefit:Cost analysis approach was developed by Cardno specifically to allow for a suitable comparative analysis to be completed rapidly with the objective of ensuring the most beneficial options are selected for implementation.

The Benefit:Cost analysis utilises two key pieces of information:

- Benefit** - the calculated benefit for each mitigative action as described below in dollars
Cost - the lifecycle cost calculated for each mitigative action as described in Section 5 in dollars.

The Benefit:Cost ratio (BCR) is simply the benefit divided by the cost. For example, a benefit might be \$1,000,000 and a cost might be \$500,000 and therefore the Benefit:Cost ratio is $\$1,000,000/\$500,000 = 2$. The common mode of decision making arising from the BCR is that those options that deliver a ratio greater than 1 are suitable for selection (as they deliver a benefit equal to or greater than the cost). However, in some cases, options that deliver a ratio less than 1 may be selected as they may be considered worthy of the additional investment to achieve a specific outcome.

6.2 Identification and Calculation of Benefits

The method of identifying the benefit was defined by the mitigation actions identified and the purpose for which they are intended (in general, protecting 'something' that may be affected by climate change). The method of calculating the 'benefit' delivered by various actions over the life of the action has been undertaken by dividing 'benefit' into three primary areas:

- Benefit in ensuring actual infrastructure or property damage is mitigated (by calculating the damage that would have otherwise been incurred on an annualised basis)
- Benefit in providing environmental outcomes (ie either retention, enhancement or provision of additional habitat areas, on an annualised basis)
- Benefit to recreation/tourism (ie retention of facilities that are integral to recreation-related or tourism-related activities in the LGA, such as beaches, boat ramps, etc, on an annualised basis).

There are a multitude of other benefits that could be derived from the options identified (eg reduction in risk to life, health benefits etc). However, these three primary benefits were selected as being representative of the major benefits and able to be calculated within the constraints of time and suitable available data.

method of calculation to convert the benefits into comparable currency with the costs (ie the dollar) was derived from various theories on environmental economics and is explained below.

Infrastructure/Property Damage

Infrastructure/Property Damage was calculated using a method similar to that described in the *Floodplain Development Manual* (NSW Government, 2005). This method was based on assumptions on floor levels of buildings in the floodplain

(being just above the known adjacent ground level) and the likely inundation that may be expected associated with events that occur on a 5 year Average Recurrence Interval basis, through to the 100 year Average Recurrence Interval (as described in Section 2.1). The calculated existing damages for flood-prone areas were compared against the findings of the *Manly Lagoon Floodplain Management Plan* (DLWC, 1997) and were found to be in a comparable range, supporting the approach. The calculated existing damages for ocean-wave inundation affected areas did not have a suitable comparison value in the *Manly Ocean Beach Coastline Management Plan* (Worley Parsons, 2008). Any benefits assigned are expected to be conservative and produce a conservative BCR (ie the full benefits are likely to be underestimated).

Environmental Benefits

Environmental benefits were calculated using data sourced from studies contained within the ENVALUE database (compiled by the Department of Environment and Climate Change, www.environment.nsw.gov.au/envalue/, accessed 22 April 2008). No specific environmental valuation study data was identified for the Manly area and therefore data was extracted from studies where the travel cost estimate approach (measuring consumers willingness to pay to utilise an area in terms of travel costs) was used for areas of national park or similar and then averaged (it is important to note that the values from which the average was derived varied dramatically in range). For example, the value of an area with intrinsic environmental value, such as a national park, or bushland area, can be assessed by calculating how much it would cost visitors to travel to and enter the location to enjoy the area. This value is then estimated on a unit area basis. The total area of bushland or area of environmental value within the Manly LGA was calculated using Council's GIS data and then multiplied to gain an appreciation of the annualised value of these environments. This annualised cost was compared against Council's current annual budget for the Environment Levy and compares well, supporting the cost.

Utilising this valuation, the predicted impacts of Climate Change, and background information regarding the current status of undeveloped areas within Manly it was possible to predict a preliminary conservative relative loss of economic value from the environment resulting from Climate Change assuming that no mitigation strategies were employed. This "Do nothing" scenario formed the basis of assessing the benefits of the proposed mitigation strategies. This valuation of a "Do nothing" option from current values was also conducted for the calculation of the Recreational/Tourism Benefits outlined below. Each Mitigation Option was assessed in terms of the extent (as a percentage) to which it could minimize the "Do nothing" loss due to climate change (the benefit). To simplify analysis and provide conservative estimates, it was assumed that the loss due to climate change and benefit from each of the mitigation options were distributed linearly across a 30 year time frame. The resultant Present Value of the benefit corresponding to each mitigation option is directly comparable to the identified costs of implementing each mitigation option.

Recreational/Tourism Benefits

There is no single value estimate of the value of recreation and tourism for the LGA and visitor number estimates reported vary considerably (eg Bureau of Tourism research 2005 statistics for Manly report day visitors on an annual basis as 450,000, whereas Sydney Ferries reports day visitors at 5.5 million per annum). Assumptions were therefore made based on judgment as to which estimates may be considered to be representative of the actual value.

Benefits to recreation and tourism were calculated using a conservative estimate of the likely spending in the LGA associated with local-regional visitors (typically staying for at most one day) and long-distance visitors (typically staying within the LGA for more than one day). Visitors staying only for a day were assumed to spend on average around \$20 per person (for example, a family of five would spend \$100) and long-distance, multiple day, visitors were assumed to spend approximately \$200 per person. Given the wide estimates concerning tourist numbers and debate over what constitutes a tourist (data from Sydney Ferries suggests the number of tourists is as high as 5.5 million visitors a year) a conservative consensus figure of 3

million was selected. In line with Tourism New South Wales, it is assumed that around 775 000 international tourists visit Manly each year and that the majority of remaining visitors were short-stay local-regional visitors. It is recognized that such an approach likely under-estimates the economic benefit that tourism provides Manly.

Thus the total annual tourism value was conservatively estimated to be \$150 million. This is consistent with predicted costs of tourism to Council of \$120 million per year (*Manly Tourism Plan of Management*, 1993). As with the Environmental Benefits a perceived loss of tourism value due to Climate Change impacts was calculated under a “Do nothing” scenario (approximately 30%). Each mitigation option was then assessed proportionately against this “Do nothing” scenario to determine the benefit from instigating the mitigation option. The Present Value for each option benefit was then calculated under the linearity assumptions outlined above to allow comparison with the relevant costs of mitigation option implementation.

6.3 Identification of Costs

The identification of costs is described in Section 6.

6.4 Application of Benefit Calculation Method

Each option was assigned a benefit based on either the areal extent of the effect of the option and/or a judgment as to value of the three primary benefits described in Section 6.2 applied (which may be a combination of one or all of the three primary benefits).

The benefit:cost ratio was then calculated and is reported for each option in Appendix A. This value was used in the prioritisation of actions for implementation (Section 8).



Subject to Qualifications

7. Preliminary Greenhouse Gas (GHG) Emissions Analysis for Preventative Actions

7.1 Overview

A preliminary Greenhouse Gas (GHG) analysis was undertaken for preventative actions' (ie those actions identified in Section 4). Given the short time frame available for the assessment, a best estimate analysis approach was developed by Cardno, based on the *National Greenhouse Accounts (NGA) Factors* (Department of Climate Change, 2008). This approach allowed for a comparative analysis to be completed. Those options with the greatest GHG reduction will be selected as a priority for implementation.

7.2 Method of Calculation

Greenhouse Gas Emissions can be categorised into 3 "scopes":

- Scope 1: Direct Emissions - Emissions produced within the LGA as a direct result of activities (e.g. vehicle emissions)
- Scope 2: Indirect Emissions (internal) - Emissions produced outside the LGA from the consumption of purchased goods within the LGA (e.g. electricity)
- Scope 3: Indirect Emissions (external) - Emissions produced outside the LGA as a direct result of activities within the LGA (e.g. vehicle emissions from tourists travelling to Manly)

The calculation of the majority of Greenhouse Gases produced under each of these scopes can be roughly calculated with the following formula:

$$\text{GHG emission (t CO}_2\text{-e)} = Q \times \text{EF}$$

Where:

- Q is the quantity of direct fuel used, indirect energy consumed,
- EF is the relevant emission factor for the source of the energy. The emission factors used here were obtained from the National Greenhouse Accounts Factors Workbook.

Some activities require more involved formulae:

$$\text{Solid Waste GHG Emissions (t CO}_2\text{-e)} = [(Q \times \text{DOC}) / 3 - R] \times 18.9$$

Where:

- Q is the quantity of municipal waste in tonnes
- DOC is the degradable organic carbon expressed as a proportion of the particular waste type and listed in the NGA Factors document (Department of Climate Change, 2008)
- R is the recovered methane (in tonnes) from wastewater in an inventory year.

Subject to Qualifications

7.3 Assumptions and Outcome

A range of assumptions were applied in the calculation of GHG savings that could potentially be expected as a result of the implementation of each option. These include:

- Only currently published information on GHG emissions was used. It would be expected that this information will be refined and updated over time.
- Where specific technologies are identified as possible examples, it is assumed it is feasible to retrofit or install these features and that they will perform in the same manner as that in either published information or in the assumptions reported.
- Where solar photo voltaic cells are proposed, it is assumed that the building structure and orientation is suitable for their placement
- Carbon uptake for revegetation options has been assumed at 300kg of Carbon per 1000 plants (over the life of the plant)
- Behavioural change associated with provision of alternative or improved public transport options has been assumed and further information would be required to confirm these assumptions before proceeding with decision making (ie likely change in the number of people currently traveling via car moving to light rail or bus transport).

The calculated GHG for each preventative action is listed in Appendix A.

Subject to Qualifications

8. Preliminary Forward Program for Implementation

8.1 Prioritisation of Actions

Each of potential preventative and mitigative actions (Appendix A) was initially assessed for inclusion in a forward planning program schedule of works on the following basis:

- Council prioritisation (High, Medium, Low Priority)
- Probability of risk being addressed (more frequent events being a higher priority)
- Benefit:Cost Ratio, OR
- Greenhouse Gas Emission Reduction.

The basis for prioritization was refined following an initial evaluation and was based on the following:

- Benefit:Cost Ratio > 1
- Preventative Actions that could be effectively implemented by Council alone (ie no other agencies required).

This prioritization was initially conducted assuming an annual spend of \$500,000 over a 30 year period (a total of \$15 million in current terms).

Following a review by Council, cost estimates to provide a significant impact reduction through preventative measures and maintaining adequate mitigative measures against climate change impacts identified the initial annual spend value of \$500,000 to be insufficient.

A revised levy structure providing for an annual spend of the order of \$2,000,000 was utilized in the assessment of the options for inclusion in a forward program.

8.2 Forward Program

Based on the prioritisation process described in Section 8.1, a forward program readying for capital and recurrent costs based on a budget of the order of \$2,000,000 each year for 30 years with a mix of mitigative and preventative actions was prepared and is shown in Appendix B.

The Program is comprised of two parts:

- Part 1 – Mitigative Measures; and
- Part 2 – Preventative Measures.

Only mitigation actions with a economic benefit:cost ratio of greater than unity were incorporated into Part 1 of the proposed 30 year schedule of works and represent options empirically justifiable for implementation.

Proposed Actions with a benefit:cost ratio of less than unity are shown in Appendix C (Part 1a) and were not included in the Forward Program at this time given the realised need to revise the levy structure to accommodate the actions providing a net



economic benefit. It should be recognised that many of the actions in this list carry substantial environmental and social benefits and should be assessed for inclusion in any subsequent forward programs to address climate change.

As the preventative measures do not have direct economic benefits with which they can be compared, inclusion under Part 2 of the Forward Program (Appendix B) was primarily a combination of the calculated greenhouse gas emission reduction, cost of implementation and ease with which programs could be implemented. For the immediate development of the forward program actions which require further investigation and extensive co-operation and consultation with external authorities (Appendix C – Part 2a) were not included in the 30 year schedule of works. Only items seen to be effective in lowering long-term greenhouse gas emissions and implemented under Council authority were included and costed in the forward program.

Released in the Public Interest By Manly Council
Subject to Qualifications

9. Recommendations and Conclusions

The list of actions provided to Council, in its entirety, carries a great potential to significantly reduced the unavoidable impacts of climate change upon Manly and reduce Manly's carbon footprint. The economic and social reality of Manly prevents the adoption of all of the options. The actions incorporated by Manly Council in the forward planning program schedule of works (Appendix B) represent an effective and economically sensible subset that has the potentiality to expeditiously instigate long-term environmental improvements and safe-guards to minimise climate change impact.

The key to preventing and mitigation climate change impacts fundamentally lies in the awareness and knowledge of the community. Programs, as included in the schedule of works, to educate the community about the potential effects and causes of climate change are essential in ensuring that first degree concerns resulting from climate change impacts (threats to life, health and safety) are minimised. Similarly, given the long-term, expected gradual nature of climate change impacts, education now provides both council and community the opportunity to react and adapt to the changes climate change will bring. In the event that 'abrupt' climate change occurs, the early implementation of these programs, with regular updating based on the best available scientific information, will be the most appropriate way to prepare for change.

Released in the Public Interest By Manly Council
Subject to Qualifications

10. References

CSIRO/BoM/AGO (2007) *Climate Change in Australia*, www.climatechangeinaustralia.gov.au, accessed 15 April 2008.

DECC (2007) *Floodplain Risk Management Guideline - Practical Consideration of Climate Change*, Version 1, October.

Department of Climate Change (2008) *National Greenhouse Accounts (NGA) Factors*, Commonwealth of Australia, February, Source: www.climatechange.gov.au/workbook/pubs/workbook-feb2008.pdf.

Department of Land and Water Conservation (1997) *Manly Lagoon Floodplain Management Plan*, Prepared for Manly Council and Warringah Council, November.

Gagosian, R. B. (2003) *Abrupt Climate Change: Should We Be Worried?*, Prepared for a panel on Abrupt Climate Change at the World Economic Forum Davos, Switzerland, January 27, 2003, Woods Hole Oceanographic Institution.

IPCC (2007) *Climate Change 2007 – Impacts, Adaptation and Vulnerability: Working Group II contribution to the Fourth Assessment Report of the IPCC Intergovernmental Panel on Climate Change*. Cambridge University Press.

TMI, JLA, and EDAW, (1993) *Manly Tourism Plan of Management*, Tourism Marketing and Investment Pty Ltd, John Larcombe & Associates, and EDAW Pty Ltd, Sydney

NSW Government (2005) *Floodplain Development Manual*, NSW Government.

Ranasinghe, R. Lord, D. Hanslow, D and McInnes, K (2007) *Climate Change Impacts on NSW Coasts and Estuaries, Proceedings, Coasts and Ports 2007*, Melbourne.

RAN (2007) *Tide Charts*, Department of Deference.

Worley Parsons (2008) *Manly Ocean Beach Coastline Management Plan*, Prepared for Manly Council, Issue No 4, March.

Released in the Public Interest By Manly Council
Subject to Qualifications

11. Qualifications

This report and the accompanying spreadsheets (Appendices A and B) have been prepared on the basis of the following assumptions:

- Best estimates of climate change impacts (as referenced through the document)
- Scale and detail of proposed actions are preliminary estimates only based on available information on Council's built and natural assets
- Costings are based on judgment only – no concept design is available at this stage
- Benefits are based on that information that was available within the timeframe for the project and adapted as required for the purposes of this assessment
- Building information has been assessed on the basis of identified land owned by Council (as shown in Council's GIS). No specific building information was available to assist with evaluating mitigative strategies (eg structure type, age and floor area)
- Greenhouse Gas emissions are estimates only and are based on a range of assumptions.

Those effects of climate change that were known of with some quantitative information have been reported and the sources of the data on the estimates of climate change have been derived from either DECC (2007), IPCC (2007) or CSIRO/BoM/AGO (2007). Other effects of climate change may be identified in the future that have not been accounted for here.

The memo and spreadsheet have relied on the accuracy of the following data and information:

- Spatial data provided by Council (including digital elevation model)
- Reports, Management Plans, Studies, Forward Budgets for Various Programs provided by Council.

This report and the accompanying Appendices were prepared over a two week period in April 2008 to assist with the initial preparation of budgets for the purposes of forward planning. Further investigations are required to further quantify the scope of the proposed actions. Further concept and detailed design will require revised cost estimates which may change from those estimates reported in this document, which are of a preliminary nature only and in most cases have been prepared based on engineering judgment.

Cardno Report Version Information:

Version 3 (Rep2459)

Final Version 28 April 2008

Contact: Louise Collier, Manager – Sustainability and Climate Change

Level 3, 910 Pacific Highway GORDON NSW 2072

Ph: +61 2 9496 7700 Fax: +61 2 9499 3033

Email: sydney@cardno.com.au

Released in the Public Interest By Manly Council
Subject to Qualifications



Appendix A

Mitigative Actions List and Preventative Actions List

Released in the Public Interest By Manly Council
Subject to Qualifications

Identifier	Option Name	Brief Description	Location (Specific Site or LGA Wide) (Street Name, Suburb or LGA)	Probability of Event being Addressed (eg Daily, Fortnightly, Monthly, Quarterly, Annually, 1% Chance of Happening Each Year)	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Present Value of Preliminary Life Cycle Cost (Over 30 years)	Present Value of Flood Damage Benefit (30 years)	Present Value of Environmental Tourism Recreational Benefit (30 years)	Total Present Value over 30yrs of Benefit	Cost/Benefit Ratio Estimate	Priority			Other Notes/Comments
												High	Medium	Low	
M1	Education Scheme on the Climate Change Levy	Development of scheme (including capital costs for website, leaflets to go in rates notice and posters). Annual information issue on how the levy has been spent and what has been achieved.	LGA-wide	Daily	\$ 30,000	\$ 10,000	\$ 154,090	\$ 3,882	\$ 3,882	\$ 3,882	0.03				
M2	Information package for private landholders identified to be affected by water-related effects of climate change (sea level rise flooding and groundwater)	Mapping shows that there is portions of private property (mainly non-dwelling areas) expected to be affected under regularly occurring conditions under conservative climate change scenarios (eg private swimming pools, private jetties, yards etc)	LGA-wide	Daily	\$ 40,000	\$ 10,000	\$ 164,090	\$ 225,773	\$ 225,773	\$ 225,773	1.38				Benefit has been assumed to be 1% of the expected overall benefit.
M3	Update of Section 149 Certificates to flag properties mapped to show climate change affectation (sea level rise, flooding and groundwater)	Like other hazards listed in a Section 149 Certificate, the water-related effects of climate change need to be flagged with landholders to allow for informed decisions.	LGA-wide	Daily	\$ 10,000	\$ 5,000	\$ 72,045	\$ 112,887	\$ 112,887	\$ 112,887	1.57				Benefit has been assumed to be 0.05% of the expected overall benefit.
M4	Develop Planning Controls for those areas where mitigation measures cannot be implemented against climate change (LEP and DCP)	In some cases land currently zoned for certain activities may be incompatible with the effects of climate change or there is no feasible mitigation measure available. In the case, planning controls are required to ensure future development is compatible with the changes expected.	LGA-wide	Annual	\$ 20,000	\$ 5,000	\$ 82,045	\$ 225,773	\$ 225,773	\$ 225,773	2.73				Benefit has been assumed to be 1% of the expected overall benefit.
M5	Voluntary Purchase for Properties Affected by sea level rise	In some cases land currently zoned for certain activities may be incompatible with the effects of climate change or there is no feasible mitigation measure available. In this case, voluntary purchase for properties is an alternative that could be pursued. The acquisition would be at current market rate (unencumbered) and undertaken in a similar fashion to the Voluntary Purchase process under the Floodplain Management Program.	Sea level rise affected properties (NB: Some properties may be Heritage listed)	Annual	\$ 16,000,000	\$ -	\$ 16,000,000	\$ 893,451	\$ 893,451	\$ 893,451	0.06				Assume approximately 20 properties affected at an average value of \$800,000 per property.
M6	Voluntary House Raising Program for Properties Affected by sea level rise	In some cases land currently zoned for certain activities may be incompatible with the effects of climate change or there is no feasible mitigation measure available. In this case, voluntary house raising for properties is an alternative that could be pursued. The raising would be generally appropriate only for those dwellings which are piered and of a wall-type construction that allows for raising to be safely undertaken. The raising process would involve the disconnection and reconnection of services to the dwelling.	Sea level rise affected properties (NB: Some properties may be Heritage listed)	Annual	\$ 1,000,000	\$ -	\$ 1,000,000	\$ 893,451	\$ 893,451	\$ 893,451	0.89				Assume approximately 10 properties affected and that all have piered foundations and can be raised.
M7	Provide protection for known and potential Aboriginal objects and places against sea level rise	Site specific protection would need to be evaluated on a case by case basis for Aboriginal objects in consultation with appropriate Aboriginal Groups (eg Metro LALC, Aboriginal Heritage Office) and the Department of Environment and Climate Change. If objects are to be moved/disturbed or worse case destroyed, consent will be required from DECC.	Approximately 16 identified Aboriginal objects are known, but a high occurrence potential exists sea level rise alone would significantly impact the coastal sites	Daily	\$ 100,000	\$ 5,000	\$ 162,045	\$ 57,306	\$ 57,306	\$ 57,306	0.35				
M8	Provide protection for known items of Non-indigenous Heritage	Site specific protection would need to be evaluated on a case by case basis for artefacts in consultation with the NSW Heritage Council and ensuring no impacts (eg on critical habitat).	Across the LGA (numerous sites including West Esplanade, Mandalay Private Hospital)	Daily	\$ 80,000	\$ -	\$ 80,000	\$ 67,779	\$ 67,779	\$ 67,779	0.85				
M9	Assist with ensuring containment strategies are in place for known contaminated land affected by sea level rise	Little Manly Point Caseworks, former Landfill Site at Manly Vale	Little Manly Point Caseworks, former Landfill Site at Manly Vale	Daily	\$ 50,000	\$ -	\$ 50,000	\$ 124,090	\$ 124,090	\$ 124,090	2.48				
M10	Assist with ensuring any actual acid sulfate soils are contained appropriately and groundwater changes do not mobilise ASS	Most significant impact is expected to be areas surrounding Manly Lagoon given the enclosed nature of the waterway.	Most significant impact is expected to be areas surrounding Manly Lagoon given the enclosed nature of the waterway.	Daily	\$ -	\$ 10,000	\$ 124,090	\$ 124,090	\$ 124,090	\$ 124,090	1.00				
M11	Implement greenways through a land acquisition program to allow for adaptation for various species to move to alternate habitat areas	Isolated ecosystems (e.g North Head) do not have significant emigration/immigration of genetic variety and new species. Under a climate change scenario this places them at severe risk as there is limited opportunity for organism migration should conditions become unfavourable. Greenways could be developed connecting major forested areas. Establishing greenways will allow emigration/immigration of organisms more suited to the changed climate. Currently much of the foreshore has a degraded forested corridor. Revegetation of this corridor or land acquisition to establish more direct corridors is recommended.	LGA-wide	Daily/Seasonal	\$ -	\$ 500,000	\$ 6,204,521	\$ 1,420,636	\$ 1,420,636	\$ 1,420,636	0.23				

Released in the Public Interest By Manly Council

Subject to Qualifications

Identifier	Option Name	Brief Description	Location (Specific Site or LGA Wide) (Street Name, Suburb or LGA)	Probability of Event being Addressed (eg Daily, Fortnightly, Monthly, Quarterly, Annually, 1% Chance of Happening Each Year)	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Present Value of Preliminary Life Cycle Cost (Over 30 years)	Present Value of Flood Damage Benefit (30 years)	Present Value of Environmental Tourism Recreational Benefit (30 years)	Total Present Value over 30yrs of Benefit	Cost/Benefit Ratio Estimate	Priority	Other Notes/Comments
M12	Boost efforts for weed management in areas already affected by weed invasion	Weed adaptability is better than native plants expected under a climate change scenario. Would expect invasive weed species to dominate existing isolated areas (e.g. North Head). Council should also ensure Noxious Weeds are controlled on private property. Weeds are linked with human health effects (allergies), contribute to flooding, effects on water quality, extinction of local species, decreased public amenity. Increased Temp and long dry periods interspersed with large rain events provide improved condition for algal growth over the spring and summer months in the Lagoon. It will be necessary to have increased monitoring and creek rehabilitation to minimise the risk to community safety from blue-green algae blooms.	Areas of Low, Medium and High Infestation already identified by Council	Daily/Seasonal	\$ -	\$ 100,000	\$ 1,240,904	\$ -	\$ 648,727	\$ 648,727	0.52	High	
M13	Education Scheme for biodiversity	The need to inform the community that change in flora/fauna composition is not a bad thing in of itself. The need to help the flora and fauna adapt to climate change is the most important way we can help the environments. The education scheme could also incorporate facilitating the community having a greater involvement in revegetation	LGA-wide	Annual	\$ 20,000	\$ 5,000	\$ 82,045	\$ -	\$ 19,408	\$ 19,408	0.24	High	
M14	Aquatic System and pond development to protect amphibians	Amphibians represent key ecological species in ecological systems and growth needs to be encouraged where possible as they are one of the most sensitive groups of animals to climate change.	LGA-wide	Daily/Seasonal	\$ 200,000	\$ 30,000	\$ 572,271	\$ -	\$ 45,286	\$ 45,286	0.08	High	
M15	Cooperative working with RFS for implementation of increased Bushfire awareness and management systems	Increased bushfire risk will require increased bushfire management and protection. It may be necessary to assess the extension of existing Bushfire Hazard protection areas around structures.	Areas in proximity to bushland areas	Annual	\$ 30,000	\$ 10,000	\$ 154,090	\$ -	\$ 628,725	\$ 628,725	4.08	High	
M16	Replacement program for vegetation, including planting of salt and water tolerant plant species	Groundwater rise, particularly around coastal areas, will increase water level and salinity. Existing species are unlikely to be able to cope with this and may die off leading to soil instability and habitat loss. Large trees capable of drawing down groundwater would be preferable.	LGA-wide	Daily/Seasonal	\$ 10,000	\$ 40,000	\$ 506,362	\$ -	\$ 19,408	\$ 19,408	0.04	High	
M17	Increased development planning controls around areas identified as likely to be utilised by the Penguins or Bandicoots under a climate change scenario		LGA-wide	Annual	\$ 15,000	\$ -	\$ 15,000	\$ -	\$ 225,990	\$ 225,990	15.07	Low	
M18	Garden Enrichment Scheme	Provide free native plant seedlings for residents (e.g. plant of the month). Increase native plant abundance and diversity now will allow greater migration of species under a climate change scenario and will assist with carbon uptake.	LGA-wide	Monthly	\$ 5,000	\$ 20,000	\$ 253,181	\$ -	\$ 25,878	\$ 25,878	0.10	High	
M19	Expansion of Aquatic Reserves	Currently there is only one Aquatic Reserve (Cabbage Tree Bay Aquatic Reserve) in the Manly LGA. Reserves lessen the cumulative impact of human disturbance and climate change on populations. Expansion of Aquatic Reserves to include the potential penguin habitat would increase the likelihood of penguin survival. Marine access to penguin nesting habits should be enforced. Reserves will require regular maintenance, monitoring and enforcement.	Specific Sites	Daily/Seasonal	\$ 100,000	\$ 10,000	\$ 224,090	\$ -	\$ 32,347	\$ 32,347	0.14	High	
M20	Community Health Awareness and Control issues.	The increase in temperature and rise of groundwater level will provide improved conditions for bacterial and viral organisms to spread. This poses an increased risk to community health. Community members should be made aware of this, particularly the more elderly members of the community. Water stagnation and flow are strong correlated to disease, particularly following flood events, must be monitored and prevented. Education programs are the most effective way to combat this.	LGA-wide	Annual	\$ 20,000	\$ 5,000	\$ 82,045	\$ -	\$ 82,045	\$ 82,045	1.00	High	
M21	Extensive Revegetation	Well established native vegetation has a higher resistance to weed invasion than stands in poor condition. The majority of stands within the Manly LGA are in poor condition and susceptible to weed invasion. The lagoon area in particular has very low proportion of native species.	Manly Lagoon	Monthly	\$ 20,000	\$ 50,000	\$ 640,452	\$ -	\$ 123,384	\$ 123,384	0.18	High	
M22	Cultural heritage mapping to manage climate change impacts and developmental pressures	There are significant areas within the LGA for the potential of Aboriginal objects. Mapping the LGA in consultation with relevant Aboriginal people, the Aboriginal Heritage Office and the DECC would assist Council in assessing the likelihood of impacts to Aboriginal objects. Because of the nature and geography of the LGA Aboriginal occupation would have been prevalent up until and including the time of settlement.	LGA-wide - Desktop study, AHIMS searches, groundtruthing, community consultation, scientific investigations, modelling	Daily	\$ 300,000	\$ 10,000	\$ 424,090	\$ -	\$ 58,050	\$ 58,050	0.14	High	

Released in the Public Interest By Manly Council
 Subject to Qualifications

Identifier	Option Name	Brief Description	Location (Specific Site or LGA Wide) (Street Name, Suburb or LGA)	Probability of Event being Addressed (eg Daily, Fortnightly, Monthly, Quarterly, Annually, 1% Chance of Happening Each Year)	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Present Value of Preliminary Life Cycle Cost (Over 30 years)	Present Value of Flood Damage Benefit (30 years)	Present Value of Environmental/Tourism/Recreational Benefit (30 years)	Total Present Value over 30yrs of Benefit	Cost/Benefit Ratio Estimate	Priority	Other Notes/Comments
M23	Manly Ocean Beach - Seawall and Beach Nourishment	Upgrade / replacement of seawall to ensure structural stability under: Greater potential erosion under increased storminess and potential shoreline retreat - increased uplift forces due to increased groundwater Seawall works must undertaken in conjunction with beach nourishment in order to: - limit the seawalls exposure under high erosion events - eliminate the need to raise the crest of the seawall to maintain current inundation hazard risk - maintain the highly regarded recreational amenity of the beach - counter potential erosive effects of increased stormwater runoff	Manly Ocean Beach	Daily - Beach Width/Amenity Considerations Quarterly - Ocean Storm erosion and inundation events	\$ 5,500,000	\$ -	\$ 5,500,000		\$ 35,123,344	\$ 35,123,344	6.30	High	Beach nourishment is needed in response to sea level rise as it happens. Nourishment as a pre-emptive action is not desirable as it will result in an overly wide beach with potential beach equilibrium and wind down sand problems. Over the next 30 years, under the high scenario range (0.91m by 2100), sea level may increase in the order of 0.2m or the low scenario range (0.18m). Associated beach recession is in the order of 10m and beach nourishment to address sea level rise may only be required once/twice over the next 30 years. The capital cost identified is a combined cost of seawall and beach nourishment in addition to councils current planned cost over the next 30 years.
M24	Harbour Seawalls	Upgrade/replacement of seawalls to counter potential shoreline recession and maintain current hazard levels as well as strengthening of design to allow for increased uplift forces due to SLR. To be addressed in all future seawall works. Options may include: - raising crest level - installation of wave deflectors at seawall crest	12 seawalls around LGA	Fortnightly - High Spring Tide	\$ 2,500,000	\$ -	\$ 2,500,000	\$ 4,515,465	\$ 4,515,465	\$ 4,515,465	1.81	Medium	To be achieved through councils current replacement/maintenance plan with between 15% and 25% increase in funds required. Desired option for a specific site will require consideration of current crest level in relation to the potential high water level, desired overtopping/inundation hazard, surrounding landscape and exposure to offshore swell wave energy.
M25	Beach Nourishment of Harbour Beaches	Nourishment of Beaches to alleviate potential shoreline recession and account for lost volume as a result of SLR	12 beaches around LGA	Fortnightly - Shoreline recession concerns	\$ 800,000	\$ -	\$ 800,000	\$ 439,042	\$ 439,042	\$ 439,042	0.55	Medium	See notes for Manly Ocean Beach - Nourishment to maintain current beach amenity as SLR progresses. Consider Low MSLR scenario over the next 30 years. 1 - 2 nourishment events to be considered.
M26	Swimming Enclosures	Upgrade/reconstruct swimming enclosures as condition/function requires. New structures to accommodate High MSLR.	6 enclosures LGA wide	Fortnightly - High Spring Tide	\$ 500,000	\$ -	\$ 500,000	\$ 439,042	\$ 439,042	\$ 439,042	0.88	Medium	
M27	Ocean Pools	Upgrade and raise concrete walls to accommodate SLR and maintain current function	2 pools LGA wide	Fortnightly - High Spring Tide	\$ 450,000	\$ -	\$ 450,000	\$ 439,042	\$ 439,042	\$ 439,042	0.98	Medium	
M28	Boat Ramps	Redevelopment boat ramp and carpark area to allow sufficient ramp space under SLR, to be done when condition/function requires	Craig Avenue, Manly	Fortnightly - High Spring Tide	\$ 400,000	\$ -	\$ 400,000	\$ 439,042	\$ 439,042	\$ 439,042	1.10	Medium	
M29	Increase in Stormwater Infrastructure Capacity - as a part of planned upgrade of system - 100% of system	Assume that all pipes need to be upgraded to 5 year capacity as a part of Council plans. Climate change require that all new pipes installed will need to be slightly larger. Most of the cost will be derived from materials costs. Assume that all pipes need to be upgraded. Based on 74 km of pipe, as per Council's GIS.	LGA wide	50% Chance each year	\$ -	\$ 150,000	\$ 1,861,356	\$ 7,500,000	\$ 7,500,000	\$ 7,500,000	4.03	High	
M30	Increase in Stormwater Infrastructure Capacity - as a part of planned upgrade of system - 50% of system	Climate Change to add additional capacity to replaced pipes. Most cost derived from material costs. Based on 74 km of pipe, as per Council's GIS.	LGA wide	50% Chance each year	\$ -	\$ 75,000	\$ 930,678	\$ 7,500,000	\$ 7,500,000	\$ 7,500,000	8.06	High	
M31	Increase in Stormwater Infrastructure Capacity - Target Areas	Only increase the capacity of the stormwater system in areas likely to have increases in overland flow (based on coarse modeling). Assume that Council to upgrade to 5 year capacity as a part of plans, with Climate Change to add additional capacity	LGA Wide	50% Chance each year	\$ -	\$ 60,000	\$ 744,542	\$ 5,000,000	\$ 5,000,000	\$ 5,000,000	6.72	High	
M32	Increase Stormwater Capacity - Ashburner Street	Increase in pipe and pit capacity to allow draining of Ashburner Street	Ashburner Street	50% Chance each year	\$ 150,000	\$ -	\$ 150,000	\$ 51,867	\$ 51,867	\$ 51,867	0.35	Medium	
M33	Increase in Stormwater Capacity - North of Corso	Increase in stormwater capacity to allow better drainage to area between the Corso and Pine Street (likely increases in peak water levels in this area). This area currently has proposed upgrade of \$2.5M.	North of Corso, up to Pine Street	50% Chance each year	\$ 325,000	\$ -	\$ 325,000	\$ 3,493,032	\$ 3,493,032	\$ 3,493,032	10.76	High	
M34	Increase in Stormwater Capacity - West of North Harbour Reserve	Increase in pit and pipe capacity in the area west of North Harbour Reserve, to reduce likely increases in peak water levels	West of North Harbour Reserve	50% Chance each year	\$ 150,000	\$ -	\$ 150,000	\$ 185,025	\$ 185,025	\$ 185,025	1.23	Medium	
M35	Increase in Stormwater Capacity - from near Valley Road to near Clarence Street	Increase in pit and pipe capacity, to reduce likely increases in peak water levels in this area	Balgownie Heights - from Valley Road to Clarence Street	50% Chance each year	\$ 150,000	\$ -	\$ 150,000	\$ 491,693	\$ 491,693	\$ 491,693	3.28	Medium	
M36	Policy - Changes to Flood Planning Levels	Changes to planning controls to include higher Flood Planning Levels to account for increases in flood levels. Note that increase will not be the same across the entire LGA.	LGA wide	1% Chance each Year	\$ 5,000	\$ -	\$ 5,000	\$ 112,887	\$ 112,887	\$ 112,887	22.58	High	
M37	Study on Changes to Flood Levels	Study to be undertaken to determine change to Flood Planning Levels across the LGA under a climate change scenario. Can utilise previous studies to undertake work.	LGA wide	5% Chance each year	\$ 30,000	\$ -	\$ 30,000	\$ 112,887	\$ 112,887	\$ 112,887	3.76	Medium	
M38	Policy - Changes to controls on rainwater tanks	Provisions to ensure rainwater tanks are sized based on climate change annual rainfall.	LGA Wide	Annually	\$ 5,000	\$ -	\$ 5,000	\$ 6,032	\$ 6,032	\$ 6,032	1.21	Medium	
M39	Study on Rainwater Tank changes	Study to be conducted by Council to provide "rating" curves for various roof sizes. Rainwater tanks potentially undersized with reduced annual rainfall volumes. Supplement to subsidise increase in rainwater tank volume as a result of climate change.	LGA Wide	Annually	\$ 15,000	\$ -	\$ 15,000	\$ 6,032	\$ 6,032	\$ 6,032	0.40	Medium	
M40	Supplement for Water Tanks		LGA wide	Annually	\$ -	\$ 20,000	\$ 359,862	\$ 6,032	\$ 6,032	\$ 6,032	0.02	Medium	

Released in the Public Interest By Manly Council

Subject to Qualifications

Identifier	Option Name	Brief Description	Location (Specific Site or LGA Wide) (Street Name, Suburb or LGA)	Probability of Event being Addressed (eg Daily, Fortnightly, Monthly, Quarterly, Annually, 1% Chance of Happening Each Year)	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Present Value of Preliminary Life Cycle Cost (Over 30 years)	Present Value of Flood Damage Benefit (30 years)	Present Value of Environmental/Recreational Benefit (30 years)	Total Present Value over 30yrs of Benefit	Cost/Benefit Ratio Estimate	Priority			Other Notes/Comments
												High	Medium	Low	
M41	Policy - Changes to Water Quality Treatment Device Controls	Water quality treatment devices to be sized to account for Climate Change. This includes the likely increase in peak storm flows, together with the likely reduction in annual rainfall	LGA wide	Quarterly	\$ 5,000	\$ -	\$ 5,000	\$ -	\$ 64,694	\$ 64,694	12.94				
M42	Upgrade of existing Council Water Quality Treatment Devices	Upgrade of Council's water quality treatment devices to account for increases in peak flows and reductions in annual rainfall	LGA wide	Quarterly	\$ -	\$ 15,000	\$ 186,136	\$ -	\$ 64,694	\$ 64,694	0.35				
M43	Provision of Levee near Manly Lagoon, including ocean storm protection of Kenneth Road - only Ocean Storm Protection	Levee to protect properties from increases in ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 1100m. Additional height protection required is approximately 0.91 metres (compared with existing ocean storm issues)	Manly Lagoon	Annually	\$ 480,000	\$ 2,000	\$ 504,818	\$ 18,743,639	\$ -	\$ 18,743,639	37.13				
M44	Provision of Floodwall near Manly Lagoon, including ocean storm protection of Kenneth Road - only Ocean Storm Protection	Floodwall to protect properties from increases in ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 1100m. Additional height protection required is approximately 0.91 metres (compared with existing ocean storm issues)	Manly Lagoon	Annually	\$ 740,000	\$ 2,000	\$ 764,818	\$ 18,743,639	\$ -	\$ 18,743,639	24.51				
M45	Provision of Levee near Manly Lagoon, properties only - only Ocean Storm Protection	Levee to protect properties from increases in ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 400m. Additional height protection required is approximately 0.91 metres (compared with existing ocean storm issues)	Manly Lagoon	Annually	\$ 150,000	\$ 2,000	\$ 174,818	\$ 18,743,639	\$ -	\$ 18,743,639	107.22				
M46	Provision of Floodwall near Manly Lagoon, properties only - only Ocean Storm Protection	Floodwall to protect properties from increases in ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 400m. Additional height protection required is approximately 0.91 metres (compared with existing ocean storm issues)	Manly Lagoon	Annually	\$ 250,000	\$ 2,000	\$ 274,818	\$ 18,743,639	\$ -	\$ 18,743,639	68.20				
M47	Provision of Levee near Manly Lagoon	Levee to protect properties from increases in flood levels as well as ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 1050m. Additional height required over existing is approximately 0.6 metres. Note that no levee is proposed for Kenneth Road as it is likely to increase flood levels upstream. Also note that this option is assumed to be incremental on existing flood control required (assumed 30% additional cost).	Manly Lagoon	1% Chance each Year	\$ 85,000	\$ -	\$ 85,000	\$ 22,577,323	\$ -	\$ 22,577,323	265.62				
M48	Provision of Floodwall near Manly Lagoon, protection of only properties	Floodwall to protect properties from increases in flood levels as well as ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 1050m. Additional height required over existing is approximately 0.6 metres. Note that no levee is proposed for Kenneth Road as it is likely to increase flood levels upstream. Also note that this option is assumed to be incremental on existing flood control required (assumed 30% additional cost).	Manly Lagoon	1% Chance each Year	\$ 110,000	\$ -	\$ 110,000	\$ 22,577,323	\$ -	\$ 22,577,323	205.26				
M49	Detention Basin to be provided upstream Burnt Bridge Creek Deviation, on Burnt Bridge Creek	Detention Basin to be provided to reduce peak flows downstream (particularly Balgowlah Road, Condamine Street and Roseberry Street Areas).	Burnt Bridge Creek	1% Chance each Year	\$ 200,000	\$ 2,000	\$ 224,818	\$ 1,717,621	\$ -	\$ 1,717,621	7.64				
M50	Increase in Culvert Sizings under Industrial Area	Increase in culvert capacity to account for increases in peak flows, and to reduce likely increases in flood levels through industrial area	Roseberry Street Industrial Area	20% Chance each year	\$ 2,600,000	\$ 2,000	\$ 2,624,818	\$ 1,354,572	\$ -	\$ 1,354,572	0.52				
M51	Pumping Systems for Manly CBD	Pumping Systems to be incorporated into the Manly CBD stormwater infrastructure, to account for a reduction in outflow due to increase ocean levels	Manly CBD	50% Chance each year	\$ 30,000	\$ 10,000	\$ 154,090	\$ 450,161	\$ -	\$ 450,161	2.92				
M52	Manly Beach Stormwater outfalls	Raising of stormwater outfalls to account for increases in ocean levels - this may not be possible due to inverts of stormwater infrastructure. Note that currently proposed to upgrade, with \$6M provision. Assume that will need additional funding for raising of outlet, increasing capacity etc	Manly CBD	Annual	\$ 500,000	\$ 1,000	\$ 512,408	\$ 450,161	\$ -	\$ 450,161	0.88				
M53	Detention Basin - Nanbaree Reserve	Provision of detention basin in Nanbaree Reserve, to reduce likely increase in peak water levels for properties downstream	Nanbaree Reserve - Balgowlah Heights	1% Chance each Year	\$ 200,000	\$ 2,000	\$ 224,818	\$ 29,676	\$ -	\$ 29,676	0.13				
M54	Barrage at Entrance to Manly Lagoon	Barrage to be provided at entrance to Manly Lagoon, to provide protection against coastal storm events. Note that will need to be designed for environmental flushing and to allow flood flows to pass.	Manly Lagoon	Annual	\$ 2,000,000	\$ 10,000	\$ 2,124,090	\$ 18,743,639	\$ -	\$ 18,743,639	8.82				
M55	Council Purchase - Rebuild	Council purchases properties in significantly affected areas. Undertakes development in compatible manner and resells the land. Assume that the number of properties are also 16	Floodplain Areas, primarily Manly Lagoon	1% Chance each Year	\$ -	\$ 100,000	\$ 1,240,904	\$ 893,451	\$ -	\$ 893,451	0.72				

Identifier	Option Name	Brief Description	Location (Specific Site or LGA Wide) (Street Name, Suburb or LGA)	Probability of Event being Addressed (eg Daily, Fortnightly, Monthly, Quarterly, Annually, 1% Chance of Happening Each Year)	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Present Value of Preliminary Life Cycle Cost (Over 30 years)	Present Value of Flood Damage Benefit (30 years)	Present Value of Environmental Tourism Recreational Benefit (30 years)	Total Present Value over 30yrs of Benefit	Cost/Benefit Ratio Estimate	Priority			Other Notes/Comments
												High	Medium	Low	
M56	Policy - Modifications to OSD Policy	Modify OSD policy to increase required savings of OSD to account for Climate Change, reducing the need to increase stormwater infrastructure downstream	LGA wide	20% Chance each year	\$ 20,000	\$ 5,000	\$ 82,045	\$ 100,000		\$ 100,000	1.22				
M57	Undertake Study to determine suitable OSD savings, in conjunction with above option		LGA Wide	20% Chance each year	\$ 50,000		\$ 50,000	\$ 100,000		\$ 100,000	2.00				
M58	Road and Footpath maintenance (existing pavements)	Road maintenance costs will increase as a result of increased rainfall intensity. Pavement deterioration is accelerated with increasing rainfall intensity. More short term maintenance measures (e.g. pot hole repairs, patching) will be required as a result of more storms of high intensity.	LGA	Monthly	\$ 30,000	\$ 300,000	\$ 3,752,712		\$ 3,752,712	\$ 3,752,712	1.00				Increase in rainfall intensities of up to 30% due to high climate change scenario could reasonably be expected to result in 30% to 50% increased expenditure on pot hole repairs and patching. Council's current annual expenditure on pavement maintenance is \$700,000 (TBC) based on "10yr Infrastructure Plan". Forecast increase attributable to climate change, say 40% x \$700,000 i.e. \$300,000. Capital costs of \$30,000 associated with programming of works - nominal allowance.
M59	Reconstruction of dilapidated pavements using material with low moisture susceptibility.	Reconstruction of dilapidated pavements (e.g. less than 5 years serviceable life remaining) using bound pavement layers (e.g. Cement treated sub bases and/or concrete base) and substantial sub-pavement drainage. High capital costs, low recurrent costs.	Low lying areas within and adjacent to flood affected areas. E.g. Manly Flats, adjacent to Manly Lagoon and Golf course.	Annually	\$ -	\$ 500,000	\$ 6,204,521		\$ 6,204,521	\$ 6,204,521	1.00				Cost estimates to be refined following review of Council road condition surveys and maintenance programs. Construction of rigid pavements typically 2 to 3 times more expensive than flexible pavements and have a serviceable life of approximately twice as long.
M60	Raise or relocate footpaths impacted by rises in sea levels	Reconstruct footpaths or relocate footpaths inundated by the rise in sea level resulting from the extreme climate change scenario. Assume flood level above floor level. Provide temporary flood barriers	Northern bank of Manly Lagoon, between Pittwater Road and Ocean beach; and Shelly Beach adjacent to Marine Parade.	Annually	\$ 500,000	\$ 10,000	\$ 624,090		\$ 624,090	\$ 624,090	1.00				Approx 1km of footpath impacted. Capital costs highly dependent on reconstruction or relocation option, e.g. concrete on grade construction vastly less expensive than raised boardwalk option.
M61	Cottages	Assuming flood level above floor level: Provide temporary flood barriers / modifications to entry areas	34 & 36 Stuart St	1% Chance each Year	\$ 30,000		\$ 30,000	\$ 111,681		\$ 111,681	3.72				Assume 3 accesses per building requiring modification/barriers
M62	State Emergency Services	Assuming flood level above floor level: Provide temporary flood barriers / modifications to entry areas	Roseberry Street	1% Chance each Year	\$ 15,000		\$ 15,000	\$ 111,681		\$ 111,681	7.45				Assume 3 building accesses requiring modification/barriers
M63	Garbage Depot	Assuming flood level above floor level: Provide temporary flood barriers / modifications to entry areas	Roseberry Street	1% Chance each Year	\$ 40,000		\$ 40,000	\$ 31,643		\$ 31,643	0.79				Assume 8 building accesses requiring modification/barriers
M64	Council Depot	Assuming flood level above floor level: Local regrading	Balgowlah Road	1% Chance each Year	\$ 40,000		\$ 40,000	\$ 71,352		\$ 71,352	1.78				Assume 8 building accesses requiring modification/barriers
M65	Former Balgowlah Womens Bowling Club	Reprovide new facility to higher level above floor level	Burton	1% Chance each Year	\$ 950,000		\$ 950,000	\$ 55,841		\$ 55,841	0.06				Assumes that new facility is to be built on site. Design levels to provide for higher flood level
M66	New Library Site	Assuming flood level above floor level: Provide temporary flood barriers / modifications to entry areas	Market Lane	1% Chance each Year	\$ 25,000		\$ 25,000	\$ 738,338		\$ 738,338	29.53				Assumes 5 doorways require temporary barriers / modification
M67	Sangrado Park Scout Hall	Assuming flood level above floor level: Provide temporary flood barriers / modifications to entry areas	Sangrado Park	1% Chance each Year	\$ 15,000		\$ 15,000	\$ 55,841		\$ 55,841	3.72				Assumes 3 accesses requiring modification/barriers
M68	Snr Citizen Ctr & Mnl Croquet Club	Reprovide facility above floor level	Balgowlah Road	1% Chance each Year	\$ 1,740,000		\$ 1,740,000	\$ 55,841		\$ 55,841	0.03				
M69	Basement Carpark Pacific Waves	Extra pumping due to additional ground water ingress	Central Avenue	1% Chance each Year	\$ -	\$ 1,000	\$ 12,408	\$ 1,241		\$ 1,241	0.10				Assumes tanked structure, ie ground water prevented from entering carpark area (ie pumping leakages) and also assumes no structural strengthening required.
M70	Central Avenue Carpark	Local regrading to protect entrance. Extra pumping due to additional ground water ingress	Central Avenue	1% Chance each Year	\$ 180,000	\$ 1,000	\$ 192,408	\$ 1,241		\$ 1,241	0.01				Assumes tanked structure, ie ground water prevented from entering carpark area (ie pumping leakages) and also assumes no structural strengthening required.
M71	Market Lane Carpark	Allow flooding of bottom level. Modifications may be required to protect elevator, ticket machines etc	Market Lane	1% Chance each Year	\$ 50,000		\$ 50,000	\$ 37,227		\$ 37,227	0.74				
M72	Short St Underground Carpark	Local regrading to protect entrance. Extra pumping due to additional ground water ingress	Short St	1% Chance each Year	\$ 180,000	\$ 1,000	\$ 192,408	\$ 1,241		\$ 1,241	0.01				Assumes tanked structure, ie ground water prevented from entering carpark area (ie pumping leakages) and also assumes no structural strengthening required.
M73	Rialto Sq & Wentworth Carpark	Local regrading to protect entrance. Extra pumping due to additional ground water ingress	Wentworth St	1% Chance each Year	\$ 175,000	\$ 1,000	\$ 187,408	\$ 1,241		\$ 1,241	0.01				Assumes tanked structure, ie ground water prevented from entering carpark area (ie pumping leakages) and also assumes no structural strengthening required.
M74	Queenscliff Surf Pavilion	Provide temporary flood barriers / modifications to entry areas	North Steyne	1% Chance each Year	\$ 20,000		\$ 20,000	\$ 55,841		\$ 55,841	2.79				Assumes 4 accesses requiring modification/barriers
M75	15 existing Public Toilets Sites currently requiring annual maintenance only	Replace low lying toilets for public health considerations	LGA Wide	1% Chance each Year	\$ 1,210,000		\$ 1,210,000	\$ 186,136		\$ 186,136	0.15				Assumes 75% of sites are below flood level and will need to be replaced with Exelco or similar
M76	10 Public Toilets Sites planned for replacement or new facility	Replace with account taken for future climate change flooding levels	LGA Wide	1% Chance each Year	\$ 10,000		\$ 10,000	\$ 124,090		\$ 124,090	12.41				Assumes \$1000 per site for additional works to elevate floor level above flood level
M77	12 Public Toilet Sites with planned refurbishment	Replace with account taken for future climate change flooding levels	North Steyne, Clontarf Reserve	1% Chance each Year	\$ 170,000		\$ 170,000	\$ 24,818		\$ 24,818	0.15				Estimate based upon \$25,000 per toilet upgrade
M78	Allowance for non flood related treatment of Council buildings (eg groundwater level rise)	Capital works such as underpinning foundations due to water table rise, recurrent cost for increased maintenance due to harsher climatic conditions	LGA Wide	1% Chance each Year	\$ 2,225,000	\$ 34,000	\$ 2,646,907	\$ 2,646,907		\$ 2,646,907	1.00				Estimated on a per building basis. Council supplied figures of 84 properties owned by Council in the LGA.

Identifier	Option Name	Brief Description	Responsibility	Location (Specific Site or LGA Wide) (Street Name, Suburb or LGA)	Annual Reduction in GHG Estimate (Tonnes CO2)	Upper Priority Range High Medium	Lower Priority Range High Medium	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrence Cost (\$ 2008)	Preliminary Life Cycle Cost (Over 30 years)	Other Notes/Comments
P1	Solar Powered Pedestrian Lighting	Replacement of all existing pedestrian lighting (not affected by heritage orders) with solar PV lighting	Council	LGA-wide	1600			\$ 50,000	\$ 200,000	\$ 2,531,808	Cost estimate is very preliminary.
P2	Retrofit T5 or HPS lamps in all sporting facility lights	Replacement of bulbs in all sporting facility lights from high energy demand to low energy demand	Council	LGA-wide	160			\$ -	\$ 10,000	\$ 124,090	9 Sportsfields. Assumed all have night lighting
P3	Provide Co-generated or tri-gen power (eg GridX) to CBD public buildings	Install a cogeneration plant to service building electrical heating and cooling requirements	Council	CBD Public Buildings (eg Council Admin)	920	needs more analysis		\$ 1,000,000	\$ 100,000	\$ 2,240,904	Assumed cost to be confirmed by contact with providers.
P4	Solar PV on all Public Buildings and Car Parks	Assume 10 buildings and 2 main carparks	Council	LGA-wide	825			\$ 700,000	\$ 10,000	\$ 824,090	
P5	Solar pumps for sportsfields irrigation		Council	LGA-wide	16			\$ 50,000	\$ 5,000	\$ 112,045	
P6	Small Wind Farm at North Head	Installation of a wind farm to provide alternative power to Manly	Partnership	North Head	15900			\$8,000,000	\$100,000	\$9,240,904	Assume a total 8 turbines (600 kW turbines) over an area of 1.5 sq km.
P7	Solar Heating for Boy Charlton Pool	Provision of solar thermal heating for the swimming centre.	Council	Boy Charlton Pool	250			\$ 500,000	\$ 5,000	\$ 562,045	To be confirmed with Council that solar thermal not currently used. Cost to be confirmed.
P8	Demonstration wave power facility on open coast		Partnership	Open Coast	185			\$ 2,000,000	\$ 5,000	\$ 2,062,045	
P9	Heavy vehicle emissions levy system	Levy on vehicles entering the CBD or the LGA that do not meet specific standards for emissions of GHG. A similar system has recently been implemented in London.	State	LGA-wide	9000			\$ 40,000	\$ 10,000	\$ 164,090	
P10	Rainwater Harvesting Tanks on all public buildings for toilet flushing.	Reduction on the need for water to be pumped and associated energy demand reduction.	Council	LGA-wide	10			\$ 250,000	\$ 5,000	\$ 312,045	Assume space available for tanks to be located. Assume 10 tanks installed and plumbed.
P11	Utilisation of gas powered/biodiesel powered council vehicles (e.g. garbage trucks)	All council vehicles (including garbage, service & staff vehicles) to run using 'green' fuel, be fuel & energy efficient. An overall reduction or removal of staff vehicles (Biodiesel, Biogas/CNG, LPG, Electric vehicles, Hybrid Vehicles)	Council	LGA-wide	1600			\$ -	\$ 100,000	\$ 1,240,904	Acquisition of a series of vehicle per year. GHG estimates are based on a complete conversion.
P12	LGA bio-banking equivalent	Provide owners of land with Council-recognised value in terms of Native Vegetation or Heritage and incentive to upkeep property which can be traded.	not sure	LGA-wide	0			\$ 5,000,000	\$ -	\$ 5,000,000	Assume funding of up to 5 properties
P13	Subsidise contractors utilising low carbon materials	Council to support 10 private construction projects per year with grants of \$10,000 per project	Council	LGA-wide	5			\$ -	\$ 100,000	\$ 1,240,904	Assume 10 projects per year with grants of \$10,000 per project
P14	Decentralise energy production	As used in Sydney2030 vision install multiple large local gas co-generation units across the main business areas of the LGA an install infrastructure so that energy produced and heating/cooling (via water pipes) can be sold off. Reduces costs for individuals as they don't have to operate their own heating/cooling systems and lower electricity bills. Reduced dependency on coal powered energy. Possible use of recycled water. Could be integrated with water/waste treatment/recycling.	State	Hotels, Motels and Businesses in the Corso	5500			\$ 5,000,000	\$ 200,000	\$ 7,481,808	Assumed cost to be confirmed by contact with GridX
P15	Decentralise waste systems.	Provide small scale local waste processing facilities (from local compost heaps to small AWTs). Any energy, greywater, compost produced could be utilised by local residents/business for free, at cost to residents further afield.	SHROC	LGA-wide, residential areas	10			\$ 2,000,000	\$ 250,000	\$ 5,102,260	Land acquisition and basic site services costs and annual costs of operation. GHG estimates are not considered reliable.
P16	Creation of plantation type vegetation areas on Council property for the sequestration of carbon (for rapidly growing crops that can be harvested where the carbon is locked in permanently - eg bamboo).		Needs Further Analysis	Available Council land, or land acquired for the purpose	300			\$ 1,000,000	\$ 100,000	\$ 2,240,904	Land acquisition and basic site services costs and annual costs of operation
P17	Change of Council's recommended landscape species to those endemic species that have max carbon uptake potential.	This will involve identifying suitable endemic species and understanding their role in carbon uptake. It is likely to require initial research.	Council	LGA-wide	5			\$ 30,000	\$ 10,000	\$ 154,090	
P18	Design guidelines for infrastructure to ensure new infrastructure is designed to accommodate effects of climate change.		Council	LGA-wide	0			\$ 30,000	\$ 2,000	\$ 54,818	
P19	Use of recycled materials in road and footpath construction.	Substitution of quarried rock road construction products with recycled concrete or blast furnace slag.	SHROC	LGA	5			\$ -	\$ 100,000	\$ 1,240,904	Note capital costs associated with recycled products are comparable to traditional quarried products, however questions have been raised recently regarding long term performance of some recycled products e.g. recycled concrete road base. This option may involve additional lifecycle costs compared to that of traditional pavement materials. GHG estimates considered unreliable.

Identifier	Option Name	Brief Description	Responsibility	Location (Specific Site or LGA Wide) (Street Name, Suburb or LGA)	Annual Reduction in GHG Estimate (Tonnes CO2)	Upper Priority Range	Lower Priority Range	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Preliminary Life Cycle Cost (Over 30 years)	Other Notes/Comments
P20	Progressive augmentation/replacement of energy network connected street lighting with solar lighting	Gradual implementation of solar powered luminaires to existing light standards for local streets (i.e. roads other than collector, regional and state standard).	Energy Australia	LGA	1100			\$ 2,500,000	\$ 40,000	\$ 2,996,362	Costs indicated are a very preliminary estimate. Project to commence with utilisation of the lower intensity solar lighting at times of low traffic volumes e.g. 1am to 5am drawing no power from the conventional energy network at these times. As solar technology improves, implementation of a street lighting network with a solar energy bias should be targeted.
P21	Middle Harbour Ferry Wharf	Provision of a wharf at Middle harbour to serve western Manly area with solar powered ferry services to North Sydney (Milsons Point) and City	State	Middle Harbour	18250			\$ 260,000	\$ 5,000	\$ 322,045	Includes new wharf, basic small shelter, allowance for minor roadworks for drop off point. Assumes that 2000 10km car trips are saved each day. Solar powered ferries not included in the cost (eg Solar Sailor)
P22	Manly - Milsons Point - Sydney CBD Ferry Service	New fast and frequent ferry service to Milsons Point from Manly wharf and the proposed Middle Harbour wharf	State	Manly CBD & Middle harbour	18250			\$ -	\$ -	\$ -	Sydney Transport Authority
P23	Subsidised Manly Ferry	Direct subsidy to ensure the existing service remains a cheap, government operated public transport service. If the service is privatised - Manly LGA residents receive subsidised fares.	Partnership	LGA	18400	needs more analysis		\$ -	\$ -	\$ -	Hypothetical situation as Manly route is one of the most utilised and hence least subsidised routes
P24	Manly - North Sydney - (possibly) Sydney CBD Light Rail	Light rail system with connections at key Manly LGA locations (CBD, ferry wharf, proposed wharf) to North Sydney and possibly to Sydney CBD	State	LGA	41000			\$ 157,500,000	\$ 500,000	\$ 163,704,521	4.5 km length to perimeter of Manly LGA @ \$35M/km. Assume GHG just for the section in Manly LGA (assume saving of 10000 car trips per day)
P25	Manly Metro Shuttle Bus Network	Network of highly visible fast & frequent, environmentally friendly shuttle buses to key locations & suburbs to provide interchange with other public transport and strategic bus corridors (major expansion of current hop-skip-jump service). Add links to Warringah Mall, Queenscliff, beachfront, Seaforth, Sydney Harbour National Park. Highly recognisable branding. All vehicles to be 'green' using alternative fuels.	Partnership	LGA	21000			\$ 1,800,000	\$ 536,000	\$ 8,451,246	Annual cost based upon Hop-On-Off service shortfall of \$200,000/yr for three buses. Capital cost is purchase of 8 buses at \$150k each. Assume 8 buses can do 1 round trip of 20 km per hour and work over a 10 hour day and take saving 60*8*10 car trips of 5 km per day.
P26	Quality Bus Corridor Network	All bus corridors in the LGA to include bus priority infrastructure including B signals, bus only lanes and full length bus lanes	Partnership	LGA	4500			\$ 1,900,000	\$ 60,000	\$ 2,644,542	Consists of bus only lanes along state roads. Costs borne by Council or RTA? Assumes reduces 10 km car trips by 500 per day.
P27	High Quality Bus Infrastructure	All bus stops along bus corridors & Metro routes in the LGA to include high quality shelters, real time passenger information, highly visible infrastructure & other key features	Partnership	LGA	9000			\$ 2,000,000	\$ 10,000	\$ 2,124,090	Small
P28	Manly Multi-modal Interchange	Highly visible Transport Interchange providing connections to proposed light rail, shuttle buses, cycle hire, taxi and ferry services in Manly CBD	Partnership	Manly CBD	900	needs more analysis		\$ 3,200,000	\$ 100,000	\$ 4,440,904	Allows for single level basic facility with a/c, landscaping for 160x40m area and roadworks around perimeter
P29	Passenger Interchange Protection	Covered walkways from the multi-modal interchange to bus stops and the CBD to provide protection from extreme weather conditions. Locations include West Promenade, Gilbert Street, Belgrave St and West Esplanade	Council	Manly CBD	300			\$ 800,000	\$ 40,000	\$ 1,296,362	Covered walkway with medium to high quality finish
P30	Park & Ride Stations	Park & Ride stations at key locations to connect to the Strategic bus corridor such as Council Depot at Fairlight (Balgowlah Road), Balgowlah Oval Balgowlah (underground car park), Manly Oval, Manly CBD (convert current CBD car park). Supporting high quality bus infrastructure to be provided. Higher parking charge for non Manly LGA residents, must have a valid PT ticket to use the car park. Will require the implementation of resident parking schemes along bus corridors within walking distance of all bus stops.	Partnership	LGA	21000			\$ 46,500,000	\$ 100,000	\$ 47,740,904	3x400 car multi storey carparks allowing for basic concrete construction; and land at \$2400/m2
P31	Free or discounted public transport	Free or discounted public transport for all Manly LGA residents at a rate of \$100 per resident per year incorporating smart card technology	Council	LGA	1250	needs more analysis		\$ -	\$ 3,500,000	\$ 43,431,644	Assume 35,000 residents to be provided for. For GHG assessment, assume 10,000 residents make at least 5 less 5 km vehicle trips per year (ie 10 km total)
P32	Manly Bike Stations	A network of bike hire stations next to public transport, residential areas, retail, office and other trip generators. Bikes are lent or hired (see Barcelona, Paris). High quality & well branded.	Partnership	LGA	50			\$ 1,400,000	\$ 140,000	\$ 3,137,266	Assume 1000 residents make at least 10 less 1 km vehicle trips per year (ie 2 km total)
P33	CBD Car Free Zone	Pedestrianisation of all streets in the CBD zone (except for delivery access)	Council	CBD	4600			\$ 900,000	\$ 45,000	\$ 1,458,407	
P34	Manly Congestion Charge	Vehicular charge to enter/exit Manly in AM and PM peak to reduce truck movements and encourage public transport usage.	Needs Further Analysis	LGA cordon	9000			\$ 50,000	\$ -	\$ 50,000	
P35	School Car Free Zones	Zones around schools to be car free/permit parking or include engineering measures such as pedestrianisation or traffic calming to encourage active transport to schools	Council	LGA	900			\$ 110,000	\$ 5,000	\$ 172,045	
P36	CBD Car Park Removal	Removal of all CBD multi story car parking to remove vehicle emissions and improve air/noise quality and safety (for example: Copenhagen)	Needs Further Analysis	CBD	900	needs more analysis		\$ 8,500,000	\$ -	\$ 8,500,000	Land Value to Council at \$3600/m2. Need to plan for reduction in central Manly parking capacity
P37	Manly Car Share	Extension of free membership to Manly residents of Flexi Car and introduction of additional locations, incorporated into new developments and at trip attractors/generators	Partnership	LGA	900			\$ 7,200,000	\$ -	\$ 7,200,000	Single membership for commercially available car share frequent user is \$360/yr. Usage rates charged to the user.

Released in the Public Interest By Manly Council

Subject to Qualifications

Identifier	Option Name	Brief Description	Responsibility	Location (Specific Site or LGA Wide) (Street Name, Suburb or LGA)	Annual Reduction in GHG Estimate (Tonnes CO2)	Upper Priority Range High Medium	Lower Priority Range High Medium	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Preliminary Life Cycle Cost (Over 30 years)	Other Notes/Comments
P38	Public Transport Business Rate Reduction	Reduced business rates where staff travel to/from work by public transport (enforcement issues)	Needs Further Analysis	LGA	9000	needs more analysis		\$ -	\$ 100,000	\$ 1,240,904	As percentage of rates paid, eg 3%
P39	Green Residential Parking Rates	Vehicles registered as part of residential parking areas will be subject to an assessment using the green vehicle guide with rates increasing for higher polluting vehicles or reductions for fewer vehicles registered etc (see North Sydney). Options if no cars - free annual PT passes.	Needs Further Analysis	LGA	9000	needs more analysis		\$ -	\$ 50,000	\$ 620,452	As percentage of rates paid, eg 5%
P40	Alternative Fuel Service Stations	Provision of alternative fuel stations in the LGA (reduced rates, planning controls to encourage) including biodiesel, Biogas/CNG, LPG etc	Partnership	LGA	1800			\$ 50,000	\$ -	\$ 50,000	Planning initiative
P41	Cycle & Walking Infrastructure Retro fit	All Council & RTA roads to be retro-fitted with cycle infrastructure (cycle lanes, lockers, racks, access, etc)	Partnership	LGA	1800			\$ 350,000	\$ 17,500	\$ 567,158	
P42	Off-Road Cycle & Walking Infrastructure	Off-road cycleways and infrastructure to be identified and constructed	Council	LGA	900			\$ 50,000	\$ 5,000	\$ 112,045	
P43	Footpaths	Increased lengths of footpaths to encourage pedestrian behaviour	Council	LGA	900			\$ 7,500,000	\$ 375,000	\$ 12,153,390	Footpaths to be on both sides of 75% of streets
P44	Transport & Planning Policy	Require all developments to include maximum parking, travel plans, convenient cycle and pedestrian access trip end facilities, TOD, free bicycles, car share parking & vehicle, consideration of car free development etc	Council	LGA	900			\$ 10,000	\$ -	\$ 10,000	Planning initiative
P45	Marketing & Education	Branding, participation in national campaigns and provision of information to educate residents about alternative transport and why Council has adopted this approach	Council	LGA	4500			\$ -	\$ 75,000	\$ 930,678	Allows for part time employee + some materials
P46	Signing & Information	Wayfinding and information systems such as timetable information to be installed	Council	LGA	900			\$ 100,000	\$ 2,000	\$ 124,818	
P47	Travel Plan Network	All major trip generators e.g. Ocean World, Hospital etc to adopt and implement travel plans	Council	LGA	900			\$ 10,000	\$ -	\$ 10,000	
P48	Freight Distribution Scheme	To reduce freight movements introduce a freight distribution scheme to Manly LGA involving a centralised warehouse where all deliveries for commercial properties would be directed to which would then have a forwarding capability. Allows for reduction in overall truck movements by ensuring each truck is full.	Council	LGA	900	needs more analysis		\$ 11,000,000	\$ 10,000	\$ 11,124,090	Allows for Land and Warehouse only. Transport/operation provided by contractor
P49	Home Delivery	Free home delivery services for Manly residents who order over internet or walk/cycle to shops.	Partnership	LGA	10	needs more		\$ -	\$ 10,000	\$ 124,090	Concept to be developed
P50	Business Practices	Encourage tele-commuting flexible hours to facilitate trip reduction or peak spreading (less congestion less emissions)	Partnership	LGA	1800			\$ 10,000	\$ -	\$ 10,000	Planning initiative
P51	Land Use & Transport Integration Planning	Policy to encourage mixed use development, higher densities around transport nodes, higher levels of facilities within residential areas etc	Council	LGA	1800			\$ -	\$ 10,000	\$ 124,090	Planning initiative



climate change actions
for Manly LGA

Appendix B

30 Year Forward Program of Work

Released in the Public Interest By Manly Council
Subject to Qualifications



innovate | adapt | reduce | combat

Part 1 Mitigative Measures - With B/C Greater than Unity

Identifier	Option Name	Brief Description	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Present Value of Flood Damage Benefit (30 years)	Cost/Benefit Ratio Estimate	Upper Priority Range	Lower Priority Range	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
M47	Provision of Levee near Manly Lagoon	Levee to protect properties from increases in flood levels as well as ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 1050m. Additional height required.	\$ 85,000	\$ -	\$ 22,577,323	265.62			\$ 85,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M48	Provision of Floodwall near Manly Lagoon, protection of only properties	Floodwall to protect properties from increases in flood levels as well as ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 1050m. Additional height required.	\$ 110,000	\$ -	\$ 22,577,323	205.25			\$ 110,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M45	Provision of Levee near Manly Lagoon, properties only - only Ocean Storm Protection	Levee to protect properties from increases in ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 400m. Additional height protection required.	\$ 150,000	\$ 2,000	\$ 18,743,639	107.22			\$ 2,000	\$ 2,000	\$ 2,000	\$ 152,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000
M46	Provision of Floodwall near Manly Lagoon, properties only - only Ocean Storm Protection	Floodwall to protect properties from increases in ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 400m. Additional height protection required.	\$ 250,000	\$ 2,000	\$ 18,743,639	68.20			\$ 252,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000
M43	Provision of Levee near Manly Lagoon, including ocean storm protection of Kenneth Road - only Ocean Storm Protection	Levee to protect properties from increases in ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 1100m. Additional height protection required.	\$ 480,000	\$ 2,000	\$ 18,743,639	37.13			\$ 482,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000
M66	New Library Site	Assuming flood level above floor level. Provide temporary flood barriers/modifications to entry areas.	\$ 25,000	\$ -	\$ 738,338	29.53			\$ 25,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M44	Provision of Floodwall near Manly Lagoon, including ocean storm protection of Kenneth Road - only Ocean Storm Protection	Floodwall to protect properties from increases in ocean levels. Note that this will require pumping behind the levee, as well as control structures on all pipe outlets in the area. Total Length = 1100m. Additional height protection required.	\$ 740,000	\$ 2,000	\$ 18,743,639	24.51			\$ 742,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000
M36	Policy - Changes to Flood Planning Levels	Changes to planning controls to include higher Flood Planning Levels to account for increases in flood levels. Note that increases will not be the same across the entire LGA.	\$ 5,000	\$ -	\$ 112,887	22.58			\$ 5,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M17	Increased development planning controls around areas identified as likely to be utilised by the Penguins or Bandicoots under a climate change scenario	Increased development planning controls around areas identified as likely to be utilised by the Penguins or Bandicoots under a climate change scenario	\$ 15,000	\$ -	\$ -	15.07			\$ 15,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M41	Policy - Changes to Water Quality Treatment Device Controls	Water quality treatment devices to be sized to account for Climate Change. This includes the likely increase in peak storm flows, together with the likely reduction in annual rainfall.	\$ 5,000	\$ -	\$ -	12.94			\$ 5,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M76	10 Public Toilets Sites planned for replacement or new facility	Replace sites account taken for future climate change flooding levels	\$ 10,000	\$ -	\$ 124,090	12.41			\$ 10,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M34	Increase in Stormwater Capacity - North of Corso	Increase in stormwater capacity to allow better drainage to area between the Corso and Pine Street (likely increases in peak water levels in this area). This area currently has proposed upgrade of \$2.5M.	\$ 325,000	\$ -	\$ 3,493,032	10.75			\$ 325,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
M54	Barrage at Entrance to Manly Lagoon	Barrage to be provided at entrance to Manly Lagoon, to provide protection against coastal storm events. Note that will need to be designed for environmental flushing and to allow flood flows to pass.	\$ 2,000,000	\$ 10,000	\$ 18,743,639	8.82			\$ 1,000,000	\$ 1,000,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000
M30	Increase in Stormwater Infrastructure Capacity - as a part of planned upgrade of system - 50% of system	assume that only 50% of pipes in LGA less than 5 year capacity. Assume that these will be replaced as a part of Council Plans. Climate Change to add additional capacity to replaced pipes. Most cost derived from material costs. Based on 74 km of pipe.	\$ -	\$ 40,000	\$ 7,500,000	8.06			\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000	\$ 40,000
M49	Detention Basin to be provided upstream Burnt Bridge Creek Deviation, on Burnt Bridge Creek	Detention Basin to be provided to reduce peak flows downstream (particularly Balgowlah Road, Condamine Street and Roseberry Street Areas).	\$ 200,000	\$ 2,000	\$ 1,717,621	7.64			\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	
M62	State Emergency Services	Assuming flood level above floor level. Provide temporary flood barriers/modifications to entry areas.	\$ 15,000	\$ -	\$ 111,681	7.45			\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M31	Increase in Stormwater Infrastructure Capacity - Target Areas	Only increase the capacity of the stormwater system in areas likely to have increases in overland flow (based on coarse modelling). Assume that Council to upgrade to 5 year capacity as a part of plans, with Climate Change to add additional capacity.	\$ -	\$ 60,000	\$ 5,000,000	6.72			\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000	\$ 60,000
M15	Cooperative working with RFS for implementation of increased Bushfire awareness and management systems	Increased bushfire risk will require increased bushfire management and protection. It may be necessary to assess the extension of existing Bushfire Hazard protection areas around structures.	\$ 30,000	\$ 10,000	\$ -	4.08			\$ 30,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000
M29	Increase in Stormwater Infrastructure capacity - as a part of planned upgrade of system - 100% of system	Assume that all pipes need to be upgraded to 5 year capacity as a part of Council plans. Climate change require that all new pipes installed will need to be slightly larger. Most of the cost will be derived from materials costs.	\$ -	\$ 150,000	\$ 7,500,000	4.03			\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000	\$ 150,000
M37	Study on Changes to Flood Levels	Study to be undertaken to determine changes to Flood Planning Levels across the LGA under a climate change scenario. Can utilise previous studies to undertake work.	\$ 30,000	\$ -	\$ 112,887	3.76			\$ -	\$ -	\$ 30,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M61	Cottages	Assuming flood level above floor level. Provide temporary flood barriers/modifications to entry areas.	\$ 30,000	\$ -	\$ 111,681	3.72			\$ -	\$ -	\$ -	\$ -	\$ 30,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M67	Sangrado Park Scout Hall	Assuming flood level above floor level. Provide temporary flood barriers/modifications to entry areas.	\$ 15,000	\$ -	\$ 55,841	3.72			\$ -	\$ -	\$ -	\$ -	\$ -	\$ 15,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
M35	Increase in Stormwater Capacity - from near Valley Road to near Clarence Street	Increase in pit and pipe capacity, to reduce likely increases in peak water levels in this area.	\$ 150,000	\$ -	\$ 491,693	3.26			\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M51	Pumping Systems for Manly CBD	Pumping Systems to be incorporated into the Manly CBD stormwater infrastructure, to account for a reduction in outflow due to increase ocean levels.	\$ 30,000	\$ 10,000	\$ 450,161	2.92			\$ 30,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000
M74	Queenscliff Surf Pavilion	Provide temporary flood barriers / modifications to entry areas.	\$ 20,000	\$ -	\$ 55,841	2.79			\$ -	\$ -	\$ -	\$ -	\$ 20,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M4	Develop Planning Controls for those areas where mitigation measures cannot be implemented against climate change (LEP and DCP)	In some cases land currently zoned for certain activities may be incompatible with the effects of climate change or there is no feasible mitigation measure available. In this case, planning controls are required to ensure future development is compatible.	\$ 20,000	\$ 5,000	\$ 225,773	2.75			\$ 25,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000
M9	Assist with ensuring containment strategies are in place for known contaminated land affected by sea level rise	Assist with ensuring containment strategies are in place for known contaminated land affected by sea level rise	\$ 50,000	\$ -	\$ -	2.48			\$ -	\$ -	\$ -	\$ -	\$ 50,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M57	Undertake study to determine suitable OSD sizings.	Assuming flood level above floor level. Local regrading.	\$ 50,000	\$ -	\$ 100,000	2.00			\$ -	\$ -	\$ 50,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
M64	Council Depot	Assuming flood level above floor level. Local regrading.	\$ 40,000	\$ -	\$ 71,352	1.78			\$ -	\$ -	\$ -	\$ -	\$ 40,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	

Released in the Public Interest By Manly Council
Subject to Qualifications</



climate change actions
for Manly LGA

Appendix C

Other Mitigative and Preventative Measures Considered

Released in the Public Interest By Manly Council
Subject to Qualifications

Part 1a Mitigative Measures - With B/C @ Unity or Less

Identifier	Option Name	Brief Description	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Present Value of Flood Damage Benefit (30 years)	Cost/Benefit Ratio Estimate	Upper Priority Range High Medium Low	Lower Priority Range High Medium Low
M10	Assist with ensuring any actual acid sulphate soils are contained appropriately and groundwater changes do not mobilise ASS		\$ -	\$ 10,000		1.00	High	High
M20	Community Health Awareness and Control issues.	The increase in temperature and rise of groundwater level will provide improved conditions for bacterial and viral organisms to spread. This poses an increased risk to community health. Community members should be made aware of this, particularly the more	\$ 20,000	\$ 5,000		1.00	High	High
M58	Road and Footpath maintenance (existing pavements)	Road maintenance costs will increase as a result of increased rainfall intensity. Pavement deterioration is accelerated with increasing rainfall intensity. More short term maintenance measures (e.g. pot hole repairs, patching) will be required as a result	\$ 30,000	\$ 300,000		1.00	High	High
M59	Reconstruction of dilapidated pavements using material with low moisture susceptibility.	Reconstruction of dilapidated pavements (e.g. less than 5 years serviceable life remaining) using bound pavement layers (e.g. Cement treated sub bases and/or concrete base) and substantial sub-pavement drainage. High capital costs, low recurrent costs.	\$ -	\$ 500,000		1.00	High	High
M60	Raise or relocate footpaths impacted by rises in sea levels	Reconstruct footpaths or relocate footpaths inundated by the rise in sea level resulting from the extreme climate change scenario.	\$ 500,000	\$ 10,000		1.00	High	High
M78	Allowance for non flood related treatment of Council buildings (eg groundwater level rise)	Capital works such as underpinning foundations due to water table rise; recurrent cost for increased maintenance due to harsh climatic conditions	\$ 2,225,000	\$ 34,000	\$ 2,646,907	1.00	High	High
M27	Ocean Pools	Upgrade and raise concrete walls to accommodate SLR and maintain current function	\$ 450,000	\$ -		0.98	High	High
M6	Voluntary House Raising Program for Properties Affected by sea level rise	In some cases land currently zoned for certain activities may be incompatible with the effects of climate change or there is no feasible mitigation measure available. In this case, voluntary house raising for properties is an alternative that could be pu	\$ 1,000,000	\$ -	\$ 893,451	0.89	High	High
M52	Manly Beach Stormwater outfalls	Raising of stormwater outfalls to account for increases in ocean levels - this may not be possible due to inverts of stormwater infrastructure. Note that currently proposed to upgrade, with \$6M provision. Assume that will need additional funding for rai	\$ 500,000	\$ 1,000	\$ 450,161	0.88	High	High
M26	Swimming Enclosures	Upgrade/reconstruct swimming enclosures as condition/function requires. New structures to accommodate High MSLR.	\$ 500,000	\$ -		0.88	High	High
M8	Provide protection for known items of Non-indigenous Heritage	Site specific protection would need to be evaluated on a case by case basis for artefacts in consultation with the NSW Heritage Council and ensuring no impacts (eg on critical habitat).	\$ 80,000	\$ -		0.85	High	High
M63	Garbage Depot	Assuming flood level above floor level: Provide temporary flood barriers /modifications to entry areas	\$ 40,000	\$ -	\$ 31,643	0.79	High	High
M71	Market Lane Carpark	Allow flooding of bottom level. Modifications may be required to protect elevator, ticket machines etc	\$ 50,000	\$ -	\$ 37,227	0.74	High	High
M55	Council Purchase - Rebuild	Council purchases properties in significantly affected areas. Undertakes development in a compatible manner and resells the land. Assume that the number of properties are also 16	\$ -	\$ 100,000	\$ 893,451	0.72	High	High
M25	Beach Nourishment of Harbour Beaches	Nourishment of Beaches to alleviate potential shoreline recession and account for lost volume as a result of SLR	\$ 800,000	\$ -		0.55	High	High
M12	Boost efforts for weed management in areas already affected by weed invasion	Weed adaptability is better than native plants expected under a climate change scenario. Would expect invasive weed species to dominate existing isolated areas (e.g. North Head). Council should also ensure Noxious Weeds are controlled on private property.	\$ -	\$ 100,000		0.52	High	High
M50	Increase in Culvert Sizings under Industrial Area	Increase in culvert capacity to account for increases in peak flows, and to reduce likely increases in flood levels through industrial areas	\$ 2,600,000	\$ 2,000	\$ 1,354,572	0.52	High	High
M39	Study on Rainwater Tank changes	Study to be conducted by Council to provide "rating" curves for various roof sizes.	\$ 15,000	\$ -		0.40	High	High
M7	Provide protection for known and potential Aboriginal objects and places against sea level rise	Site specific protection would need to be evaluated on a case by case basis for Aboriginal objects in consultation with appropriate Aboriginal Groups (eg Metro LALC, Aboriginal Heritage Office) and the Department of Environment and Climate Change. If obje	\$ 100,000	\$ 5,000		0.35	High	High
M42	Upgrade of existing Council Water Quality Treatment Devices	Upgrade of Council's water quality treatment devices to account for increases in peak flows and reductions in annual rainfall	\$ -	\$ 15,000		0.35	High	High
M32	Increase Stormwater Capacity - Ashburner Street	Increase in pipe and pit capacity to allow draining of Ashburner Street	\$ 150,000	\$ -	\$ 51,867	0.35	High	High

Released in the Public Interest By Manly Council

Subject to Qualifications

Identifier	Option Name	Brief Description	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Present Value of Flood Damage Benefit (30 years)	Cost/Benefit Ratio Estimate	Upper Priority Range	Lower Priority Range
							High	Medium
M13	Education Scheme for biodiversity.	The need to inform the community that change in flora/fauna composition is not a bad thing in of itself. The need to help the flora and fauna adapt to climate change is the most important way we can help the environments. The education scheme could also	\$ 20,000	\$ 5,000		0.24		
M11	Implement greenways through a land acquisition program to allow for adaptation for various species to move to alternate habitat areas	Isolated ecosystems (e.g North Head) do not have significant emigration/immigration of genetic variety and new species. Under a climate change scenario this places them at severe risk as there is limited opportunity for organism migration should condition	\$ -	\$ 500,000		0.23		
M21	Extensive Revegetation	Well established native vegetation has a higher resistance to weed invasion than stand in poor condition. The majority of stands within the Manly LGA are in poor condition and susceptible to weed invasion. The lagoon area in particular has very low propo	\$ 20,000	\$ 50,000		0.19		
M75	15 existing Public Toilets Sites currently requiring annual maintenance only	Replace low lying toilets for public health considerations	\$ 1,210,000	\$ -	\$ 186,136	0.15		
M77	2 Public Toilet Sites with planned refurbishment	Replace with account taken for future climate change flooding levels	\$ 170,000	\$ -	\$ 24,818	0.15		
M19	Expansion of Aquatic Reserves	Currently there is only one Aquatic Reserve (Cabbage Tree Bay Aquatic Reserve) in the Manly LGA. Reserves lessen the cumulative impact of human disturbance and climate change on populations. Expansion of Aquatic Reserves to include the potential penguin h	\$ 100,000	\$ 10,000		0.14		
M22	Cultural heritage mapping to manage climate change impacts and developmental pressures	There are significant areas within the LGA for the potential of Aboriginal objects. Mapping the LGA in consultation with relevant Aboriginal people, the Aboriginal Heritage Office and the DECC would assist Council in assessing the likelihood of impacts to	\$ 300,000	\$ 10,000		0.14		
M53	Detention Basin - Nanbaree Reserve	Provision of detention basin in Nanbaree Reserve, to reduce likely increase in peak water levels for properties downstream	\$ 200,000	\$ 2,000	\$ 29,676	0.13		
M18	Garden Enrichment Scheme	Provide free native plant seedlings for residents (e.g. plant of the month). Increasing native plant abundance and diversity now will allow greater migration of species under a climate change scenario and will assist with carbon uptake.	\$ 5,000	\$ 20,000		0.10		
M69	Basement Carpark Pacific Waves	Extra pumping due to additional ground water ingress	\$ -	\$ 1,000	\$ 1,241	0.10		
M14	Aquatic System and pond development to protect amphibians	Amphibians represent key ecological species in ecological systems and growth needs to be encouraged where possible as they are one of the most sensitive groups of animals to climate change.	\$ 200,000	\$ 30,000		0.08		
M65	Former Balgowlah Womens Bowling Club	Reprovide new facility to higher level above flood level	\$ 950,000	\$ -	\$ 55,841	0.06		
M5	Voluntary Purchase for Properties Affected by sea level rise	In some cases land currently zoned for certain activities may be incompatible with the effects of climate change or there is no feasible mitigation measure available. In this case, voluntary purchase for properties is an alternative that could be pursued	\$ 16,000,000	\$ -	\$ 893,451	0.06		
M16	Replacement program for vegetation, including planting of salt and water tolerant plant species	Groundwater rise, particularly around coasta areas, will increase water level and salinity. Existing species are unlikely to be able to cope with this and may die off leading to soil instability and habitat loss. Large trees capabl of drawing down groun	\$ 10,000	\$ 40,000		0.04		
M68	Snr Citizen Ctr & Mnl Croquet Club	Reprovide facility above flood level	\$ 1,740,000	\$ -	\$ 55,841	0.03		
M1	Education Scheme on the Climate Change Levy	Development of scheme (including capital costs for website, leaflets to go in rates notice and posters). Annual information issue on how the levy has been spent and what has been achieved.	\$ 30,000	\$ 10,000		0.03		
M24	Harbour Seawalls	Upgrade/replacement of seawalls to counter potential shoreline recession and maintain current hazard levels as well as strengthening of design to allow for increased uplift forces dur to SLR. To be addressed in all future seawall works.	\$ 2,500,000	\$ -	\$ 4,515,465	1.81		
M23	Manly Ocean Beach - Seawall and Beach Nourishment	Upgrade / replacement of seawall to ensure structural stability under: Greater potential erosion under increased storminess and potential shoreline retreat - increased uplift forces due to increased gr	\$ 5,500,000	\$ -		6.39		
M40	Supplement for Water Tanks	Rainwater tanks potentially undersized with reduced annual rainfall volumes. Supplement to subsidise increase in rainwater tank volume as a result of climate change.	\$ -	\$ 29,000		0.02		
M73	Rialto Sq & Wentworth Carpark	Local regrading to protect entrance, Extra pumping due to additional ground water ingress	\$ 175,000	\$ 1,000	\$ 1,241	0.01		
M70	Central Avenue Carpark	Local regrading to protect entrance, Extra pumping due to additional ground water ingress	\$ 180,000	\$ 1,000	\$ 1,241	0.01		
M72	Short St Underground Carpark	Local regrading to protect entrance, Extra pumping due to additional ground water ingress	\$ 180,000	\$ 1,000	\$ 1,241	0.01		
			\$ 38,650,000	\$ 1,792,000	\$ 12,125,466			

Released in the Public Interest By Manly Council

Subject to Qualifications

Part 2a Preventative Measures - Significant Items & Other Than Council

Identifier	Option Name	Brief Description	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Annual Reduction in GHG Estimate (Tonnes CO2)	Responsibility	Upper Priority Range High Medium Low	Lower Priority Range High Medium Low
P20	Progressive augmentation/replacement of energy network connected street lighting with solar lighting	Gradual implementation of solar powered luminaires to existing light standards for local streets (i.e. roads other than collector, regional and state standard).	\$ 2,500,000	\$ 40,000	1,100	Energy Australia	High	High
P12	LGA bio-banking equivalent	Provide owners of land with Council-recognised value in terms of Native Vegetation or Heritage and incentive to upkeep property which can be traded.	\$ 5,000,000	\$ -	0	not sure	High	High
P16	Creation of plantation type vegetation areas on Council property for the sequestration of carbon (for rapidly growing crops that can be harvested where the carbon is locked in permanently - eg bamboo).		\$ 1,000,000	\$ 100,000	300	Needs Further Analysis	High	High
P34	Manly Congestion Charge	Vehicular charge to enter/exit Manly in AM and PM peak to reduce truck movements and encourage public transport usage.	\$ 50,000	\$ -	9,000	Needs Further Analysis	High	High
P36	CBD Car Park Removal	Removal of all CBD multi story car parking to remove vehicle emissions and improve air/noise quality and safety (for example: Copenhagen)	\$ 8,500,000	\$ -	900	Needs Further Analysis	needs more analysis	High
P38	Public Transport Business Rate Reduction	Reduced business rates where staff travel to/from work by public transport (enforcement issues)	\$ -	\$ 100,000	9,000	Needs Further Analysis	needs more analysis	High
P39	Green Residential Parking Rates	Vehicles registered as part of residential parking areas will be subject to an assessment using the green vehicle guide with rates increasing for higher polluting vehicles or reductions for fewer vehicles registered etc (see North Sydney). Options if no c	\$ -	\$ 50,000	9,000	Needs Further Analysis	needs more analysis	High
P3	Provide Co-generated or tri-gen power (eg GridX) to CBD public buildings	Install a cogeneration plant to service building electrical heating and cooling requirements	\$ 1,000,000	\$ 100,000	920	Council	needs more analysis	High
P31	Free or discounted public transport	Free or discounted public transport for all Manly LGA residents at a rate of \$100 per resident per year incorporating smart card technology	\$ -	\$ 3,500,000	1,250	Council	needs more analysis	High
P48	Freight Distribution Scheme	To reduce freight movements introduce a freight distribution scheme to Manly LGA involving a centralised warehouse where all deliveries for commercial properties would be directed to which would then have a forwarding capability. Allows for reduction in	\$ 11,000,000	\$ 10,000	900	Council	needs more analysis	High
P30	Park & Ride Stations	Park & Ride stations at key locations to connect to the Strategic bus corridor such as Council Depot at Fairlight (Balgowlah Road), Balgowlah Oval Balgowlah (underground car park), Manly Oval, Manly CBD (convert current CBD car park). Supporting high qual	\$ 46,500,000	\$ 100,000	21,000	Partnership	High	High
P23	Subsidised Manly Ferry	Direct subsidy to ensure the existing service remains a cheap, government operated public transport service. If the service is privatised - Manly LGA residents receive subsidised fares.	\$ -	\$ -	18,400	Partnership	needs more analysis	High
P6	Small Wind Farm at North Head	Installation of a wind farm to provide alternative power to Manly	\$ 8,000,000	\$ 100,000	15,900	Partnership	High	High
P27	High Quality Bus Infrastructure	All bus stops along bus corridors & Metro routes in the LGA to include high quality shelters, real time passenger information, highly visible infrastructure & other key features	\$ 2,000,000	\$ 10,000	9,000	Partnership	High	High
P26	Quality Bus Corridor Network	All bus corridors in the LGA to include bus priority infrastructure including B signals, bus only lanes and full length bus lanes	\$ 1,900,000	\$ 60,000	4,500	Partnership	High	High
P40	Alternative Fuel Service Stations	Provision of alternative fuel stations in the LGA (reduced rates, planning controls to encourage) including biodiesel, Biogas/CNG, LPG etc	\$ 50,000	\$ -	1,800	Partnership	High	High
P41	Cycle & Walking Infrastructure Retro fit	All Council & RTA roads to be retro-fitted with cycle infrastructure (cycle lanes, lockers, racks, access, etc)	\$ 350,000	\$ 17,500	1,800	Partnership	High	High
P50	Business Practices	Encourage tele-commuting flexible hours to facilitate trip reduction or peak spreading (less congestion less emissions)	\$ 10,000	\$ -	1,800	Partnership	High	High
P28	Manly Multi-modal Interchange	Highly visible Transport Interchange providing connections to proposed light rail, shuttle buses, cycle hire, taxi and ferry services in Manly CBD	\$ 3,200,000	\$ 100,000	900	Partnership	needs more analysis	High
P37	Manly Car Share	Extension of free membership to Manly residents of Flexi Car and introduction of additional locations, incorporated into new developments and at trip attractors/generators	\$ 7,200,000	\$ -	900	Partnership	High	High
P8	Demonstration wave power facility on open coast		\$ 2,000,000	\$ 5,000	185	Partnership	High	High
P49	Home Delivery	Free home delivery services for Manly residents who order over internet or walk/cycle to shops.	\$ -	\$ 10,000	10	Partnership	needs more analysis	High
P15	Decentralise waste systems.	Provide small scale local waste processing facilities (from local compost heaps to small AWTs). Any energy, greywater, compost produced could be utilised by local residents/business for free, at cost to residents further afield.	\$ 2,000,000	\$ 250,000	10	SHROC	High	High

Released in the Public Interest By Manly Council

Subject to Qualifications

Identifier	Option Name	Brief Description	Preliminary Estimate Capital Cost (\$ 2008)	Preliminary Estimate Annual Recurrent Cost (\$ 2008)	Annual Reduction in GHG Estimate (Tonnes CO2)	Responsibility	Upper Priority Range High Medium Low	Lower Priority Range High Medium Low
P19	Use of recycled materials in road and footpath construction.	Substitution of quarried rock road construction products with recycled concrete or blast furnace slag.	\$ -	\$ 100,000	5	SHROC	Blue	Green
P24	Manly - North Sydney - (possibly) Sydney CBD Light Rail	Light rail system with connections at key Manly LGA locations (CBD, ferry wharf, proposed wharf) to North Sydney and possibly to Sydney CBD	\$ 157,500,000	\$ 500,000	41,000	State	Green	Green
P21	Middle Harbour Ferry Wharf	Provision of a wharf at Middle harbour to serve western Manly area with solar powered ferry services to North Sydney (Milsons Point) and City	\$ 260,000	\$ 5,000	18,250	State	Blue	Green
P22	Manly - Milsons Point - Sydney CBD Ferry Service	New fast and frequent ferry service to Milsons Point from Manly wharf and the proposed Middle Harbour wharf	\$ -	\$ -	18,250	State	Green	Green
P9	Heavy vehicle emissions levy system	Levy on vehicles entering the CBD or the LGA that do not meet specific standards for emissions of GHG. A similar system has recently been implemented in London.	\$ 40,000	\$ 10,000	9,000	State	Green	Green
P14	Decentralise energy production	As used in Sydney2030 vision install multiple large local gas co-generation units across the main business areas of the LGA an install infrastructure so that energy produced and heating/cooling (via water pipes) can be sold off. Reduces costs for individu	\$ 5,000,000	\$ 200,000	5,500	State	Blue	Green
			\$ 265,060,000	\$ 5,367,500	200,580			

Part 2a + Part 2b

\$ 303,610,000 \$ 7,159,500

Released in the Public Interest By Manly Council
Subject to Qualifications