

Lake Indawarra

Concept and Vegetation Plan

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17 June 2009



LIMITATIONS STATEMENT

The sole purpose of this report and the associated services performed by Delta Environmental Consulting is to write a concept plan for Lake Indawarra in accordance with the scope of services set out in the contract between Delta Environmental Consulting ('Delta') and the Tintinara Action Club ('the Client'). That scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

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GLOSSARY

aliennot native to Australia
conservation interesta taxon with status of uncertain, uncommon or poorly known
conservation significance	.....a taxon with legislative protection or a status of extinct, endangered, vulnerable or rare
endangered	.....a taxon in serious risk of disappearing in the wild within 10-20 years
endemic	.....native only to the particular region specified, not found elsewhere
eutrophic	.....an environment with high availability of nutrients
exotic	.....not native to Australia
extinct	.....a taxon not collected or verified in the past fifty years
floristic association (SA)	.....dominant groupings of species that occur together
forb	.....a herbaceous plant
habitat group	.....a broad vegetation classification based on floristic/geographic class
indigenous	.....native to Australia or more locally (eg indigenous to Mt Lofty Ranges)
native	.....as for indigenous - native to Australia
oligotrophic	.....an environment with low availability of nutrients
poorly known	.....a taxon where little is known about its population
provenanced seed	.....seed from the local population
rare	.....a taxon which is rare within Australia but not facing any identifiable threat
rarity	.....may mean a large population in a small specific habitat, or a tiny population
sabkha	.....coastal salt flats occurring behind salt marshes in arid areas
Schedule 7	.....endangered within South Australia
Schedule 8	.....vulnerable within South Australia
Schedule 9	.....rare within South Australia
structural vegetation formation	.....growth form and canopy separation of site vegetation
taxon	.....a taxonomic group of plants (usually species but not necessarily)
uncertain	.....a taxon where little is known about its population
uncommon	.....a taxon which is not seen frequently but not known to be facing any identifiable threat
voucher	.....a preserved specimen of flora or fauna lodged with herbarium or museum
vulnerable	.....a taxon not presently endangered but at risk over 20-50 years
weed	.....a plant out of place (may apply to indigenous & endemic plants as well as exotics)



Table of Contents

1.	INTRODUCTION	6
2.	LOCATION, GENERAL DESCRIPTION & SITE HISTORY	6
3.	LIST OF STAKEHOLDERS	8
4.	EXISTING SITE ASSESSMENT	8
4.1	Soil analysis	8
4.2	Water quality	10
4.2.1	Chemical	10
4.2.2	Sulfate reduction impacts	11
4.2.3	Carteria bloom	13
4.2.4	Faecal bacteria	14
4.3	Flora	15
4.4	Fauna observations	16
4.5	Weed, maintenance and management observations	17
4.6	Dial before you dig search	18
5.	SITE CONCEPT PLANNING	19
6.	ACTION PLAN	19
6.1	Site clean-up and beautification	20
6.2	Earthworks and infrastructure	21
6.3	Weed control	25
6.4	Revegetation plan	26
6.4.1	Zone 1 – remnant native vegetation	26
6.4.2	Zone 2 – lake edge and island plantings	27
6.4.3	Zone 3 – parkland and recreational area	28
6.4.4	Zone 4 – lake floor	29
6.5	Monitoring plan	30
7.	REFERENCES	31
8.	APPENDICES	32



8.1	Flora list	33
8.2	Groundwater chemical analysis	36
8.3	Dial-before-you-dig results	37
8.4	Compiled action tableDetails of the consultants	38
8.4	Details of the consultants	39

Tables

Table 1 - Results of soil testing	8
Table 2 - Results of in-situ water testing.....	10
Table 3 - Water quality data	10
Table 4 - Comparison between lake water and sea water	11
Table 5 - Results of bacterial testing	14
Table 6 – Management zones at Lake Indawarra.....	15
Table 7 – Site floral biodiversity.....	16
Table 8 – Site observations.....	17
Table 9 Action sub-table 1 – Site cleanup	20
Table 10 - Action sub-table 2 – Earthworks etc	21
Table 11 - Action sub-table 3 - Weeds	25
Table 12 - Control methods for specified weeds.....	25
Table 13 - Action sub-table 4 - Revegetation.....	26
Table 14 - Species list for Zone 1	27
Table 15 - Species list for Zone 2.....	28
Table 16 - Species list for Zone 3.....	29
Table 17 - Species list for Zone 4.....	29
Table 18 - Action sub-table 5 - Monitoring	30

Figures

Figure 1 - General overview of Lake Indawarra.....	7
Figure 2 – Soil and water sample locations	9
Figure 3 - Desulfobibrio, purple bacteria, Beggiatoa and Thiobacillus (L-R)	11
Figure 4 - Conceptual diagram of sulfur cycle in Lake Indawarra (symbols for diagram courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science)	13
Figure 5 - Chlorophycean bloom of Carteria sp.	14
Figure 6 - Vegetation zones	15
Figure 7 - Observation locations.....	18
Figure 8 - Use of geotextile & gabions.....	22
Figure 9 - Proposed earthworks and infrastructure	23
Figure 10 - Cross section of the lake	22



1. Introduction

The aim of this report is to provide a concept and vegetation plan outlining the future development of the Lake Indawarra public reserve at Tintinara.

The deliverables expected from this project included;

- plans of the site showing existing conditions (area of water, area of land, path locations, significant weed infestations etc),
- concept plans and cross sections for the site,
- background information on the site's soils, vegetation and fauna,
- a plan of actions to improve the site,
- a revegetation and weed control plan, and
- a list of stakeholders.

Fieldwork was undertaken on the 11th of December 2008, and 26 March 2009. Given the hot dry nature of the season, the species of animals and plants observed are unlikely to be comprehensive, however they do provide an indication of the biodiversity present on the site.

Consultation with committee members from several local service organisations, who have formed a joint sub-committee for the care of the Lake Indawarra reserve, was conducted on-site on 26 March 2009.

2. Location, general description & site history

Lake Indawarra is located south of the main township of Tintinara. The lake occurs in the South Eastern Herbarium region and South-East NRM and soil conservation zones and lies within the Naracoorte Coastal Plain IBRA region (subregion 4, Tintinara).

Interim Biogeographic Regionalisation for Australia (IBRA) is a classification of the Australian land mass into 85 bioregions. Each bioregion is a large geographically distinct area of similar climate, geology, landform, vegetation and animal communities. The Naracoorte Coastal Plain bioregion is described as a broad coastal plain of Tertiary and Quaternary sediments with a regular series of calcareous sand ridges separated by inter-dune swales, closed limestone depressions and young volcanoes at Mount Gambier. Vegetation is dominated by heathy woodlands and mallee shrublands with wet heaths in the inter-dune swales. The bioregion has been extensively cleared for agriculture.

Lake Indawarra is an artificial water body, having been dug as a borrow pit for railway ballast. The ballast pit was first dug in the 1890's. Extraction enlarged the pit over time and at one point, before 1937, the unconfined aquifer was intercepted. After this the pit became a local swimming hole. Reports from the period reveal the water was very clear and the lake bottom visible. It was popular for water sports until the 1950's when silting and water quality issues reduced the aesthetics of the lake. The lake was dug out in 1979-80, and a competition to rename the water place was held. Since that time the water body has been called Lake Indawarra.



In the thirty years since 1979 the lake once again gradually lost its amenity value. Recent work (2008) to remove silt has resulted in some improvement in both the substrate quality and water quality. The local Lake Indawarra subcommittee have also undertaken considerable works to improve amenity of the lake surrounds.

When visited, the wetted area of the lake was just under a hectare (9,623m²). During wet periods, it is likely that this increases to just over 1.5 hectares (15,357m²).

The Lake's water source appears to be the regional unconfined aquifer. The lake is usually wet though out the year, however the lake and groundwater levels dropped far enough in the summer of 2007/8 to allow the area to be restored and reshaped. A small island (485m²) was created in the centre as part of this effort, which some residents hope will be used by nesting birds.

The site layout below provides a basic understanding of the spatial relationships between the lake and surrounding developments or infrastructure.

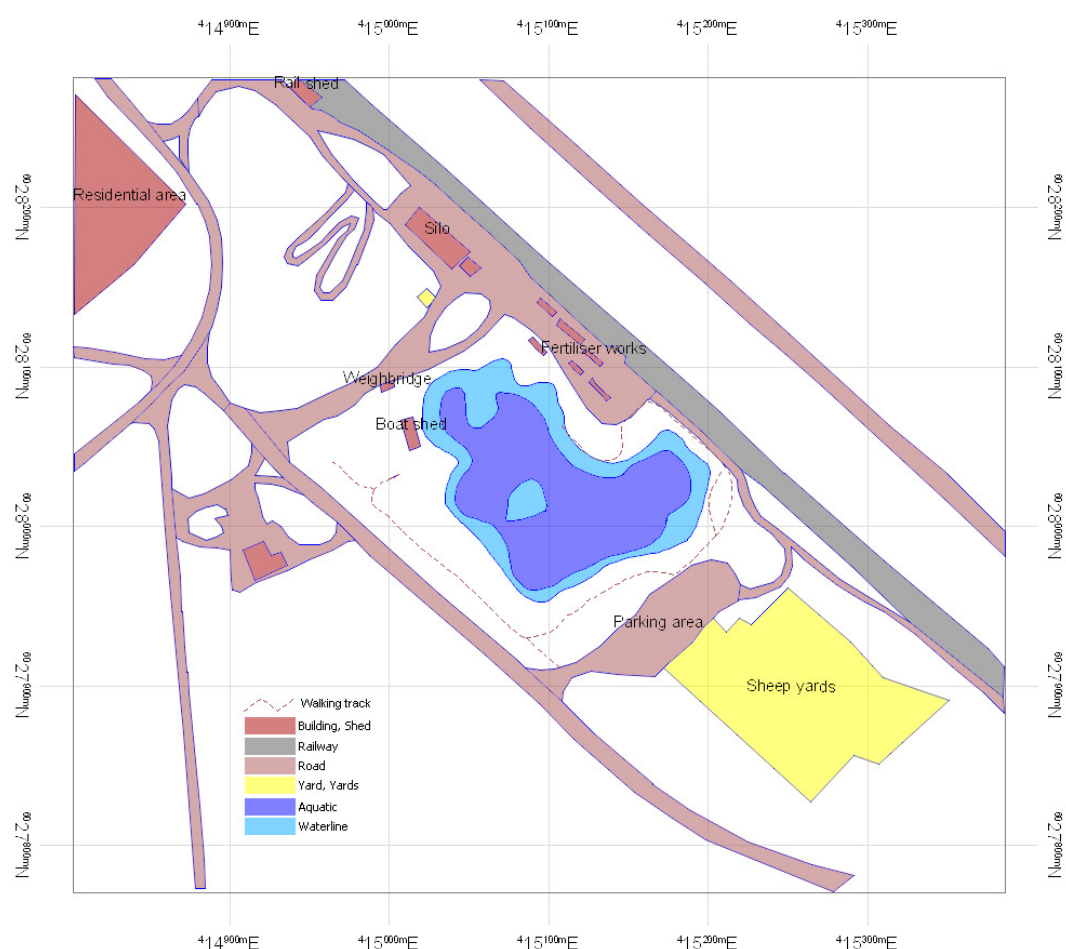


Figure 1 - General overview of Lake Indawarra

All geographic eastings and northings reported in this study are derived from the GDA datum, Zone 54.



3. List of stakeholders

A diverse list of stakeholders were contacted in person, attended meetings, corresponded via phone calls or email during the preparation of this document. People contacted included;

Tracey Strugnell	Deanna Keller
Gail Traeger	Leigh Fatchen
Jim Fairbairn	Tim Walsh (ABB Grain)
Ben Hooper	Stephen Yam (CDC)
Geoff Smith	Ron Downs (CDC)
Ian Zadow	Sue Prendergast (CDC)
Denise Richardson	Dennis Martin (DETI)
Ben Holbrook	Evelyn Zwar (DETI)
Malcolm Becker	Thea Marrone (DETI)
Josh Kennett	Graham Gates (LAP)
Bruce Connor	Dean Button (ARTC)
Richard Harkness	Ruth Warren (ARTC)
Jacki Cunningham	

Copies of any written correspondence are kept on file by Delta Environmental Consulting, and are available to the project team by request.

4. Existing site assessment

An assessment of the current state of the lake and its surrounding reserve was undertaken in December 2008, in order to inform the planning process.

4.1 Soil analysis

Samples of soil were collected from four locations around the lake. The geographic locations are recorded in *Table 1* and are also represented graphically in *Figure 2 – Sample Locations*.

Sample No	Easting	Northing	pH	EC (mS/cm)	Class	Comments
1	415023	6028089	8.29	0.2	Sand	Slightly water repellent, layer of organics on surface
2	415030	6028079	9.26	2.4	Sand	At field moisture (saturated)
3	415022	6028030	8.83	0.1	Sand	Strongly water repellent, fine organic layer
4	415069	6027963	8.32	2.1	Clayey sand	Light orange colour.

Table 1 - Results of soil testing

Sample 2 (sediment from the lake shore) contained significant quantities of a fine organic matter. This material had a low specific gravity, settling out of suspension several minutes after the majority of sediment particles. When washed it was white to light cream in colour, with a gelatinous nature that did not take an iodine stain.



Given the highly decomposed nature of the organic matter, there were considered to be two likely potential sources - grain dust from the grain handling facilities or decomposing material from submerged aquatic vegetation.



Figure 2 – Soil and water sample locations

During a second site visit (March, 2009) considerable die-off of one particular species of submerged aquatic vegetation, the stonewort *Lamprothamnium macropogon*, was observed with a parallel increase in the quantity of fine decomposed organic matter. This was observed at several locations using sediment samples suspended in settling tubes. It is most likely that a substantial quantity of the organic material may comprise decomposing stonewort.

To identify whether grain dust is also contributing to the organic loading in the lake, observation immediately before and after the main grain harvesting period is recommended.

4.2 Water quality

During December 2008, a number of water samples were taken, and measurements of water quality (chemical and biological) were either made in-situ, or performed on the samples at the Delta laboratory. Further biological tests were undertaken during the March 2009 field visit.

4.2.1 Chemical

The samples below were taken during the December 2008 field visit, at the water sample locations shown in Figure 2.

Sample No	Easting	Northing	pH	EC (mS/cm)	Turbidity (NTU)	Temperature (°C)
1	415152	6028023	10.14	37.9	9	26.4
2	415093	6027966	10.15	38.1	2	26.1
3	415078	6027997	10.14	38.3	4	26.3
4	415047	6028012	10.13	37.8	3	25.8
5	415062	6028088	10.17	38.1	4	26.3
6	415039	6028078	10.19	38.1	3	25.9

Table 2 - Results of in-situ water testing

During the March 2009 field visit, samples were taken to identify the presence of an algae bloom at Site 6 (clean) and half-way between Site 1 & 2 (bloom). These were tested for pH (using strips) in the field to see if the bloom had caused a difference in water alkalinity. A difference of 1 pH unit was noted, with the coloured water sample having a pH of approximately 9, and clear sample having a pH of approximately 10.

A combined sample of water from the December 2008 samples was analysed for total hardness, average specific gravity and electrical conductivity. The latter two measures were used to calculate the salinity, as total dissolved salts, of the water.

Parameter	Result (December 2008)
Hardness	2980mg/L CaCO ₃ equ.
SG	1.018
EC	37.9 ms/cm
TDS	≈25400 mg/L

Table 3 - Water quality data

In December, the salinity of the lake water was slightly more than half the salinity of seawater, with a similar range of ionic species. In March, the salinity had increased, to just over seawater salinity.

A major ion analysis for the nearby unconfined aquifer was provided to the consultants by Jim Fairbairn. The results of this analysis are provided in the appendices.

When test results from the Lake Indawarra sample were compared to the major ion analysis, the results were similar, suggesting that the lake waters are sourced from TAC-IND-002-FC/PC



the local unconfined aquifer. Both waters have a similar composition to seawater, when scaled according to salinity, so the salts are most likely to be of marine origin.

While marine-derived ground waters are sodium chloride dominated, they also contain a range of other salts, including sulfates. Sulfates are likely to play an important role in controlling the amenity value of the water.

Comparison with estuarine and seawater							
	Cl	CO ₃	SO ₄	Mg	Ca	Na	Units
Estuarine (56% seawater)	11880		1652	793	257	6570	mg/L
Estuarine (74% seawater)	15551		2163	1037	335	8580	mg/L
SA Gulf seawater	21420		2986	1428	500	11860	mg/L
Indawarra Sample	12762	456	1540	615	178	8009	mg/L

Table 4 - Comparison between lake water and sea water

Salinity data from DWLBC and LAP/LWMP monitoring reveals the lake waters reach higher salinities than surrounding ground water (as it has a higher evaporation rate) and also reduces to lower salinities (due to runoff and direct rainfall onto the lake surface).

4.2.2 Sulfate reduction impacts

Previous reports of the lake (Wilkins, 2003) have reported the presence of a sulphur smell at the lake and the presence of pink “algae” on the mud surrounding the lake. These are typical symptoms of sulfate reduction.

Seawater contains a relatively high concentration of sulfates (SO₄), mostly in the form of gypsum (calcium sulfate) and epsom salts (magnesium sulfates). Ancient and more recent marine-derived ground water is also rich in sulfates. Lake Indawarra falls into this category.

Sulfates in the lake’s water are present in both the oxygen-rich surface waters and the oxygen-poor waters in the underlying mud. The common saying that everything needs oxygen to survive is true, however not everything obtains oxygen from the air or from dissolved free oxygen. In anaerobic (oxygen-poor) environments there are organisms that can obtain their oxygen needs by stripping it from sulfates.

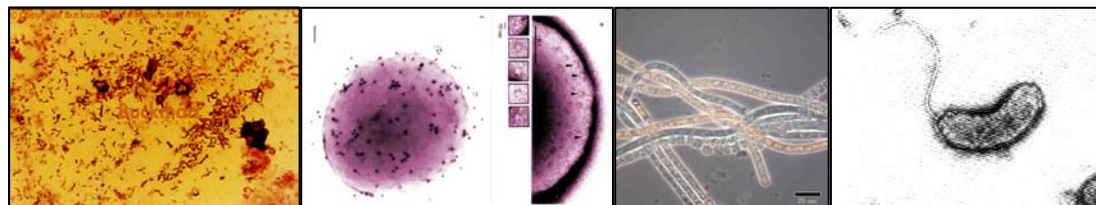


Figure 3 - Desulfobibrio, purple bacteria, Beggiatoa and Thiobacillus (L-R)

There are four main bacterial groups responsible for the sulfur cycle in Lake Indawarra:



- *Desulfovibrio* only occurs where there is no free oxygen, buried in the soft mud in the bottom of the lake. It obtains its supply of oxygen from the SO_4 leaving dissolved hydrogen sulfide (H_2S & HS^-) in the water between the mud particles. The HS^- reacts with any available metals to make insoluble metal sulfide, while the H_2S may off-gas in warm weather, producing a characteristic odour.
- Green and purple bacteria are free-oxygen haters that live in sunlight, using the hydrogen from H_2S in photosynthesis, and storing S in their bodies as colourful ferredoxin (Fe-S) globules. You may be able to see these sometimes as patches of pink or green 'cream' on the surface of the mud in warm, shallow waters that have lost any dissolved oxygen, near the edge of the lake.
- *Beggiatoa* is a long chain-like bacterium that occurs where there is plenty of oxygen. It uses the hydrogen in H_2S to help it utilise the nitrogen available in the decomposing stoneworts and waste grain. It stores elemental S as 'white' globules in its body, so you can sometimes spot *Beggiatoa* as a white or yellowish layer on the surface of the mud.
- *Thiobacillus* is an incredibly small bacterium that oxidizes S (from Fe-S deposits, other metal sulfides and elemental S) while extracting nitrogen from decomposing organics such as broken down stoneworts and waste grain, making sulfuric acid as a by-product.

In Lake Indawarra, the sulfur cycle (Figure 4) is driven by several different factors. The available sulfate comes from the groundwater. The organics are supplied by the breakdown of stoneworts when the water becomes hot or too saline, and possibly by grain dust or grain wastes.

While some sulfate reduction in the lake is inevitable, it possibly may be slowed down. The supply of SO_4 from the groundwater is a factor that cannot be controlled, however the quantity of organic sediment and muddy sediment that can host the bacteria, water temperature and water oxygenation may all be modified.



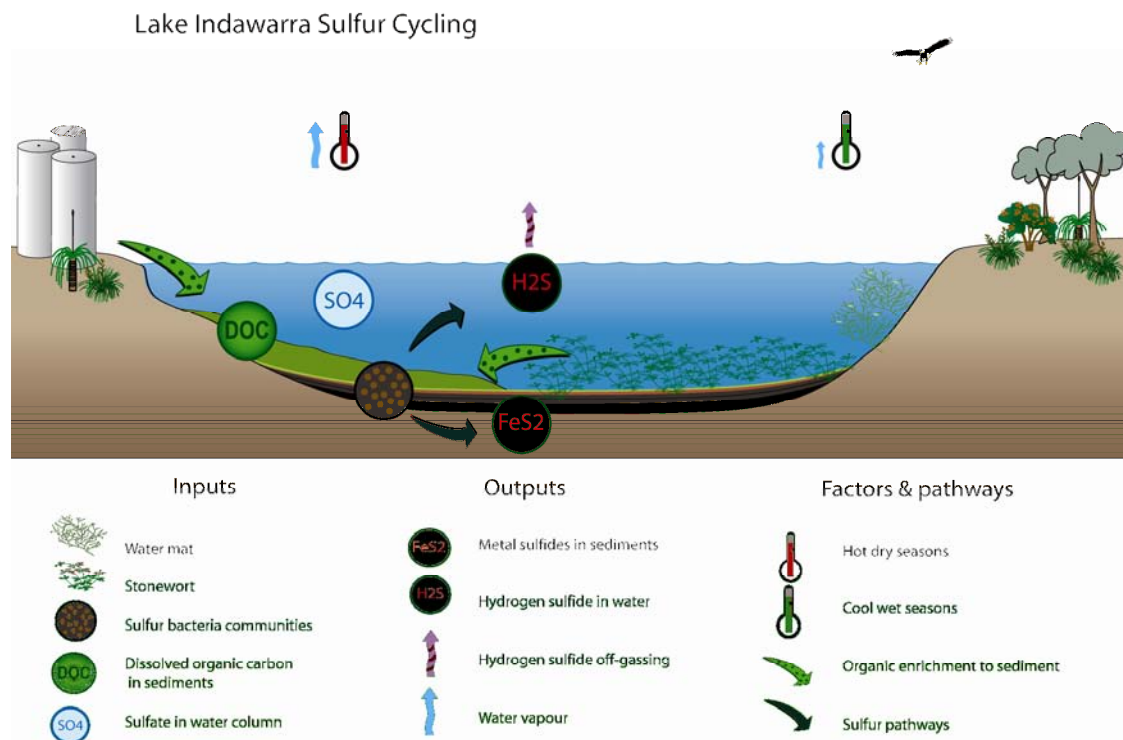


Figure 4 - Conceptual diagram of sulfur cycle in Lake Indawarra (symbols for diagram courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science)

Actions to reduce the quantity of sulfate reduction include ensuring no waste grain or by-products enter the lake, ensuring the lake is maintained at a reasonable depth to allow water temperatures to stay low and reduce the evaporation effects on salinity (maintaining the health of the stoneworts), removal of as much 'soft bottom' as possible to reduce areas where anoxic sulfate reducing bacteria can establish large colonies, and maintenance of water movement by bubblers or paddlewheels to ensure oxygenation is maintained.

Should a source of clean stormwater be available, this could be used to dilute the water in the lake, reducing the sulfate concentrations. This should only be considered if the freshwater has a very low nutrient concentration. The addition of any water (eg treated septic or sewage wastes) containing organic carbon, or concentrations of nitrogen or phosphorus above the EPA's limits for ecosystem health, will only exacerbate the issue.

4.2.3 Carteria bloom

On the field visit in March 2009, the water of the lake (mainly near the undredged section on the south-eastern side) was discoloured by a bloom of microalgae. The bloom was *Carteria* sp., a unicellular green algae distinguished from similar genera by the presence of four flagella (Figure 5). The algae has been reported as "bloom-forming" in other Australian lakes during periods of low water levels (eg Lake Wendouree near Ballarat) and is also recorded from estuaries.



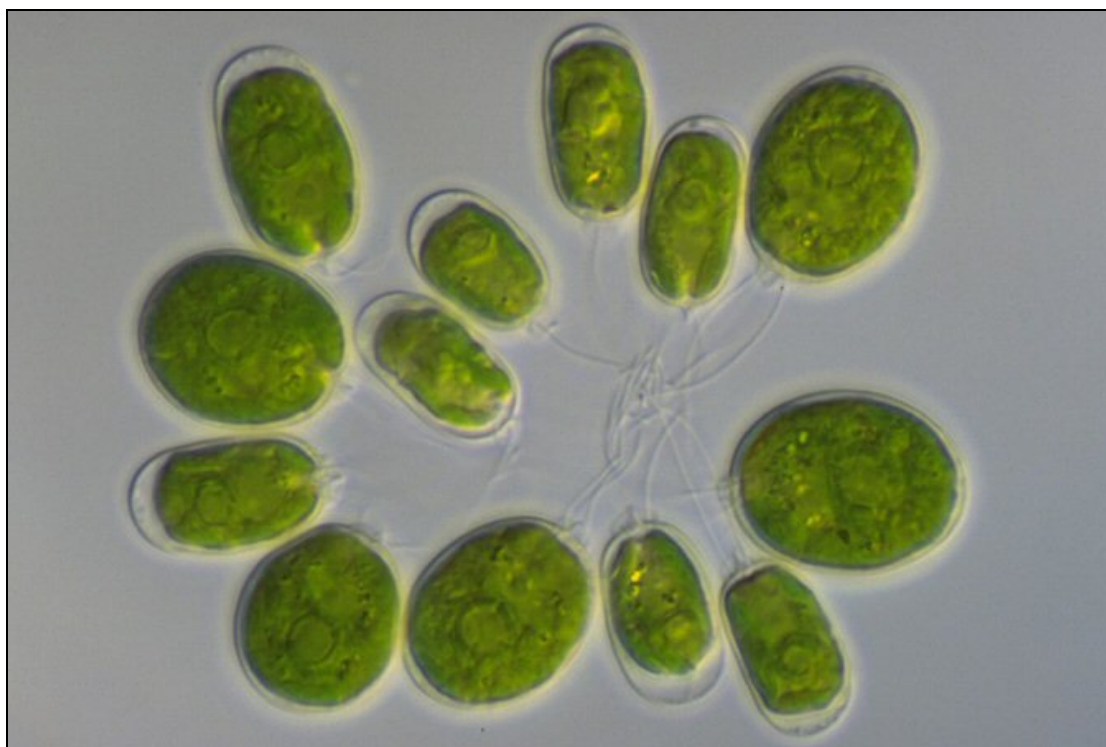


Figure 5 - Chlorophycean bloom of *Carteria* sp.

4.2.4 Faecal bacteria

Prior to the lake 's renovation in 2008, annual presence/absence testing of the lake water had returned consistently positive results for *Escherichia coli*, a gut bacterium that indicates faecal contamination with animal (usually mammalian) wastes.

Bacteria	Near Boatshed, December 2008	Near Boatshed, March 2009	South-eastern bank, March 2009
Total coliforms	2005 cells/100mL	697cells/100mL	>2005 cells/100mL
<i>E. coli</i>	0 cells/100mL	0 cells/100mL	0 cells/100mL

Table 5 - Results of bacterial testing

During December 2008, a single sample for bacterial sample was taken from the shallows near the boat shed. In March 2009, two further samples were taken. Bacterial counts were undertaken within 24 hours of sampling, on refrigerated samples, and the results show that *E.coli* counts were within the recreational water guidelines for primary contact.



4.3 Flora

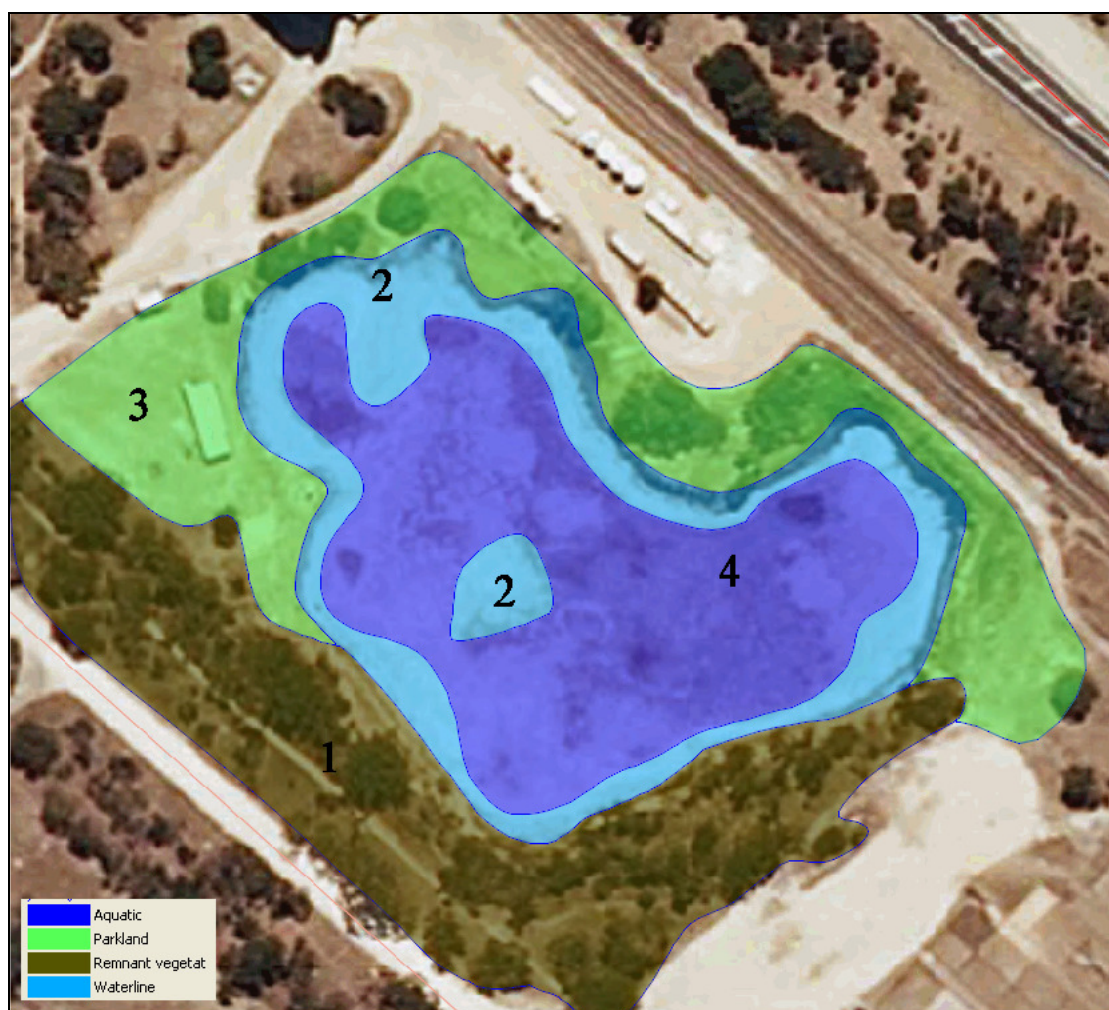


Figure 6 - Vegetation zones

The development of the Lake Indawarra site over time has resulted in four distinct vegetation zones. The eastern and northern areas have been developed for recreational purposes as a park land and these areas support grassed expanses and several plantings of locally exotic trees and shrubs.

Along the western and southern side of the lake the higher land is clothed in remnant native mallee shrubland vegetation. Close to the water line around the lake, the shore supports a dwarf closed chenopod shrubland.

Zones	Description
1	Remnant veg on western & southern sides
2	Around waterline
3	Eastern & northern side
4	Aquatic

Table 6 – Management zones at Lake Indawarra



The water body itself supports a closed submerged aquatic herbland made up of water mat and stonewort. This herbland was dense where the base was rocky, and was absent where the lake floor was soft sediment.

A walkover survey of the site was conducted on 11 December 2008. Summer surveys may miss many of the winter and spring flowering grass and herb species. As an existing survey of the site was available, this data was incorporated into the species list for the site.

The two surveys show the distinct difference between spring and summer surveys, with the more recent Delta survey identifying a greater range of summer flowering grasses and the Wilkins & Alcock survey identifying a greater range of spring flowering herbs. Twenty-two species were reported by both surveys. These commonly reported plants were dominated by structural species, such as trees and shrubs.

The number of species recorded from the two surveys was eighty-two (82). Of these, there were fifty-one (51) native species and thirty-one (31) exotic species.

Three (3) species were of conservation significance, with State or Regional ratings of Rare. These species included *Austrostipa drummondii* (R in SE), *Eragrostis infecunda* (R in SE & SA) and *Melaleuca wilsonii* (R in SE & SA).

One (1) additional species, *Acrotriche patula*, has conservation interest as it has a rating of Uncertain in the Region.

The full list of plant species is included in Appendix 1. The list is arranged by family. Details include the species' names, common names, conservation ratings, the vegetation zone around the lake in which the plant occurs (Delta records only) and the surveys in which the plant species was recorded.

Number of species	82
Number of native species	51
Number of exotic species	31
Number with conservation significance	3
Number with conservation interest	1

Table 7 – Site floral biodiversity

4.4 Fauna observations

The small island in the lake lacked vegetative cover and appeared to be an attractive roosting area for water fowl and seagulls. As a result there was a significant quantity of bird guano on the soil surface. There were also a number of small burrows in sediment near the waterline.

There were many reptile holes in the areas supporting remnant vegetation and these areas often provide excellent 'bush-bird' and macroinvertebrate (insects, spiders etc) habitat.

The water mat and stonewort submerged meadows within the lake itself support a large population of very tiny seed shrimps, *Mytilocypris* prob. *tasmanica*. These are microscopic ostracods of the family Cyprididae. During the March site visit some very small fish were noted but not captured. Over time it is likely that the lake will be



colonised by a wider variety of aquatic invertebrates. This colonisation usually occurs when eggs, cysts and individual animals are transported into new lakes in the feathers and webbing of water birds.

4.5 Weed, maintenance and management observations

While completing fieldwork on the site, the surveyors made notes and observations on weed control, maintenance and other management issues. In general, the site was reasonably well maintained, with minimal weed populations.

The table following provides all observations in the order they were recorded. Each observation is given a “type” to assist with management:

- Weed observations relate to where weed species were seen, and control of these species at these locations should be undertaken.
- Maintenance observations are where a general maintenance action is required (e.g. removal of rubbish or tending to a lawned area).
- The third type of observation recorded at this site is ‘nature’ which is simply where a single patch of unusual vegetation, form or habitat has been observed and where interpretive signage may be useful in the future.

Figure 4 shows the locations of each observation. The type of observation is shown by the symbol used to display its location.

Obs No.	Obs Type	Easting	Northing	Detail
1	Weed	415090	6027925	Boxthorn plant
2	Weed	414996	6028028	Evidence of bridal creeper control, more required next year.
3	Weed	415216	6028031	Kikuyu overgrowth.
4	Weed	415167	6028079	Kikuyu overgrowth.
5	Nature	415138	6027962	Large patch of Rough Halgania
6	Weed	415130	6027956	Occasional Boneseed plant
7	Weed	415160	6027971	Occasional Boneseed plant
8	Maintenance	415083	6028093	Occasionally irrigated lawn area
9	Maintenance	415145	6028062	Path needs rolling
10	Weed	415199	6027987	Rice Millet tussocks
11	Weed	415177	6027965	Potato weed
12	Weed	415111	6028085	Potato weed and Prickly Lettuce
13	Maintenance	415120	6028050	Road sign needs removal
14	Nature	415141	6028043	Self sown Melaleuca seedlings

Table 8 – Site observations





Figure 7 - Observation locations

4.6 Dial before you dig search

The results of a dial-before-you-dig search showed that there are a number of Telstra assets within the parcel of land that contains Lake Indawarra (D28915 Q1 (L176)), however the nearest assets appear to be near Cunningham's, the silo, the weighbridge and the action club boatshed.

SA Water have a major mains water pipeline running between Dump Road and the Lake, but no records of treated or untreated waste water pipes in this area.

As no significant earthworks are proposed at these locations, accurate location of these assets was not considered necessary, however a copy of the provided plans have been attached to this report in the appendices. We suggest that those undertaking earthworks on site reference these plans whenever they undertake work to ensure that they are not likely to disturb underground assets.

As land ownership or leasehold is not clear over some portions of the lake, a map of lease areas has been included with the search results.



5. Site concept planning

The water quality in the lake has improved significantly since remodelling of the basin (2007/8). This has, in turn, had positive effects on the aquatic flora and fauna present at the site. The presence of new organic matter depositing along the shoreline suggests these improvements are unlikely to be permanent, however the duration of the improvement may be extended by adopting management practices to reduce the build-up of material.

To extend the longevity of water quality improvements, a number of actions are being undertaken. These include;

- Removal of remaining sediment and restructuring of the island to prevent slumping.
- Deepening areas of the lake to at least 2m below the low water mark, to provide retreat zones for plants and animals during summer.
- Construction of a shallow swale and rill system along surrounding dirt tracks, draining road runoff away from the lake, preventing contaminant entry.
- Planting dense trees and other vegetation between the lake and surrounding developments to reduce water-borne and air-borne pollutant entry.
- Dense plantings of groundcovers on the remains of the island, to prevent erosion and reduce nutrient input to the lake.
- Installation of bubblers or other aeration devices to prevent anaerobic events over summer.
- Revegetation of the lake-shore to improve water treatment and sediment aeration.
- Installation of a boardwalk and gabions to enhance public usability of the water body, while reducing erosion and creating areas from which to undertake water quality monitoring.

6. Action plan

There are a range of tasks that need to be undertaken at the lake over the next five years. Although these estimates are simply for conceptual purposes, based on similar projects elsewhere, we suggest that the on-ground works program associated with this document has a commercial value of \$180,000 - \$220,000 (+/- 30%). Of this, approximately \$45,000 is labour that could be contributed by members of the community, using a volunteer value of \$25 per person. The remaining costs are in materials, use of heavy machinery or skilled trade workers.

To complete this program within the five year period, community members will need to contribute an average of 52 person-days per year, while sourcing \$35,000 in cash grants or in-kind contributions. This does not include the costs and time involved in administering this plan, raising community awareness, keeping a record of community contributions or applying for external grants.

The action table at the beginning of each of the following subsections documents the main tasks for that section. These will need undertaking to achieve the community's vision for the site. Details of the who, what, where and when of each action are also included in these tables. Costs are approximate, provided to enable prioritisation and planning. These are based on costs for similar projects elsewhere, and should be within +/- 30% of final costs.



Coordination of on-ground works and liaising with stakeholders will continue to be done by the TRADE representative, Gail Traeger. The responsible party for each action is the party who has the lead for that action, although others may also be involved.

Funding bodies (where known) are given in brackets in the responsible party column. It should be assumed that all actions and commitments are subject to funding, unless an action is current, has a funding body stated, or is predominantly volunteer labour. It is the responsibility of the coordinator, in conjunction with the stated responsible party, to secure funding when opportunities arise.

6.1 Site clean-up and beautification

Description	Timing	Responsible party	Approximate cost (materials/equipment)	Approximate cost (labour)
Finish circuit path	As soon as practicable	Coorong District Council	\$650	\$400
Preparation and installation of interpretive signage along circuit path	Winter 2009	Action Club (EnviroFund)	\$3,485	\$500
Remove rubbish from in and around lake	Clean Up Australia Day, annually.	Action Club and other community members	\$100 p.a.	\$260 p.a.

Table 9 Action sub-table 1 – Site cleanup

The site already has a reasonable length of path around the top of the lake banks, however it peters out near the Cunningham's facility, leaving pedestrians with no other option than to go bush, or walk through the fertiliser depot. Much of the material to finish this path is already laid out and needs rolling, however further crushed aggregate will need sourcing from the Coorong District Council, spreading and rolling.

Once the path has been completed, it may be possible to install 3-5 signs around the lake, highlighting areas of interest, such as the area where fill has been placed, colonies of native plants, or discussing the aquatic life within the lake.

As the lowest point in the town, with a history of low aesthetic value, the lake has often been the recipient of a range of anthropogenic wastes. All rubbish remaining in the lake needs removal, and an annual Emu Pick should be undertaken to remove new deposits, possibly on Clean Up Australia Day.

The intentional deposition of human wastes within the lake, for example treated waste water or untreated stormwater, should be avoided if at all practical, unless it can be proved that the material has very low contaminants. This would generally mean that such wastewater would comply with SA EPA aquatic ecological health criteria.



6.2 Earthworks and infrastructure

Description	Timing	Responsible party	Approximate cost (materials/ equipment)	Approximate cost (labour)
Reshaping of lake bed as per the proposed alterations diagram, and removal of sediment.	Once only, as soon as practical	Tintinara Action Club (Coorong District Council)	\$14,000	\$7,000
Construction of swales & rills along dirt roads to redirect runoff	Once only, as soon as practical.	Coorong District Council	\$1,200	\$900
Shaping the island for aesthetic and habitat value	Once only, current.	Action Club (EnviroFund)	\$8,000	
Construction of gabions on North-eastern side of lake (2m x 2m x 85m).	Once only, Autumn 2010-11.	Action Club	\$13,600 - \$20,400 (gabions) \$1,530 - \$2,295 (geotextile)	
Installation of mechanical aeration infrastructure.	Summer, 2010	Action Club	\$14,000	\$5,000
Installation of picnic facilities in the Boat Shed and on the lawn area.	April, 2010	Coorong District Council	\$7,000	\$2,400
Construction of a 60-80m boardwalk	2013	Action Club	\$19,500 - \$38,000, depending on material, end treatments, substrate and final length.	
Construction of a 25-50m ² viewing platform	2013	Action Club	\$3,000 - \$13,500, depending on material, entry and edge treatments, support structure and final size.	

Table 10 - Action sub-table 2 – Earthworks etc

There are considerable earth works to be undertaken on the site to optimise the long term health and aesthetic value of the lake.

The first four actions (reshaping of the lake bed, reshaping the island and track edges) need to be done as soon as practicable, as these measures will prevent further decay in lake water quality. The success of these measures is highly dependant on strict compliance with the following diagrams. GPS locations are available from the Delta office if required.

Due to the high fine sediment content of surrounding soils, it is important that all gabion or retaining structures are separated from the soil they retain by a layer of geotextile. As it will not be subject to heavy vehicle traffic or wave action, a light to medium grade should be sufficient. The diagram below shows best practice installation of geotextiles and gabions to minimise site erosion or slumping.



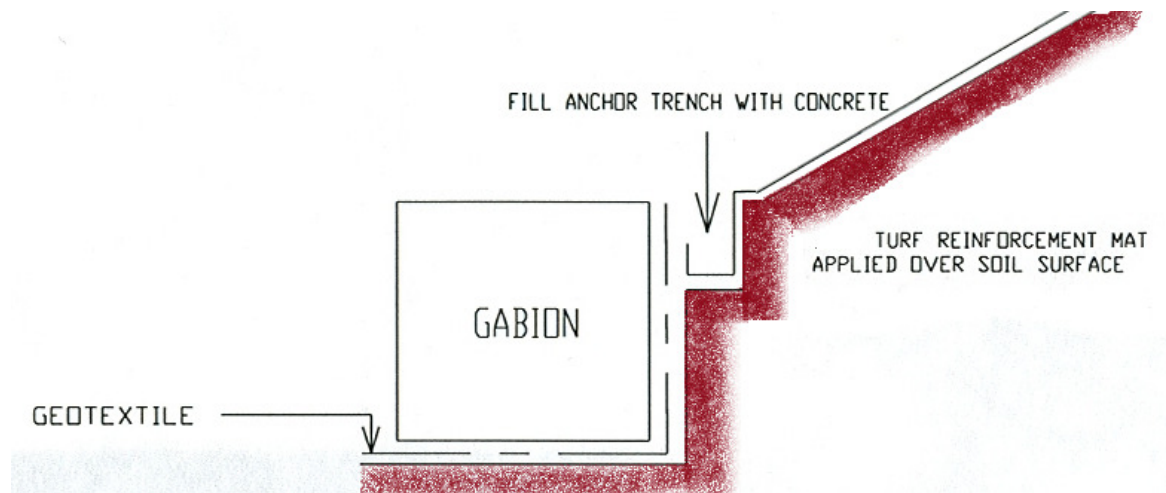


Figure 8 - Use of geotextile & gabions

Suitable areas to receive road run-off, redirected by the rill and swale system, are the teardrop-shaped traffic island near the silos, and the area of parkland north of the track into Lake Indawarra.

The chart below shows a cross section of the lake, with the current and proposed elevations, from the corner of the lake nearest the silos, through the most southern corner of the proposed viewing platform.

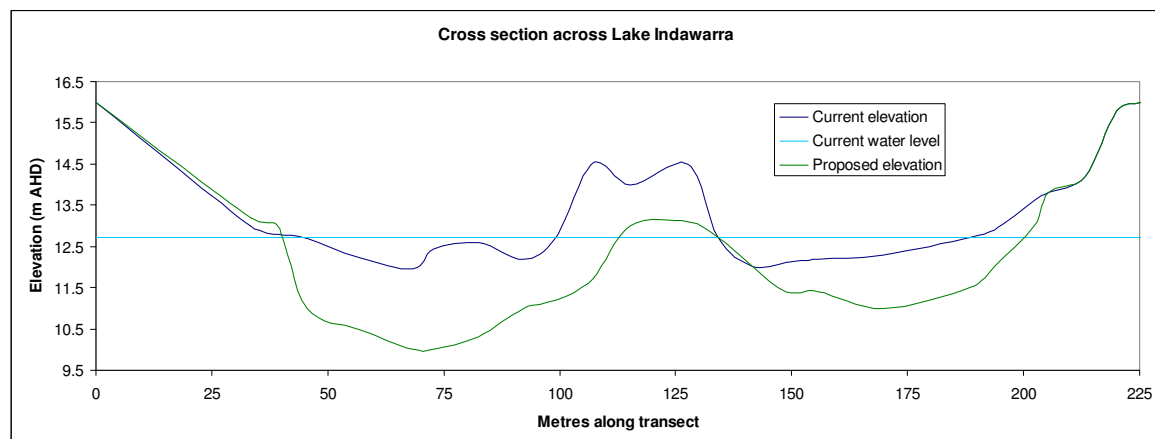


Figure 9 - Cross section of the lake



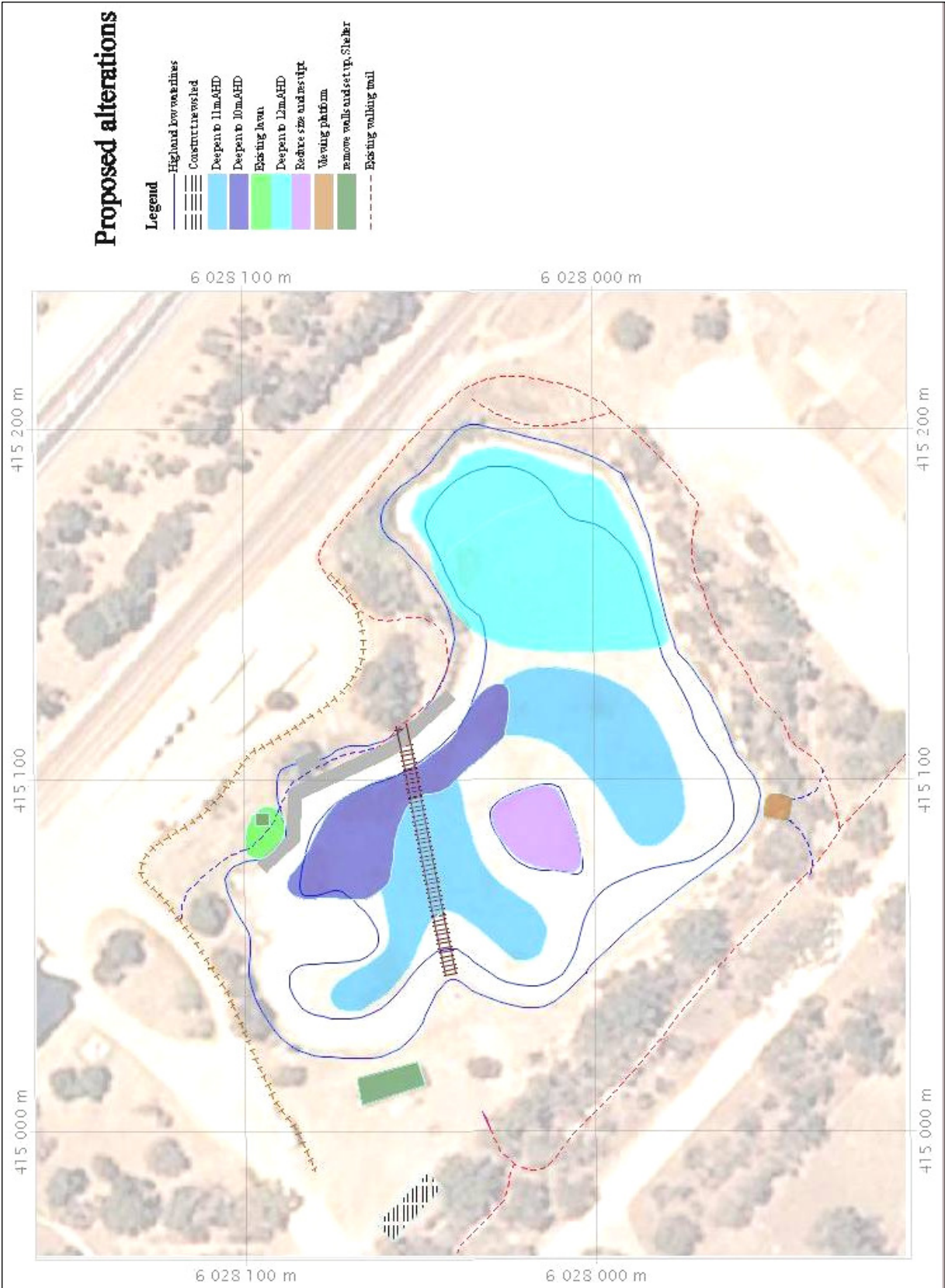


Figure 10 - Proposed earthworks and infrastructure

In total, aeration infrastructure installed in the lake should have the capacity to aerate at least 2,400 ML of water with 5,400 ML or more being optimal. This equates to a single one acre system if purchasing a pre-made solar or wind aeration plant.

The aeration infrastructure should be installed so that the deepest areas of the lake are aerated, as these are the most likely areas to contain water and sediment during the warm summer months. Aeration infrastructure that services shallower areas should be considered for aesthetic purposes only, and should be switched off as soon as the water level drops below any constructed water outlet/inlet.

An aeration system that also increase lake water circulation or breaks up the water surface should be considered of greater benefit than one that simply provides aeration.

Aeration systems should not be designed to increase the temperature of water, e.g. by flowing it across a hot mud flat, however they can be designed to cool the water, e.g. by propelling water into the air.

The picnic facilities, viewing platform and boardwalk will need to be constructed according to the appropriate Australian Standards, and be suitable for the highly corrosive environment of the area.

It is understood that the picnic facilities in the old boatshed will consist of at least two tables with bench seats, plus a public barbeque. These will be supplied and installed by the Coorong District Council (CDC) and will similar to facilities in other public areas.

The Action Club has proposed that they build the boardwalk and viewing platform. To assist the members of this club, we have provided our client contact with a single printed or electronic copy of several guides addressing boardwalk, platform and path construction.



6.3 Weed control

Description	Timing	Responsible party	Approximate materials cost	Approximate labour cost
Weed control	Spring and Autumn	Action Club / Coorong District Council / NRM Board	\$150 p.a.	\$260 p.a.

Table 11 - Action sub-table 3 - Weeds

The site has a low level of weed infestation, however there are small populations of weeds that will need control to ensure they do not become an issue. Weeds to be controlled include Boxthorn, Boneseed, Kikuyu (where rampant), Rice millet, Potato weed and Prickly lettuce. The table below provides volunteers and weed controllers with some guidance on how and when the weeds present should be controlled.

Name	Lifeform	Reproductive unit	Suggested management method
Box Thorn	Perennial	Seed, suckers and stem layering	Inject with neat glyphosate (Feb-May). Foliar spray regrowth with 10% glyphosate.
Boneseed	Perennial	Seed	Hand-pull or cut in late summer.
Bridal Creeper	Perennial	Rhizome, tubers and seed	Spray with 1% glyphosate during flowering
Kikuyu	Perennial	Rhizomes, stolons	Solarisation in summer, spray with glyphosphate (1%) + wetting agent, 2-3 times during growth season
Rice Millet	Perennial	Seed	Cut out younger plants, slash larger clumps in spring then spot spray with glyphoshate.
Potato Weed	Annual	Seed	Out compete with native plants or cultivate the soil in late spring.
Prickly Lettuce	Annual to biannual	Seed	Minimise soil disturbance

Table 12 - Control methods for specified weeds



6.4 Revegetation plan

Description	Timing	Responsible party	Approximate cost (materials/ equipment)	Approximate cost (labour)
Plantings to improve water quality.	Winter 2010	Tintinara Area School / Coorong LAP	\$5,000	\$4,400
Augmentation planting in remnant vegetation	Annual, early winter.	Tintinara Area School / Coorong LAP	\$5,000 (total)	\$4,100 (total)
Lake edge plantings	Autumn 2010-2012	Tintinara Area School / Coorong LAP	\$1200	\$300
Encouraging submergent vegetation	Autumn 2010-2013	Action Club / Coorong LAP	\$500	\$150
Planting island with tube stock to stabilise sediment	July 2009 & 2010	Tintinara Area School / Coorong LAP	\$1,100	\$1,200

Table 13 - Action sub-table 4 - Revegetation

The surrounds of Lake Indawarra already have a reasonable cover of vegetation, however there are some areas of the site that have been recently disturbed, or have had management changes, resulting in either a lack of cover (causing soil erosion) or a lack of diversity (reducing aesthetic and environmental values).

The site has various vegetation zones within it, as described on pages 18-19. These revegetation actions are aimed at targeting the weaker areas each of these zones.

6.4.1 Zone 1 – remnant native vegetation

The remnant vegetation in this zone has a good quality upper story, however it is lacking groundcover diversity and density. Over the next five years, this plan proposes to plant 5000 groundcover and lower storey species within this zone, using species from the list below. If difficulties arise sourcing these species, or a greater diversity is desired, members of the group should approach local botanists, DEH Bush advisors or LAP officers to recommend further species, appropriate to the site.

Where possible, all plants and reproductive material used in this zone should be of local provenance.

Species	Common name
<i>Halgania cyanea</i>	Rough halganian, mallee blue-flower
<i>Atriplex semibaccata</i>	Scrambling berry saltbush
<i>Chenopodium glaucum</i>	Goosefoot
<i>Enchylaena tomentosa</i>	Ruby saltbush
<i>Threlkeldia diffusa</i>	Coast bonefruit
<i>Callitris canescens</i>	Scrubby cypress-pine
<i>Lepidosperma prob carphoides</i>	Black rapier-sedge
<i>Lepidosperma concavum</i>	Sandhill sword sedge
<i>Hibbertia sericea</i>	Silky guinea flower
<i>Acrotriche patula</i>	Shining ground-berry



Species	Common name
<i>Dampiera dysantha</i>	A dampiera
<i>Austrodanthonia caespitosa</i>	A wallaby grass
<i>Austrostipa drummondii</i>	Cottony spear-grass
<i>Austrostipa eremophila</i>	Desert spear-grass
<i>Acacia farinosa</i>	Mealy wattle
<i>Acacia pycnantha</i>	Golden wattle
<i>Eutaxia microphylla</i>	Mallee bush-pea
<i>Dianella revoluta</i>	Black anther flax-lily
<i>Lomandra effusa</i>	Scented mat-rush or irongrass
<i>Lomandra collina</i>	Irongrass
<i>Xanthorrhoea caespitosa</i>	Grasstrees
<i>Billardiera cymosa</i>	Sweet apple-berry
<i>Bursaria spinosa</i>	Sweet bursaria
<i>Clematis microphylla</i>	Old man's beard
<i>Exocarpos sparteus</i>	Broom ballart, slender cherry
<i>Leptomeria aphylla</i>	Leafless currant bush

Table 14 - Species list for Zone 1

6.4.2 Zone 2 – lake edge and island plantings

The lake edge and island areas will require planting to minimise erosion and nutrient input from these areas. Plantings will also assist with sediment aeration and provision of additional habitat for native fauna and flora.

The salinity range in the lake waters is wide, making the selection of species for plantings a challenge. Some of the species in this list will grow well throughout the zone, where as other species will have specific locations where they grow, and others areas where they do not survive. This difficulty with establishment can be compensated by hand-scattering reproductive material for these species throughout the zone, rather than planting of tubestock.

Species	Common name
<i>Atriplex semibaccata</i>	Scrambling berry saltbush
<i>Chenopodium glaucum</i>	Goosefoot
<i>Enchylaena tomentosa</i>	Ruby saltbush
<i>Sarcocornia blackiana</i>	Big headed glasswort
<i>Puccinellia stricta</i>	Native Puccinellia
<i>Sarcocornia quinqueflora</i>	Bearded glasswort
<i>Suaeda australis</i>	Austral sea-blite
<i>Threlkeldia diffusa</i>	Coast bonefruit
<i>Bolboschoenus caldwellii</i>	Sea club rush
<i>Juncus kraussii</i>	Sea rush
<i>Melaleuca halmaturorum</i>	Swamp paperbark
<i>Samolus repens</i>	Creeping brookweed



Species	Common name
<i>Apium annuum</i>	Sea celery
<i>Hydrocotyle</i> sp.	
<i>Cressa cretica</i> (on clay areas)	Rosin weed

Table 15 - Species list for Zone 2

6.4.3 Zone 3 – parkland and recreational area

Plantings within the parkland and recreational area are not aimed towards restoring site biodiversity. They are for amenity or pollution prevention purposes only.

To reduce the noise, run-off and dust issues that may arise from industrial leases near the railway, dense stands of vegetation should be planted between the lease boundaries and the lake.

These stands of plants should be lozenge shaped, running along the contour of the banks, and be in planted in small depressions, which will maximise their potential to capture stormwater.

Unlike other areas on the site, the species planted do not need to be limited to those native to the site. Species planted could be wider Australian natives, from the local area or from areas with a similar or lower rainfall. All non-indigenous plants selected for planting in the parkland area should be checked with a botanist or nursery person to ensure they have a low weediness potential.

Table 16 provides some suggested species that could be planted in the parkland area, with a column showing the lifeform to enable species to be selected by size.

Species	Common name	Lifeform
<i>Allocasuarina muelleriana</i>	Slaty she-oak	Tree
<i>Atriplex semibaccata</i>	Scrambling berry saltbush	Forb
<i>Chenopodium glaucum</i>	Goosefoot	Forb
<i>Enchylaena tomentosa</i>	Ruby saltbush	Low shrub
<i>Threlkeldia diffusa</i>	Coast bonefruit	Low shrub
<i>Callitris canescens</i>	Scrubby cypress-pine	Tall shrub
<i>Hibbertia sericea</i>	Silky guinea flower	Shrub
<i>Acrotriche patula</i>	Shining ground-berry	Shrub
<i>Dampiera dysantha</i>	A dampiera	Forb (clumping)
<i>Austrodanthonia caespitosa</i>	A wallaby grass	Tussock grass
<i>Austrostipa drummondii</i>	Cottony spear-grass	Tussock grass
<i>Austrostipa eremophila</i>	Desert spear-grass	Tussock grass
<i>Acacia farinosa</i>	Mealy wattle	Shrub
<i>Acacia pycnantha</i>	Golden wattle	Tall shrub
<i>Eutaxia microphylla</i>	Mallee bush-pea	Shrub
<i>Dianella revoluta</i>	Black anther flax-lily	Forb (clumping)
<i>Lomandra effusa</i>	Scented mat-rush or Irongrass	Forb (clumping)
<i>Lomandra collina</i>	Irongrass	Forb (clumping)



Species	Common name	Lifeform
<i>Eucalyptus astringens</i>	Brown mallet	Tree
<i>Eucalyptus gracilis</i>	Yorrell, white mallee	Tree/mallee
<i>Eucalyptus leptophylla</i>	Narrow leafed red mallee	Tree/mallee
<i>Eucalyptus leucoxylon</i>	Blue gum (red flowered variety)	Tree
<i>Melaleuca lanceolata</i>	Moonah, or dryland tea-tree	Shrub
<i>Melaleuca uncinata</i>	Mallee broombush	Tall shrub
<i>Melaleuca wilsonii</i>	Wilson's honey-myrtle	Shrub
<i>Billardiera cymosa</i>	Sweet apple-berry	Vine
<i>Bursaria spinosa</i>	Sweet bursaria	Shrub
<i>Clematis microphylla</i>	Old man's beard	Vine
<i>Exocarpos sparteus</i>	Broom ballart, slender cherry	Tall shrub
<i>Leptomeria aphylla</i>	Leafless currant bush	Shrub

Table 16 - Species list for Zone 3

6.4.4 Zone 4 – lake floor

Plants and algae currently growing in the bed of the lake provide adequate coverage, and will recolonise disturbed areas once the floor has been reshaped. The diversity is, however, low and it is dominated by soft celled charophyte species, which die back and decompose rapidly in adverse conditions. Encouraging more ridged celled flowering aquatic plant species will help stabilise the lake ecosystem, binding the remaining nutrients and organic matter into less accessible forms.

Planting lake floor species as tubes can be difficult and unreliable. We recommend that the project obtains as much reproductive material as possible for the species suggested in the table below, and scatters it across the lake in late Autumn.

Species	Common name
<i>Lepilaena cylindocarpa</i>	Long-fruit water-mat
<i>Ruppia polycarpa</i>	Widgeon grass
<i>Ruppia megacarpa</i>	Widgeon grass

Table 17 - Species list for Zone 4



6.5 Monitoring plan

Description	Timing	Responsible party	Approximate cost (materials/ equipment)	Approximate cost (labour)
Sediment and water quality monitoring	Monthly, ongoing	Tintinara Area School / Individual community members	\$140 per annum	\$1,200 p.a.

Table 18 - Action sub-table 5 - Monitoring

The water quality will require ongoing monitoring to ensure that it is fit for purpose. During summer, total coliforms and *E. coli* should be sampled and tested for presence/absence once a month, as per instructions in the appendices. If *E. coli* are found to be present, a sample should be collected and delivered to a test laboratory that is able to undertake bacterial counts.

The water level and sedimentation within the lake will also require ongoing observation. Once earthworks within the lake are complete, the level (in mAHD) of the lake floor within a deeper area should be surveyed and a level peg installed.

The level of water against the peg will need recording once a month. Once per annum, the monitoring personnel should wade out to the peg, refresh the level marks, and note the amount of sediment that has accumulated at the base of the peg.

For the first year, a monthly sediment core should be taken from the strandline near the boat shed, and this should be examined to assess organic content and type. This would include visual inspection of the core, separation of particle densities using a settling tube, iodine treatment of slow settling or light coloured sediments to determine starch content and inspection of these sediments under a light microscope. Once a full year of sediment samples have been obtained, sediment sampling may be reduced to once or twice per annum.



7. References and bibliography

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8. Appendices



8.1 Flora list

Family	Species	Common name	Lifeform	Exotic	Cons. Rating	Main zone	Delta survey	Wilkins & Alcock survey
Flowering plants								
BORANGINACEAE	<i>Echium plantagineum</i>	Salvation Jane	Forb	*				x
BORANGINACEAE	<i>Halgania cyanea</i>	Rough halgania, mallee blue-flower	Forb			1	x	
BORANGINACEAE	<i>Heliotropium europaeum</i>	Potato weed or Common Heliotrope	Forb	*		1	x	x
CASUARINACEAE	<i>Allocasuarina muelleriana</i>	Slaty she-oak	Tree					x
CHENOPODIACEAE	<i>Atriplex semibaccata</i>	Scrambling berry saltbush	Forb			1	x	x
CHENOPODIACEAE	<i>Chenopodium glaucum</i>	Goosefoot	Forb	*		2	x	x
CHENOPODIACEAE	<i>Enchylaena tomentosa</i>	Ruby saltbush	Low shrub			1	x	
CHENOPODIACEAE	<i>Sarcocornia blackiana</i>	Big headed glasswort	Dwarf shrub					x
CHENOPODIACEAE	<i>Sarcocornia quinqueflora</i>	Bearded glasswort	Dwarf shrub			2	x	x
CHENOPODIACEAE	<i>Suaeda australis</i>	Austral sea-blite	Shrub					x
CHENOPODIACEAE	<i>Threlkeldia diffusa</i>	Coast bonefruit	Low shrub			1	x	
COMPOSITAE	<i>Chrysanthemoides monilifera</i>	Boneseed	Shrub	*		1	x	x
COMPOSITAE	<i>Lactuca serriola</i>	Prickly lettuce	Forb	*		3	x	
COMPOSITAE	<i>Pallenis spinosa</i>	Starwort	Forb	*				x
COMPOSITAE	<i>Sonchus oleraceus</i>	Common sow-thistle	Forb	*		3	x	
CRUCIFERAE	<i>Rapistrum rugosum</i>	Short fruited wild turnip	Forb	*		3	x	
CUPRESSACEAE	<i>Callitris canescens</i>	Scrubby cypress-pine	Tall shrub			1	x	
CYPERACEAE	<i>Lepidosperma prob carphoides</i>	Black rapier-sedge	Sedge			1	x	
CYPERACEAE	<i>Lepidosperma concavum</i>	Sandhill sword sedge	Sedge					x
DILLENIACEAE	<i>Hibbertia sericea</i>	Silky guinea flower	Shrub					x
EPACRIDACEAE	<i>Acrotriche patula</i>	Shining ground-berry	Shrub		K in SE			x
GOODENIACEAE	<i>Dampiera</i> sp (not flowering)	A dampiera	Forb (clumping)			1	x	
GOODENIACEAE	<i>Dampiera dysantha</i>	A dampiera	Forb (clumping)					x
GRAMINEAE	<i>Austrodanthonia</i> sp.	A wallaby grass	Tussock grass					x
GRAMINEAE	<i>Austrostipa drummondii</i>	Cottony spear-grass	Tussock grass		R in SE	1	x	
GRAMINEAE	<i>Austrostipa eremophila</i>	Desert spear-grass	Tussock grass			1	x	
GRAMINEAE	<i>Austrostipa</i> sp.	A spear-grass	Tussock grass			1	x	x
GRAMINEAE	<i>Avena barbata</i>	Wild oat	Grass	*		1	x	
GRAMINEAE	<i>Bomus diandrus</i>	Great brome	Grass	*		3	x	
GRAMINEAE	<i>Bromus rubens</i>	Red brome	Grass	*		3	x	
GRAMINEAE	<i>Cynodon dactylon</i>	Couch	Grass	*		3	x	x
GRAMINEAE	<i>Dactylis glomerata</i>	Cocksfoot	Grass	*				x
GRAMINEAE	<i>Ehrharta calycina</i>	Veldt grass	Grass	*		3	x	
GRAMINEAE	<i>Eragrostis infecunda</i>	Barren cane-grass	Grass		R in SA & SE			X
GRAMINEAE	<i>Eragrostis</i> sp.	A love grass	Grass			2	x	



Family	Species	Common name	Lifeform	Exotic	Cons. Rating	Main zone	Delta survey	Wilkins & Alcock survey
GRAMINEAE	<i>Hordeum</i> sp.	Barley grass	Grass	*		1	x	
GRAMINEAE	<i>Lagurus ovatus</i>	Hare's tail	Grass	*		1	x	X
GRAMINEAE	<i>Lolium</i> spp.	Rye grasses	Grass	*		3	x	
GRAMINEAE	<i>Panicum effusum</i>	Hairy panic	Grass					X
GRAMINEAE	<i>Parapholus incurva</i>	Curly rye	Grass	*		1	x	
GRAMINEAE	<i>Pennisetum clandestinum</i>	Kikuyu	Grass	*		3	x	X
GRAMINEAE	<i>Piptatherum miliaceum</i>	Rice millet	Tussock grass	*		3	x	
GRAMINEAE	<i>Poa</i> sp.	A poa	Grass					X
GRAMINEAE	<i>Polypogon monspeliensis</i>	Annual beard grass	Grass	*		2	x	
LABIATAE	<i>Salvia verbenaca</i>	Wild sage	Forb	*				X
LEGUMINOSAE	<i>Acacia brachybotrya</i>	Grey mulga	Shrub			1	x	X
LEGUMINOSAE	<i>Acacia farinosa</i>	Mealy wattle	Shrub					X
LEGUMINOSAE	<i>Acacia melanoxydon</i>	Blackwood	Tall shrub					X
LEGUMINOSAE	<i>Acacia pycnantha</i>	Golden wattle	Tall shrub			1	x	X
LEGUMINOSAE	<i>Eutaxia microphylla</i>	Mallee bush-pea	Shrub			1	x	X
LILIACEAE	<i>Asparagus asparagoides</i>	Bridal creeper	Vine	*		1	x	X
LILIACEAE	<i>Asparagus officinalis</i>	Garden asparagus	Forb	*		1	x	X
LILIACEAE	<i>Dianella revoluta</i>	Black anther flax-lily	Forb (clumping)			1	x	X
LILIACEAE	<i>Lomandra effusa</i>	Scented mat-rush or Irongrass	Forb (clumping)			1	x	X
LILIACEAE	<i>Lomandra collina</i>	Irongrass	Forb (clumping)					X
LILIACEAE	<i>Xanthorrhoea</i> sp.	Grasstrees	Shrub			1	x	X
LORANTHACEAE	<i>Amyema miquelii</i>	Box mistletoe	Parasite			1	x	
MALVACEAE	<i>Malva parvifolia</i>	Small flowered mallow	Forb	*		3	x	
MYRTACEAE	<i>Eucalyptus astringens</i>	Brown mallet	Tree	*		1	x	
MYRTACEAE	<i>Eucalyptus gracilis</i>	Yorrell, white mallee	Tree/mallee					X
MYRTACEAE	<i>Eucalyptus leptophylla</i>	Narrow leafed red mallee	Tree/mallee					x
MYRTACEAE	<i>Eucalyptus leucoxylon</i>	Blue gum (red flowered variety)	Tree			3	x	
MYRTACEAE	<i>Eucalyptus socialis</i>	Red mallee	Tree/mallee			1	x	
MYRTACEAE	<i>Melaleuca acuminata</i>	Melaleuca	Shrub					x
MYRTACEAE	<i>Melaleuca armillaris</i>	Bracelet honey-myrtle	Tall shrub	*				x
MYRTACEAE	<i>Melaleuca brevifolia</i>	Mallee honey-myrtle	Tall shrub			1	x	x
MYRTACEAE	<i>Melaleuca halmaturorum</i>	Swamp paperbark	Tall shrub			2	x	x
MYRTACEAE	<i>Melaleuca lanceolata</i>	Moonah, or dryland tea-tree	Shrub			1	x	x
MYRTACEAE	<i>Melaleuca raphiophylla</i>	Needle-leafed honey-myrtle	Tall shrub			3	x	
MYRTACEAE	<i>Melaleuca uncinata</i>	Mallee broombush	Tall shrub					x
MYRTACEAE	<i>Melaleuca wilsonii</i>	Wilson's honey-myrtle	Shrub		R in SA & SE	1	x	x
PINACEAE	<i>Pinus halepensis</i>	Aleppo pine	Tree	*				x
PINACEAE	<i>Pinus pinaster</i>	Maritime pine	Tree	*				x
PITTOSPORACEAE	<i>Billardiera cymosa</i>	Sweet apple-berry	Vine					x



Family	Species	Common name	Lifeform	Exotic	Cons. Rating	Main zone	Delta survey	Wilkins & Alcock survey
PITTOSPORACEAE	<i>Bursaria spinosa</i>	Sweet bursaria	Shrub			1	x	
POLYGONACEAE	<i>Rumex crispus</i>	Curly dock	Forb	*		3	x	
RANUNCULACEAE	<i>Clematis microphylla</i>	Old man's beard	Vine					x
SANTALACEAE	<i>Exocarpos sparteus</i>	Broom ballart, slender cherry	Tall shrub			1	x	x
SANTALACEAE	<i>Leptomeria aphylla</i>	Leafless currant bush	Shrub			1	x	
SOLANACEAE	<i>Lycium ferocissimum</i>	African boxthorn	Shrub	*		1	x	
ZANNICHELLIACEAE	<i>Lepilaena cylindocarpa</i>	Long-fruit water-mat	Aquatic			4	x	
Algae & Charophytes								
CHARACEAE	<i>Lamprothamnium macropogon</i>	Stonewort	Aquatic			4	x	



8.2 Groundwater chemical analysis



FINAL REPORT: 32789

Analytical Results

Customer Sample Description	M. Whitford Sec 149 HD Richards
Sampling Point	93120-South East Irrigation Supplies
Sampled Date	25/01/2008 12:00:00AM
Sample Received Date	5/02/2008 1:02:51PM
Sample ID	2008-000-8053
Status	Endorsed
Collection Type	Customer Collected

Inorganic Chemistry - Metals	LOR	Result
Aluminium - Total TIC-004 W09-023		
Aluminium - Total	0.010	0.028 mg/L
Arsenic - Total TIC-003 W09-023		
Arsenic - Total	0.001	<0.001 mg/L
Beryllium - Total TIC-003 W09-023		
Beryllium - Total	0.0005	<0.0005 mg/L
Boron - Soluble TIC-001 W09-023		
Boron - Soluble	0.040	4.19 mg/L
Cadmium - Total TIC-004 W09-023		
Cadmium - Total	0.005	<0.005 mg/L
Calcium TIC-001 W09-023		
Calcium	0.1	160 mg/L
Chromium - Total TIC-003 W09-023		
Chromium - Total	0.003	<0.003 mg/L
Cobalt - Total TIC-003 W09-023		
Cobalt - Total	0.0005	0.0011 mg/L
Copper - Total TIC-003 W09-023		
Copper - Total	0.010	<0.010 mg/L
Iron - Total TIC-004 W09-023		
Iron - Total	0.005	0.039 mg/L
Lithium - Total TIC-003 W09-023		
Lithium - Total	0.0010	0.1652 mg/L
Magnesium TIC-001 W09-023		
Magnesium	0.3	6.4 mg/L
Manganese - Total TIC-003 W09-023		
Manganese - Total	0.0005	0.0055 mg/L
Mercury - Total T0565-01 W09-023		
Mercury - Total	0.0003	<0.0003 mg/L
Molybdenum - Total TIC-003 W09-023		
Molybdenum - Total	0.0005	0.0061 mg/L
Nickel - Total TIC-003 W09-023		
Nickel - Total	0.005	<0.005 mg/L
Selenium - Total T0585-22 W09-023		
Selenium - Total	0.001	0.004 mg/L
Sodium Adsorption Ratio W09-023		
Sodium Adsorption Ratio - Calculation		51.1



Corporate Accreditation No. 1116
Chemical and Biological Testing
This document is issued in accordance
with NATA's accreditation requirements

Notes
1. The last figure of the result value is a significant figure.
2. Samples are analysed as received.
3. # determination of the component is not covered by NATA Accreditation.
4. * indicates result is out of specification according to the reference Guideline. Refer to Report footer.
5. * indicates incident have been recorded against the sample. Refer to Report footer.
6. & indicates the results have changed since the last issued report.

FINAL REPORT: 32789

Analytical Results

Customer Sample Description	M. Whitford (Sec. 149 HD Richards
Sampling Point	93120-South East Irrigation Supplies
Sampled Date	25/01/2008 12:00:00AM
Sample Received Date	5/02/2008 1:02:51PM
Sample ID	2008-000-8053
Status	Endorsed
Collection Type	Customer Collected

Sodium TIC-001 W09-023

Sodium	0.5	6350 mg/L
--------	-----	-----------

Uranium - Total TIC-003 W09-023

Uranium - Total	0.0005	0.0173 mg/L
-----------------	--------	-------------

Vanadium - Total TIC-003 W09-023

Vanadium - Total	0.003	0.025 mg/L
------------------	-------	------------

Zinc - Total TIC-003 W09-023

Zinc - Total	0.030	<0.030 mg/L
--------------	-------	-------------

Inorganic Chemistry - Nutrients

LOR Result

Chloride T0104-02 W09-023

Chloride	4.0	10500 mg/L
----------	-----	------------

Fluoride W09-023

Fluoride	0.10	7.0 mg/L
----------	------	----------

Inorganic Chemistry - Physical

LOR Result

Conductivity & Total Dissolved Solids T0016-01 W09-023

Conductivity	1	29700 µS/cm
Total Dissolved Solids (by EC)	1.0	18000 mg/L

pH T0010-01 W09-023

pH		7.6 pH units
----	--	--------------

Notes

1. The last figure of the result value is a significant figure.
2. Samples are analysed as received.
3. A determination of the component is not covered by NATA Accreditation.
4. * indicates result is out of specification according to the reference Guideline. Refer to Report footer.
5. * indicates incident have been recorded against the sample. Refer to Report footer.
6. * indicates the results have changed since the last issued report.

8.3 Dial-before-you-dig results



Tintinara

Water Mains



Report generated : 11:25:12 9/06/2009

Copyright SA Water 2004

Scale 1:6069

(@ A4)

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16.04.2009 17:02:25 Dial b4 U Dig (DBD_USER)

DIAL BEFORE YOU DIG

Call 1100, Fax 1300 652 077

PO Box 7710 MELBOURNE, VIC 8004

Utilities are requested to respond within 2 working days and reference the Sequence number.

[REFERRAL DETAILS]

FROM= Dial Before You Dig - Phoned

TO= Facilities Records Coordinator

UTILITY ID= 50800

COMPANY= Etsa

ENQUIRY DATE= 16/04/2009 16:47

COMMENCEMENT DATE= 20/04/2009

SEQUENCE NO= 15699426

PLANNING= No

[CALLER DETAILS]

CUSTOMER ID= 810559

CONTACT NAME= Mrs Faith Cook

CONTACT HOURS= 0

COMPANY= Delta Environmental

ADDRESS= 12 Beach Rd

SUBURB= St Kilda

STATE= Sa

POSTCODE= 5110

TELEPHONE= 0882805910

MOBILE= 0429802191

FAX TYPE= Private

FAX NUMBER= Not Supplied

PUBLIC ADDRESS=

PUBLIC TELEPHONE=

EMAIL ADDRESS= faith@deltaenvironmental.com.au

[LOCATION DETAILS]

ADDRESS= Lake Indawarra Dump Road

SUBURB= Tintinara

STATE= SA

POSTCODE= 5266

DEPOSITED PLAN NO= 0

SECTION & HUNDRED NO= 0

PROPERTY PHONE NO=

SIDE OF STREET= NE

INTERSECTION= Northcott Tce

DISTANCE= 0-525m SE

ACTIVITY CODE= 15

ACTIVITY DESCRIPTION= Mechanical Excavation

MAP TYPE= Satopo

MAP REF= 6926G3

MAP PAGE=

MAP GRID 1=

MAP GRID 2=

MAP GRID 3=

MAP GRID 4=

MAP GRID 5=

GPS X COORD=

GPS Y COORD=

PRIVATE/ROAD/BOTH= P

TRAFFIC AFFECTED= No

NOTIFICATION NO= 3331732

MESSAGE= Digging around Lake Indawarra.

MOCSMESSAGE= Digsafe generated referral

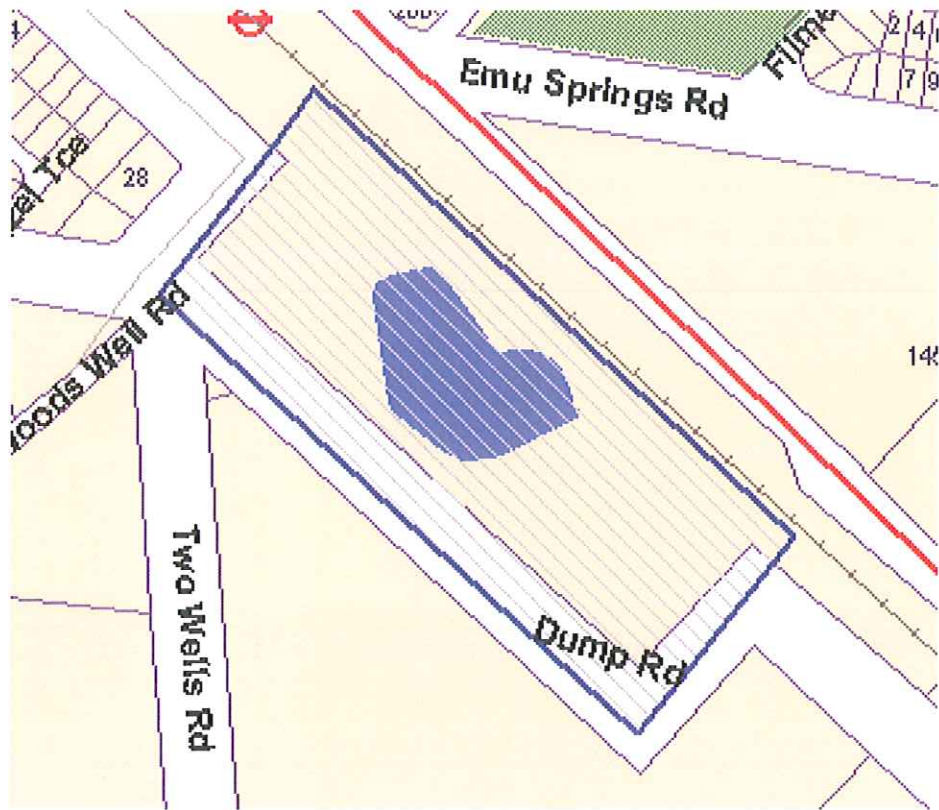
Notice: Please DO NOT REPLY TO THIS EMAIL as it has been automatically generated and replies are not monitored. Should you wish to advise Dia

Before You Dig of any issues with this enquiry, please Call 1100

(See attached file: 3331732_LLGDA94.GML)(See attached file: 3331732.GI

NO ETSA CABLING
SHOWN ON PLANS
DATE 20/4/09

WENDY STEELE
PH 8282 1542
FAX 8282 1587



IMPORTANT NOTICE FOR USERS OF CABLE LOCATION INFORMATION SUPPLIED BY ETSA UTILITIES

RELIABILITY OF DATA

The data contained in the attached plan is indicative only as to cable location and cable depth. The depth of cable, particularly, may be affected by subsequent road works. There may also be a delay between cable work being carried out and the updating of our plans which means that the attached plan may not be up to date.

COMPLETENESS OF DATA

The attached plan will **not** show any underground electrical services not owned or operated by ETSA Utilities. In particular, it will **not** show any underground connection to a customer's premises.

RECOMMENDED USE OF DATA

It is recommended that if you intend to dig within 5 metres of the location of a high voltage cable indicated on the attached plan:

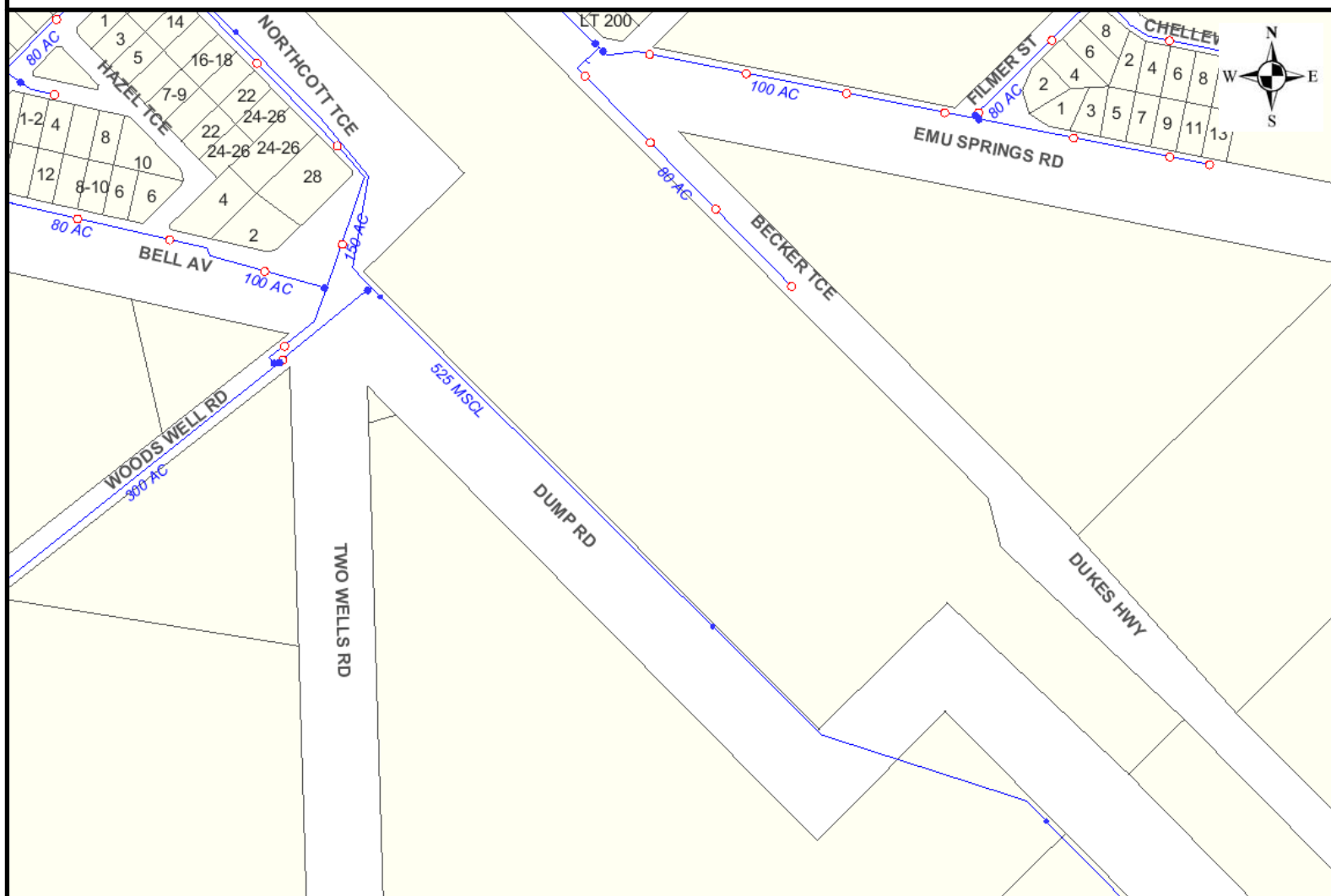
- a. You obtain an on-site cable location form from ETSA Utilities [contact: 8292 0218] or some other professional cable locating service to accurately locate the cable. ETSA Utilities will provide such a cable location service on a "cost recovery only" basis and will also advise whether other safeguards can be implemented to prevent an electric shock event; and
- b. When excavating within 1 metre of a cable following an on-site cable location or where it is suspected that a cable may be located, following removal of top soil or hard surface, hand digging should be carried out until the cable is physically located; and
- c. **NOTE:** If the cable is indicated to be **66KV** or above and you intend to dig within 5 metres of the location of the **66KV** cable indicated on the attached plan, you must contact the ETSA Utilities Cable Management Technical Officer on (08) 8292 0459 or 0403 582 130 for a site-specific clearance.

BASIS OF SUPPLY OF DATA

Because it is your choice whether or not to undertake an on-site location service in order to obtain completely reliable information as to the location of electrical cable and because this information has been provided to you by ETSA Utilities without charge and without any obligation to do so;









- a. ETSA is not responsible for any inaccuracy or incompleteness of the information provided by you as to your requirements for cable locating or for the interpretation of that information in determining the data requested or required by you;
- b. ETSA is not responsible for any inaccuracy or incompleteness in the attached plan or the data contained in the attached plan; and
- c. ETSA is not responsible for any failure by you to properly interpret or use the attached plan or the data supplied in the attached plan; and
- d. To the greatest extent permitted by law the application of any law which would impose any obligations on ETSA Utilities concerning the supply of the attached plan to you is expressly excluded.
- e. It is an offence, under the Electricity Industry of SA Acts & Regulations, to excavate or open the ground so as to cause damage to ETSA Utilities underground cables.

If you do not accept these conditions then you should not use the data contained in the attached plan and you should undertake an on-site cable location.





Enquiries: (08) 8207 1480
Facsimile: (08) 8207 1483
DIAL.BEFORE.YOU.DIG@sawater.com.au

Water Valves

-  Locked
-  Not locked
-  Other
-  Water Valves (Abandoned)
-  Water Pillar Hydrants
-  Water Hydrants
-  Water Connections
-  Water Connections (Abandoned)

Water Mains Planning

Water Mains

-  Not Allocated
-  Potable - Non Potable Area
-  Potable - Drinking Water
-  Non-Potable
-  Water Mains (Abandoned)
-  Land Parcels



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Lake Indawarra Dump Rd Tintinara
15699423

Report generated : 10:43:48 20/04/2009

Scale 1:4982 (@ A4)



Enquiries: (08) 8207 1480

Facsimile: (08) 8207 1483

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- Wastewater Maintenance Shaft
- Wastewater Maintenance Hole
- Wastewater Inspection Opening

Wastewater GIP

● Location Pending

● Location Known

● Wastewater Valves

● Wastewater Valves (Abandoned)

— Wastewater Ancillary Pipes

— Wastewater Ancillary Pipes (Abandoned)

— Wastewater Connections

— Wastewater Connections (Abandoned)

— Wastewater Mains Planning
Wastewater Pumping Mains*

— Standard

— Sludge

— Effluent Outfall

— Other

— Wastewater Low Pressure

— Wastewater Vacuum Mains

— Wastewater Gravity Mains



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20/04/2009

Scale 1:4982

(@ A4)



Enquiries: (08) 8207 1480

Facsimile: (08) 8207 1483

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Recycled Water Main Labels

Recycled Water Valves

Recycled Water Mains Planning

Recycled Water Connections

-  Abandoned
-  Gazetted
-  Recycled Water Mains
-  Abandoned
-  Abandoned and Replaced
-  Other
-  Land Parcels



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Lake Indawarra Dump Rd Tintinara
15699423

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Enquiries: (08) 8207 1480

Facsimile: (08) 8207 1483


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-  Salt Interception Attachments
-  Salt Interception Valves
-  Salt Interception Observation Bores

-  Salt Interception Production Bores


-  Salt Interception Pumps


-  Salt Interception Structure Outlines

Salt Interception Main Labels

-  Salt Interception Mains
-  Salt Interception Mains (Shared)

-  Salt Interception Mains (Bookpurnong)

-  Salt Interception Mains (Loxton)

-  Salt Interception Mains (Qualco)

-  Salt Interception Mains (Waikerie)

-  Salt Interception Mains (Woolpunda)



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Lake Indawarra Dump Rd Tintinara

15699423

Report generated : 10:43:48

20/04/2009

Scale 1:4982

(@ A4)

PO Box 7710
Melbourne VIC 8004
Phone: 1100
Fax: 1300 652 077
www.dialbeforeyoudig.com.au

**DIAL BEFORE YOU DIG
Utility Notification**



Please be advised the person below has requested information about underground assets in your area of interest. You are requested to respond within 2 working days and reference the both Sequence number and Job number.

To:	Dean Button	Sequence No:	15699427
Utility:	90077	Start Date:	20/04/2009
Enquiry Date:	16/04/2009 4:47:45 PM	Priority Type:	Normal - Phone

Caller Details

Customer Id:	810559	Phone:	0882805910
Contact:	Mrs Faith Cook	Mobile:	0429802191
Company:	Delta Environmental	Fax:	Not Supplied
Address:	12 Beach Rd St Kilda Sa 5110	Email:	faith@deltaenvironmental.com.au

Location Details

	Address:	Lake Indawarra Dump Road Tintinara SA 5266
	Intersection:	Northcott Tce
	Side of Street:	NE
	Distance:	0-525m SE
	Activity Code:	15 - Mechanical Excavation
	Location Type:	Private Property
	For Planning:	No
	Traffic Affected:	No
	GPS X Coord:	
	GPS Y Coord:	
Parcel ID:		

Map Ref: SATOPO 6926G3

Additional work site information: Digging around Lake Indawarra.

DBYD Message: Visit our new Web site - www.dialbeforeyoudig.com.au

END OF TRANSMISSION

Job No: 3331732

8.4 Compiled action table

Description	Timing	Responsible party	Approx cost (external)	Approx cost (labour)
Shaping the island for aesthetic and habitat value	Once only, current.	Action Club (EnviroFund)	\$8,000	
Finish circuit path	As soon as practicable	Coorong District Council	\$650	\$400
Reshaping of lake bed as per the proposed alterations diagram, and removal of sediment.	Once only, ASAP	Tintinara Action Club (Coorong District Council)	\$14,000	\$7,000
Construction of swales & rills to redirect road / track runoff	Once only, ASAP	Coorong District Council	\$1,200	\$900
Sediment and water quality monitoring	Monthly, ongoing	Tintinara Area School / community members	\$140 per annum	\$1,200 p.a.
Preparation and installation of interpretive signage along circuit path	Winter 2009	Action Club (EnviroFund)	\$3,485	\$500
Weed control	Spring and Autumn	Action Club / Coorong District Council / NRMB	\$150 p.a.	\$260 p.a.
Remove rubbish from in and around lake	Clean Up Aust Day, annually.	Action Club and other community members	\$100 p.a.	\$260 p.a.
Augmentation planting in remnant vegetation	Annual, early winter.	Tintinara Area School / Coorong LAP	\$5,000 (total)	\$4,100 (total)
Augmentation planting in remnant vegetation	Annual, early winter.	Tintinara Area School / Coorong LAP	\$5,000 (total)	\$4,100 (total)
Planting island with tube stock to stabilise sediment	July 2009 & 2010	Tintinara Area School / Coorong LAP	\$1,100	\$1,200
Installation of mechanical aeration infrastructure.	Summer, 2010	Action Club	\$14,000	\$5,000
Plantings to improve water quality.	Winter 2010	Tintinara Area School / Coorong LAP	\$5,000	\$4,400
Installation of picnic facilities in the Boat Shed and on the lawn area.	April, 2010	Coorong District Council	\$7,000	\$2,400
Construction of gabions on North-eastern side of lake (2m x 2m x 85m).	Once only, Autumn 2010-11.	Action Club	\$13,600 - \$20,400 (gabions) \$1,530 - \$2,295 (geotextile)	
Lake edge plantings	Autumn 2010-2012	Tintinara Area School / Coorong LAP	\$1200	\$300
Encouraging submergent vegetation	Autumn 2010-2013	Action Club / Coorong LAP	\$500	\$150
Construction of a 60-80m boardwalk	2013	Action Club	\$19,500 - \$38,000, depending on material, treatments, length etc.	
Construction of a 25-50m ² viewing platform	2013	Action Club	\$3,000 - \$13,500, depending on material, treatments, support structure and final size.	



8.5 Details of the consultants



Delta staff members have extensive experience with providing high quality environmental information to Commonwealth, State, Regional and Local governing bodies, to assist with operational and policy making decisions. Regular clients include a range of metropolitan Councils, regional Councils, the Department for Environment and Heritage, the Adelaide and Mount Lofty NRM Board, the South Australian Environment Protection Authority and the Department for Transport, Energy and Infrastructure.

In the mining, agricultural and industrial sectors Delta personnel provide technical services varying from environmental and biological assessments and water quality testing to solar saltfield and evaporative basin operational advice.

Peri Coleman



Peri Coleman (M AppSc - Environmental Management and Restoration) has extensive experience in identifying intertidal and terrestrial flora and fauna of the mainland states and Tasmania, conducting biological surveys, and producing reports and educational materials.

Her main interests include biological survey work, revegetation and rehabilitation, scientific illustration and desktop publishing, preparation of herbarium and museum specimens, management plans, taxonomy and classification, solar salt field biology, environmental education programs, computer application development, wetland studies and mangrove and samphire ecosystems.

Peri owns, and is senior consultant for, Delta Environmental Consulting. She is a long standing member of the Coast Protection Board, assisting Branch staff by representing the Board on committees including the Adelaide Coastal Waters Study, the Estuary Policy Group and the Sea Level Rise Advisory Committee.

Peri has a strong commitment to research, with several recent papers accepted for international publication. She is a fellow of the Royal Society of South Australia and member of the International Society for Salt Lake Research.

Faith Cook

Faith Cook (Grad Dip GIS & Remote Sensing, Dip Environmental Management) is employed by Delta Environmental Consulting to provide technical and consulting services. Faith has strengths in Natural Resource Management policy, remote sensing, statistics and biometrics.

Faith spent two years preparing and starting implementation of the Tintinara-Coonalpyn Land and Water Management Plan. Faith's duties included community empowerment, issues documentation, community & stakeholder consultation, interagency liaison, management of salinity risk assessment and GDE consultancies, media relations, peer mentoring and grant applications.

Faith provides services in the areas of GIS and mapping, policy development, environmental risk assessments, water quality management, laboratory testing, fieldwork, and desktop design. She has extensive project management experience, regularly working to tight timeframes, often in situations that require significant systems analysis and prioritization.

Faith's interests include saltlake research, kayaking and radio telemetry. She has an Australian Communications Authority Amateur Radio Operator license, a CAMS official license and a Marine band license for operation of marine emergency systems. She is a Resource Leader for Guides Australia, providing mentoring and leadership opportunities to teenage youth. Faith is a fellow of the Royal Society of South Australia and a member of the International Society for Salt Lake Research. Her current research interests include diatom ecological preferences, and samphire ecology.



Detailed CVs for each of these team members is available for download from www.deltaenvironmental.com.au.