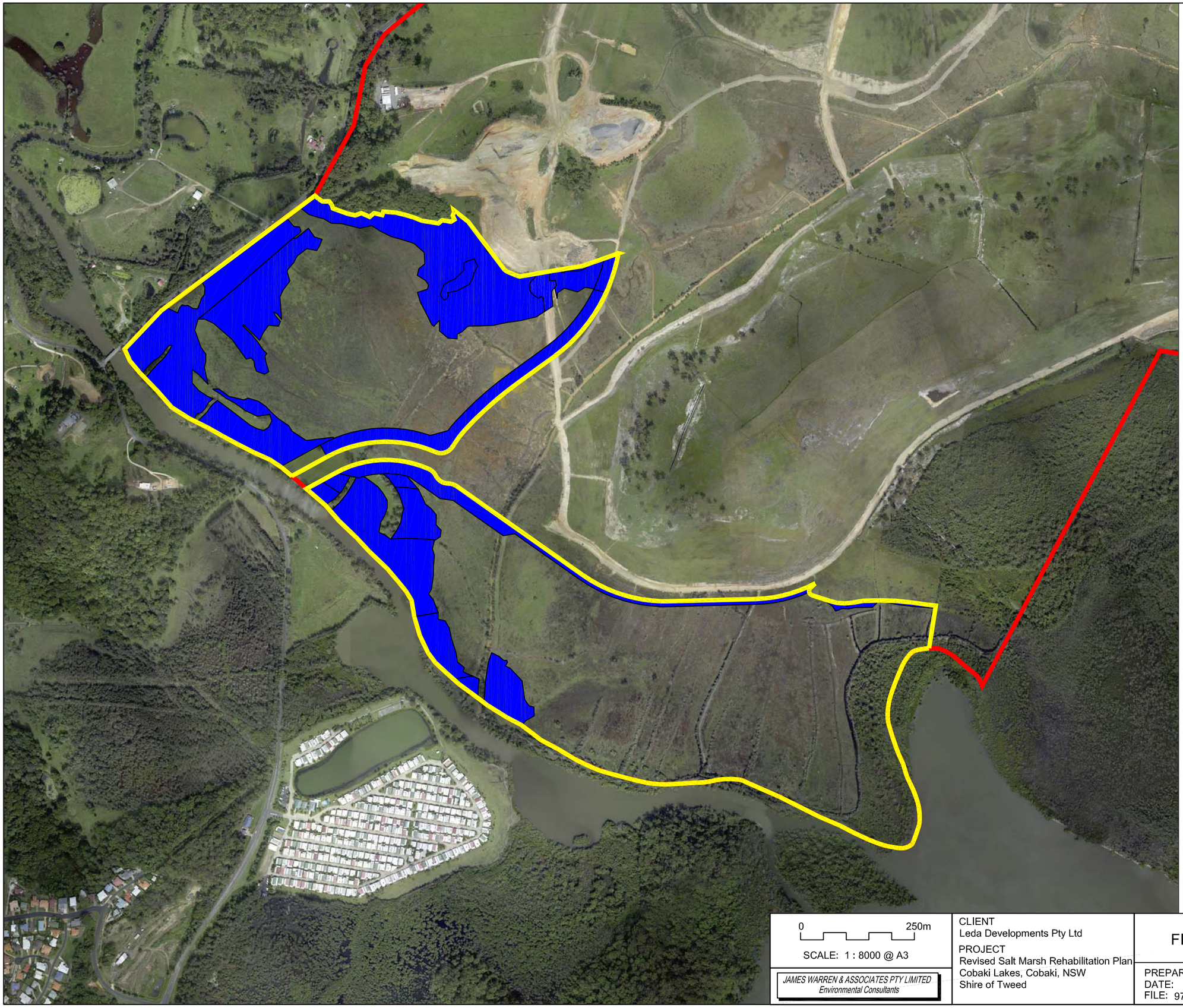

LEGEND

- Proposed Revegetation Areas - Swamp Oak / Salt Marsh
- Salt Marsh Rehabilitation Area
- Cobaki Lakes Site Outline

SOURCE:
Revegetation - James Warren & Associates Pty Ltd
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 250m

SCALE: 1 : 8000 @ A3

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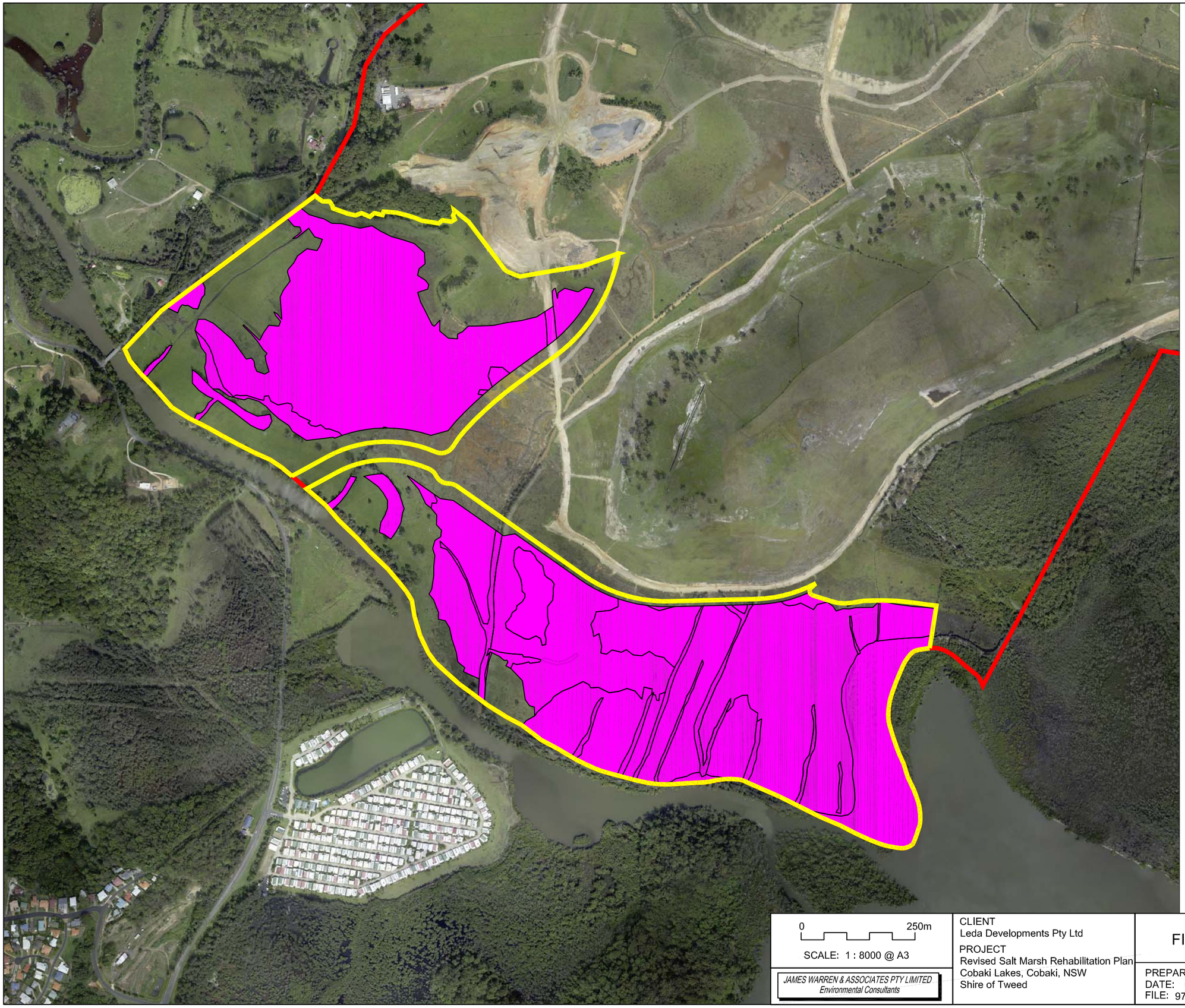
Revised Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 10

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE

REVEGETATION AREAS



LEGEND

- Proposed Natural Regeneration Areas
- Salt Marsh Rehabilitation Area
- Cobaki Lakes Site Outline

SOURCE:
Regeneration - James Warren & Associates Pty Ltd
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 250m

SCALE: 1 : 8000 @ A3

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Shire of Tweed

FIGURE 11

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_base.dwg

TITLE

REGENERATION AREAS

6 PROPOSED REHABILITATION

6.1 Aims and Objectives

6.1.1 Aims

The broad aim of this rehabilitation plan will be to restore native vegetation communities within the 90.16ha SRA. Several other aims and objectives for the rehabilitation of the Saltmarsh area include the following:

- Provide compensation for the removal of degraded Saltmarsh communities from the Cobaki Lakes development site;
- Provide compensation for the removal of small patches of Swamp-oak floodplain forest EEC;
- Establishment of healthy Saltmarsh, Mangrove and Swamp oak communities;
- Control of exotic weed species;
- Assist in improving the quality of stormwater entering Cobaki Creek and the Cobaki Broadwater;
- Provision of habitat for fauna;
- Reduce the impact of mosquitoes in the Cobaki Broadwater area; and
- Provide retreat opportunities for the Saltmarsh community as sea levels rise.

6.1.2 Objectives

The Department of Environment and Climate Change (DECC 2008) list the following recovery action measures that may aid in the rehabilitation of Saltmarsh communities. These actions have been adapted to the site in order to provide objectives that are to be assessed in the determination of the success or failure of this rehabilitation plan. The objectives of the plan are as follows:

- Rehabilitate and manage the Saltmarsh so as to assist in the reduction of mosquito breeding on the site;
- Protect areas of Saltmarsh from runoff that contains high levels of nutrients or pollutants;
- Maintain buffer zones of terrestrial vegetation (rehabilitated) adjacent to Saltmarsh to allow for retreat of Saltmarsh;
- Allow areas of Saltmarsh to regenerate naturally where possible;
- Protect from clearing and development through fencing, signage and active management;
- Minimise human disturbance by preventing access by recreational vehicles, including four wheel drives;
- Erect educational signs to provide information to visitors and residents of the importance of coastal Saltmarsh;
- Undertake weed control programs;
- Prohibit grazing and burning;
- Monitoring and subsequent control of tidal regimes to allow the required number of tides per year onto the Saltmarsh.

6.2 Rehabilitation methods

6.2.1 Introduction

The section discusses the rehabilitation methods that will be employed within the SRA to re-establish healthy and viable vegetation communities after the completion of the construction activities.

The rehabilitation methods to be used include:

- Promote tidal exchange within the rehabilitated Saltmarsh community through re-engineering existing levee and drainage systems and some regrading works;
- Control of invasive grasses and weeds;
- Erection of exclusion fencing;
- Revegetation of Swamp oak and other native species surrounding the Saltmarsh areas;
- Assisted natural regeneration where appropriate; and
- Transplanting patches of Saltmarsh where appropriate.

6.2.2 Tidal exchange

Historical farming activities have led to the clearance of the Paperbark, the construction of one (1) major drain (Dunn's Drain) and a number of smaller drains, and the placement of a tidal flap at the mouth of Dunn's Drain. Vandalism of the tidal flap and other breaches of the berm to the Cobaki Broadwater have allowed tidal water onto the site for over twenty (20) years. However, once tidal waters encroach into the low-lying areas of the site, large pools of standing water remain for extended periods of time. These areas of standing water are detrimental to Saltmarsh species and create ideal breeding conditions for a variety of salt and freshwater mosquito species.

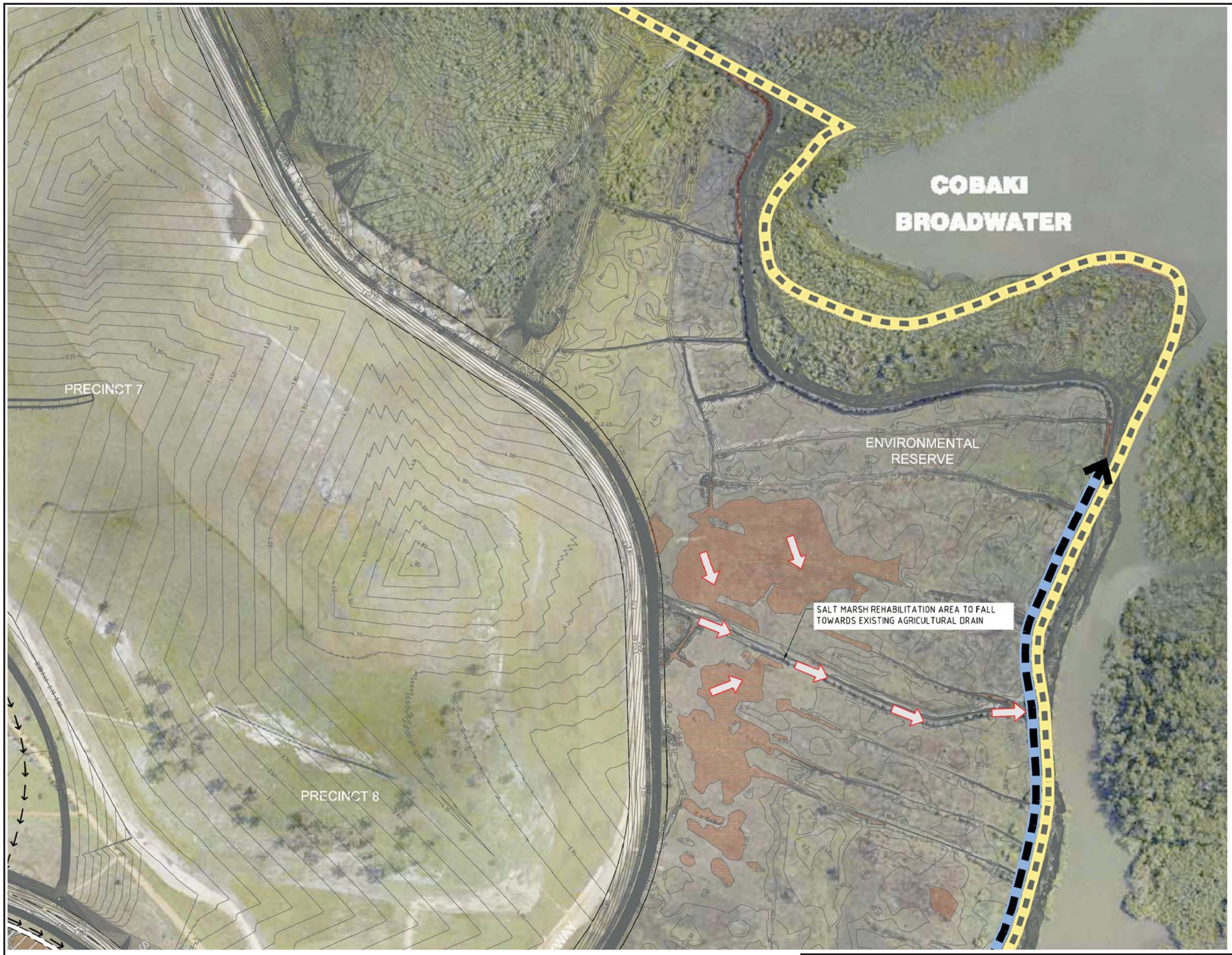
To promote tidal exchange within the Saltmarsh communities on the site, the following measures are proposed (**FIGURES 12a & 12b**):

1. The existing levee north of Dunn's drain will be lowered to RL 0.3;
2. Tidal exchange between the Saltmarsh communities to the east and west of the proposed Cobaki Parkway will be maintained via a 10m wide channel (RL 0.3) and a bank of culverts; and
3. As the tidal exchange is to be regulated at RL 0.3, the Dunn's drain outlet and a proposed new outlet adjacent to a main agricultural drain (located approximately 400m north of Dunn's drain) will enable areas of ponded water below RL 0.3 to free drain.

There are also some filling and regrading works required within areas of the Saltmarsh community (**FIGURES 13a & 13b**):

1. Low-lying areas which currently hold pooled water will be filled to RL 0.0. These areas will need some minor profiling to ensure drainage; and
2. The majority of existing agricultural drains will be filled (with the exception of Dunn's drain and the drain approximately 400m north).

These works will be staged to minimise impacts on the Saltmarsh EEC (**FIGURES 13a & 13b**). Where filling is required and Saltmarsh vegetation is present, fill will be placed in



LEGEND

- ROAD RESERVE
- ROAD CENTRELINE
- REHABILITATION WORKS TO RL0.0m AHD
- SITE BOUNDARY
- OVERLAND FLOW DIRECTION
- 3.70 FINISHED CONTOURS
- LOWER EXISTING DREDGED BUND
- TREATED MINOR DEVELOPMENT FLOW DIRECTION

TIDAL INFORMATION

- HIGHEST ASTRONOMICAL TIDE (H.A.T.) - 0.73mAHD
- MEAN HIGH WATER SPRING (M.H.W.S.) - 0.43mAHD
- MEAN HIGH WATER NEAPS (M.H.W.N.) - 0.22mAHD
- AVERAGE WATER LEVEL - 0.00mAHD
- MEAN LOW WATER NEAPS (M.L.W.N.) - -0.25mAHD
- MEAN LOW WATER SPRING (M.L.W.S.) - -0.41mAHD
- LOWEST ASTRONOMICAL TIDE (L.A.T.) - -0.53mAHD

N

0 100m 200m

1 : 8000

SOURCE: Yeats (Ref: YC0229 - SK 114 SALT MARSH DRAINAGE PLAN - SHEET 1 OF 2.pdf)

SCALE: 1 : 8000 @ A3

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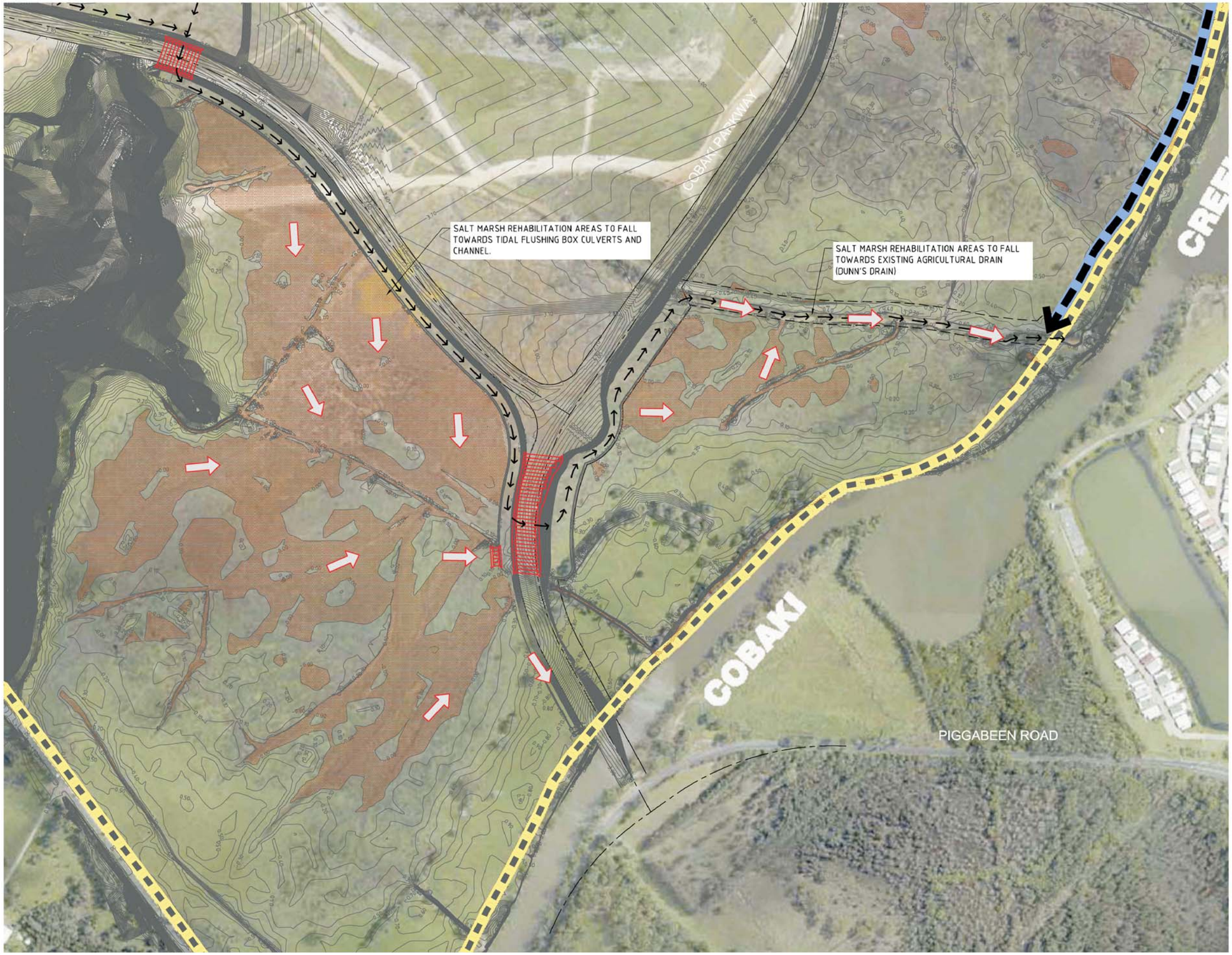
Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 12A

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Tidal.cdr

TITLE

TIDAL EXCHANGE MEASURES



LEGEND

- ROAD RESERVE
- ROAD CENTRELINE
- REHABILITATION WORKS TO RL0.0m AHD
- SITE BOUNDARY
- OVERLAND FLOW DIRECTION
- 3.70 FINISHED CONTOURS
- LOWER EXISTING DREDGED BUND
- TREATED MINOR DEVELOPMENT FLOW DIRECTION

TIDAL INFORMATION

- HIGHEST ASTRONOMICAL TIDE (H.A.T.) - 0.73mAHD
- MEAN HIGH WATER SPRING (M.H.W.S.) - 0.43mAHD
- MEAN HIGH WATER NEAPS (M.H.W.N.) - 0.22mAHD
- AVERAGE WATER LEVEL - 0.00mAHD
- MEAN LOW WATER NEAPS (M.L.W.N.) - -0.25mAHD
- MEAN LOW WATER SPRING (M.L.W.S.) - -0.41mAHD
- LOWEST ASTRONOMICAL TIDE (L.A.T.) - -0.53mAHD

N

0 100m 200m

1 : 8000

SOURCE: Yeats (Ref: YC0229 - SK 115 SALT MARSH DRAINAGE PLAN - SHEET 2 OF 2.pdf)

SCALE: 1 : 8000 @ A3

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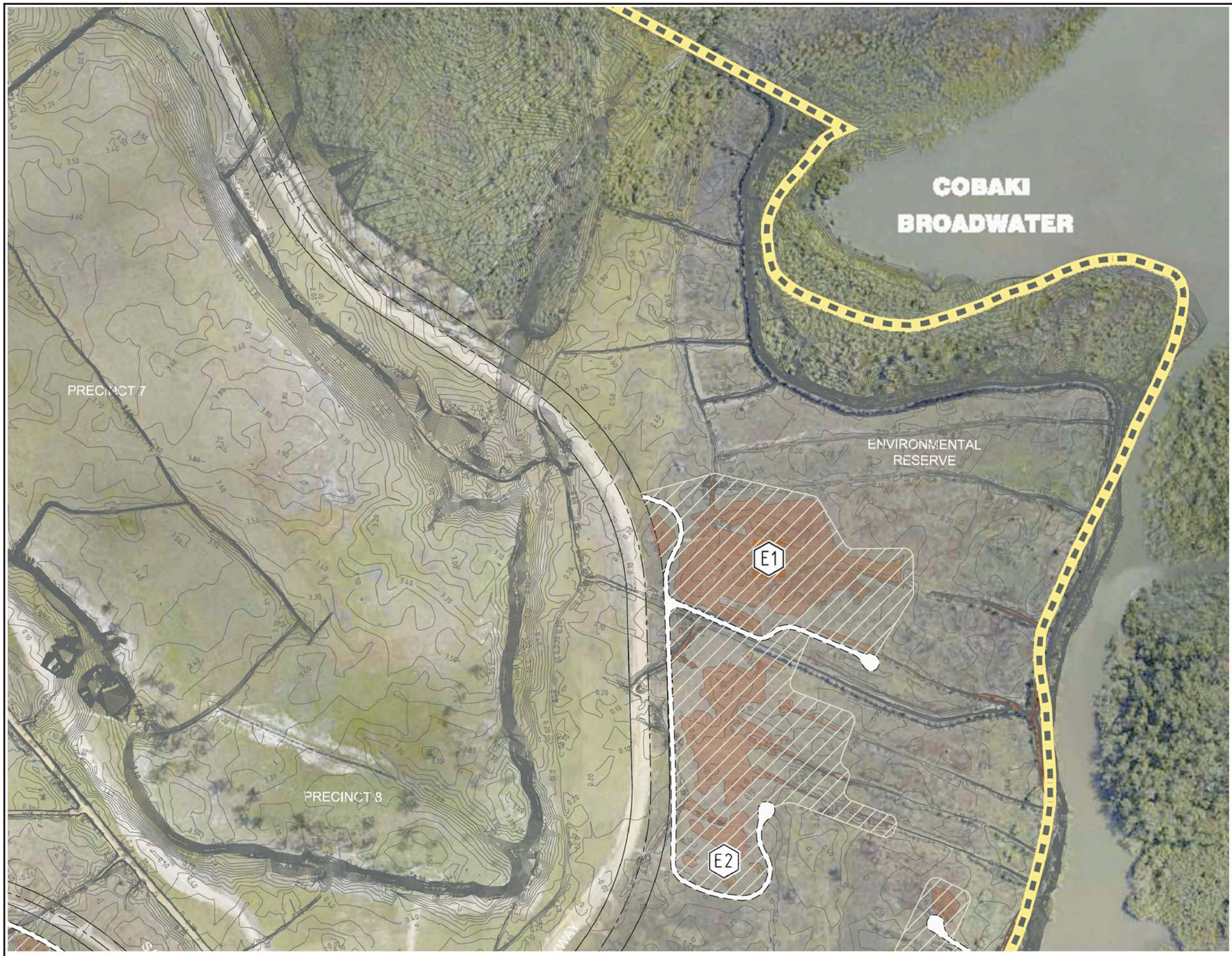
Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 12B

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Tidal.cdr

TITLE

TIDAL EXCHANGE MEASURES



LEGEND

- ROAD RESERVE
- ROAD CENTRELINE
- REHABILITATION WORKS TO RL0.0m AHD
- REHABILITATION STAGING
- TEMPORARY SALT MARSH REHABILITATION ACCESS TRACK
- SITE BOUNDARY
- 3.70 EXISTING CONTOURS

TIDAL INFORMATION

- HIGHEST ASTRONOMICAL TIDE (H.A.T.) - 0.73mAHD
- MEAN HIGH WATER SPRING (M.H.W.S.) - 0.43mAHD
- MEAN HIGH WATER NEAPS (M.H.W.N.) - 0.22mAHD
- AVERAGE WATER LEVEL - 0.00mAHD
- MEAN LOW WATER NEAPS (M.L.W.N.) - -0.25mAHD
- MEAN LOW WATER SPRING (M.L.W.S.) - -0.41mAHD
- LOWEST ASTRONOMICAL TIDE (L.A.T.) - -0.53mAHD

NOTE:
TEMPORARY ACCESS TRACK TO BE REMOVED AND RESTORED FOLLOWING REHABILITATION WORKS TO RL0.0m AHD.

N

0 50m 100m
1 : 4000

SOURCE: Yeats (Ref: YC0229 - SK 116 SALT MARSH REHABILITATION STAGING WORKS - SHEET 1 OF 2.pdf)
SCALE: 1 : 4000 @ A3

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Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 13A

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Staging.cdr

TITLE
PROPOSED SALT MARSH REHABILITATION STAGING WORKS

LEGEND

- ROAD RESERVE
- ROAD CENTRELINE
- REHABILITATION WORKS TO RL0.0m AHD
- REHABILITATION STAGING
- TEMPORARY SALT MARSH REHABILITATION ACCESS TRACK
- SITE BOUNDARY
- 3.70 EXISTING CONTOURS

TIDAL INFORMATION

- HIGHEST ASTRONOMICAL TIDE (H.A.T.) - 0.73mAHD
- MEAN HIGH WATER SPRING (M.H.W.S.) - 0.43mAHD
- MEAN HIGH WATER NEAPS (M.H.W.N.) - 0.22mAHD
- AVERAGE WATER LEVEL - 0.00mAHD
- MEAN LOW WATER NEAPS (M.L.W.N.) - -0.25mAHD
- MEAN LOW WATER SPRING (M.L.W.S.) - -0.41mAHD
- LOWEST ASTRONOMICAL TIDE (L.A.T.) - -0.53mAHD

NOTE:
TEMPORARY ACCESS TRACK TO BE REMOVED AND RESTORED FOLLOWING REHABILITATION WORKS TO RL0.0m AHD.

N

0 50m 100m
1 : 4000

SOURCE: Yeats (Ref: YC0229 - SK 117 SALT MARSH REHABILITATION STAGING WORKS - SHEET 2 OF 2.pdf)
SCALE: 1 : 4000 @ A3

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Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 13B

PREPARED: BW
DATE: 06 October 2010
FILE: 97038_SMRP_Staging.cdr

TITLE
PROPOSED SALT MARSH REHABILITATION STAGING WORKS

a top-dressing fashion at depths of 50mm at a time. Once Saltmarsh vegetation has penetrated the sandy fill a further 50mm can be placed and so on until the desired level of fill is reach.

There are currently two (2) options being considered for completion of the filling works. One option is to pump a mixture of sand and water into the areas requiring fill. Another option is to transport the sand to the required sites using modified light-weight all terrain vehicles. Regardless of which option is utilised, temporary access tracks will be required and are shown in (**FIGURES 13a & 13b**).

6.2.3 Weed management

Currently, weed species are only a minor problem within the existing Saltmarsh area. Weed species present include:

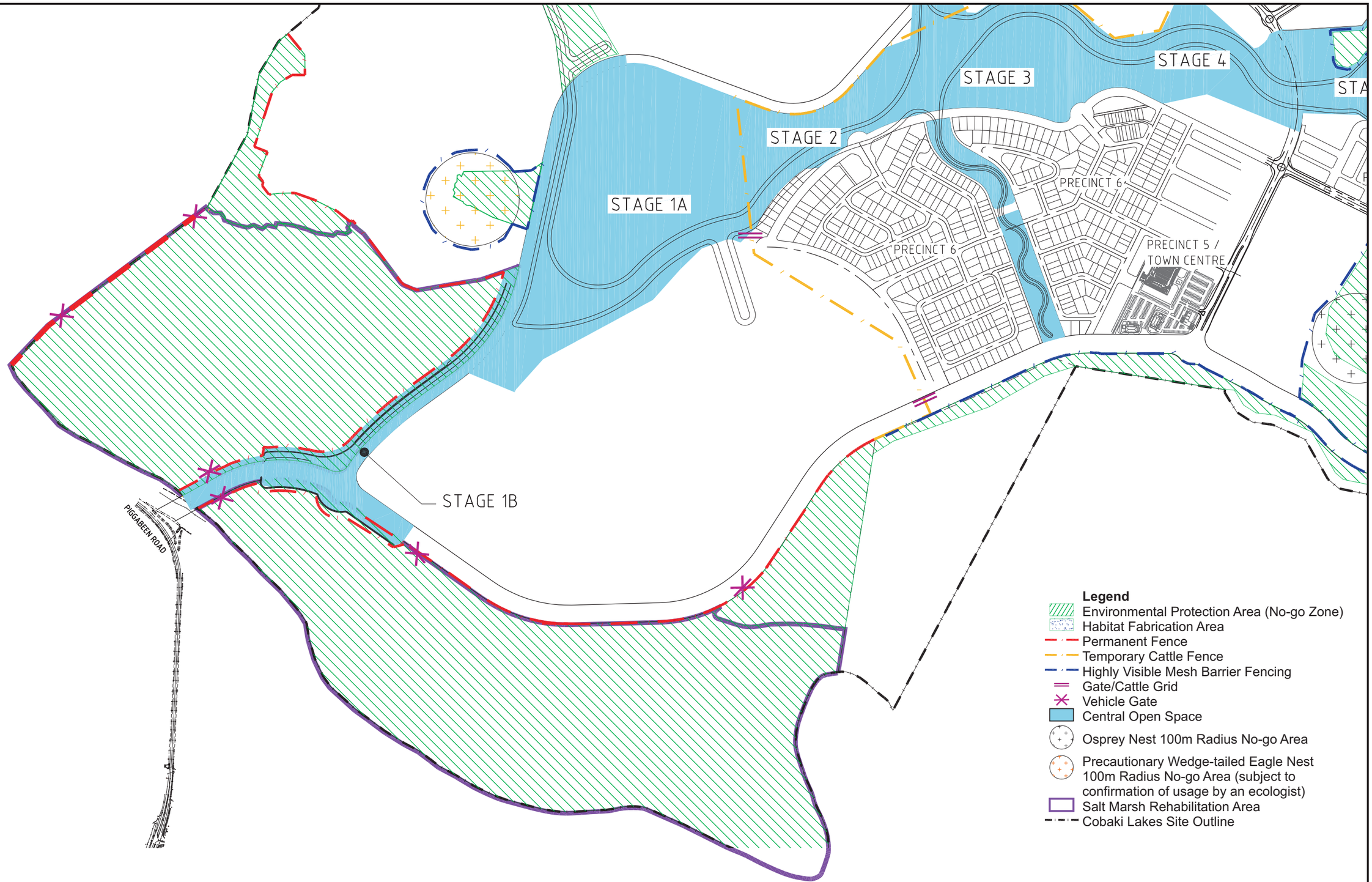
- Exotic Grasses;
- Groundsel bush;
- Coastal morning glory; and
- Other exotic herbs.

Weed control is to be completed by a suitably qualified Bush regenerator engaged via a tendering process. Monitoring and maintenance of weeds will be important components of the SRP and are discussed in Sections 7 & 8.

6.2.4 Access and exclusion

Exclusion of cattle and restrictions on human traffic are vital for the continued regeneration of the SRA. The following procedures are to be followed with regard to access to and exclusion from the SRA:

- The SRA will be fenced to exclude traffic and to clearly identify revegetation areas. The approved fencing layout is shown in **FIGURE 14;**
- Fences must be erected upon the commencement of the enhancement planting works;
- The fencing will be fauna friendly and will consist of 1.2 m star pickets at 4 metre intervals and with three (3) strands of smooth galvanized wire. A top strand of barbed-wire should also be included to prevent access by cattle;
- A drainage reserve will be created over Dunn's drain as required by Tweed Shire Council to allow implementation of future maintenance rights over this drainage path. An indicative maintenance track with passing bays and a turnaround located along the northern side of Dunn's drain in shown in **FIGURE 9.** Vehicle access is to be strictly limited to maintenance vehicles;
- Any gates are to be locked and maintained/repaired if gates or fences are damaged;
- Signage is to be erected on exclusion fencing stating: "No Entry – Native Plant Revegetation Area". All contractors are to be made aware of restrictions applying to the exclusion zones;
- Buffer plantings are to be provided where appropriate (i.e. adjacent to Cobaki Parkway) and designed provide a screen of trees that will reduce human access;
- Public access into the Saltmarsh area is to be limited to designated pathways and/or boardwalks;



SOURCE: SMEC
(Ref: Earthworks Fencing Plan.pdf)

SCALE: 1 : 8000 @ A3

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PROJECT
Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 14

PREPARED: BW
DATE: 05 April 2013
FILE: 97038_SMRP_Fencing.cdr

TITLE

FENCING PLAN

- Educational signage is to be provided which informs visitors and residents of the importance of Coastal Saltmarsh. The signage is to be displayed along the boardwalk;
- Only authorised personnel will be allowed within the Rehabilitation area; and
- No fires will be permitted within the SRA.

6.2.5 Assisted Natural Regeneration

Often maintenance of tidal flushing, removal of cattle or other activities which cause physical damage to soil, combined with the existence or creation of appropriate marsh morphology (i.e. elevation, slope, grade, substrate, etc.) will be enough to rapidly revegetate an area with native Saltmarsh communities (Sinicrope *et al* 1990).

It is considered that the most appropriate method to regenerate large areas of the SRA will be to use the principles of natural regeneration (**ANNEXURE 2**).

Natural regeneration refers to the natural process by which plants replace or re-establish themselves. Cremer (1990) defines "natural regeneration as "*reproduction from self-sown seeds of by vegetative recovery*". Temple and Bungey (1980) define it as "*regrowth which occurs naturally after stress or disturbance. It may be grown from seed of both pioneer and permanent species*".

Natural regeneration ensures that plants established on a site are from parents that currently occupy the site. Natural regeneration is a powerful tool to be used to re-establish native vegetation which is capable of with-standing the long term condition variations and should do well, once established.

Within the SRA a diversity of native species have been observed to be naturally regenerating, including:

- Salt couch (*Sporobolus virginicus)*
- Streaked arrow grass *(Triglochin striata)*
- Swamp oak (*Casuarina glauca)*
- Tuckeroo (*Cupaniopsis anacardioides)*
- Twig rush *(Baumea juncea)*
- Salt rush *(Juncus kraussii)*
- Samphire *(Sarcocornia quinqueflora)*

It is considered that with regular weed control and re-introduction of the appropriate tidal regime, natural regeneration will continue to occur. The methods that are to be used to encourage the natural regeneration process will include:

- Promote tidal exchange within the rehabilitated Saltmarsh community through re-engineering existing levee and drainage systems and some regrading works;
- Erection of fences and regular maintenance of the fencing;
- Primary weed control to be completed by a qualified bush regenerator;
- Regular maintenance & weed control;
- Monitoring and regular reporting; and
- Adaptive management.

Several areas within the SRA have been identified as suitable areas for utilising natural regeneration techniques. The areas designated for natural regeneration are shown in **FIGURE 11.**

6.2.6 Revegetation/Compensatory Plantings

6.2.6.1 Introduction

This section discusses the revegetation/compensatory plantings, including a rationale, a species selection and the planting methodology.

6.2.6.2 Rationale for plantings

Within the SRA several patches of Swamp oak forest/woodland currently occur. It is considered appropriate to embellish some of the areas surrounding the Saltmarsh community through compensatory plantings (**FIGURE 10**). Some of the benefits of the enhancement plantings will include the following:

- Buffer functions;
- Provision of habitat for fauna;
- Provision of wildlife corridors;
- Protection of areas of Saltmarsh from runoff that contain high levels of nutrients or pollutants; and
- Maintenance of buffer zones of terrestrial vegetation adjacent to Saltmarsh to allow for the gradual retreat of Saltmarsh in the event of sea-level rise.

6.2.6.3 Species selection

It is considered that revegetation is required for the areas currently dominated by exotic pasture grasses. As tidal exchange within the SRA is proposed to be significantly improved through re-engineering and regrading works, all areas currently dominated by exotic grasses within the SRA are considered to be suitable for planting Saltmarsh and/or Swamp oak communities, however the exact areas for revegetation of these communities will be based on topography after the completion of bulk earthworks. These areas will provide retreat areas for Saltmarsh communities in the event of future sea-level rise.

Species to be utilised in revegetation areas within the SRA are listed in **TABLE 2.**

TABLE 2
SUGGESTED SPECIES FOR REVEGETATION AREAS WITHIN THE SRA

Botanical Name	Common Name
Trees	
Casuarina glauca	Swamp oak
Shrubs/small trees	
Hibiscus tiliaceus	Cottonwood
Cupaniopsis anacardioides	Tuckeroo
Glochidion ferdinandi	Cheese tree
Breynia oblongifolia	Coffee bush
Groundcovers	

Baumea juncea	Bare twig-rush
Crinum pedunculatum	Swamp lilly
Entolasia marginata	Wiry panic
Juncus kraussii	Salt rush
Sarcocornia quinqueflora	Samphire
Sporobolus virginicus	Salt couch
Triglochin striata	Streaked arrowgrass
Isolepis inundata	Swamp club rush
Isolepis nodosa	Nodding club rush

6.2.6.4 Planting methodology

The bush regeneration contractor is to adhere to the following methods for the completion of the revegetation plantings:

- All plantings are to be completed by a qualified bush regenerator.
- Existing native trees should be retained wherever possible as the root zones of these trees are already established. This diversity of planting should also allow for some assisted natural regeneration where appropriate.
- Planting is recommended between February and June when rainfall is most likely and weather conditions most favourable. Initial efforts should focus on site preparation.
- All species selected for planting should be sourced locally where possible and sun hardened.
- The preparation will consist of the spraying of grasses and weeds with a suitable herbicide (e.g. Roundup biactive©). Areas selected for planting should be prepared two (2) weeks before planting is to occur to allow for dieback of any grasses or weeds before planting.
- All trees should be well watered, fertilised and heavily mulched with organic material sourced from on-site. If conditions at the time of planting are particularly dry, the use of water crystals is recommended.
- Any plantings that fail will be replaced.
- Planting methods (including material adapted from Greening Australia 2001) are summarised in **TABLE 3**.

TABLE 3
A GUIDE TO PLANTING

Selecting plant stock
Plants to be used should be acquired from a nursery that propagates plants using locally sourced seeds and cuttings (i.e. from within 10-20 km of the Subject site). Stock should be fully sun hardened and not planted direct from a shade house. Tube stock is the best as it is a cost effective plant container size, light in weight and easy to handle. Plants should have a strong stem and not be root bound or have yellowing or discoloured leaves.
Site preparation

Trees should be planted at 2 metre centres (for rainforest trees). Glyphosate (Roundup) is generally used as a "knockdown" non-residual herbicide. Where grass cover is established on the area to be planted, Glyphosate should be sprayed at planting centres to kill grass in a 60cm diameter circle. Plants can be planted without the need for Glyphosate if they are regularly hand-weeded until established, although this is recommended only for small-scale plantings.
Planting
Planting should begin when the weeds and grass cover have died (about 3 weeks). Dead grass and weeds should be trimmed to ground level. Holes should be dug in the centre of each circle at least 10 cm deeper than the tree container and twice as wide. The soil at the base and sides of the hole should be loose to allow root penetration. Plants should be watered well before planting to ensure a moist root ball.
A generous amount of water should be placed into each hole before planting (2-4 litres if the soil is dry), as losses are reduced by planting into a moist root zone. The plant should be tapped out of its container and any pot bound or circular roots loosened. Roots should be pruned if they are very bound up. The plant should be put in the hole with the water and fertiliser and filled in with loose crumbly soil. The tree should be firmed in well with the hands. This is very important for settling the tree roots in, and to provide a stress free start for each plant.
A slow release fertiliser (e.g. Osmocote/Nutricote, or plant fertiliser pills) should be incorporated into each planting hole and mixed well with the back filled soil, so that the roots are not in direct contact with concentrated fertiliser. Banksias should not be fertilised unless specific fertiliser is available.
Straw or hay should be used for mulching the whole planting area. Mulch should be laid right up to the stem, but should be “fluffed up” rather than laid in heavy slabs.
Maintenance of the planting
Weeds should be controlled in the planting area until canopy cover is established (approximately three (3) years). Weed control should be carried out by suitably experienced persons. Weed control is essential for strong healthy growth as grass and weeds compete for nutrients, water and light.
Weeds should be controlled on a regular basis. Three or four visits a year should be adequate for weed control.
Re-fertilising and re-mulching is recommended in the second growth season.

7 MAINTENANCE PROGRAM

7.1 Introduction

Maintenance or follow up works are vital for the continuing rehabilitation of the SRA. This section discusses the maintenance requirements as well the timing of the maintenance visits, and the personnel responsible for the implementation of this maintenance plan.

7.2 Maintenance requirements

7.2.1 Background

Maintenance within the SRA is to be completed by a suitably qualified bush regenerator and/or fencing contractor, employed by the landowner. Maintenance will occur within two (2) discrete areas i.e.:

- Revegetation/compensatory planting areas; and
- Natural regeneration areas.

7.2.2 Revegetation/Compensatory Planting Areas

Maintenance within the revegetation areas is to be completed by an experienced Bush Regeneration company and will include:

- Control of invasive weeds and grasses;
- Ensuring adequate soil nutrient levels within revegetation zones through periodic fertilising;
- Ensuring adequate soil moisture levels within revegetation zones through irrigation during times of prolonged drought;
- Repairing exclusion fencing when required;
- Pruning and thinning to allow for optimal growth and form;
- Staking or propping–up of trees which have fallen or developed a permanent lean;
- Replacing any dead plants;
- Re-mulching and re-fertilising of the revegetation plantings is recommended after the first year.

Continued maintenance after canopy closure will be required only once every six (6) months, and will include:

- Pruning and thinning to allow for optimal growth and form;
- Control of invasive weeds and grasses; and
- Repairing or removing fencing when required.

Regular maintenance will be completed by the regeneration team. Once canopy closure has been achieved the period of time between maintenance visits will increase.

7.2.3 Natural Regeneration Areas

Maintenance of the natural regeneration areas is likely to involve spraying of invasive grasses and other exotic species.

Continued monitoring will ensure that adaptive management techniques are used in the natural regeneration areas. Some of the adaptive management techniques that may be employed include the following:

- Replacement areas of Saltmarsh community using tiles removed from the local Saltmarsh areas which are to be lost;
- Potential planting of Saltmarsh species within areas which have failed to colonise;
- Reconfiguration of the tidal gates to allow for a more appropriate tidal regime; and
- Various other adaptive management techniques that will need to be implemented in the case of sea level rise.

7.3 Timing of Maintenance

After primary weeding and revegetation works, regular follow up maintenance will be required within the regeneration and revegetation areas. The Contracted Bush Regeneration Team will be required to complete regular maintenance of the natural regeneration & revegetation areas (i.e. once every three (3) months) until:

- Canopy closure has been achieved within the revegetation areas; or
- Saltmarsh or another appropriate vegetation community has adequately colonised within the natural regeneration areas.

This is expected to take between two (2) – three (3) years.

After canopy closure or substantial biomass increases of plantings in the natural regeneration areas has been achieved, the removal of weed re-growth and other general maintenance tasks will only be completed every six (6) months for the duration of the five (5) year project.

7.4 Adaptive management

The principles of adaptive management have been incorporated into the administration of restoration projects within a variety of governmental funding authorities and programs (Thom 1997). Comprehensive, long-term monitoring is a component of adaptive management, which relies on the accumulation of evidence (via long-term monitoring) to support a decision that demands action. If established early in the project planning phase and implemented during successive monitoring and management phases, adaptive management can be a powerful method to systematically assess and improve the performance of restored ecosystems (Thom 2000).

Examples of some potential adaptive management actions that may be required in the future include:

- Areas of natural regenerating Saltmarsh might reveal encroachment by Phragmites or other invasive plant species;
- Monitoring of tidal and/or Stormwater devices may reveal deficiencies in the design of a culvert or water control structure, which may result in insufficient drainage;
- Manual harvesting or chemical control may be periodically required to control the spread of invasive plants;
- The specific design features of a culvert or water control structure may require enhancement or modification during successive years to optimize tidal flow patterns; and
- Lowering the dredged bund levee adjacent to Cobaki Creek below 0.3m AHD.

Before the implementation of any Adaptive management strategies a report is to be provided to the Tweed Shire Council detailing the proposed management actions and the predicted outcomes from such management practices.

8 MONITORING PROGRAM

8.1 Introduction

A well-designed restoration monitoring program will allow project managers to detect results months, years, or decades following implementation of a plan. This section outlines the monitoring for the Cobaki Lakes Saltmarsh Rehabilitation Area and will include a description of the general monitoring of the naturally regenerating Saltmarsh areas and the Revegetation areas.

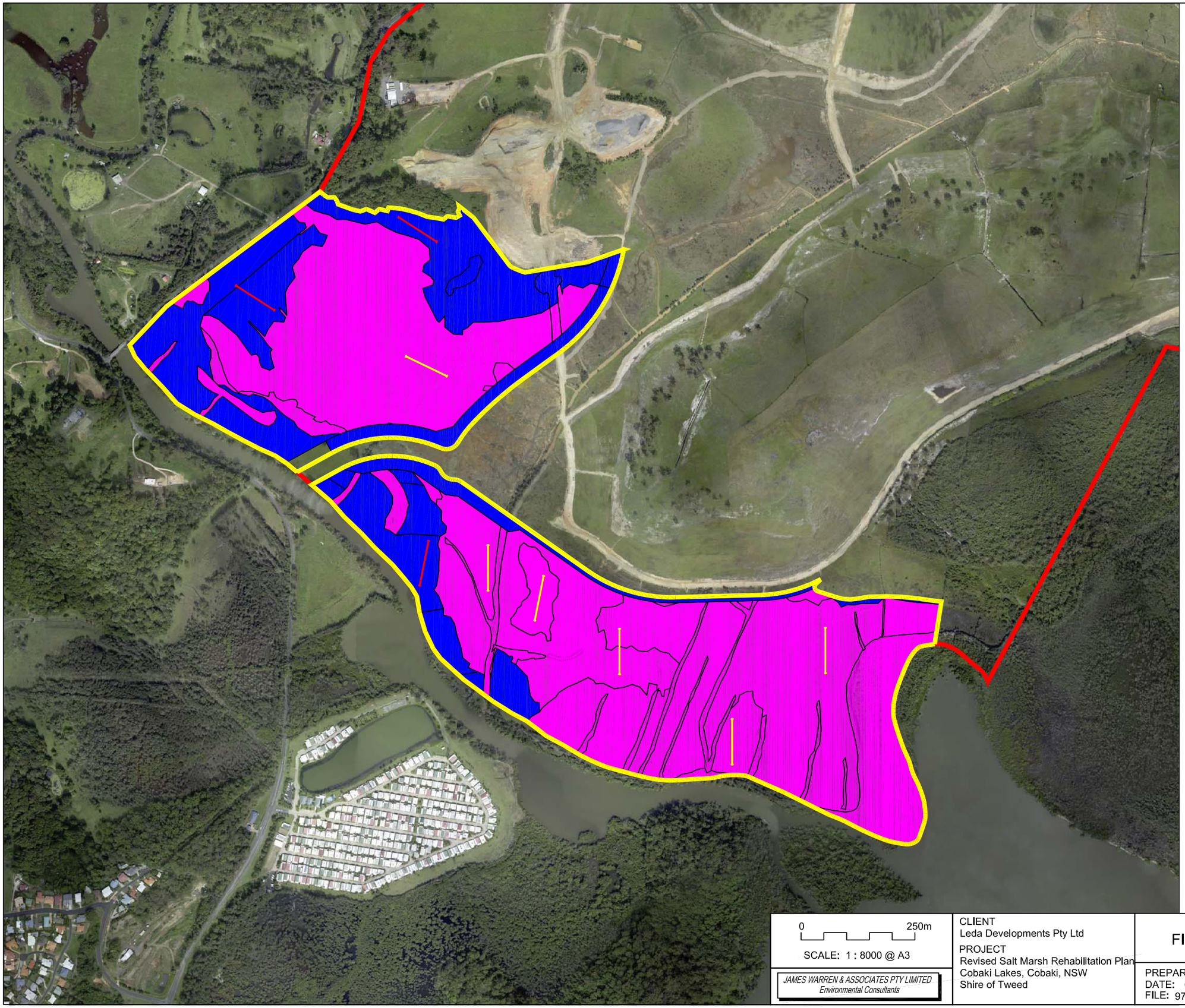
Long term monitoring of the overall vegetation communities within the SRA is to be completed using aerial photography and ground truthing of the vegetation composition. A plan for the long term monitoring is also included in this section. Monitoring data can be used by project managers to demonstrate the ability of the project to meet stated goals and objectives.

8.2 Monitoring of Saltmarsh Natural Regeneration Areas

The monitoring of natural regeneration areas will include regular monitoring by a qualified ecologist who is to complete the following:

- **Transects**
  - Six (6) transects are to be evenly placed across the Saltmarsh;
  - Transect locations are to be permanently marked (**FIGURE 15**);
  - Transects are to be 100 metres in length;
  - During monitoring visits tape measures are to be placed on the ground and the specific measureable features recorded along the transects. The zero distance is to be placed at the marker that is most near the development site;
  - Specific measurable features include:
    - Areas of vegetation cover (Saltmarsh species);
    - Areas of vegetation cover (other native species);
    - Areas of weed cover; and
    - Areas of salt pans/bare ground/mud
  - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Quadrats**
  - Five (5) Quadrats ($1m^2$) are to be placed along each of the transects;
  - Quadrats must be placed 20m apart along the length of the transect ;
  - Quadrats are to be placed semi randomly within five (5) meters of the transect line;
  - The boundary of the quadrat with respect to the tape measure (e.g. between 3.5 – 4.5 metres on tape measure) will be recorded;
  - For each quadrat the following specific measurable features will be recorded:
    - Plant species occurring;
    - Percentage cover;
    - Height;
    - Relative abundance of Saltmarsh species; and



N

LEGEND

- Monitoring Transects - Revegetation Areas (100m Transects)
- Monitoring Transects - Natural Regeneration Areas (100m Transects)
- Proposed Revegetation Areas - Swamp Oak / Salt Marsh
- Proposed Natural Regeneration Areas
- Salt Marsh Rehabilitation Area Boundary
- Cobaki Lakes Site Outline

SOURCE:
Transects - James Warren & Associates Pty Ltd
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 250m

SCALE: 1 : 8000 @ A3

JAMES WARREN & ASSOCIATES PTY LIMITED
Environmental Consultants

CLIENT
Leda Developments Pty Ltd

PROJECT
Revised Salt Marsh Rehabilitation Plan
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 15

PREPARED: BW
DATE: 05 April 2013
FILE: 97038_SMRP_base.dwg

TITLE

MONITORING TRANSECTS

        - Weed cover
    - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Fixed Photo points**
    - The transect markers which occur closest to Cobaki Creek are to be used as permanent photo stations for photographic monitoring;
    - Four (4) photos are to be taken from each transect. Photo are to be taken to the north, south, east and west;
    - Photos should be taken at low tide;
    - Photos should be labelled with the:
        - Transect code;
        - Direction of view;
        - The date & time; and
        - The tide
    - Photos must be supplied in the monitoring reports in a form of prints no smaller than 4" x 6" and must be colour.

8.3 Monitoring of Revegetation areas

The monitoring or revegetation areas is to be completed at the same time as the Saltmarsh natural regeneration areas. The monitoring will be completed by a suitably qualified ecologist who is to complete the following:

- **Transects**
    - Three (3) transects are to be evenly placed across the revegetation areas;
    - Transect locations are to be permanently marked (**FIGURE 15**);
    - Transects are to be 50 metres in length;
    - During monitoring visits the transects are to be walked and specific measurable features recorded along the length of the transect. The zero distance is to be placed at the marker that is most near the development site;
    - Specific measurable features include:
        - Areas of vegetation cover (revegetation species);
        - Areas of vegetation cover (other species);
        - Areas of weed cover; and
        - Areas of deceased plants/bare ground/mud
    - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Quadrats**
    - Three (3) Quadrats ($5m^2$) are to be placed along each of the transects;
    - Quadrats must be placed 10m apart along the length of the transect
    - Quadrats are to be placed semi randomly within five (5) meters of the transect line;
    - For each quadrat the following specific measurable features will be recorded:
        - Plant species and number occurring;
        - Percentage cover;

        - Canopy height; and
        - Weed cover
    - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Fixed Photo points**
    - The transect markers which occur closest to Cobaki Creek are to be used as permanent photo stations for photographic monitoring;
    - Four (4) photos are to be taken from each transect. Photo are to be taken to the north, south, east and west;
    - Photos should be labelled with the:
        - Transect code;
        - Direction of view;
        - The date & time; and
        - The tide
    - Photos must be supplied in the monitoring reports in a form of prints no smaller than 4" x 6" and must be colour.

8.4 Timing of monitoring visits

The monitoring is to be completed by a suitably qualified ecologist. Site visits should occur:

- Six (6) weeks after primary weeding;
- Six (6) weeks after initial plant-out;
- Every three (3) months thereafter until plants are sufficiently established (i.e. between two (2) - three (3) years); and
- Every six (6) months after establishment until project is completed.

8.5 Reporting of Monitoring Results

Following each inspection by the qualified ecologist, a report will be prepared that will include tables and photographs from the monitoring visits. At the end of each year a detailed report will be prepared for the Department of Environment and Climate Change (DECC) and Tweed Shire Council. The report will discuss the following:

- Works undertaken;
- Progress of regeneration/revegetation areas using photos and tables showing the results of the monitoring visits;
- Significant problems encountered (death of seedlings, broken fences, vandalism etc.) and the effect of these on the plantings and aims of the revegetation or regeneration strategy;
- Success or failures of measures implemented to rectify previously identified problems; and
- Measures to be taken to rectify new problems.

8.6 Long term Monitoring

Along with the regular monitoring within the revegetation and regeneration areas, the overall vegetation composition within the SRA is to be regularly assessed and recorded. Long term monitoring will use both aerial photos and yearly assessments (ground truthing) of the vegetation communities using a hand held GPS.

The Long term monitoring of the vegetation composition with the SRA will include:

- A detailed vegetation map at a scale of 1:5,000 is to be completed within the SRA every twelve (12) months;
- Each year, after completion of vegetation mapping, a report is to be completed showing the changes in the composition of the vegetation communities within he SRA. The results are to be shown in a table that shows the vegetation community and the area of the vegetation community as a percentage of the SRA.

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ANNEXURE 1

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions - Endangered Ecological Community listing

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.
The Scientific Committee has found that:

1. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is the name given to the ecological community occurring in the intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast. Coastal saltmarsh has been recorded from sites along the NSW coast. (NSW North Coast, Sydney Basin and South East Corner Bioregions).
2. Characteristic vascular plant species of Coastal Saltmarsh are:

Baumea juncea	*Isolepis nodosa*
Juncus kraussii	*Samolus repens*
Sarcocornia quinqueflora	*Selliera radicans*
Sporobolus virginicus	*Suaeda australis*
Triglochin striata	*Zoysia macrantha*

The total list of species is larger, with many species present in low abundance or at few sites. A more extensive list of species is provided by Adam et al. (1988). The sediment surface may support a diversity of both micro-algae and macro-algae.

3. Communities with similar floristic composition, but with a different fauna, are found supratidally on exposed headlands (Adam et al. 1988). These headland communities and those of inland saline areas are not included within this Determination of the Coastal Saltmarsh Ecological Community.

4. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions provide habitat for a diverse invertebrate fauna, which includes both marine (crabs and molluscs) and terrestrial (insects and spiders) elements. During tidal flooding a number of fish species utilise saltmarsh habitats. Grazing by macropods may occur between tidal events. Some coastal saltmarshes provide important high tide roosts for migratory wading birds, and a range of other birds also utilise coastal saltmarsh as habitat. Diversity of macrofauna in mangrove forests adjacent to saltmarsh has been found to be greater than in mangroves that do not border saltmarsh (Yerman & Ross 2004).

5. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is frequently found as a zone landward of mangrove stands. Occasional scattered mature *Avicennia marina* trees occur through saltmarsh at some sites, and

Avicennia (and less frequently *Aegiceras corniculatum*) seedlings may occur throughout saltmarsh. In brackish areas dense stands of tall reeds (*Phragmites australis*, *Bulboschoenus spp.*, *Schoenoplectus spp.*, *Typha* spp.) may occur as part of the community.

6. West et al. (1985) estimated the total area of coastal saltmarsh in NSW was approximately 5700 hectares distributed in fragmented patches mostly less than 100 hectares. Since this estimate, further reduction and fragmentation have occurred.

7. Species composition within Coastal Saltmarsh varies with elevation. *Sarcocornia quinqueflora* dominates at lower, and hence more frequently flooded, levels than *Sporobolus virginicus* which dominates the mid saltmarsh, while *Juncus kraussii* and *Baumea juncea* are upper saltmarsh species. There is also geographic variation, with much more extensive stands of *Sporobolus virginicus* being found in northern NSW, and conversely more extensive *Sarcocornia quinqueflora* stands in the south. Coastal Saltmarsh in southern NSW is generally more species rich than further north, with *Austrostipa stipoides*, *Gahnia filum*, *Limonium australe* and *Sclerostegia arbuscula* forming a characteristic southern suite of species. A number of other species with restricted distribution in Coastal Saltmarsh include *Distichlis distichophylla* (endangered), *Halosarcia pergranulata* subsp. *pergranulata*, *Wilsonia backhousei* (vulnerable) and *Wilsonia rotundifolia* (endangered).

8. Saltmarshes are globally threatened, and many of the threatening processes identified by Adam (2002) operate in NSW including infilling, modified tidal flow, weed invasion, damage by domestic and feral animals, human disturbance, altered fire regimes and climate change.

9. Historically, substantial areas of saltmarsh have been infilled for roads and aerodromes and for residential, recreational, waste disposal, industrial and agricultural purposes. With increased recognition of the ecological value of saltmarshes, the threat of further large-scale reclamation is less, but smaller scale infilling still occurs (Harty and Cheng 2003).

10. Patterns of tidal flow have been restricted by artificial structures in many NSW saltmarshes (Williams and Watford 1997), while discharge of stormwater alters salinity regimes, increases nutrient levels and facilitates the spread of Phragmites and weeds.

11. In recent decades there has been widespread invasion of saltmarsh in southeast Australia by mangroves (Mitchell and Adam 1989, Saintilan and Williams 1999, 2000). The factors driving mangrove invasion are still unclear. The mangrove invasion limits the use of saltmarshes by birds that would normally make use of this habitat and has been a factor in their decline (Saintilan 2003, Straw 1999, 2000).

12. A large number of weed species occur in NSW saltmarshes (Adam 1981, Adam et al. 1988). In terms of change to the community structure and function, the most serious weed is *Juncus acutus*; other major weeds include *Baccharis halimifolia*, *Cortaderia selloana* and *Hydrocotyle bonariensis*. The upper saltmarsh zone may be dominated by introduced annuals or shortlived perennials, including *Parapholis incurva*, *Plantago coronopus* and *Polypogon monspeliensis*.

13. Damage to saltmarshes by recreational vehicles, including four wheel drives, is widespread, and deep wheel ruts persist for many years even after exclusion of vehicles. Use of BMX and mountain bikes is increasing, and even saltmarshes within conservation reserves have been seriously damaged (Adam 2002).

14. Grazing and trampling by domestic stock and feral herbivores occurs at a number of sites. Stock grazing has been shown to substantially change the vegetation composition and structure (Adam 1990), while on muddy substrates trampling can cause loss of plant cover and modify drainage patterns.

15. Saltmarshes have frequently been used for casual rubbish dumping and are at risk from waterborne pollution - including oil and chemical spills, both from shipping and road accidents, and catchment runoff of nutrients and agricultural chemicals.

16. Upper saltmarsh stands dominated by Juncus kraussii and Baumea juncea have high flammable fuel loads. While the natural incidence of fire in saltmarshes is likely to have been low, a number of saltmarshes have been burnt in recent years. The recovery of these sites is relatively slow and the long-term impacts of burning are uncertain.

17. Global warming and increased relative sea level are likely to pose an increasing threat to the survival of many areas of Coastal Saltmarsh (Adam 2002, Hughes 2003).

18. Coastal Saltmarsh occurs in a number of conservation reserves including the Ramsar listed sites at Towra Point and Kooragang Island Nature Reserves. Reserve status, however, does not confer protection from mangrove and weed invasion, recreational vehicles, pollution, fire or sea level rise without active management.

19. In view of the above the Scientific Committee is of the opinion that the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate.

Dr Lesley Hughes
Deputy Chairperson
Scientific Committee

Proposed Gazettal date: 04/06/04
Exhibition period: 04/06/04 - 16/07/04

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ANNEXURE 2

Ecological Restoration Principles

Ecological restoration aims to restore pre-existing indigenous ecosystems and ecological processes on disturbed sites, maintaining and developing the natural ecosystem to self perpetuate (Perkins 1992). Perkins (1992) put forward a restoration continuum spanning from assisted natural regeneration, the least interventionist, to reconstruction (of original communities on cleared sites) and fabrication (of new communities on changed sites). These activities are undertaken in different circumstances in the field, but the boundaries are blurred, allowing practitioners to consider sites on an individual basis, according to the level of disturbance and the restoration potential identified in the site. The aim of ecological restoration is to restore to the highest practicable extent, and to develop a system that is sustainable in the long term.

In disturbed areas that cannot solely rely on natural regeneration potential, revegetation can be undertaken to reconstruct the original forested communities. Cleared sites can be replanted with species grown from seed collected in nearby local native vegetation. The use of seed of local provenance (origin) is a key principle underpinning the integrity of the work, and avoids possible genetic pollution of local woodland when future pollen exchange takes place between remnant and replanted woodland.

Unfortunately the suite of species that is available is often narrow, determined by practicalities of seed collection, the ability to propagate in a nursery and limits on field establishment in the environmental conditions prevailing on cleared land. Conceptually, this is merely establishing a framework into which additional plant and animal diversity can recruit or be reintroduced once the environment is modified (Perkins 1992).

Cleared sites are seldom completely devoid of native species. It is common to observe paddocks supporting threads of the original ground cover vegetation. This is often apparent in paddocks historically sown with exotic grasses to improve pasture. While the introduced grasses are usually dominant, a surprising diversity of native grasses and groundcovers can often persist. They have remained through a history of sustained grazing and are by definition adapted to grazing. The act of excluding livestock or other management activities can threaten native diversity, as biomass from the introduced grasses smothers these plants. Alternative biomass reduction can be achieved with slashing and fire however these have different effects and their own practical limitations.

Total groundcover biomass is reduced under a developing canopy, a phenomenon also evident in re-growing forest communities. The vigour of exotic grasses is greatly diminished and some are unable to grow, leaving room for native plants that are adapted to the woodland ecosystem. Of course some native plants lose vigour in the forest canopy as well. Revegetation is thus forming an important mechanism for grassland manipulation and as a tool for creating a variety of niches in the ground layer. At the same time, revegetation is achieving the obvious objectives of increasing habitat values, restoring normal hydrology and increasing the range of species available to recover in a site after disturbance. Revegetation needs to be used in combination

with other techniques, and these processes will need to be studied in detail before they can be conclusively described as positive.

The mechanism of planting is likely to be a most important strategy in revegetation of the site, not as an end in itself, but as an important tool to ameliorate changed sites and release ecosystem resilience. While prolonged monitoring needs to be maintained in revegetation areas, there are indications that environmental conditions within the site will change in interesting ways as revegetation develops.

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