Climate change mitigation - natural coastal assets:

Derwent Estuary Program planning tool discussion paper for **tidal wetlands & saltmarshes**

Jason Whitehead January 2011

Derwent Estuary Program

The Derwent Estuary Program (DEP) is a regional partnership between local governments, the Tasmanian State Government, commercial and industrial enterprises, and community-based groups to restore and promote our estuary. The DEP was established in 1999 and has been nationally recognised for excellence in coordinating initiatives to reduce water pollution, conserve habitats and species, monitor river health and promote greater use and enjoyment of the foreshore. Our major sponsors include: Brighton, Clarence, Derwent Valley, Glenorchy, Hobart and Kingborough councils, the Tasmanian State Government, Southern Water, Tasmanian Ports Corporation, Norske Skog Boyer, Nyrstar Hobart and Hydro Tasmania

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SUMMARY

Development and incompatible land uses, upon and adjacent to tidal wetlands and saltmarshes, pose a current and impending threat to these sensitive coastal habitats and their capacity to adapt to sea level rise. In late 2009 a study was conducted by University of Tasmania researchers (in Prahalad *et al.* 2009), for the Derwent Estuary Program (DEP), and funded by NRM South, to assess potential saltmarsh and tidal wetland extent in the Derwent estuary in 2100 under a high level IPCC sea-level projection (110 cm AHD). The study indicates that there is definite potential for tidal wetlands and saltmarshes to migrate upland, provided the land use is compatible with colonisation by these habitat types. Some refuge areas lie within public land, which can be designated for future wetland conservation. However, most areas identified as future tidal wetland and saltmarsh habitat lie within private land and as such may benefit from appropriate local government planning. The outcome of previous discussions about this study, between the DEP and local government planning staff in municipalities bordering the estuary, was the recommendation that the DEP draft a relevant regional planning overlay for further discussion. The current paper presents this draft planning overlay, which has been called the 'natural coastal processes' overlay. This has been populated with two area categories:

1) Current sensitive coastal habitat (in BLUE stippled for current tidal wetlands complex and saltmarsh extent)
2) Near future (2100) sensitive coastal habitat. This is our recognised near term transition zone (in RED stippled for 2100 tidal wetlands and saltmarsh extent). Note: this excludes areas where infrastructure currently exists.

It is the Derwent Estuary Program's intent that this paper will assist in discussion of the draft 'natural coastal processes' planning overlay in order to explore at a future workshop the following:

- Options to manage existing and future tidal wetlands and saltmarshes
- Appropriateness of a regional 'natural coastal processes' planning overlay
- What planning codes, associated tools etc, should apply to such an overlay?
- A communication strategy

The discussion should also consider long term wetland and saltmarsh refugia – beyond 2100, keeping in mind 'migration pathways' or 'migration corridors' rather than only looking at the current future modelled 2100 extent. Roading and other infrastructure should be designed, or in places existing infrastructure modified, to allow saltmarsh/wetland movement.

Disclaimer

The Derwent Estuary Program, and all persons acting on their behalf preparing data that has been used in this discussion paper, accept no liability for the accuracy of or inferences from the material contained in this publication, or for any action as a result of any person's or group's interpretations, deductions, conclusions or actions in relying on this material. It must be noted that draft planning overlay development used current vegetation data (from multiple sources) and a preliminary assessment of the future extent of tidal wetlands and saltmarshes in the Derwent estuary. The areas depicted as future tidal wetland and saltmarsh are only indicative of where favourable conditions (i.e. tidal inundation) might prevail in the future to allow the establishment of these vegetation communities. The modelled future extent does not take into account factors such as: sedimentation or erosion (vertically or laterally), wind-wave modelling, other vegetation associations, rainfall effects on storm-surge height, historical change analysis or anthropogenic threats. Also, no ground truthing has been done as a part of the project. Hence, while the outputs from this project may provide an important first step in assessing the future conservation needs of Derwent Estuary tidal wetlands and saltmarshes in the face of future sea level rise to 2100 only. The projections are based upon best –currently available scientific projections, which will undoubtably be revised in the future. Further work might be in order to substantiate these findings and improve our understanding of these highly dynamic coastal environments in time of change. The University of Tasmania uses reasonable means to verify the validity and accuracy of the data contained within Prahalad *et al.* (2009), which has been extensively cited within this discussion paper; however, to the extent allowed by law, it does not warrant or represent that the data will be correct, current, fit/suitable for a particular purpose or not-misleading. Specifically, the data should not be relied upon (that is, professional advice should be sought) if the data is to be used for purposes outside the scope of this project, such as for assessing inundation risks to infrastructure.

1.0 INTRODUCTION

This paper reviews potential climate change-related impacts on sensitive tidal wetlands and coastal saltmarshes in the Derwent estuary. Mitigating the impacts of climate change induced sea-level rise within coastal areas utilised by people will create complex challenges, as it poses threats to infrastructure, social, cultural, economic and natural values. Local government planning will play a pivotal role in managing the balance between the sustainability of our natural assets and management responses pertaining to current and future built assets.

In recent years there have been a large number of climate change reports, studies, risk assessments and mitigation strategies developed by councils, State Government and research institutions at a range of scales. In southern Tasmania, Local Government has played a leading role, particularly in the areas of mitigation and impact assessment. A number of excellent reports have also recently been published by the CSIRO, ACE-CRC, State Government, and other organisations. Derwent estuary relevant findings, in reports available prior to February 2009, have been previously summarised by the Derwent Estuary Program (DEP) in Whitehead (2009). The report was developed to help guide the Derwent Estuary Program's activities, and provide a useful resource to other organisations working in the region.

There have been a number of subsequent research advances over the last two years, including an assessment of projected effects of sea-level rise (to the year 2100) on the Derwent estuary tidal wetlands and saltmarshes (Prahalad *et al.* 2009). This report was initiated by the DEP, undertaken by the University of Tasmania, and funded by NRM-South. The DEP has shared the Prahalad *et al.* (2009) report findings with most of the Local Governments boarding the estuary (Derwent Valley, Brighton, Glenorchy, Kingston and Clarence Councils), the Tasmanian Parks and Wildlife Service, Southern Tasmania Councils Authority, Department of Primary Industries Water and Environment (DPIPWE) – Environment Division and the Tasmanian Planning Commission. The current discussion paper has arisen from DEP discussions with staff from the above organisations, and is intended to help facilitate the development of Local Government planning mechanisms that can improve the long term management and use of the Derwent estuary coastal area, so as to sustain important natural assets (such as tidal wetlands and saltmarshes).

It is hoped that a regional planning overlay can be endorsed by the DEP local government partners, STCA and TPC, which identifies areas where natural coastal processes may take precedent over other conflicting land-uses, and that appropriate codes/schedules be created relating to activities in sensitive coastal areas. If such a planning tool can be endorsed within the Derwent estuary region for tidal wetlands and saltmarshes, it may be possible to extend this to include other natural asset types (e.g. beaches) and encourage expansion to include areas outside of the Derwent estuary as new information becomes available.

2.0 BACKGROUND

The Derwent estuary is the largest estuary in south eastern Tasmania. The estuary extends from New Norfolk (maximum extent of salt water) to the mouth, which lies between Tinderbox and the Iron Pot light. The Derwent estuary lies at the heart of the greater Hobart metropolitan area and is an integral part of Tasmania's natural, cultural and economic activity. The estuary is an important and productive ecosystem, the coastal area supports important vegetation remnants, notably wetlands and saltmarshes. Approximately 40% of Tasmania's population – 202,000 people – live around the estuary's margins and the coastal area is used for recreation, notably foreshore walking tracks, beach activities and fishing. The estuary supports several large industries, including paper production, zinc smelting and boat building, and is Tasmania's fourth busiest port. Coastal areas adjacent to the estuary are an attractive area to live, play and work; but associated coastal development has contributed to the loss of 51% of the native vegetation extent along the Derwent foreshore (vegetation mapping from mean high water mark (MHWM) to 100m inland, by NorthBarker Ecosystem Services). Land filling and wharf construction has also resulted in ~14% of the estuary foreshore now being occupied by artificial structures.

Climate change influences on sea-level, storm-surge, and coastal erosion are challenges now being faced in coastal areas. Previous Derwent estuary research has focussed on the impact from these processes upon coastal infrastructure, notably within some areas of the Clarence municipality (Carley *et al.* 2008; Clarence City Council 2008). A number of DPIPWE reports also provide information for determining the probability of storm surge events accompanied by different sea-level rise scenarios (DPIW 2008a,2008b). A first pass assessment of the area occupied by different infrastructure asset types affected by inundation (due to sea-level rise and storm surge) has been undertaken for each Tasmanian coastal municipality (DPIW 2008c). To date the risks assessments have been largely focused on coastal infrastructure, but there is also a need to assess risks to natural assets, such as the recent assessment of sensitive tidal wetlands and saltmarshes along the Derwent estuary by Prahalad *et al.* (2009).

2.1 What and where are the Derwent tidal wetlands & saltmarshes

Wetlands and saltmarshes are characterised by the presence of water, either permanently or periodically. In the Derwent estuary, the formally recognized wetland and saltmarsh vegetation (TASVEGE– see (Harris and Kitchener (2005)) types are

<u>Wetlands</u>
Fresh water aquatic sedgeland and rushland (ASF) covering 130Ha
Lacustrine herbland (AHL) covering 0.2 Ha

<u>Saltmarshes</u>
Saline sedgeland/rushland (ARS) covering 130 Ha
Succulent saline herbland (ASS) covering 80 Ha
Saline aquatic herbland (AHS) covering 2 Ha

Three of the major vegetation types are illustrated (Figures 1, 2 & 3).

Figure 1. Wetland *Fresh water aquatic sedgeland and rushland* (ASF)

Figure 2. Saltmarsh *Saline sedgeland/rushland* (ARS)

Figure 3. Saltmarsh *Succulent saline herbland* (ASS)

It must be noted that the current TASVEGE categories are not thought to capture the true floral diversity and structural differences found within tidal wetlands and saltmarshes, and that it is likely there are several different vegetation communities that are currently being grouped within some of the existing vegetation types. This needs to be resolved, as it has bearing on the representativeness and significance of these vegetation types from a management perspective.

Wetlands and saltmarsh are distinctive vegetation communities, and can be broadly differentiated in that saltmarshes are saline types of wetlands. Saltmarshes occur on saline flats and estuarine areas fringing low energy coasts and are characterised by a high cover of salt tolerant species. They are variously dominated by succulent shrubs (samphire), grasses, sedges, rushes or herbs. Wetlands typically occur in the upper estuary (where brackish conditions sometimes occur) and in some places occur inland of, or on sites adjacent to, saltmarsh vegetation. These vegetation types cover a ~350 Ha area of the Derwent estuary and fringe 13% of the foreshore (Whitehead *et al.* 2010). However, in reality much of the wetland and saltmarsh vegetation in the Derwent estuary occurs as a mosaic inter-dispersed with other vegetation types (**Figure 4**). As such, a broader definition of tidal-wetland and saltmarsh will be used here (i.e. tidal wetland and saltmarsh complex), as it is impractical to discuss the management of these vegetation types without these. This has only been applied to the upper Derwent estuary, but as a result the area now being discussed in context to tidal wetlands and saltmarshes covers ~591.62 Ha.

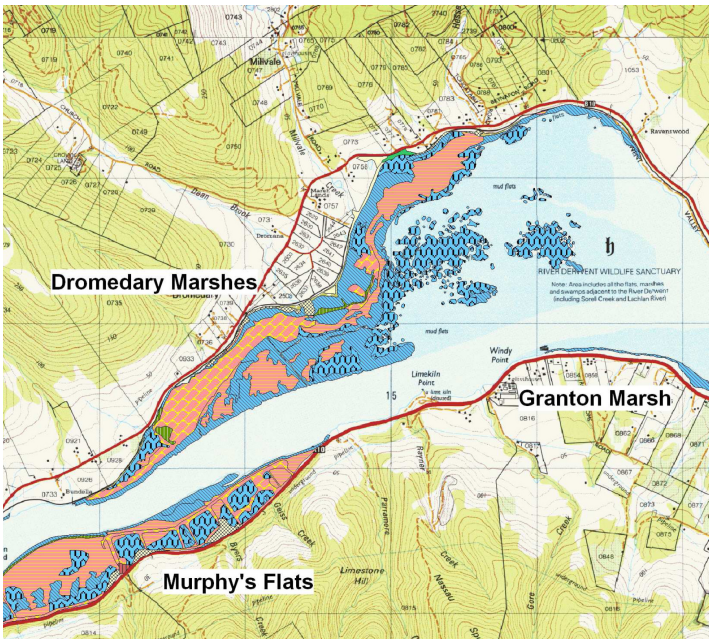

Figure 4. Example of upper Derwent estuary wetlands. Formal wetland and saltmarsh vegetation types are in blue. Other vegetation types are inter-dispersed (solid coloured polygons) within the formal wetland and saltmarsh vegetation. There is little hight difference between these vegetation types (typically <1m), which may be creating some of the vegetation mosaic observed. From a management perspective the entire coastal area will be called wetland/saltmarsh.

Many of the Derwent estuary's original wetlands and saltmarshes have been lost through land filling, foreshore reclamation, and draining and clearing for agriculture. The most extensive remaining area of tidal wetland and saltmarsh complex is found along a 15 km stretch of the upper estuary, between New Norfolk and Bridgewater. Other important wetland and saltmarshes occur at Goulds Lagoon, Lauderdale (Racecourse Flats), southern Ralphs Bay and several smaller vegetation remnants at other sites. The amount of Derwent estuary tidal wetlands and saltmarshes within the different municipalities bordering the estuary can be seen in **Figure 5.**

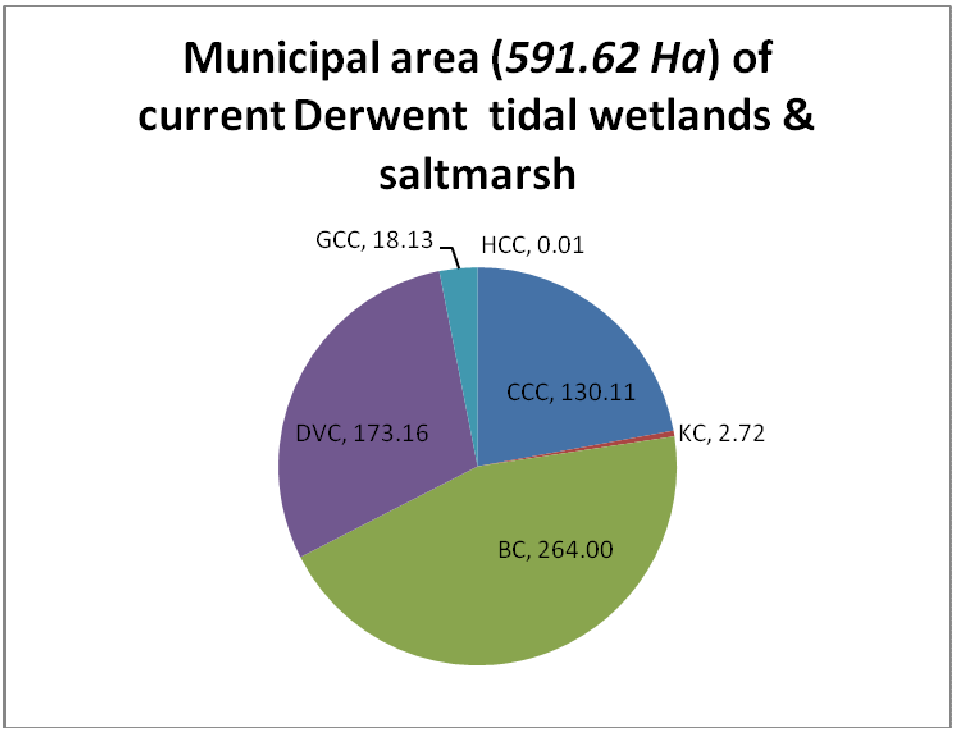

Figure 5. Approximately 591 Ha of tidal wetland and saltmarsh currently fringes the Derwent estuary. Much of this occurs in the upper estuary (within the Derwent Valley and Brighton municipalities). Different, and florally significant, saltmarshes occur in the Clarence Municipality. A number of small remnant tidal wetlands and saltmarshes occur in the other municipalities.

2.2 Why bother protecting tidal wetlands & saltmarshes

Large areas of Derwent estuary wetlands and saltmarshes have been lost due to landflling. The remaining areas of these habitats provide a number of specific functions, which are of human benefit:

- protect coastal properties against wind wave and boat wash coastal erosion
- prevent erosion and exposure of' potential acid sulphate soils', which can damage infrastructure (e.g. concrete corrosion) and harm aquatic environments (e.g. cause fish kills);.
- transit and spawning areas for recreationally targeted fish species (such as bream, trout and whitebait);
- provide a water filtering function, which is beneficial to the overall water quality of the estuary and appreciated by all estuary users.
- is aesthetically appealing for some tourists and residents. In many places around the world, wetlands and saltmarshes (and the fauna they support) are natural attractions, which provide income for local communities.

The Derwent tidal wetlands and saltmarshes also contain a number of high conservation values, such as:

- Some vegetation communities listed under Schedule 3A of "Nature Conservation Act 2002" as threatened native vegetation. These are the wetland types: Wetland (Undifferentiated) (AWU), Fresh water aquatic

sedgeland and rushland (ASF) and Lacustrine herbland (AHL); and the saltmarsh type: Saline aquatic herbland (AHS).

- Some areas are listed as nationally important & of state significance
- Some areas are on the directory of important wetlands (Environ. Aust. 2001)
- Some areas occur within formal Conservation Areas
- The upper Derwent wetland land for is a geoheritage listed delta
- Some areas are listed on the CFEV database as having "VERY HIGH" Conservation Management Priority
- Contains numerous threatened species
- Important habitat for birds and fish
- Spawning areas for genetic distinct whitebait population

2.3 Threats to tidal wetland & saltmarshes - an ongoing image problem!

It would be fair to assume that tidal wetlands & saltmarshes around the Derwent have been viewed as 'wasteland' over the last 200 years. There are many examples of landfilling of wetlands for alternate land uses, including: agriculture, rubbish tips, and infrastructure development (**Figure 6, 7 and 8**).

Threats: land filling

Figure 6. Area in RED land filled at Austins Ferry since 1954, note areas in BLUE were former wetlands. A similar fate has occurred at the head of most of the small bays within the middle stretches of the Derwent estuary.

Figure 7. Area in BLUE was former Howrah wetlands, since 1954 these were land filled for a rubbish tip. Similar wetlands also occurred behind Bellerive Beach.

Figure 8. Area in YELLOW was former Lauderdale rubbish tip built on top of saltmarsh vegetation. The health of the saltmarsh has also been impaired by coastal development (houses, a canal and road construction) and live stock grazing. Coastal erosion is also reducing the saltmarsh on the side exposed into Ralphs Bay (Prahalad 2008).

Land filling of wetland and saltmarsh areas is still continuing (example - **Figure 9**).

Figure 9. Land filling within the upper Derwent wetlands (comparative images taken approximately late 2009 & early 2010).

Many tidal wetlands and satmarshes occur over areas of potential acid sulphate soils (PASS) (e.g. Figure 10). Acid sulphate soils maps can be found on the "The List" website http://www.thelist.tas.gov.au [cited 10-10-2010]

Category: Natural Environment (soils)

Layer: Coastal Acid Sulphate Soils (0-20m AHD)

State Guidelines for Acid Sulphate Soil management apply to any land filling activity 500m^3 greater than 0.5m deep occurring at any elevation below <20m AHD. These guidelines apply to all the Derwent tidal wetland & saltmarsh and adjacent areas. The guidelines also apply to various excavation activities. To see a full description of the risks associated with acid sulphate soils go to: http://www.dpipwe.tas.gov.au/inter.nsf/ThemeNodes/EKOE-4ZG66F?open [cited 10-10-201].

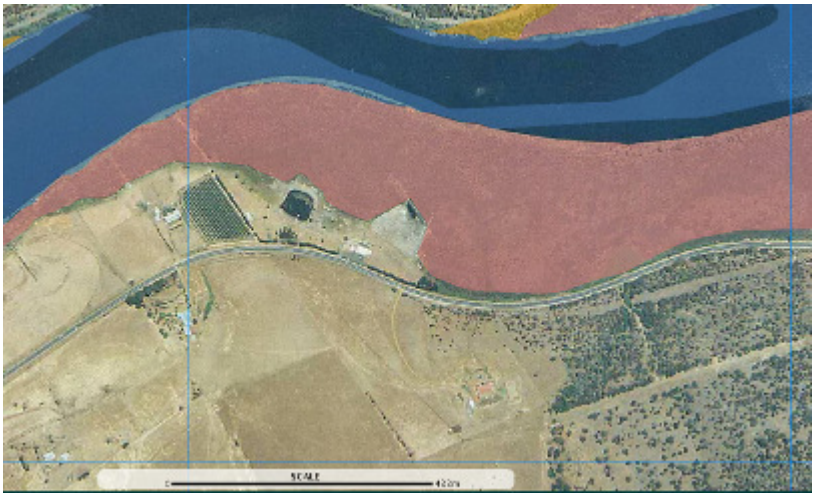

Figure 10. Are recently land filled within the upper Derwent wetlands occurred over areas mapped as having potential acid sulphate soils (RED) – made from 'The List' website [cited 10-10-2010]

Threats: infrastructure (roads, stormwater pipes and other structures)

The installation, upgrading and maintenance of various 'hardstand' infrastructure (notably roads and stormwater outfalls) continue to cause incremental loss of tidal wetlands and saltmarshes. A recent example has been the 2009/10 DIER upgrades to the Lyell Highway, which have caused the loss of some areas of state listed threatened wetlands (ASF vegetation type). Although the road works were given the necessary approvals no 'offset' scheme exists to counterbalance such impacts.

Road development has also disrupted the hydrological connectivity between the estuary and some adjacent areas of tidal wetlands and saltmarshes. The most noteworthy example is the Lauderdale saltmarsh that has been cut off from the estuary through road embankment. The hydrology can also be impacted through upstream development (e.g. urbanisation and dam development (see Figure 11)

Figure 11. Gage Cove wetlands (left hands side of road) and Gage Brook dam (turbid water on the right hand side of the road). Dam development occurred on a freshwater wetland, and has altered the freshwater flow regime to the tidal wetlands at the head of gage Cove. The dam wall also creates a barrier to landward migration (up the rivulet) of the tidal wetland vegetation as it is expected to move due to projected sea-level rise.

Threats: land use practices and weeds

Upstream urbanisation, agriculture (and irrigation) and other land-use practices (e.g. high intensity/frequency of bushfires) can affect water quantity and quality entering wetlands from surface, as well as ground water contributions. In some locations the actual area occupied by tidal wetlands were historically drained for agriculture and livestock grazing. This was very apparent in the upper estuary; however, in some locations native vegetation has returned. This risk is still present on some of the remaining private tidal wetlands in the upper estuary. In the past agricultural use of the upper Derwent wetlands was also accompanied with burning of the vegetation mosaic, in efforts to remove native vegetation cover. Fire still remains a moderate risk to some upper Derwent wetland areas. Grazing continues in on some areas of saltmarsh vegetation (and potential saltmarsh) in the outer Derwent estuary. In some locations there have been problems with vehicle access on saltmarshes, horse riding, and the illegal dumping of rubbish. At a couple of locations the maintenance of sporting facilities (e.g. Lauderdale football ground and Kingston golf course) may restrict the natural extent of tidal wetlands and saltmarshes.

Weed encroachment into tidal wetlands and saltmarshes is of varying concern. Some weeds are highly invasive, and of greatest concern in the upper Derwent wetlands is the introduced New Zealand shrub called Karamu (*Comprosma robusta*). It has only been present for a decade, and is dispersed by water and birds and where well established around New Norfolk it is forming monocultural thickets that are largely displacing the native wetland and coastal vegetation. The Derwent Estuary Program has just been awarded funding from the Australian Government “Caring for our Country” grant scheme to initiate containment of this problem. Another high risk weed, which has almost been eradicated from the estuary by the DEP and DPIPWE, is the introduced Rice Grass (*Spartina anglica*). Other weeds also pose differing degrees of risk, but proximity to disturbed areas of ground, infrastructure and

agriculture appear to increase the likelihood of weed encroachment into tidal wetlands and saltmarshes.

Threats: climate change

There are a number of climate change related process that are expected to impact upon the Derwent tidal wetlands and saltmarshes, a few are briefly discussed here.

Sea-level rise and storm surge: Inundation of low lying areas around the Derwent estuary will impact upon 591 Ha of tidal wetlands and saltmarshes. It is likely that some areas will be lost if they are unable to adjust, through deposition keeping pace with the sea-level inundation rate. In some areas the vegetation may be able to shift inland into 'refugia corridors', but only if the topography, infrastructure and land-use of these sites allow for tidal wetlands and saltmarshes to establish Potential near future (2100) refugia areas around the Derwent Estuary have been mapped (Prahalad *et al.* 2009) The current report will deal with these issue in greater detail.

Increased wind and waves - causing coastal erosion: Coastal erosion may be exacerbated along sandy/unconsolidated shorelines causing habitat change. Coastal erosion also has the potential to expose acid sulphate soils and reduce water quality. Comparison of historic and recent saltmarsh vegetation distributional information in Ralphs Bay has documented a net decrease in coverage, in part due to coastal wind wave erosion (Figure 12), but this work needs to be extended to other estuary areas. In some Derwent locations shoreline hardening (e.g. seawall construction) has occurred to protect against coastal erosion. This may become more prevalent in the future. This may allow for continued human occupancy and use in some Derwent locations, but will prevent natural habitat transgression and adjustment to sea-level rise. The retention of coastal wetland and saltmarsh vegetation dissipates wave energy on the coast and can reduce erosion risks to infrastructure.

Increased rainfall intensity in Greater Hobart: An increase in the intensity of rainfall events has the potential to increase soil erosion and scour urban and rural streams throughout the greater Hobart area. Where urban and rural streams discharge in, or adjacent to, wetlands and saltmarshes, there is a risk of siltation and release of pollutants (excessive nutrients, hydrocarbons, etc).

Changes in River Derwent flow and local hydrology: Climate change impacts on River Derwent flow, and localised hydrology (stream and ground water flows), are unclear. This is a serious knowledge gap for future DEP attention. There is an urgent need to reassess the environmental flow requirements for the upper Derwent estuary wetlands and the role played by surface and ground water in other tidal wetland and saltmarsh areas.

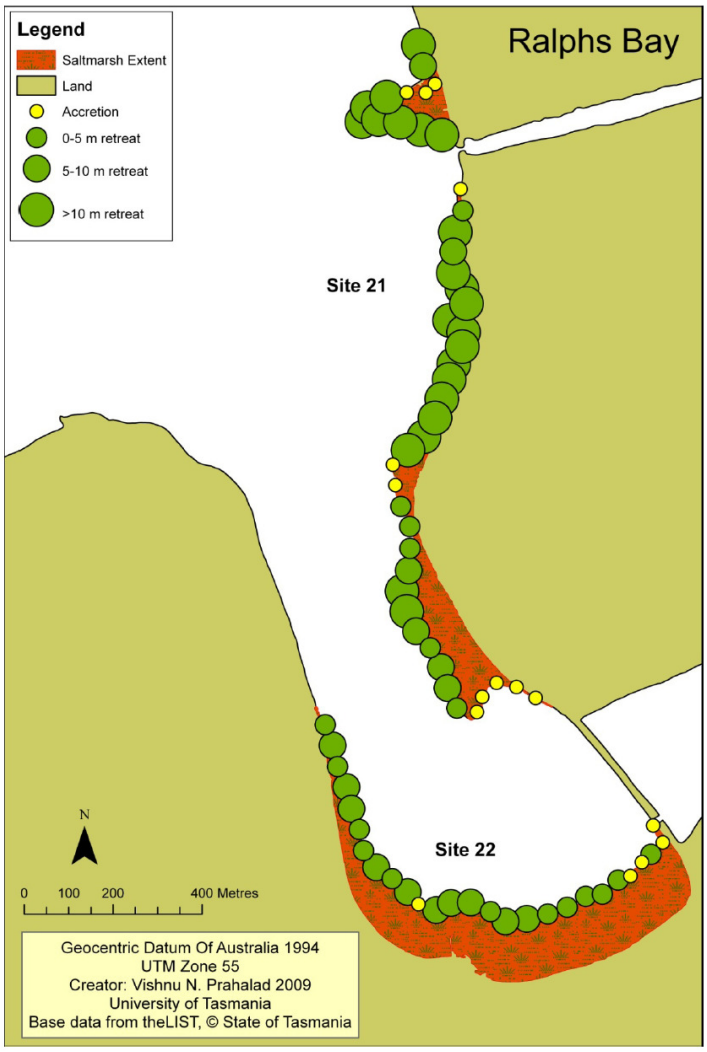

Figure 12.Saltmarsh along the Ralphs Bay exposed coastal margin has retreated in most locations, on the order of 5 to 10m, between 1975 and 2006 attributed largely to wind driven wave erosion (Prahalad 2009)

2.4 Research (current tidal wetland & saltmarsh extent & near future (2100) refugia)

Sea level rise poses a major threat to tidal wetlands and saltmarshes in the Derwent. Research was conducted by University of Tasmania researches (see full report in Prahalad *et al.* (2009)), for the Derwent Estuary Program, and funded by NRM South, to assess potential saltmarsh and wetland extent in 2100 under medium level and high level IPCC sea-level projections The objective of this project was to conduct a preliminary assessment in the Derwent estuary to better understand the impact of sea level rise on these habitats and identify areas to which they can migrate to (refugia corridors). The findings from this project indicate there is definite potential for tidal wetlands and saltmarsh to migrate upland, provided the land use is compatible with their colonisation (Figure 13). It is important to note that this general discussion about potential changes in vegetation extent have not considered more detail changes in representativeness of the various and different types of saltmarsh and wetlands vegetation.

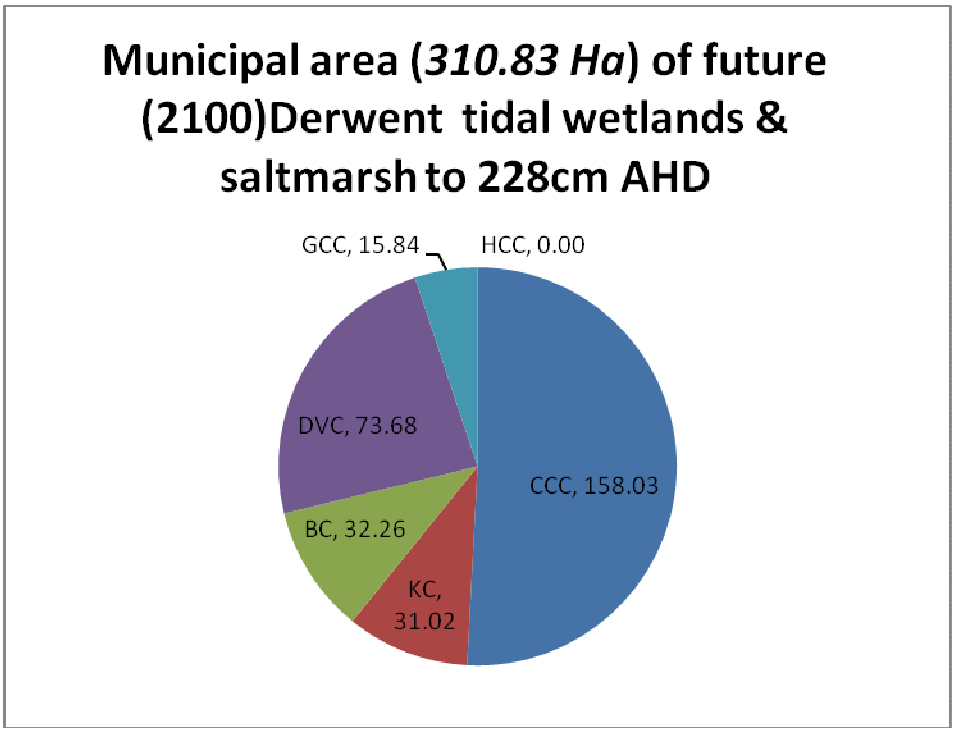

Figure 13. Approximately 310 Ha of land surrounding the current tidal wetland and saltmarsh in the Derwent estuary could potentially support similar vegetation in the future. This figure is based upon the loss of all existing areas of tidal wetland and saltmarsh (due to sea-level rise), which may not be the case if in some areas deposition enables these vegetation communities to persist over some of their current extent. The future figure of 310 Ha has been determined by excluding those areas already occupied by infrastructure that will not allow tidal wetland and saltmarsh migration inland. The figure also assumes that current 'green field areas' are either left undeveloped/ or developed in a sensitive manner (allowing native vegetation establishment) and that land use is also compatible with wet and saltmarsh development.

2.5 Tenure & management of tidal wetland & saltmarshes

It is important to note that a considerable portion of current tidal wetlands and saltmarsh throughout the Derwent estuary is within Crown land (~60%), with lesser amounts in private ownership (~20%), and on council land (~17%). If this vegetation is not sustainable on its current location, due to sea-level rise, ~59% of this vegetation extent in 2100 may be occurring on private land if it is allowed to establish (Figure 14). It is likely that beyond 2100 the relative representation of tidal wetlands and saltmarsh occurring on private land may increase. The current and future management of private land will play a crucial role in securing the future of these vegetation types around the Derwent estuary. A range of management options will need to be considered to achieve this, they may include:

i) create land use planning tools (e.g. planning overlays) so as to identify and manage activities within sensitive areas,
ii) acquire (through purchase) important areas of private land for reservation,
iii) encourage private landowners to place conservation covenants over important wetland and saltmarsh remnants and future refuge areas.

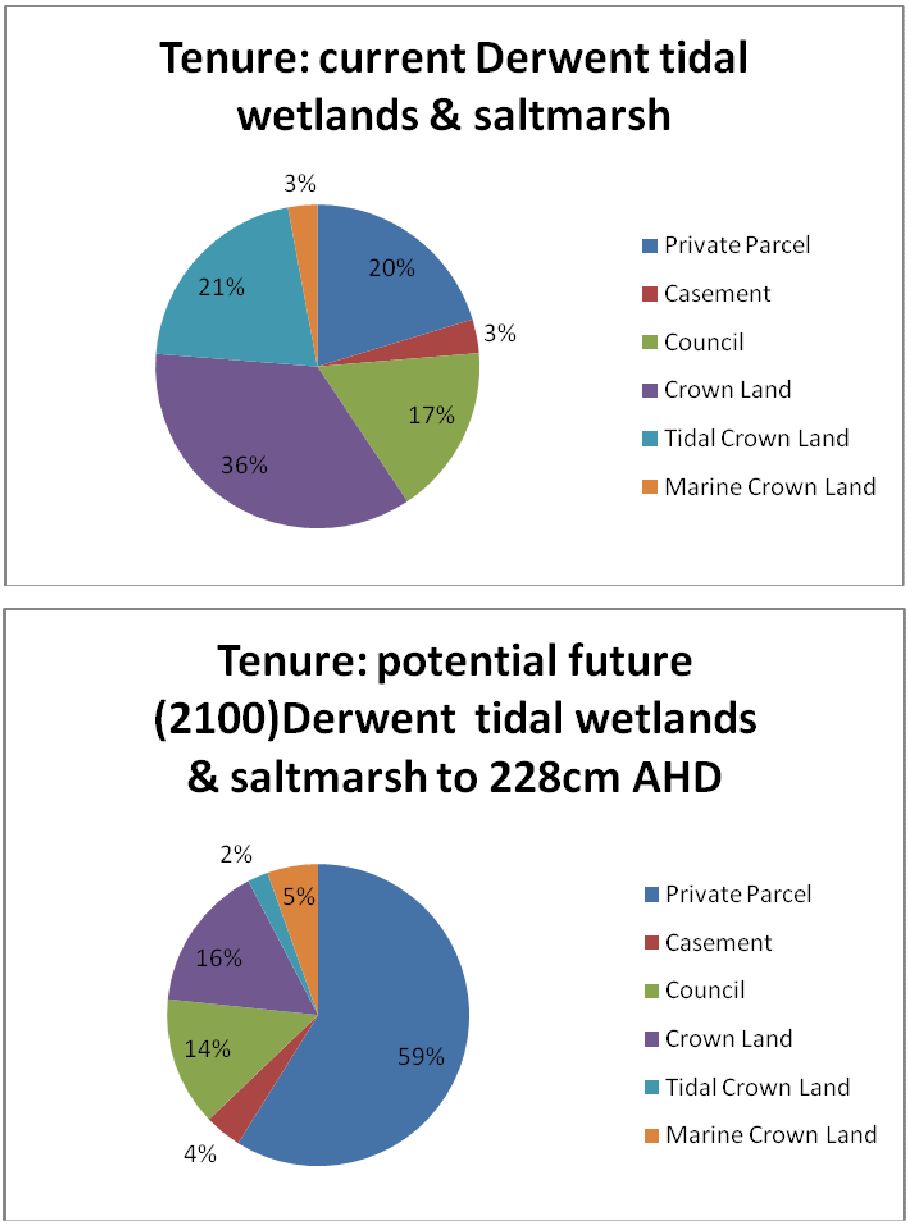

Figure 14. The two graphs enable comparison of the tenure of current and future (2100) tidal wetlands and saltmarsh around the Derwent estuary. What is most apparent is the potential shift from most of these vegetation types (~60%) now occurring on crown land, but in 2100 this may decline (to ~23%). The relative importance of the management of private lands is apparent with proportional increase from 20% currently on private land to ~60% in the future. It must be noted that current vegetation extent is 591 Ha, The future extent may be 310 Ha, this assumes the loss of all existing areas of tidal wetland and saltmarsh (due to sea-level rise),and excludes areas already occupied by infrastructure and assumes that current 'green field areas' are either left undeveloped/ or developed in a sensitive manner (allowing native vegetation establishment) and that land use is also compatible with wet and saltmarsh development.

For a more detailed analysis of tenure within each of the municipal areas bordering the Derwent estuary can be seen in Figure 15. The issue of public versus private tenure is particularly critical in a number of the Derwent estuary municipalities and will become increasingly so towards 2100 in Clarence and Kingbrough. Significant areas of potential tidal wetlands and samltmarsh may also occur on private land in Brighton and the Derwent Valley municipalities.

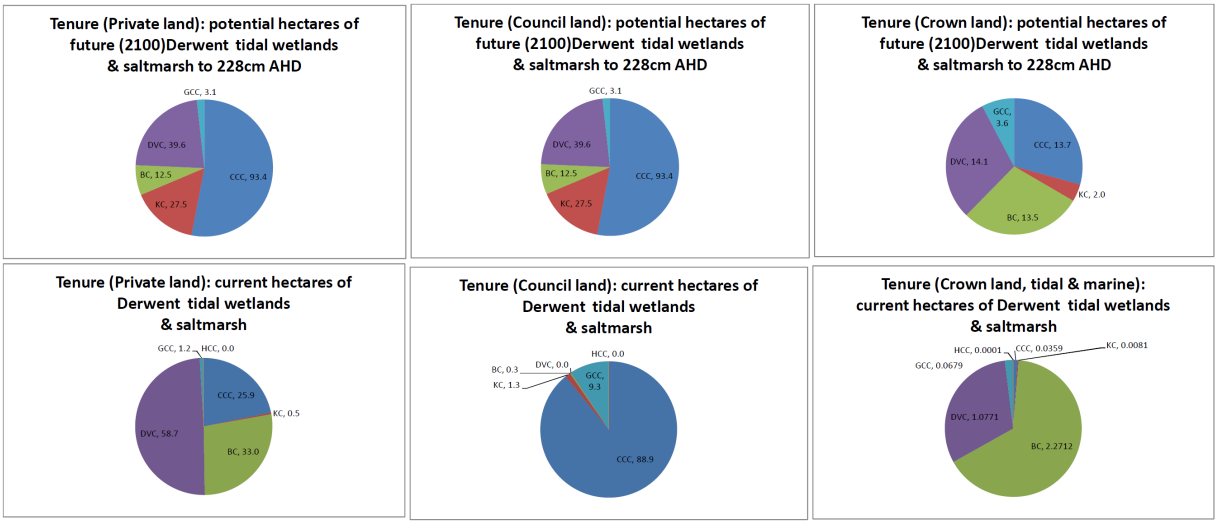

Figure 15. The top row of graphs illustrates the current tenure break down for tidal wetlands and saltmarshes within the Derwent estuary (per municipality (area given in hectares). The bottom row is for the tenure of the near future extent (projected to 2100). The future projection assumes the loss of all existing areas of tidal wetland and saltmarsh (due to sea-level rise),and excludes areas already occupied by infrastructure and assumes that current 'green field areas' are either left undeveloped/ or developed in a sensitive manner (allowing native vegetation establishment) and that land use is also compatible with wet and saltmarsh development.

3.0 LOCAL GOVERNMENT PLANNING

Given that current and future tidal wetlands and saltmarshes occur across different land tenure types, there is merit in developing local government planning tools that are integrated across tenure. Local government will play a pivotal role in the long term sustainability of the these habitats types into the future, The previous discussion on land tenure has identified that planning conditions relating to private land development and use will become increasingly important; however, the location and nature of current and near-future developments will govern how much space we will provide for tidal wetlands and saltmarshes into the future. The following section details initial discussion outcomes with the key planning bodies (most of the local governments bordering the estuary (Derwent Valley, Brighton, Glenorchy, Kingston and Clarence Councils), STCA and TPC) and provides some potential planning options for further consideration. It is intended that the DEP host a workshop with council planning and environmental management staff to see if a regional consistent planing approach can be developed.

3.1 Local Government Planning Discussions

Following the completion of the current and projected (2100) mapping of Derwent estuary tidal wetlands and saltmarshes by Prahalad *et al .(*2009), the DEP circulated the report, and organised a number of opportunities to discuss the findings. A quick summary of information sessions include:

10-9-2009 – Similar work in Pittwater DPIPWE, local government, TPWS, NRM South and others (presented by Vishnu Prahalad)

The Derwent estuary assessment was then presented to:

4-11-2010 –DEP monitoring Taskforce (presented by Vishnu Prahalad)

The DEP then modified the Derwent estuary presentations to focus on areas of interest to the following organisations and to seek advice on how this information could be used for planning purposes.

22-1-2010 - Brighton Council

3-2-2010 - TPWS

4-2-2010 - Kingborough Council

11-2-2010 – Glenorchy

11-2-2010 STCA (and additional discussions with STCA staff (Emma Riley and Damien Mackey)

18-2-2010 – Clarence (and subsequent discussions with Phil Watson)

10-3-2010 – Derwent Valley Council

2-8-2010 –DEP Monitoring Taskforce

Additional discussions have been had with staff at the TPC (Greg Alomes, Brian Risby, and Stewart Johnson) and DPIPWE Protected Areas on Private Land Program (PAPL) (Dean Vincent). Discussion were also held with the Hobart City Council's Environment and Climate Change Officer (Katrina Graham), but given the minor amount of remnant saltmarsh in this municipality (and the low potential for the establishment of future tidal wetlands and saltmarshes here), the DEP have not engaged in discussion with Hobart City Council planning staff.

The following points appeared consistent from discussion with local government planning and environmental management staff:

- There is value in creating a regional planning overlay with codes (schedules) relating to current and future tidal wetlands and saltmarshes.
- Seek advice from STCA and aim to integrate with current regional planning project if and where possible
- Consider how such a planning tool may integrate with other coastal inundation risks to infrastructure.
- There is a need for communication of any proposed planning tools with elected council members and the public. A communication strategy may be required for promoting this planning overlay and code application to private landholders.

3.2 Planning Overlay & Refugia Corridor Development

There were different suggestion from the people consulted as to the potential extent and nature of the proposed planning overlays, some comments include:

- Consider how the overlay fits within the Tasmanian Planning Commission planning scheme template. The overlay could potentially occur in multiple zones within the planning template (e.g., Environmental Management, Rural Living, Rural Resource and Recreation Zones).

- STCA advised constructing and naming the overlay (e.g. Natural Coastal Processes Overlay so that there will be potential for inclusion of other natural coastal assets (e.g. sandy beach transgression). Note that associated codes will also need to be constructed in a manner that may enable this flexibility.
- Divide the overlay into two categories with separate coverage of the:
    - Current tidal wetlands and saltmarsh extent
    - Near future (2100) tidal wetlands and saltmarsh extent
- Any overlay areas should be flexible (allowing for periodic review and revision), so that it can be moved with sea-level rise and as future sea-level and storm surge projections improve. We must keep in mind that coastal processes and potential sea-level rise will continue beyond 2100. To enable this flexibility, it may be beneficial to fully map long term refugia corridors to higher altitudes and ensure that appropriate codes apply to future developments within these corridors. There is an urgent need to integrate such corridor identification into regional land-use planning projects.

In response to the initial comments and suggestions, the DEP have created a draft planning overlay that includes two categories (and provide some discussion on a potential third) for the:

1) Current sensitive coastal habitat (in BLUE stippled for current tidal wetlands complex and saltmarsh extent)
2) Near future (2100) sensitive coastal habitat. This is our recognised near term transition zone (in RED stippled for 2100 tidal wetlands and saltmarsh extent). This excludes areas where infrastructure currently exists.
3) Long term refugia corridors.

The draft planning overlay category 1 has been created using known current vegetation extent. This has been mapped by Prahalad *et al*. (2009) primarily from QuickBird satellite imagery compiled for the greater Hobart area in 2005 (provided by DigitalGlobe). Images covered the upper and middle Derwent estuary, between New Norfolk and Tasman Bridge comprehensively, but not the lower section of the estuary (Prahalad *et al.* 2009). Orthorectified Aerial Photographs (dated 2001) were used to map vegetation in the lower estuary. The mapped vegetation polygons were then verified with satellite imagery available online from Google Earth and compared to recent vegetation mapping undertaken by North Barker Ecosystem Services (who used 2001 aerial photographic coverage over the entire estuary and some ground truthing in 2008). Some oblique aerial photographs (from 2009), obtained from Richard Mount (University of Tasmania), were also used to verify the extent of the wetland polygons in some areas (Prahalad *et al.* 2009). The mapping was edited by Jason Whitehead in January 2010, so as to include some areas of wetland and saltmarsh within the middle estuary missed by these previous mapping efforts. Polygons were redrawn in a number of locations using the QuickBird satellite imagery compiled for the Greater Hobart Area in 2005, and verified from field based knowledge.

The draft planning overlay category 2 has been created using information from multiple sources. The landward extent of tidal wetland and saltmarsh vegetation is correlated to the elevation of the 1/100 year storm tide height, which is ~118cm AHD around the Derwent estuary (Prahalad *et al.* 2009). An upper projection of sea-level rise by 2100 is 110cm and when this is combined with the 1/100 storm tide height, the projected landward extent of tidal wetland and saltmarsh vegetation may be 228cm AHD by 2100 (Prahalad *et al.* 2009). The 228cm contour height has been mapped around the Derwent estuary using the Climate FuturesTasmania LiDAR Digital Elevation Model (DEM) dataset that was compiled for the Climate Futures of Tasmania project being undertaken by the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) and the State Emergency Service. The dataset is though to have a vertical and horizontal accuracy of +/- 25 cm. An example of how the 228cm AHD contour map has been used to create the overlay category 2 area can be seen in Figure 16.

Figure 16. *Left hand side* RED line indicates 228cm AHD and is the projected upper limit of wetlands and saltmarsh in the Derwent estuary based on 110cm sea-level rise (from Prahalad *et al .(*2009)).The Derwent Estuary Program have used this information and current tidal wetland and saltmarsh mapping (from: Prahalad et al. 2009; NorthBarker Ecosystems Service, TASVEG 2.0, CFEV and DEP staff ground truthed some middle estuary sites visible from QuickBird satellite data) to create the two planning categories within the proposed overlay.

On the left hand side of the figure the red line illustrates the contour height 228cm AHD, to which saltmarsh is expected to migrate up to by 2100 based on a sea-level rise of 110 cm and if there were no infrastructure or land use impediments to

vegetation establishment. However, it is likely that continued use and protection of current infrastructure will prevent much of the projected vegetation movement as it adjusts to sea-level rise, restricting future available new habitat area to the stippled RED area on Figure 16 (right hand side). The stippled BLUE area is currently occupied by saltmarsh. These two stippled areas comprise the two planning categories within the proposed overlay.

Examples of this overlay for each of the municipal areas bordering the Derwent can be found in Appendices 1 to 6. It is apparent that any new, and future development of the green field areas that are currently recognised as being capable of supporting sensitive coastal habitats (i.e. RED near future 2100 habitat area) , may create barriers that will cause the inevitable loss of these natural assets. However, the year 2100 is arbitrary in the context of sea-level rise and that it may also be appropriate to identify a much longer timeframe refugia corridor. Questions then arise as to what height should such a corridor (if identified) be mapped to? A possible longer term refugia corridor relevant to the Lauderdale saltmarsh may be seen in Figure 17. How do such concepts fit within current land use planning?

Figure 17. A hypothetical long term refugia corridor for Lauderdale and pipeclay lagoon saltmarshes (within dashed line). The blue circled areas are non-Derwent wetlands and saltmarshes that currently exist (and may warrant including within the proposed overlay).

The proposed overlay could then also be flexible so it can shift upland in the future through a potential long term refugia corridor. This raises the question, should there be three overlay category areas for long term refugia corridors?

The concept of flexible overlays, which would move upland as sea-level rises have been discussed in the USA – and are described as 'rolling easements' (Titus 1998). This is described as an option that enables both private use of the property and also enables natural assets to transgress inland. However, this requires the probable abandonment / removal of infrastructure that has been built on the conditions that at certain trigger levels/time frames that establishment of the natural asset on the site will take precedent over the infrastructure presence (Figure 16).

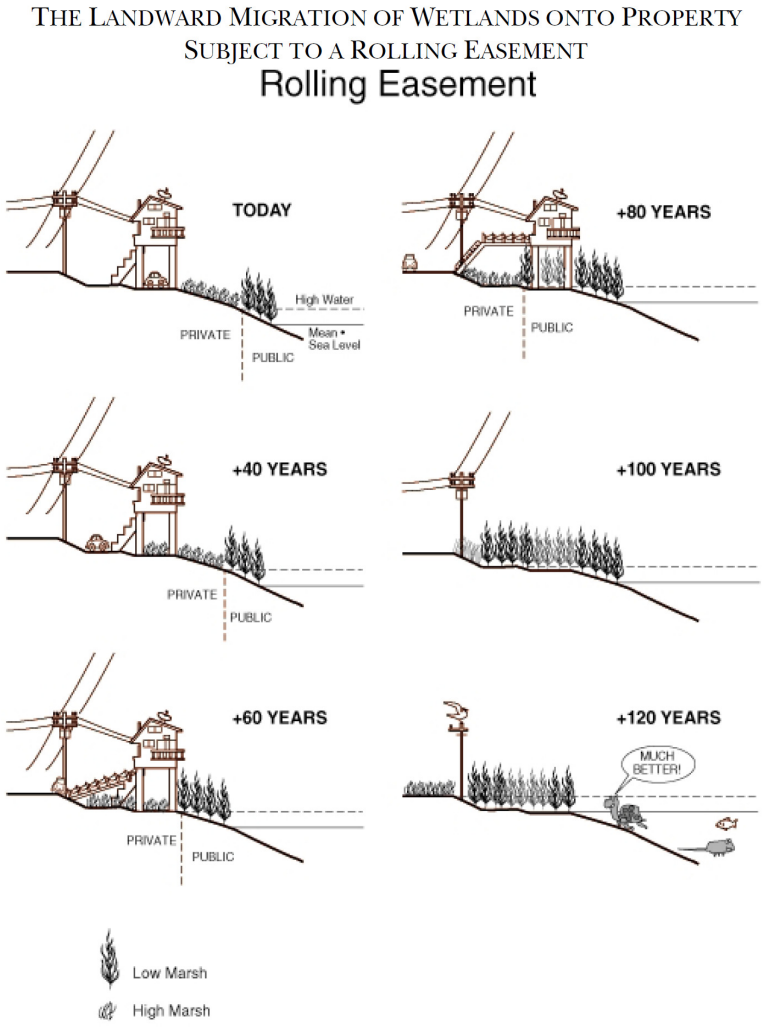

Figure 16. A diagrammatic representation of the 'rolling easement' concept, with landward transgression of the public/private land boundary and 'idealised 'movement of wetlands underneath a house on stilts (image from Titus 1998).

In reality would a 'rolling easement' like approach ensure future movement of tidal wetlands and saltmarshes in the Derwent if new developments were conditioned to allow such a process to occur?

3.3 Integrate with infrastructure risk mapping from inundation (sea-level rise and storm surge) and coastal erosion

A brief review of the local government planning schemes, for those councils bordering the Derwent estuary identified that in most instances that development is allowed to proceed within some areas of the proposed overlay (especially within the near future (2100) sensitive coastal habitat areas) if inundation risks are removed. The simplest way to achieve this is through land filling the relevant low lying areas so that the height of the structure meets building standards. Land filling and future infrastructure protection from inundation on such sites may conflict with the long term viability of tidal wetlands and saltmarshes, which will lose the ability to move inland due to sea-level rise. Planning solutions are required to help address this issue, perhaps through the creation of codes that place conditions on new developments, occupation and land-use within sensitive near future and long term refugia areas. This illustrates the need to integrate natural asset risk mapping (as done through the tidal wetland and saltmarsh 'Natural Coastal Processes' overlay) with infrastructure risk mapping.

3.4 Planning Code (Schedule) Development

There were different suggestion from local government as to the potential content of planning codes that relate to the tidal wetlands and saltmarsh overlay proposed. Some informative comments included:

- Any overlay areas should be flexible, and should move with sea-level rise and as future sea-level and storm surge projections improve.
- Codes relating to areas identified as supporting future tidal wetland and saltmarsh areas may still enable some kinds of development , but there needs to be discussion as to (note: the following points relate to green field sites):
    - what amount of any given area can be disturbed (earthworks etc)
    - what triggers would result in abandonment or removal of any structures within the path of transgressing sensitive coastal habitats.

Some possible land uses for consideration in three different category areas should be discussed.

1) Current sensitive coastal habitat (in BLUE stippled for current tidal wetlands and saltmarsh extent)

Possible planning code intent (DEP suggestions to assist discussion):

The current BLUE wetland & saltmarsh overlay category should ensure protection of all remaining tidal wetlands and saltmarshes. There should be a prohibition on vegetation clearance, fires, live stock grazing, land filling and excavation with some exception for the provision of essential services, and limited public access/interpretative infrastructure. Where disturbance is allowed to occur, an appropriate off-set scheme should be created.

2) Near future (2100) sensitive coastal habitat. This is our recognised near term transition zone (in RED stippled for 2100 tidal wetlands and saltmarsh extent)

Possible planning code intent (DEP suggestions to assist discussions):

The RED near future (2100) sensitive coastal habitat area should discourage all but essential land filling and excavations. Assets that are allowed to be constructed, should have a limited lifespan (e.g. 50 years) and should be removed once trigger conditions/timeframes are reached. Any earth works allowed, should also be created to ensure that hydrologic connectivity with the sea and upland will be possible. Live stock grazing should be prohibited (through fencing) at the lower edge of this zone (a prescribed height or distance above existing vegetation).

3) Long term refugia corridors

Possible planning code intent (DEP suggestions to assist discussions):

Future development in the 'long term refugia corridor' could be subject to conditions within the overlay categories 1) and 2) (potential examples described above) and that future infrastructure within the 'long term refugia corridor' may need to be designed to enable natural assets to establish.

3.5 Planned retreat of infrastructure assets

Where planned retreat of the coastline is required, questions arise as to who should pay for this? It is not the purpose of the current discussion paper to explore these options, but it is acknowledged that this is an important aspect of potential future discussions

The current overlay developed has not created a detailed assessment of potential areas that may be included within the 'long term refugia corridor' category. It is expected that it is within this area that managing planned retreat is of greatest pertinence, given that the current overlay are has attempted to exclude current infrastructure. Future planning of any new infrastructure and management of current infrastructure and land use will determine if the potential long term refugia corridors will be viable from habitat, economic and social perspectives.

4.0 COMMUNICATION STRATEGIES

Local government staff mentioned the importance of communication in gaining support and successful implementation of any planning related tools relevant to sensitive coastal habitats. This was highlighted by the fact that the 2100 future habitat projection identified that ~60% of the Derwent tidal wetlands and saltmarsh extent may occur on private lands. The Clarence Council, as an important component of their recent climate change investigations, engaged the services of Clive Attwater to undertake public survey and communication sessions. Although the news concerning coastal inundation and erosion is not good for a number of coastal residences, the public appreciated information concerning the risks to their properties.

However, the Clarence experience has also potentially lead to an increased rate of land filling activities in some low lying areas (Clarence council staff, *pers comm.),* which has implications for sensitive saltmarsh habitat movement. This highlights the need for a communication strategy that will assist in the management of areas that are important for the long term viability of sensitive coastal habitats. It is likely that different communication approaches will be required for different audiences, and that professional advice and assistance may be required.

Wetland and saltmarshes are currently undervalued from a social and economic perspective, whilst these habitats provide a large ecosystem service. A recent study on general public perception of these habitats has been conducted in Victoria. Advice to the DEP from the lead investigator - Paul Boon (Professor of the Institute for Sustainability and Innovation, Victoria University) is that these habitats are 'under the radar' of the general public. Paul has proposed a 'state of change strategy' to improve awareness and perception of their value. The Victorian report, once released, may inform the communication strategy required for the Derwent estuary tidal wetlands and saltmarshes.

<u>Planning and natural resource management staff (Government, STCA, TPC, & NRM)</u>

The DEP have already engaged in discussion with planning and natural resource management staff from different organisations and at different levels within government. This document is the next step, after initial discussions of the Prahalad *et al.* (2009) study findings. A follow-up work shop is intended (early 2011) to seek feedback on this document and advice as to if the ideas presented can be improved and implemented.

Discussion is also required on the topics of:

- The planning overlay name, possibly 'Natural Coastal Processes overlay', so as to enable inclusion of other coastal asset types.
- How does the proposed overlay fit within the TPC planning template? It is likely that the overlay proposed will occur across multiple zones.
- Should the overlay include a third category that identifies long term refugia corridors, through which the other two categories will move through time?
    - What mechanism will make the planning overlay categories flexible (like the rolling easement concept).
- What activities will be allowed within the overlay category areas? What triggers/timeframes would be a condition with the codes (causing planned retreat of infrastructure and any site restoration?
- How to integrate the proposed overlay with infrastructure risk assessments (inundation and erosion)
    - identify what will be the achievable balance between natural and built assets.
- How to help fund future planned infrastructure retreat.

Whilst the current discussion concerns tidal wetlands and saltmarshes, in the future the DEP would like to encourage discussion relating to other natural coastal assets, notably:

- sandy beaches (especially those adjacent to urban areas),:
- Where should coastal protection be allowed and what triggers should enable this to be created. What type of options will be allowed where (soft versus hard engineering).

Local council elected members

Local government planning and natural resource management staff have stated that support from elected council members will be required.

Land managers: Authority (crown lands, conservation areas, council land) & Private

There are multiple land tenures involved within the discussion of potential planning overlay and codes relating to 'Natural Coastal Processes'. An improved and consistent planning approach (with the Derwent estuary region) will require better communication among the different tenure holders, land managers about any proposed planning changes.

Any communication approach should attempt to reduce conflict where possible, but also ensure good environmental outcomes are achieved. The proposed RED future 2100 habitat areas have been created in a manner that should hopefully prevent conflict with the management of existing infrastructure. However, several larger private properties have been included within this overlay. The inclusion of these properties is of strategic importance to the maintenance of tidal wetlands and saltmarshes at these locations. Potential issues relating to some of these properties have been discussed with local council staff and expert advice on the appropriate communication strategy may be required. Once these discussions have been held, and any potential issues resolved it may be appropriate to release the proposed planning overlays and codes for public comment during local planning scheme amendment or review.

5.0 OTHER TOOLS & RESOURCES

It is acknowledge that local government planning is a very important tool, but that other concurrent mechanisms and tools should also be developed to improve protection and management of our sensitive coastal habitats. The DEP, with the help of others, are exploring some of the following options:

- Improved public knowledge as to the value of tidal wetlands and saltmarshes
- An application for inclusion of the *Succulent saline herbland* (ASS), vegetation type as a threatened community type covered under the Nature Conservation Act 2002.

- Options for private land conservation covenants, through the DPIPWE Protected Areas on Private Land Program (PAPL) and the Tasmanian Land Conservancy
- Explore options for purchasing critically important areas that are currently in private ownership.

6.0 WHERE TO NEXT

The DEP appreciate the research, advice and discussion that people have contributed to date, which has assisted in the development of this discussion paper. The DEP wishes to facilitate a workshop, with local government planners and natural resource management staff to seek feed back on the draft overlays and contents of this paper. It is the intention of the DEP to host this workshop in early 2011, so as to progress the following:

- Consensus on the creation of a region a planning overlay, which includes:
    - Current tidal wetlands and saltmarsh extent
    - Near future (2100) tidal wetlands and saltmarsh extent
- Discuss potential overlay for the long term refugia corridors
- Development of planning codes pertaining to the overlay areas.
- Communication strategy
- Other climate change coastal issues

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