6. Entrance Behaviour

6.1 Characteristics of ICOLLS

Intermittently closed and open lakes and lagoons (ICOLLs) are created in wave-dominated entrances when the wave action becomes so dominant that entrance closure occurs on an intermittent basis (Hanslow et al. 2000). ICOLLs go through a cyclical process of infilling and berm formation due to wave action and subsequent breaching and scour due to fluvial action.

Due to their intermittent closure ICOLLS are linked to specific management issues such as water quality problems, periodic flooding of areas below berm level, algal blooms and odour. Over three-quarters of the ICOLLs in NSW are artificially opened for reasons of poor water quality or flooding. The most common justification for the artificial opening of lagoon entrances is for flood mitigation (Lugg 1998). When Saltwater Creek entrance closes, the community perceives a problem with water quality and high water levels. Council generally mechanically opens the entrance prior to school holidays in December. When Council fails to do so, local residents are known to open the creek mouth (pers. comm. A. Mayne 2001).

The hydrology of the lagoon is determined by the frequency and duration of entrance opening. Lagoons with permanently open entrances tend to have relatively stable water levels, varying across the tidal range on a twelve-hour cycle (Lugg 1998). This is similar in open conditions for intermittently opening lagoons. More extreme conditions exist within closed entrance conditions. Water levels tend to be stable on a daily basis, but vary to a much greater extent over a time scale of months. Salinity can vary from hypersaline during droughts to near-fresh during floods.

Under natural conditions the frequency and duration of closure of estuarine entrances is influenced by a number of factors including the morphology of the entrance site, exposure of the entrance site to the processes of longshore drift, the size of the catchment, the tidal prism and prevailing climatic conditions (Lugg 1998). Regular artificial opening can degrade wetland and riparian vegetation, reduce fishery production in the long term and contribute to a decline in regional biodiversity (Hanslow et al. 2000) (see Section 6.5).

ICOLLs have a natural breakout range and an artificial opening within this range is not likely to have significant environmental effects. They can be considered part of the natural variation of the system. Continued artificial opening of the entrance at a level within the natural range is likely to have significant impact since the frequency distribution will be altered (Lugg 1998). Continued artificial opening at a level outside the natural range is expected to have large impacts on the system, especially on ecological processes. Conceptual frequency distribution curves for natural and artificial breakouts are presented in Figure 6.1.

6.2 Historical Assessment of Entrance Characteristics

6.2.1 Wave Climate

The wave climate at South West Rocks may be inferred from data from the Crowdy Head Waverider buoy operated by MHL which is located in 79 m of water about 10 km east of Crowdy Head (approximately 110 km south of South West Rocks). Long-term statistical analysis of this data is available from 10 October 1985 to date and includes deepwater wave direction from hindcasting from October 1985 to December 1996. A summary of wave height exceedance statistics for the period 10 October 1985 to 31 December 1999 is shown in Figure 6.2 and directional statistics are presented in Figure 6.3.

6.2.2 Storm History

Storms are generally defined as events in which the significant wave height (Hs) exceeds 3 m. Storm events recorded by the Crowdy Head Waverider buoy from 1985 to 1999 where Hs exceeded 5 m are listed in Table 6.1.

Table 6.1 Occurrence of Significant Waves H_s > 5 m at Crowdy Head for Period 1985 to 1999

Storm Start Date	Storm End Date	Peak H_s (m)	Mean T_s (s)	Peak Direction
12-May-86	15-May-86	5.1	8.1	E
4-Aug-86	12-Aug-86	5.9	10.1	SE
12-Nov-87	13-Nov-87	5.9	9.6	S
8-Feb-88	11-Feb-88	6.5	10.6	S
9-Apr-88	12-Apr-88	5.0	9.9	SSE
24-Aug-88	25-Aug-88	5.0	9.6	SSE
23-Apr-89	30-Apr-89	5.3	9.0	E
20-Jun-89	25-Jun-89	5.8	10.2	ESE
26-Sep-89	29-Sep-89	5.8	10.0	SSE
7-Mar-90	10-Mar-90	6.3	10.4	SSE
28-May-90	30-May-90	6.7	9.2	SE
24-Aug-90	28-Aug-90	5.0	10.0	SSE
12-Oct-90	15-Oct-90	6.4	11.1	S
8-Jun-91	11-Jun-91	5.0	9.0	E
30-Nov-92	2-Dec-92	5.2	9.6	SE
12-Mar-94	15-Mar-94	5.3	11.0	S
7-Sep-94	9-Sep-94	5.0	11.2	S
2-Mar-95	5-Mar-95	7.4	9.9	ESE
6-Mar-95	8-Mar-95	6.3	10.4	E
5-Sep-95	8-Sep-95	5.1	10.8	S
25-Sep-95	28-Sep-95	5.4	10.0	SSE
19-Aug-96	20-Aug-96	5.8	9.9	S
9-May-97	12-May-97	6.3	10.1	SSE
4-Feb-99	5-Feb-99	5.3	9.8	E
22-Apr-99	25-Apr-99	6.5	11.2	ESE
13-Jul-99	17-Jul-99	6.8	10.5	ESE
9-Nov-99	12-Nov-99	5.0	11.0	SSE

As waves propagate from deep water onto the continental margin their speed and direction may be altered by the decreasing water depth. Waves approaching at an angle are refracted, or bent, such that their wave crests tend to align more parallel to the shore. The net longshore transport rate depends on the prevailing wave conditions. At South West Rocks the dominant angle of approach of waves (neglecting local wind waves) is from between east and south with waves from between north and east occurring less than 5% of the time. Net longshore transport is consequently strongly to the north and hence across the entrance at Saltwater Creek.

Storm waves often occur in conjunction with strong winds that effectively cause an increase in the general ocean level in addition to the tides. If the entrance is closed the combination of high water level and high waves may result in waves overtopping the entrance berm, transporting salt water and sediment into the creek. In general the waves cause onshore sediment transport but during high waves the shoreline erodes and these events may enhance the entrance berm breakout. When the entrance is open these events can effectively cause increased exchange of ocean waters with previously resident lagoon/creek waters.

6.3 Effect of Sea Level Rise on Entrance Conditions

Over the next 100 years the global mean temperature and sea level are expected to rise due to an increased 'greenhouse effect'. The greenhouse effect is a predicted global warming associated with the build-up of certain gases in the atmosphere. Greenhouse gases are essentially transparent to incoming short-wave solar radiation, but they absorb the longer wavelength infrared radiation (heat) emitted by the earth. Thus heat is trapped in the atmosphere and the global temperature is increased.

The most up-to-date estimates of temperature and sea level rise are those provided by the International Panel on Climate Change (IPCC). In the third assessment report of 2001 (Albritton et al. 2001), the IPCC predicts an increase of global averaged surface temperature of 1.4 to 5.8°C over the period 1990 to 2100. The range is due largely to uncertainty in the amounts of greenhouse gases which nations will emit and the use of a variety of different climate models. The projected temperature increases are higher and display a wider range than those in the IPCC second assessment report of 1995 (Houghton et al. 1996). Since then a greater understanding of climate change has developed due to improved data analysis and modelling techniques.

'Global warming' is associated with sea level rise as a result of thermal expansion of the oceans and melting of glaciers and ice-sheets. Despite higher temperature change projections in the IPCC third assessment report, the sea level rise projections are slightly lower compared to earlier assessments. This is due to improved models which give a smaller contribution from glaciers and ice-sheets. The latest projected global mean sea level rise is 0.09 to 0.88 m between 1990 to 2100 (Albritton et al. 2001).

Increased sea level is expected to lead to general beach recession. Concerning ICOLLs, beach recession is expected to be accompanied by landward and upward translation of the entrance berm (Hanslow et al. 2000). This results in higher lagoon levels and a higher flood risk to shoreline development.

Besides sea level and temperature rise another possible effect of climatic change is a change in weather patterns through changes in wind and precipitation patterns. These changes may severely affect coastal areas, including foreshore alignment and stability, siltation, shoal formation and foreshore inundation levels. These potential changes need to be accommodated in planning foreshore development, facilities and services.

6.4 Berm Height and Flooding

Berms are depositional features on beaches that develop as a result of wave runup and overwash. Berm development represents the final stage in an entrance closure. The formation of berms (shown in Figure 6.4) occurs when sediment is deposited near the limit of wave runup as the wave velocity decreases due to gravity, friction and percolation. If the wave height remains constant vertical growth of the berm continues until the berm height equals the maximum height of the wave runup. Higher waves produce higher berms but above the critical erosion-accretion threshold higher waves erode the beachface leading to rapid berm removal (Hanslow et al. 2000).

Berm levels at ICOLLs on eastern facing NSW coastline may be up to 3.5 m AHD and higher. The entrance of Saltwater Creek into Trial Bay faces north and has a lower energy wave climate resulting in berm heights that reach ~2 m AHD (pers. comm. D. Hanslow). Mounser (1981) presents a maximum berm height of 1.45 m and recent berm surveys recorded berm heights under closed conditions of 1.6 to 1.8 m (Kempsey Shire Council).

If an entrance management strategy of allowing the berm to open naturally were to be adopted (see discussion in Section 6.6), then it is possible that the berm may attain a level of about 3 m AHD, similar to the berm height on the beach immediately east of the entrance. In the event of a significant rainfall event the likely area of flood risk is shown in Figure 2.1, which was assumed to coincide with the 4 m contour. This area includes possible residential blocks near Arakoon and along the southern bank of Saltwater Creek. For a berm height of 2 m the flood risk area would be similar to that estimated by Mounser (1981), whose ocean tailwater level was set at 2 m (see Section 2.9).

While there is insufficient information at present to predict the impacts of flooding with various berm heights on the local surroundings, water levels and berm height are likely to be directly related and thus the area of wetland and infrastructure affected by inundation is also likely to increase with berm height. As recommended in Section 2.9, a detailed flood study that takes into account berm conditions will provide valuable information for management of the entrance, stormwater inputs and flooding in the catchment.

6.5 Effects of Entrance Opening Strategies on Fringing Flora and Fauna

Entrance manipulation has the potential to have a large effect on the biota of the lagoon and creek. Fringing wetland communities are affected by changes in water level, as floods are an important component for the maintenance of such vegetation. Regular and repeated breakouts may degrade these wetlands and other riparian vegetation, particularly if continued opening below the ‘natural breakout range’ is practised. Breaching the barrier can also result in the oxidation of sediments and decomposition of aquatic vegetation, resulting in malodorous

conditions and deoxygenation of the water column, which may affect fish and other fauna within the lake. Conversely, periods of prolonged high water can also lead to deterioration in water quality, due to inputs of nutrients and pollutants from the surrounding catchment and the inundation of adjacent urban areas.

In general, the assemblage structure of intermittently open lagoons is linked strongly to the timing and duration of entrance opening. Over the longer term, intermittently open estuaries tend not to support biota that is strongly dependent on tidal range, e.g. mangroves. However, the presence of mangroves within the lagoon suggests that the creek is open to the ocean frequently enough for these species to persist.

Given the strong linkages between estuaries and other aquatic habitats, the regime of opening and closing of intermittent lagoons becomes critical to the ecology of many species. Pollard (1994) compared the assemblages of three NSW lagoons and found that overall, species richness in the permanently open lagoon (Lake Conjola) was approximately 2.5 times that of each of two intermittently open lagoons (Swan and Wollumboola lagoons). The two intermittently open lagoons were, however, found to support larger fisheries (in terms of both catch weight and value) than the permanently open lagoon, in spite of the larger number of species in the latter and also its greater water surface. In another intermittently open lagoon in NSW (Shellharbour), species diversity was found to increase after lagoon opening (Griffiths 1998). Allen et al. (1985) found that species richness was variable and dependent on the duration and timing of lagoon opening coinciding with recruitment periods. In addition to effects on migration and reproduction, lagoon entrance changes can affect water quality, which can, in turn, affect fish ecology within the lagoon.

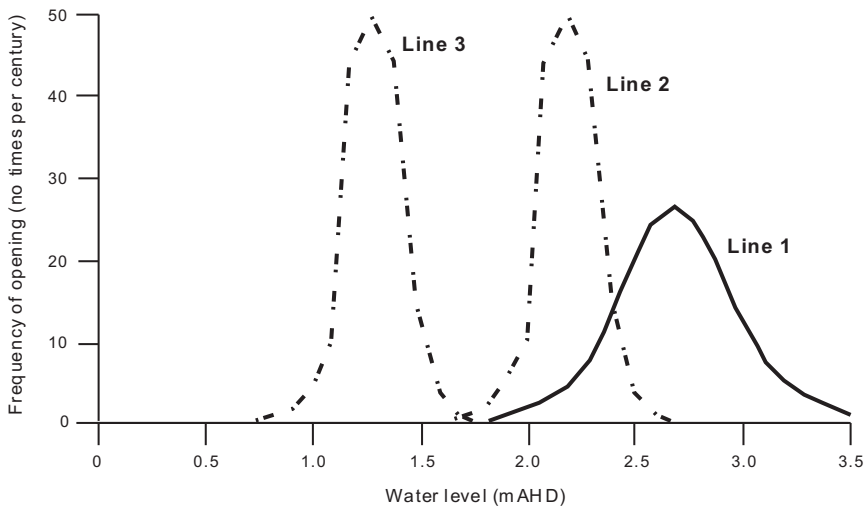
6.6 Entrance Management Strategies

The entrance has been artificially opened for a number of years either by Council or local residents. Recent changes in legislation now require entrance managers seek permission from NSW Fisheries and DLWC prior to carrying out any works. The optimal entrance opening regime can only be determined through careful consultation and environmental impact assessment. Presently there is not sufficient information, firstly on the times the entrance was opened and for how long it remained open, and secondly on the environmental condition following the opening.

There are a number of conflicting arguments about the merits of opening the entrance, and at the most recent request Fisheries refused permission on the grounds that it was better for fish recruitment processes. Recreational users of the creek waters near the entrance and at the caravan park would prefer the entrance to be opened more frequently while bird habitat enthusiasts and Fisheries promote a more ‘natural’ longer closure to assist fish and bird species. The water quality has probably declined over decades due to increased loads and hence it may be argued that more frequent opening will enhance flushing and reduce the risk of flooding. Counter to this argument enhanced flushing will also cause greater saline ingress and a shift to more salt-tolerant species that will affect biodiversity.

Selection of an optimal strategy will depend on an agreed set of environmental targets, an improved understanding of the key processes affecting these targets and the influence of entrance condition on the processes.

As described above the optimal strategy will necessarily be a compromise between the various environmental, social and economic interests. Future management options will be developed during the management study and plan phase with full community and stakeholder consultation. This process will involve debating a range of scenarios from doing nothing to developing comprehensive stormwater management strategies and managing the entrance to achieve an agreed set of objectives.



Line 1 - Natural breakout frequency curve. Upper and lower limits define natural breakout range

Line 2 - Artificial breakout frequency curve for a level set within the natural breakout range (in this case 2.2m)

Line 3 - Artificial breakout frequency curve for a level set below the natural breakout range (in this case 1.3m)

(Note: each of these lines represents exactly the same frequency of breakout i.e. 175 times per century)

Source: Lugg, A. 1998

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CONCEPTUAL FREQUENCY DISTRIBUTION CURVES FOR NATURAL AND ARTIFICIAL BREAKOUTS OF ICOLLS

MHL Report 1126
Figure 6.1
DRAWING 1126-06-01.CDR

EXCEEDANCE STATISTICS FOR CRHDC

Public Works Department, NSW
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Nominated start/finish: 10-OCT-85 to 31-DEC-99
Data start/finish: 10-OCT-85 to 31-DEC-99

Creation date: 13-JAN-00
Maximum value: 7.35 recorded on 04-MAR-95
Minimum value: 0.42 recorded on 04 JUL 92

PERCENTAGE EXCEEDANCES FOR HSIG IN METRES

HSIG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	HSIG
0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.000	0.00
0.25	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.000	0.25
0.50	100.00	100.00	99.99	99.94	99.89	99.94	99.94	99.94	100.00	99.80	100.00	100.00	99.953	0.50
0.75	98.02	99.05	98.82	98.07	96.43	96.88	97.43	95.98	98.16	96.57	98.15	98.08	97.617	0.75
1.00	83.32	90.34	93.86	89.31	85.86	88.30	87.10	84.41	86.10	80.86	86.06	83.87	86.468	1.00
1.25	62.91	70.94	80.58	70.97	68.73	70.72	70.83	65.95	65.99	58.12	64.50	62.19	67.508	1.25
1.50	42.52	48.47	59.73	51.92	52.48	54.56	52.37	49.89	46.89	40.29	42.91	40.18	48.339	1.50
1.75	25.57	33.88	42.02	37.23	38.36	39.31	37.27	35.55	31.19	27.36	27.77	26.35	33.331	1.75
2.00	15.66	23.24	28.33	24.79	25.72	26.67	25.51	26.17	21.22	17.96	18.10	16.99	22.416	2.00
2.25	8.83	16.31	19.53	16.25	16.41	18.40	16.91	19.07	14.15	11.76	11.73	10.92	14.935	2.25
2.50	4.36	11.26	13.86	10.85	10.39	11.84	11.41	14.07	9.37	7.71	7.56	6.84	9.896	2.50
2.75	2.24	8.14	9.12	7.81	6.37	8.38	7.61	9.85	6.12	5.55	4.97	4.01	6.628	2.75
3.00	0.98	5.68	6.27	5.81	3.96	5.95	4.55	6.98	4.52	3.99	3.23	2.36	4.480	3.00
3.25	0.44	3.83	4.27	4.45	2.92	4.25	2.83	4.69	3.49	2.75	2.12	1.20	3.066	3.25
3.50	0.14	2.36	3.30	3.33	2.15	3.18	1.79	3.37	2.64	1.87	1.26	0.69	2.142	3.50
3.75	0.03	1.57	2.49	2.37	1.34	2.23	1.14	2.32	1.75	1.33	0.77	0.37	1.453	3.75
4.00	0.02	0.96	1.93	1.65	0.82	1.51	0.86	1.56	1.17	0.87	0.48	0.25	0.990	4.00
4.25	0.00	0.71	1.62	1.16	0.55	1.07	0.68	0.92	0.83	0.51	0.30	0.21	0.698	4.25
4.50	0.00	0.52	1.24	0.82	0.38	0.69	0.51	0.58	0.62	0.31	0.17	0.15	0.495	4.50
4.75	0.00	0.32	1.01	0.52	0.32	0.33	0.47	0.44	0.35	0.14	0.09	0.10	0.333	4.75
5.00	0.00	0.21	0.74	0.26	0.24	0.19	0.43	0.27	0.23	0.11	0.05	0.03	0.224	5.00
5.25	0.00	0.17	0.60	0.17	0.17	0.08	0.36	0.16	0.13	0.07	0.04	0.00	0.157	5.25
5.50	0.00	0.12	0.43	0.15	0.15	0.04	0.24	0.09	0.07	0.04	0.01	0.00	0.108	5.50
5.75	0.00	0.11	0.34	0.13	0.09	0.01	0.18	0.03	0.01	0.02	0.01	0.00	0.075	5.75
6.00	0.00	0.07	0.27	0.09	0.07	0.00	0.12	0.00	0.00	0.02	0.00	0.00	0.051	6.00
6.25	0.00	0.04	0.18	0.01	0.03	0.00	0.08	0.00	0.00	0.01	0.00	0.00	0.028	6.25
6.50	0.00	0.00	0.10	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.009	6.50
6.75	0.00	0.00	0.09	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.007	6.75
7.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.003	7.00
7.25	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001	7.25

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Number of data points used for statistical analysis:	8703	8022	8204	8762	9149	9043	9278	9298	8535	9091	10418	9898	108398
Percent capture based on Data start/finish:	83.53	82.74	78.76	86.92	87.84	89.71	89.07	89.27	94.67	83.13	96.46	88.70	86.78
Percent capture based on Nominated start/finish:	83.53	82.33	78.76	86.92	87.84	89.71	89.07	89.27	84.67	83.07	96.46	88.70	86.74
Average value:	1.49	1.67	1.80	1.69	1.66	1.71	1.68	1.68	1.61	1.52	1.55	1.51	1.63

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MANLY HYDRAULICS LABORATORY

CROWDY HEAD
WAVE HEIGHT EXCEEDANCE STATISTICS
OCTOBER 1985 TO DECEMBER 1999

MHL Report 1126

Figure 6.2

DRAWING 1126-06-02.CDR

NSW DEPARTMENT OF PUBLIC WORKS AND SERVICES
MANLY HYDRAULICS LABORATORY

CROWDY HEAD
DIRECTIONAL STATISTICS
OCTOBER 1985 TO DECEMBER 1999

MHL Report 1126
Figure 6.3
DRAWING 1126.6.3.CDR

MHL1126 - 75

OCCURRENCE STATISTICS FOR CRHDO

Nominated start/finish: 10-OCT-85 to 31-DEC-99
Data start/finish: 10-OCT-85 to 31-DEC-99

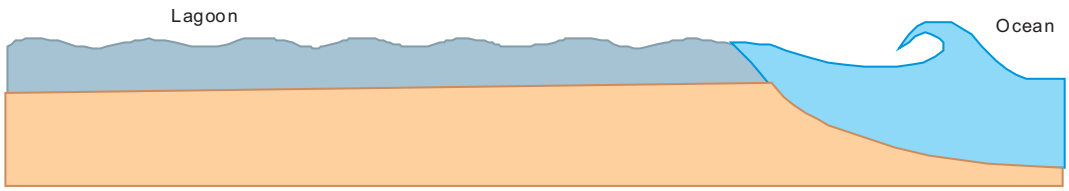
Creation date: 29-AUG-01

Wave direction origin:
Hindcast - 100 %

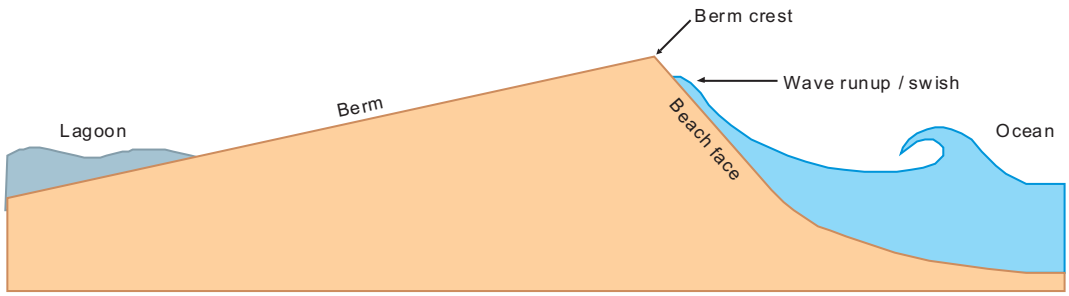
Public Works Department, NSW
Manly Hydraulics Laboratory
1101B King Street
MANLY VALE NSW 2093

PERCENTAGE OCCURRENCE FOR WAVE_DIRECTION IN DEGREES FROM TRUE NORTH

DIRN	DEG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
N	348.75 - 11.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
NNE	11.25 - 33.74	1.17	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.58	0.52	0.255
NE	33.75 - 56.24	8.67	1.73	2.48	2.79	2.55	1.78	1.61	2.61	6.66	13.61	9.83	13.71	5.852
ENE	56.25 - 78.74	16.36	11.99	10.03	9.85	7.63	4.20	7.82	6.96	11.36	12.50	17.28	15.60	11.085
E	78.75 101.24	20.35	23.13	21.59	22.81	17.60	18.41	11.33	14.25	14.90	11.00	13.93	17.91	17.131
ESE	101.25 123.74	20.81	23.62	23.34	16.55	21.10	20.41	22.38	15.81	15.82	13.01	13.88	13.96	18.229
SE	123.75 - 146.24	17.81	23.62	21.56	21.99	27.75	26.57	27.65	31.89	20.99	22.33	23.00	17.40	23.541
SSE	146.25 - 168.74	8.03	10.74	12.86	15.38	14.04	15.38	14.65	15.80	17.45	14.71	11.26	9.98	13.289
S	168.75 - 191.24	6.78	5.18	8.15	10.66	8.69	13.25	14.56	12.68	12.83	12.84	10.24	10.92	10.619
SSW	191.25 - 213.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
SW	213.75 - 236.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
WSW	236.25 - 258.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
W	258.75 - 281.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
WNW	281.25 - 303.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
NW	303.75 - 326.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
NNW	326.25 - 348.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Number of days used for statistical analysis:		287	270	269	281	297	302	298	297	270	294	354	332	3550
Percent capture based on Data start/finish:		84.30	85.30	78.85	85.03	87.15	91.38	87.46	87.10	81.70	88.97	98.19	89.12	86.44
Percent capture based on Nominated start/finish:		84.30	84.77	78.85	85.03	87.15	91.38	87.46	87.10	81.70	88.90	98.19	89.12	86.39
Average direction:		105.39	113.99	117.31	120.04	121.57	127.19	128.33	127.84	121.44	115.48	111.62	106.79	118.23



Open entrance conditions



Closed entrance conditions

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BERM FORMATION AS A RESULT OF WAVE RUNUP

MHL Report 1126
Figure 6.4
DRAWING 1126-06-04.CDR

7. Estuary Sediments

7.1 Introduction

Little information exists on the sediment characteristics and processes operating in Saltwater Creek and lagoon. At the time of preparing this report no known sediment sampling programs have been undertaken in the creek or lagoon. These investigations would provide new insights into the sources of sediments infilling the estuary, long-term rates of estuarine infilling and levels of sediment contamination in Saltwater Creek/Lagoon.

A conceptual model of estuarine sedimentation in Saltwater Creek has been produced based on results of previous studies on similar systems and preliminary observations (Figure 7.1). Limited sediment sampling by DLWC conducted in 2001 qualitatively confirms the boundaries shown in Figure 7.1.

Major depositional environments within the study area include sandy fluvial deltas and estuarine mud basin deposits. The fluvial deltas occur in the entrance of the creek and are comprised of coarse grained marine sands washed in by wave action while the creek is open and by wind erosion from the beach/dune system. Mud basin sediments (organic rich muds and sandy muds) accumulate in the deeper sections of the estuary further away from the entrance and appear to be derived from both local (Saltwater catchment) and remote (Macleay River catchment) sources.

The shape of the system, with a broad lagoon area that captures most of the runoff from the catchment separated from the ocean by a long creek, suggests that most material entering the lagoon is trapped in the lagoon and surrounding wetlands.

7.2 Littoral Transport

The entrance sediment dynamics are influenced by the littoral sediment transport along the beach, transport within the channel due to tidal and flood flow currents and aeolian sand drift along the aerial beach. The entrance channel is comprised of marine sands indicating a net ingress of marine sediments.

There are no known studies of littoral transport rates in the vicinity of South West Rocks and in particular near the Saltwater Creek entrance. In general there is a south to north littoral drift along the NSW coast that is relatively small south of Newcastle and gradually increases toward the maximum rate between Byron Bay and Tweed Heads.

Littoral transport is the major factor affecting the entrance closure. From the available water level data it appears the entrance may be blocked by littoral transport within a week of its opening.

7.3 Creek Morphology, Sediment Erosion and Deposition

Aerial photographs of Saltwater Creek have been examined from 1956, 1980, 1988 and 1993, with some interesting observations made concerning creek morphology over time. Inferences regarding changes in sediment erosion and deposition patterns can be made from these observations.

In 1956 the lower reaches of the creek were wide and meandering and from the photograph it is difficult to see clear boundaries to its path. Large areas of sediment deposition (of unknown origin) can be seen as well as deeper pool areas. The dune system between the creek and the ocean was well developed and it is unlikely at this time that the entrance was artificially opened at all. This would mean that in dry periods the creek was in effect an extension of the lagoon, with little flow and high amounts of sediment deposition. The connection between the creek and the ocean would only occur with very high creek volumes. Vegetation between the creek and the beach appears to be less well developed than in recent photographs and aeolian transport of sand from the beach may have been a more significant source of sediment in 1956 than it is now.

By 1980 development had occurred along the road running roughly parallel to the creek and the Caltex oil terminal had been built with a pipe running across the creek to the ocean. The channel boundaries of the creek appear to be more defined. By this time it is likely that the creek was artificially opened and creek/lagoon volumes were lower, with water flows confined to the well defined channel. Sediment deposition may therefore have been reduced and a more uniform channel depth without pool-riffle sequences formed.

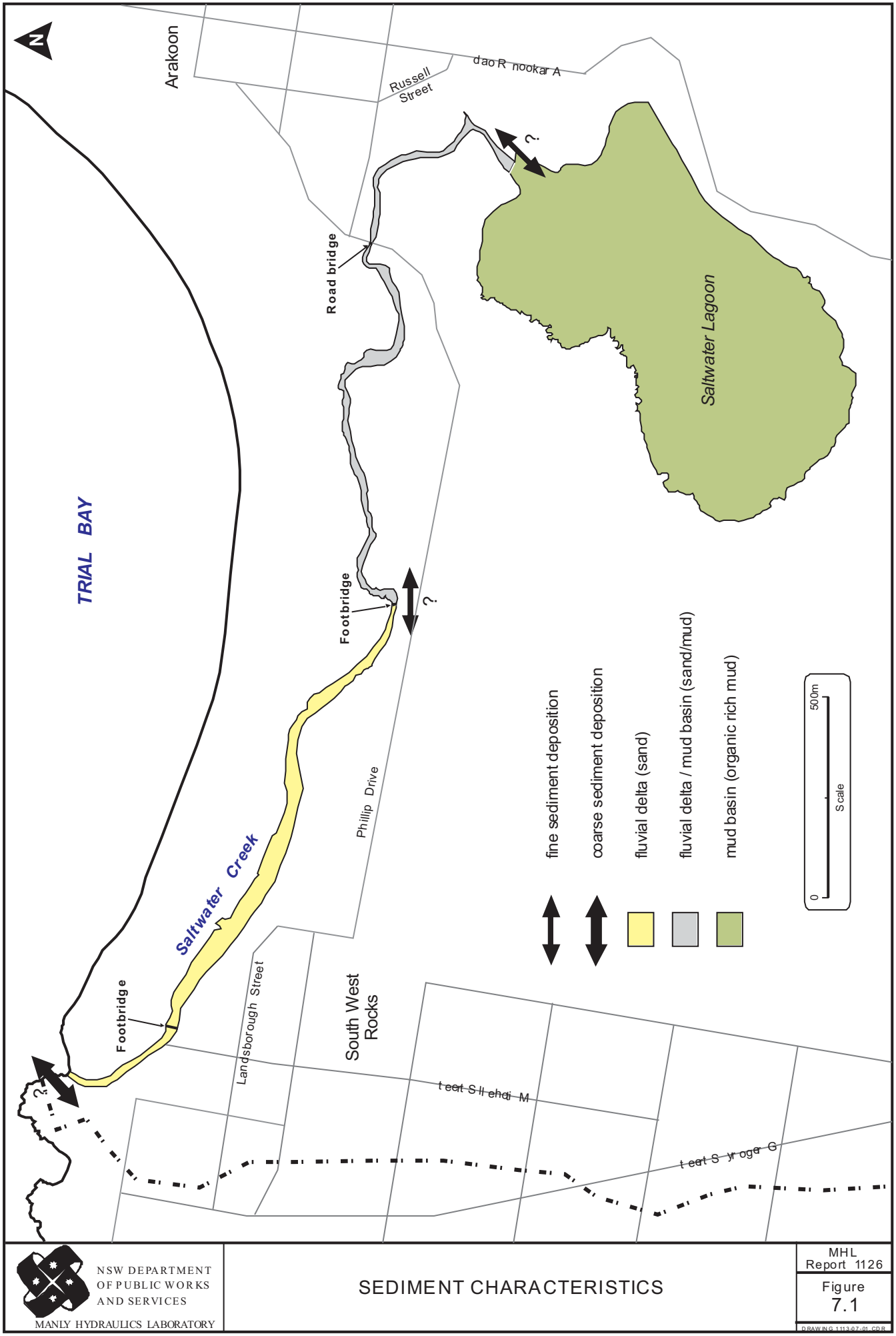
The photograph taken in 1988 shows the creek with well defined boundaries and no visible areas of deposition, but this may be due to high flows as the entrance to the ocean at this time is open. Substantial vegetation has been established both between the creek and the beach and near the creek mouth, which would stabilise the dune system and reduce its role as a sediment source. This appears to have also created further definition of the creek's path when open to the ocean. Urban development has increased in the nearby catchment, which may have resulted in an increase in sediment input from runoff from impervious surfaces.

The 1993 photograph shows little change from 1988, except for a further increase in vegetation near the creek mouth. The entrance is closed in this case but the channel appears to be well defined with no visible sand banks, which may be due to limited water clarity at the time.

From these observations some of the more interesting points to note regarding sedimentation are:

- An increase in channel definition over time, with an apparent loss of pool-riffle sequences.
- An increase in vegetation and thus sand/soil stability in the area surrounding the creek, causing a probable reduction of aeolian sand transport and soil runoff as sediment sources.
- An increase in urban development in the nearby catchment area which may have caused an increase in sediment input from runoff from impervious surfaces.

From the available information it is not possible to comment on rates of sediment transport and deposition or specific locations or sources of sediment.


N
Arakoon
Russell Street
Road bridge
Saltwater Lagoon
TRIAL BAY
Footbridge
Saltwater Creek
Phillip Drive
Footbridge
Landsborough Street
South West Rocks
fine sediment deposition
coarse sediment deposition
fluvial delta (sand)
fluvial delta / mud basin (sand/mud)
mud basin (organic rich mud)
0
500m
Scale
NSW DEPARTMENT OF PUBLIC WORKS AND SERVICES
MANLY HYDRAULICS LABORATORY
SEDIMENT CHARACTERISTICS
MHL Report 1126
Figure 7.1

8. Issues for Future Management

8.1 Key Issues Identified by the Committee and Community Consultation

The following issues were raised by the Saltwater Creek Working Group and the Coastal and Estuary Management Committee and were outlined in the brief.

- Flooding
  - Increased runoff due to urbanisation of catchment
  - Large storm events
  - Effect of cyclonic swells, king tides and high intensity rainfall on creek heights
  - Implications of greenhouse predicted sea-level rise
  - Flooding of golf course
  - Backup of water as a result of entrance closure.

- Stormwater management
  - Debris and litter from CBD of South West Rocks village
  - Implications of changed catchment conditions on runoff characteristics
  - Increased runoff from new subdivisions
  - Adequacy of runoff control and treatment measures required of developers
  - Use of lagoon as stormwater detention basin versus individual detention basins
  - Stormwater management plan
  - Individual lot responsibility for stormwater control.

- Entrance management
  - Natural characteristics, height, shape and location of the berm
  - Duration and cycle of creek opening
  - Interaction of gaol wall with beach processes
  - Effects of breakout on creek
  - Impacts of berm height on wetland areas (SEPP 14)
  - National Park Estate (lagoon)
  - Breeding cycles of fish species
  - Open and closed conditions – dangerous conditions for swimmers when open and tannin stained water when closed.

- Biodiversity
  - Character of system when opened and effect of different water levels when closed
  - Protection of the ecological functions that the system supports (fish breeding etc.)

- Development control
  - Compliance of developers
  - Areas zoned for future developments
  - Stormwater management and runoff quantity and quality control addressed by planning controls (LEPs, DCPs and development guidelines).

- Water quality
  - Is water quality OK for recreational swimming?
  - Determination of acid sulfate soil potential in catchment
  - Status of remediation of Shell oil tank sites, potential for groundwater contamination to impact Saltwater Creek.

- Siltation
  - Historical changes in response to catchment change.

- Land status
  - Amount of land occupied by Crown, National Parks, freehold and amount available for development.

- Social
  - Willingness of local community to accept management options
  - Need to involve indigenous peoples into planning process
  - Potential for increased public recreational opportunity within this catchment.

- Consultation/communication
  - Local newspapers, media release
  - Public consultation once consultant engaged to undertake studies to provide information to develop a communication strategy.

8.2 Key Issues Identified by the Community

In addition, issues were discussed at the community meeting held on 4 April 2001. Issues identified as important to the community follow.

- Entrance management – concerns associated with allowing the creek to close. Flooding with elevated berm heights, residential development floor heights might be below tidal range if entrance is allowed to close, inundation of terrestrial vegetation at high water levels.
- Development controls – provision for pollution control devices in all developments in the catchment, management of land within the catchment to ensure the creek is kept in a healthy state.
- Urban runoff – control of pollutants from urban runoff.
- Water quality – visual, odour of the creek, stagnant water provides potential breeding ground for mosquitoes.
- Pest controls – mosquitoes.
- Flooding – low-lying areas experience reduced recreational amenity when the water level is increased (i.e. when entrance is closed coinciding with heavy rainfall).
- Recreational access – pathways, wheelchair access.
- Foreshore management – recreational access (surf club).

Attendees at the meeting were asked to identify features of the estuary that they consider valuable. The most common response was the value of the estuary for future generations and as a recreational and natural amenity now. Protection of the foreshore, bushland and habitats were considered important, as well as maintenance of the creek for recreation.

The community was asked which of the valuable features were important to preserve and identified the natural habitats and features of the creek, access and recreational usage, aquatic fauna populations and a protected zone between development and the creek. Options for management of the creek were also discussed.

8.3 Recommendations for Further Work

In order to address the issues of concern identified by the community and to improve the understanding of the Saltwater Creek and lagoon system a well-defined management plan must be initiated. It is recommended that such a plan be in line with the Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000) to provide clear definition of management objectives and desired outcomes. To ensure that outcomes are meaningful the process recommended by ANZECC (2000) requires establishment of overall study objectives and a detailed study design, including preparation of a field sampling program and laboratory analysis protocol. Collected data should be quality controlled and retained in a robust database in a central location for access in future years when comparative assessments may be required.

Examples of studies that are required to enhance understanding and improve management performance of the Saltwater Creek and lagoon system are listed below. Assessment of the prioritisation and need for these studies will be based on the strategies resulting from the Management Study.

- *Mapping* – Detailed surveying of the entrance berm at regular intervals and immediately after breakout events and installation of a permanent water level gauge in Saltwater Lagoon. This will provide greater understanding of entrance behaviour and relationships between water level and entrance berm height.

- *Flooding* – A definitive flood risk assessment should be undertaken, including a detailed flood study with a range of flood risk scenarios. The flood study should consider inputs from the urban, rural and natural catchment areas and the likely creek entrance berm height.

  It is important that potential future urban development is considered in flood planning and stormwater management activities. Adequate planning of flooding associated with stormwater inputs must acknowledge the entrance management policy that will affect potential flood levels. Council and developers must make a cooperative and integrated effort to manage stormwater, with the common goals of minimising urban inputs to the creek and maintaining and improving water quality.

- *Biota* – Detailed surveys of flora/fauna communities both in main drains into the creek and the foreshores of the creek and lagoon. Combined with good quality entrance survey information and water quality data the impact of the hydrological regime and catchment inflows on biota may be determined.

- *Water quality* – Installation of a water quality monitoring device capable of measuring chlorophyll-a and salinity, which in combination with the survey task described above will enhance understanding of the effects of changing entrance conditions and water levels on water quality. Following the ANZECC (2000) guidelines, clear water quality objectives should be developed for the Saltwater Creek and lagoon system so that a well-defined management strategy and actions can be implemented. Water quality processes that may be investigated through short-term specific studies include an assessment of denitrification efficiency and investigation of nutrient inflows to the lagoon during dry conditions.

- *Data collection, analysis and storage* – As mentioned above it is imperative that all data collection programmes be coordinated under a management plan to ensure that meaningful data is collected which provides quality input towards management outcomes. Data should be stored in a database and a framework for detailed analysis should be derived to allow interpretation after a long period (for example three years) of data collection.

An integrated and holistic approach is required to achieve realistic strategies for the management of the Saltwater Creek and lagoon system. A comprehensive assessment of flood risk in the catchment, related to urban stormwater management as well as natural catchment flows, will provide information to assist in the development of an entrance management strategy. However, the policy developed to manage the opening and closing of the creek entrance will influence water levels throughout the whole creek and lagoon system, with implications for the fringing vegetation assemblages and aquatic fauna (see Section 5.4). Management decisions must consider the full range of implications in order to achieve a sustainable management framework.

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Appendix A

Community Consultation

MANLY HYDRAULICS LABORATORY

110B King Street
Manly Vale NSW 2093

NSW DEPARTMENT
OF PUBLIC WORKS
AND SERVICES

Telephone 02 9949 0200
Facsimile 02 9948 6185

File No. LRE6-0107

26 February 2001

Mr S Sample
Organisation
Address line 1
Address line 2

Dear Mr Sample,

SALTWATER ESTUARY PROCESS STUDY

As you may be aware Kempsey Shire Council has commissioned the Department of Public Works and Services' Manly Hydraulics Laboratory to carry out the Saltwater Creek Estuary Process Study. To assist in this project Manly Hydraulics Laboratory have engaged the services of subconsultants, The Ecology Lab Pty Ltd to assist with ecological issues.

Need for a Process Study

Saltwater Creek has substantial benefit for the local economy. It is also important visually and as a recreational facility for the local community and visitors to the area. The creek provides a safe swimming environment and attracts day picnickers and tourists. The adjacent Caravan Park and beach attract large numbers especially during the Easter, Christmas and school holidays. There is concern however, about the water quality in the creek.

In the preparation of planning measures for the future it is necessary to gain an understanding of the natural processes and their interactions with a range of activities that may affect this balance.

Project Process and Timing

The process study will take place in two stages. The first stage involves an intensive review of literature and information on the area and the identification of issues of importance to the community. Stage two involves investigation into processes operating in the creek and in similar systems, and production of a report including recommendations which will form a starting point for the development of a plan of management for the estuary.

We are currently at the beginning of stage one and seek your help to gather as much information on the system as possible.

What can you do to help?

If you have any information that may be of use in the study either:

- Make a written statement – written submissions can be made in relation to the project and should be sent to Manly Hydraulics Laboratory at the address below.
- Send information to Kempsey Shire Council – any information in relation to the project, photos, data collected etc. can be delivered to Kempsey Council at the address below.

Saltwater Creek Estuary Process Study
Manly Hydraulics Laboratory
110B King St
MANLY VALE NSW 2093

Saltwater Creek Estuary Process Study
Kempsey Shire Council
Civic Centre, Cnr Elbow & Tozer Sts
WEST KEMPSEY NSW 2440
Attn: Mr Tom Vermeulen

In order to progress the project please provide any written submissions or data that you may have by 20 April 2001.

If you require any submitted data (eg. photos) to be returned, please indicate in your submission and provide a return address.

We thank you very much for your assistance and look forward to reviewing the information shortly.

A community meeting will follow the receipt and synthesis of material relevant to Saltwater Creek. Information will be provided on the processes operating in the creek and a discussion will take place on the issues of importance to the community.

Regards,

David van Senden
Principal Engineer
Manly Hydraulics Laboratory

MANLY HYDRAULICS LABORATORY

110B King Street
Manly Vale NSW 2093

NSW DEPARTMENT
OF PUBLIC WORKS
AND SERVICES

Telephone 02 9949 0200
Facsimile 02 9948 6185

SALTWATER CREEK COMMUNITY SURVEY

Please take a moment to answer the following questions. Your responses will be reflected in a report on the issues of importance to the community at South West Rocks. Your answers provide important information from the community on the importance of your estuary.

1. Why is the future of Saltwater Creek important to you?

2. What makes Saltwater Creek/Lagoon different from other estuaries in NSW?

3. Which features of Saltwater Creek are valuable to you?

4. Which of these features are important to preserve?

Please return this questionnaire by 20 April 2001 to:

Manly Hydraulics Laboratory
110B King St
Manly Vale NSW 2093
Attn: Megan Liddelow

or

Kempsey Shire Council
PO Box 78
West Kempsey NSW 2440
Attn: Tom Vermeulen

d:\projects\kempsey epss\saltwater\questionnaire.doc/

Delivering solutions

Table 1 Recipients of Letter

Name	Organisation	Address
Mr Kevin Ball		PO Box 17 SOUTH WEST ROCKS NSW 2431
Mr John Barnett	Macleay River Shellfish QAP Com	209 Inner Austral Eden Rd KEMPSEY NSW 2440
Ms Lee Blade	NSW Fisheries	PO Box 969 PORT MACQUARIE NSW 2444
Ms Janelle Brooks	NSW National Parks and Wildlife Service, Coffs Harbour	Northern Zone, PO Box 914 COFFS HARBOUR NSW 2450
Mr Colin Campbell	National Parks and Wildlife	PO Box 61 PORT MACQUARIE NSW 2444
Mrs Laura Dwyer		49 Gilbert Cory St SOUTH WEST ROCKS NSW 2431
Mr Max Enklaar	NSW Fisheries	PO Box 154 BALLINA NSW 2478
Mr Peter Ennis	MASSLAG	684 Left Bank Rd KINCHELA CREEK NSW 2440
Mr Bob Ford	Macleay River District Fisherman's Co-op	PO Box 88 SOUTH WEST ROCKS NSW 2431
Mr Jason Green		34 Delmer Close SOUTH WEST ROCKS NSW 2431
Mr Victor Grezl	South West Rocks Marine Action Group	12 Entrance St SOUTH WEST ROCKS NSW 2431
Mr Peter Hadlow		21 Paragon Ave SOUTH WEST ROCKS NSW 2431
Mr John Hampson		PO Box 50 SOUTH WEST ROCKS NSW 2431
Mr Scott Henderson	Department of Agriculture	PO Box 141 WEST KEMPSEY NSW 2440
Mr Alan Hill		PO Box 138 SOUTH WEST ROCKS NSW 2431
Kim Hogno		PO Box 13 SOUTH WEST ROCKS NSW 2431
Mr John Jeayes	Crescent Head Residents & Ratepayers Association	56 Dulconghi St CRESCENT HEAD NSW 2440
Ms Diane Jensen		70 Ocean St SOUTH WEST ROCKS NSW 2431
Mr Graham Johnson		291 Arakoon Rd ARAKOON NSW 2431
Mr Andy Lang		32 Cardwell St ARAKOON NSW 2431
Mr Howard Lee		501 Mooneba Rd MOONEBA NSW 2440
Mr Allen Lyons	Trial Bay Fishing Club	14 James Carney Crescent WEST KEMPSEY NSW 2440

Councillor P Mainey	Kempsey Shire Council	PO Box 78 WEST KEMPSEY NSW 2440
Mr Tony Mayne	Macleay Valley Tourism Network	161-171 Phillip Dve SOUTH WEST ROCKS NSW 2431
Mr Rod McDonagh	Waterways Authority	PO Box 156 SOUTH WEST ROCKS NSW 2431
Mrs M Morris	Kempsey Shire Council	PO Box 78 WEST KEMPSEY NSW 2440
Mr Lewis Nicholl	Hat Head Dune Care	61 Straight St HAT HEAD NSW 2440
Mr Max Osborne		4 Prince of Wales Ave SOUTH WEST ROCKS NSW 2431
Karen and David Osborne		77 Gap Beach Rd ARAKOON NSW 2431
Mr Terry Parkhouse	North Coast Environmental Council	442 Grassy Head Rd GRASSY HEAD NSW 2440
Councillor P Parkinson		Po Box 68 WEST KEMPSEY NSW 2440
Mr Malcolm Ptolemy		1557 Right Bank Rd BELMORE RIVER NSW 2440
Mr John Schmidt	DLWC	PO Box 149 WEST KEMPSEY NSW 2440
Mr Dick Shirt	South West Rocks Country Club	Phillip Drive SOUTH WEST ROCKS NSW 2431
Sir/Madam	MRHS Journal	PO Box 390 KEMPSEY NSW 2440
Sir/Madam	Environmental Protection Authority	PO Box 498 GRAFTON NSW 2460
Sir/Madam	Aboriginal Land Council	PO Box 450 KEMPSEY NSW 2440
B Snell		PO Box 33 SOUTH WEST ROCKS NSW 2431
Mr Tom Vermeulen	Kempsey Shire Council	PO Box 78 WEST KEMPSEY NSW 2440
Mr Dave Walton	Killuke	Maria River Rd CRESCENT HEAD NSW 2440
Mr Roger Wilkinson		PO Box 51 SOUTH WEST ROCKS NSW 2431
Mr Mark Williams		6-8 Cooper St East SOUTH WEST ROCKS NSW 2431
	South West Rocks Community Dune Care Group	c\ 4 Prince of Wales Ave SOUTH WEST ROCKS NSW 2431

Table 2 Parties Submissions Were Received From

Name	Address
Mr Kim Hogno	PO Box 13 SOUTH WEST ROCKS NSW 2431
Mr Anthony Mayne	Trial Bay Tourist Park 161-171 Phillip Drive SOUTH WEST ROCKS NSW 2431

In addition, surveys were completed and returned by four of the eight residents who left their details at the meeting in order to make submissions. This information has been included in the section on important issues to the community.

Appendix B

Flora and Fauna Lists

Table B.1 List of birds, amphibians, mammals and reptiles observed within approximately 20km of Saltwater Creek (NSW NPWS Wildlife Atlas) and their protected status under the TSC Act (1995). E1 = Endangered, V= Vulnerable, I = Introduced, P = Protected (NSW Wildlife Act, 1974), U = Unprotected. (nb: These data are only indicative and cannot be considered a comprehensive inventory, and may contain errors). Vulnerable and endangered species have been shaded.

		Scientific Name	Common Name	Legal Status	Count
Amphibia	Hylidae	*Litoria aurea*	Green and Golden Bell Frog	E1	17
		Litoria caerulea	Green Tree Frog	P	3
		Litoria dentata	Bleating Tree Frog	P	3
		Litoria fallax	Eastern Dwarf Tree Frog	P	11
		Litoria lesueuri	Lesueur's Frog	P	6
		Litoria nasuta	Rocket Frog	P	6
		Litoria pearsoniana/phyllochroa	Leaf Green Tree Frog species complex	P	3
		Litoria peronii	Peron's Tree Frog	P	6
		Litoria tyleri		P	4
	Myobatrachidae	*Adelotus brevis*	Tusked Frog	P	9
		Crinia parinsignifera	Plains Froglet	P	1
		Crinia signifera	Common Eastern Froglet	P	3
		Crinia tinnula	Wallum Froglet	V	2
		Limnodynastes dumerilii	Eastern Banjo Frog	P	2
		Limnodynastes peronii	Brown-striped Frog	P	11
		Mixophyes fasciolatus	Great Barred Frog	P	5
		Mixophyes iteratus	Giant Barred Frog	E1	2
		Pseudophryne coriacea	Red-backed Toadlet	P	13
		Uperoleia fusca		P	10
Aves	Accipitridae	*Accipiter cirrhocephalus*	Collared Sparrowhawk	P	4
		Accipiter fasciatus	Brown Goshawk	P	2
		Accipiter novaehollandiae	Grey Goshawk	P	3
		Aquila audax	Wedge-tailed Eagle	P	2
		Aviceda subcristata	Pacific Baza	P	12
		Circus approximans	Swamp Harrier	P	10
		Elanus axillaris	Black-shouldered Kite	P	5
		Haliaeetus leucogaster	White-bellied Sea-Eagle	P	13
		Haliastur indus	Brahminy Kite	P	13
		Haliastur sphenurus	Whistling Kite	P	7
		Hamirostra melanosternon	Black-breasted Buzzard	V	1
		Lophoictinia isura	Square-tailed Kite	V	7
		Pandion haliaetus	Osprey	V	33
	Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar	P	25
	Alcedinidae	*Alcedo azurea*	Azure Kingfisher	P	2
	Anatidae	*Anas castanea*	Chestnut Teal	P	10
		Anas gracilis	Grey Teal	P	14
		Anas platyrhynchos	Mallard	U	1
		Anas rhynchotis	Australasian Shoveler	P	3
		Anas superciliosa	Pacific Black Duck	P	10
		Aythya australis	Hardhead	P	4
		Chenonetta jubata	Australian Wood Duck	P	8
		Cygnus atratus	Black Swan	P	7
		Malacorhynchus membranaceus	Pink-eared Duck	P	1
	Anhingidae	*Anhinga melanogaster*	Darter	P	1
	Anseranatidae	*Anseranas semipalmata*	Magpie Goose	V	1
	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	P	11
	Ardeidae	*Ardea alba*	Great Egret	P	7
		Ardea ibis	Cattle Egret	P	9
		Ardea intermedia	Intermediate Egret	P	3
		Ardea pacifica	White-necked Heron	P	7
		Butorides striatus	Striated Heron	P	4
		Egretta garzetta	Little Egret	P	2
		Egretta novaehollandiae	White-faced Heron	P	14
		Egretta sacra	Eastern Reef Egret	P	5
		Ixobrychus flavicollis	Black Bittern	V	5
		Nycticorax caledonicus	Nankeen Night Heron	P	2
	Artamidae	*Artamus cyanopterus*	Dusky Woodswallow	P	1
		Artamus leucorhynchus	White-breasted Woodswallow	P	8
		Artamus personatus	Masked Woodswallow	P	1
		Artamus superciliosus	White-browed Woodswallow	P	1
		Cracticus nigrogularis	Pied Butcherbird	P	4
		Cracticus torquatus	Grey Butcherbird	P	17

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	Scientific Name	Common Name	Legal Status	Count
	Gymnorhina tibicen	Australian Magpie	P	18
	Strepera graculina	Pied Currawong	P	16
	Strepera versicolor	Grey Currawong	P	1
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	P	1
	Cacatua roseicapilla	Galah	P	2
	Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	P	9
	Calyptorhynchus lathami	Glossy Black-Cockatoo	V	49
Campephagidae	*Coracina lineata*	Barred Cuckoo-shrike	V	2
	Coracina novaehollandiae	Black-faced Cuckoo-shrike	P	17
	Coracina papuensis	White-bellied Cuckoo-shrike	P	4
	Coracina tenuirostris	Cicadabird	P	7
	Lalage leucomela	Varied Triller	P	6
	Lalage sueurii	White-winged Triller	P	3
Caprimulgidae	*Eurostopodus mystacalis*	White-throated Nightjar	P	9
Centropodidae	*Centropus phasianinus*	Pheasant Coucal	P	9
Charadriidae	*Charadrius bicinctus*	Double-banded Plover	P	2
	Charadrius ruficapillus	Red-capped Plover	P	2
	Elseyornis melanops	Black-fronted Dotterel	P	7
	Pluvialis fulva	Pacific Golden Plover	P	1
	Vanellus miles	Masked Lapwing	P	15
	Vanellus tricolor	Banded Lapwing	P	2
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	E1	16
Cinclosomatidae	*Cinclosoma punctatum*	Spotted Quail-thrush	P	1
	Psophodes olivaceus	Eastern Whipbird	P	9
Climacteridae	*Climacteris erythrops*	Red-browed Treecreeper	P	3
	Cormobates leucophaeus	White-throated Treecreeper	P	14
Columbidae	*Chalcophaps indica*	Emerald Dove	P	4
	Columba leucomela	White-headed Pigeon	P	11
	Columba livia	Rock Dove	U	3
	Geopelia humeralis	Bar-shouldered Dove	P	12
	Geopelia striata	Peaceful Dove	P	5
	Leucosarcia melanoleuca	Wonga Pigeon	P	11
	Lopholaimus antarcticus	Topknot Pigeon	P	4
	Macropygia amboinensis	Brown Cuckoo-Dove	P	8
	Ocyphaps lophotes	Crested Pigeon	P	7
	Phaps chalcoptera	Common Bronzewing	P	1
	Ptilinopus magnificus	Wompoo Fruit-Dove	V	8
	Ptilinopus regina	Rose-crowned Fruit-Dove	V	2
	Streptopelia chinensis	Spotted Turtle-Dove	U	7
Coraciidae	*Eurystomus orientalis*	Dollarbird	P	10
Corvidae	*Corvus coronoides*	Australian Raven	P	3
	Corvus orru	Torresian Crow	P	5
	Corvus tasmanicus	Forest Raven	P	16
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	P	10
	Cacomantis variolosus	Brush Cuckoo	P	8
	Chrysococcyx lucidus	Shining Bronze-Cuckoo	P	10
	Chrysococcyx minutillus	Little Bronze-Cuckoo	P	3
	Cuculus pallidus	Pallid Cuckoo	P	4
	Eudynamys scolopacea	Common Koel	P	20
	Scythrops novaehollandiae	Channel-billed Cuckoo	P	8
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	P	11
Dicruridae	*Dicrurus bracteatus*	Spangled Drongo	P	6
	Grallina cyanoleuca	Magpie-lark	P	11
	Monarcha melanopsis	Black-faced Monarch	P	10
	Monarcha trivirgatus	Spectacled Monarch	P	6
	Myiagra cyanoleuca	Satin Flycatcher	P	1
	Myiagra inquieta	Restless Flycatcher	P	3
	Myiagra rubecula	Leaden Flycatcher	P	8
	Rhipidura fuliginosa	Grey Fantail	P	19
	Rhipidura leucophrys	Willie Wagtail	P	13
	Rhipidura rufifrons	Rufous Fantail	P	6
Falconidae	*Falco berigora*	Brown Falcon	P	2

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	Scientific Name	Common Name	Legal Status	Count
	Falco cenchroides	Nankeen Kestrel	P	2
	Falco longipennis	Australian Hobby	P	3
Haematopodidae	*Haematopus fuliginosus*	Sooty Oystercatcher	V	6
	Haematopus longirostris	Pied Oystercatcher	V	6
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	P	21
	Todiramphus macleayii	Forest Kingfisher	P	7
	Todiramphus sanctus	Sacred Kingfisher	P	14
Hirundinidae	*Cheramoeca leucosternus*	White-backed Swallow	P	1
	Hirundo ariel	Fairy Martin	P	2
	Hirundo neoxena	Welcome Swallow	P	15
	Hirundo nigricans	Tree Martin	P	4
Jacanidae	*Irediparra gallinacea*	Comb-crested Jacana	V	15
Laridae	*Larus novaehollandiae*	Silver Gull	P	6
	Stercorarius parasiticus	Arctic Jaeger	P	1
	Sterna albifrons	Little Tern	E1	3
	Sterna bergii	Crested Tern	P	9
	Sterna hirundo	Common Tern	P	2
Maluridae	*Malurus cyaneus*	Superb Fairy-wren	P	13
	Malurus lamberti	Variegated Fairy-wren	P	15
	Malurus melanocephalus	Red-backed Fairy-wren	P	4
	Stipiturus malachurus	Southern Emu-wren	P	2
Megapodiidae	*Alectura lathami*	Australian Brush-turkey	P	4
Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater	P	1
	Acanthorhynchus tenuirostris	Eastern Spinebill	P	8
	Anthochaera carunculata	Red Wattlebird	P	4
	Anthochaera chrysoptera	Little Wattlebird	P	16
	Epthianura albifrons	White-fronted Chat	P	3
	Lichenostomus chrysops	Yellow-faced Honeyeater	P	14
	Lichmera indistincta	Brown Honeyeater	P	9
	Manorina melanocephala	Noisy Miner	P	6
	Meliphaga lewinii	Lewin's Honeyeater	P	18
	Melithreptus albogularis	White-throated Honeyeater	P	1
	Melithreptus lunatus	White-naped Honeyeater	P	5
	Myzomela sanguinolenta	Scarlet Honeyeater	P	21
	Philemon citreogularis	Little Friarbird	P	2
	Philemon corniculatus	Noisy Friarbird	P	15
	Phylidonyris nigra	White-cheeked Honeyeater	P	13
	Plectorhyncha lanceolata	Striped Honeyeater	P	10
	Xanthomyza phrygia	Regent Honeyeater	E1	1
Menuridae	*Menura novaehollandiae*	Superb Lyrebird	P	4
Meropidae	*Merops ornatus*	Rainbow Bee-eater	P	6
Motacillidae	*Anthus novaeseelandiae*	Richard's Pipit	P	8
Muscicapidae	*Zoothera dauma*	Unindentified Ground Thrush	P	1
	Zoothera sp.	unidentified ground thrush	P	1
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	P	4
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole	P	15
	Sphecotheres viridis	Figbird	P	10
Orthonychidae	*Orthonyx temminckii*	Logrunner	P	5
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	P	19
	Falcunculus frontatus	Crested Shrike-tit	P	6
	Pachycephala pectoralis	Golden Whistler	P	12
	Pachycephala rufiventris	Rufous Whistler	P	10
Pardalotidae	*Acanthiza apicalis*	Inland Thornbill	P	1
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	P	3
	Acanthiza lineata	Striated Thornbill	P	7
	Acanthiza nana	Yellow Thornbill	P	6
	Acanthiza pusilla	Brown Thornbill	P	16
	Acanthiza reguloides	Buff-rumped Thornbill	P	4
	Gerygone levigaster	Mangrove Gerygone	P	6
	Gerygone mouki	Brown Gerygone	P	11
	Gerygone olivacea	White-throated Gerygone	P	3
	Pardalotus punctatus	Spotted Pardalote	P	9

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	Scientific Name	Common Name	Legal Status	Count
	Pardalotus striatus	Striated Pardalote	P	4
	Sericornis citreogularis	Yellow-throated Scrubwren	P	1
	Sericornis frontalis	White-browed Scrubwren	P	10
	Sericornis magnirostris	Large-billed Scrubwren	P	5
Passeridae	*Lonchura castaneothorax*	Chestnut-breasted Mannikin	P	6
	Lonchura punctulata	Nutmeg Mannikin	U	2
	Neochmia temporalis	Red-browed Finch	P	16
	Passer domesticus	House Sparrow	U	3
	Taeniopygia bichenovii	Double-barred Finch	P	2
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican	P	8
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	P	9
	Microeca fascinans	Jacky Winter	P	4
	Petroica multicolor	Scarlet Robin	P	1
	Petroica phoenicea	Flame Robin	P	1
	Petroica rosea	Rose Robin	P	4
	Tregellasia capito	Pale-yellow Robin	P	3
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant	P	4
	Phalacrocorax melanoleucos	Little Pied Cormorant	P	8
	Phalacrocorax sulcirostris	Little Black Cormorant	P	7
	Phalacrocorax varius	Pied Cormorant	P	4
Phasianidae	*Coturnix ypsilophora*	Brown Quail	P	3
Pittidae	*Pitta versicolor*	Noisy Pitta	P	1
Podargidae	*Podargus ocellatus*	Marbled Frogmouth	V	1
	Podargus strigoides	Tawny Frogmouth	P	19
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	P	7
Procellariidae	*Puffinus pacificus*	Wedge-tailed Shearwater	P	2
	Puffinus tenuirostris	Short-tailed Shearwater	P	4
Psittacidae	*Alisterus scapularis*	Australian King-Parrot	P	7
	Glossopsitta pusilla	Little Lorikeet	P	3
	Platycercus elegans	Crimson Rosella	P	1
	Platycercus eximius	Eastern Rosella	P	5
	Psephotus haematonotus	Red-rumped Parrot	P	1
	Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	P	8
	Trichoglossus haematodus	Rainbow Lorikeet	P	17
Ptilonorhynchidae	*Ailuroedus crassirostris*	Green Catbird	P	8
	Ptilonorhynchus violaceus	Satin Bowerbird	P	9
	Sericulus chrysocephalus	Regent Bowerbird	P	7
Rallidae	*Fulica atra*	Eurasian Coot	P	2
	Gallinula tenebrosa	Dusky Moorhen	P	10
	Gallirallus philippensis	Buff-banded Rail	P	9
	Porphyrio porphyrio	Purple Swamphen	P	8
	Porzana fluminea	Australian Spotted Crake	P	1
	Porzana pusilla	Baillon's Crake	P	3
	Porzana tabuensis	Spotless Crake	P	1
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt	P	9
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	P	3
	Arenaria interpres	Ruddy Turnstone	P	1
	Calidris acuminata	Sharp-tailed Sandpiper	P	6
	Calidris ruficollis	Red-necked Stint	P	1
	Gallinago hardwickii	Latham's Snipe	P	5
	Heteroscelus brevipes	Grey-tailed Tattler	P	4
	Limosa lapponica	Bar-tailed Godwit	P	3
	Limosa limosa	Black-tailed Godwit	V	1
	Numenius madagascariensis	Eastern Curlew	P	2
	Numenius phaeopus	Whimbrel	P	2
	Tringa glareola	Wood Sandpiper	P	1
	Tringa nebularia	Common Greenshank	P	2
	Tringa stagnatilis	Marsh Sandpiper	P	8
Strigidae	*Ninox novaeseelandiae*	Southern Boobook	P	8
	Ninox strenua	Powerful Owl	V	3
Sturnidae	*Sturnus vulgaris*	Common Starling	U	5
Sulidae	*Morus serrator*	Australasian Gannet	P	2

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		Scientific Name	Common Name	Legal Status	Count
	Sylviidae	*Acrocephalus stentoreus*	Clamorous Reed-Warbler	P	6
		Cinclorhamphus cruralis	Brown Songlark	P	1
		Cisticola exilis	Golden-headed Cisticola	P	6
		Megalurus gramineus	Little Grassbird	P	3
		Megalurus timoriensis	Tawny Grassbird	P	5
	Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill	P	1
		Platalea regia	Royal Spoonbill	P	8
		Plegadis falcinellus	Glossy Ibis	P	2
		Threskiornis molucca	Australian White Ibis	P	8
		Threskiornis spinicollis	Straw-necked Ibis	P	5
	Turnicidae	*Turnix varia*	Painted Button-quail	P	2
	Tytonidae	*Tyto novaehollandiae*	Masked Owl	V	2
		Tyto tenebricosa	Sooty Owl	V	9
	Zosteropidae	*Zosterops lateralis*	Silvereye	P	13
Mammalia	Balaenopteridae	*Megaptera novaeangliae*	Humpback Whale	V	4
		Whale sp.	Unidentified Whale	P	1
	Burramyidae	*Acrobates pygmaeus*	Feathertail Glider	P	2
	Canidae	*Canis familiaris*	Dingo and Dog (feral)	U	1
		Vulpes vulpes	Fox	U	5
	Dasyuridae	*Antechinus stuartii*	Brown Antechinus	P	1
		Antechinus swainsonii	Dusky Antechinus	P	1
		Dasyurus maculatus	Spotted-tailed Quoll	V	1
		Phascogale tapoatafa	Brush-tailed Phascogale	V	4
		Sminthopsis murina	Common Dunnart	P	1
	Delphinidae	*Dolphin sp.*	Unidentified Dolphin	P	2
		Globicephala macrorhynchus	Short-finned Pilot Whale	P	1
		Grampus griseus	Risso's Dolphin	P	3
		Peponocephala electra	Melon-headed Whale	P	1
		Tursiops truncatus	Bottlenose Dolphin	P	3
	Felidae	*Felis catus*	Cat (feral)	U	4
	Leporidae	*Oryctolagus cuniculus*	Rabbit	U	2
	Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo	P	6
		Macropus rufogriseus	Red-necked Wallaby	P	6
		Thylogale thetis	Red-necked Pademelon	P	1
		Wallabia bicolor	Swamp Wallaby	P	6
	Molossidae	*Mormopterus sp 1*	undescribed mastiff-bat	P	2
		Nyctinomus australis	White-striped Mastiff-bat	P	1
	Muridae	*Mus musculus*	House Mouse	U	7
		Rattus fuscipes	Bush Rat	P	2
		Rattus lutreolus	Swamp Rat	P	2
		Rattus rattus	Black Rat	U	8
	Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot	P	1
		Isoodon/Parameles sp.	unidentified Bandicoot	P	1
		Perameles nasuta	Long-nosed Bandicoot	P	1
	Petauridae	*Petauroides volans*	Greater Glider	P	3
		Petaurus australis	Yellow-bellied Glider	V	6
		Petaurus breviceps	Sugar Glider	P	5
		Petaurus norfolcensis	Squirrel Glider	V	5
		Pseudocheirus peregrinus	Common Ringtail Possum	P	4
	Phalangeridae	*Trichosurus caninus*	Mountain Brushtail Possum	P	3
		Trichosurus sp.	brushtail possum	P	4
		Trichosurus vulpecula	Common Brushtail Possum	P	7
	Phascolarctidae	*Phascolarctos cinereus*	Koala	V	40
	Phocidae	*Hydrurga leptonyx*	Leopard Seal	P	1
	Physeteridae	*Kogia breviceps*	Pygmy Sperm Whale	P	1
		Physeter macrocephalus	Sperm Whale	V	1
	Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	P	6
	Rhinolophidae	*Rhinolophus megaphyllus*	Eastern Horseshoe-bat	P	2
	Suidae	*Sus scrofa*	Pig (feral)	U	1
	Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	P	2
	Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	P	6
		Miniopterus australis	Little Bent-wing Bat	V	3

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		Scientific Name	Common Name	Legal Status	Count
		Nyctophilus geoffroyi	Lesser Long-eared Bat	P	1
		Nyctophilus gouldi	Gould's Long-eared Bat	P	1
		Nyctophilus sp.	long-eared bat	P	1
		Scoteanax rueppellii	Greater Broad-nosed Bat	V	1
		Scotorepens orion	Eastern Broad-nosed Bat	P	3
		Scotorepens sp 1	undescribed broad-nosed bat	P	1
		Vespadelus pumilus	Eastern Forest Bat	P	10
		Vespadelus regulus	Southern Forest Bat	P	1
		Vespadelus vulturnus	Little Forest Bat	P	2
Reptilia	Agamidae	*Amphibolurus muricatus*	Jacky Lizard	P	2
		Physignathus lesueurii	Eastern Water Dragon	P	4
		Pogona barbata	Bearded Dragon	P	1
	Chelidae	*Chelodina longicollis*	Eastern Long-necked Tortoise	P	1
	Cheloniidae	*Caretta caretta*	Loggerhead Turtle	V	2
		Chelonia mydas	Green Turtle	V	2
	Elapidae	*Cacophis krefftii*	Krefft's Dwarf Snake	P	2
		Cacophis squamulosus	Golden Crowned Snake	P	1
		Demansia psammophis	Yellow-faced Whip Snake	P	2
		Furina diadema	Red-naped Snake	P	1
		Hemiaspis signata	Black-bellied Swamp Snake	P	1
		Pseudechis porphyriacus	Red-bellied Black Snake	P	2
		Rhinoplocephalus nigrescens	Eastern Small-eyed Snake	P	4
	Pygopodidae	*Lialis burtonis*	Burton's Legless Lizard	P	3
	Scincidae	*Calyptotis ruficauda*		P	8
		Ctenotus allotropis		P	1
		Ctenotus robustus	Striped Skink	P	4
		Ctenotus taeniolatus	Copper-tailed Skink	P	4
		Egernia major	Land Mullet	P	4
		Eulamprus quoyii	Eastern Water Skink	P	4
		Lampropholis delicata	Grass Skink	P	15
		Lampropholis guichenoti	Garden Skink	P	1
		Lampropholis sp.	unidentified grass skink	P	2
		Saiphos equalis	Three-toed Skink	P	4
		Tiliqua scincoides	Eastern Blue-tongued Lizard	P	1
	Varanidae	*Varanus varius*	Lace Monitor	P	23

Table B.2 List of plants observed within approximately 20 km of Saltwater Creek (NSW NPWS Wildlife Atlas) and their protected status under the TSC Act. E1 = Endangered, V= Vulnerable, I = Introduced, P13 = Protected Plants (NSW Wildlife Act, 1974) U = Unprotected. (nb: These data are only indicative and cannot be considered a comprehensive inventory, and may contain errors). Vulnerable and endangered species have been shaded.

	Scientific Name	Common Name	Legal Status	Count
Acanthaceae	*Brunoniella australis*	Blue Trumpet	U	1
	Brunoniella pumilio	Dwarf Blue Trumpet	U	1
	Pseuderanthemum variabile	Pastel Flower	U	5
Adiantaceae	*Cheilanthes austrotenuifolia*	Rock Fern	U	1
	Cheilanthes sieberi ssp sieberi		U	1
Aizoaceae	*Carpobrotus glaucescens*		U	1
Anacardiaceae	*Euroschinus falcata var falcata*	Ribbonwood	U	1
Anthericaceae	*Arthropodium species B*		U	1
	Caesia parviflora	Pale Grass-lily	U	1
	Tricoryne elatior	Yellow Autumn-lily	U	1
Apiaceae	*Hydrocotyle sp. aff. acutiloba*		U	1
	Xanthosia pilosa		U	1
Apocynaceae	*Parsonsia dorrigoensis*	Milky Silkpod	V	1
	Parsonsia straminea	Common Silkpod	U	3
	Tabernaemontana pandacaqui	Banana Bush	U	3
Araceae	*Gymnostachys anceps*	Settler's Flax	U	1
Araliaceae	*Astrotricha latifolia*		U	1
	Polyscias elegans	Celery Wood	U	1
	Polyscias sambucifolia	Elderberry Panax	U	4
	Polyscias sambucifolia ssp A		U	1
Arecaceae	*Archontophoenix cunninghamiana*	Bangalow Palm	P13	2
Asclepiadaceae	*Cynanchum carnosum*		U	1
	Marsdenia rostrata	Common Milk Vine	U	1
	Tylophora paniculata	Thin-leaved Tylophora	U	1
Aspleniaceae	*Asplenium attenuatum*	Simple Spleenwort	U	1
	Asplenium australasicum forma australasic	Bird's Nest Fern	P13	1
Asteliaceae	*Cordyline stricta*	Narrow-leaved Palm Lily	U	3
Asteraceae	*Chrysanthemoides monilifera*		U	1
	Chrysanthemoides monilifera ssp rotundata	Bitou Bush	U	1
	Cirsium vulgare	Spear Thistle	U	1
	Conyza albida	Tall Fleabane	U	1
	Hypochaeris glabra	Smooth Catsear	U	1
	Hypochaeris radicata	Catsear	U	1
	Lagenifera gracilis	Slender Lagenophora	U	2
	Ozothamnus diosmifolius	White Dogwood	U	4
	Ozothamnus whitei		U	1
	Senecio madagascariensis	Fireweed	U	1
	Vernonia cinerea		U	2
	Vernonia cinerea var cinerea		U	3
Avicenniaceae	*Avicennia marina subsp australasica*	Grey Mangrove	U	1
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	U	5
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern	U	1
	Blechnum indicum	Swamp Water Fern	U	2
	Blechnum minus	Soft Water Fern	U	1
	Doodia aspera		U	2
Casuarinaceae	*Allocasuarina littoralis*	Black Sheoak	U	3

Table B.2 List of plants observed within approximately 20 km of Saltwater Creek (NSW NPWS Wildlife Atlas) and their protected status under the TSC Act. E1 = Endangered, V= Vulnerable, I = Introduced, P13 = Protected Plants (NSW Wildlife Act, 1974) U = Unprotected. (nb: These data are only indicative and cannot be considered a comprehensive inventory, and may contain errors). Vulnerable and endangered species have been shaded.

	Scientific Name	Common Name	Legal Status	Count
	Allocasuarina torulosa	Forest Oak	U	4
	Casuarina glauca	Swamp Oak	U	2
Celastraceae	*Denhamia celastroides*	Denhamia	U	1
	Maytenus silvestris	Narrow-leaved Orangebark	U	1
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	U	1
	Enchylaena tomentosa	Ruby Saltbush	U	1
Commelinaceae	*Commelina cyanea*		U	2
Convolvulaceae	*Convolvulus remotus*		U	1
	Ipomoea cairica		U	1
Cunoniaceae	*Callicoma serratifolia*	Black Wattle	U	1
	Schizomeria ovata	Crabapple	U	1
Cupressaceae	*Callitris rhomboidea*	Port Jackson Pine	U	1
Cyatheaceae	*Cyathea cooperi*	Straw Treefern	P13	1
Cyperaceae	*Cyperus laevis*		U	1
	Cyperus spp.		U	1
	Gahnia clarkei		U	2
	Gahnia melanocarpa		U	1
	Gahnia sieberiana		U	2
	Isolepis nodosa	Knobby Club-rush	U	1
	Lepidosperma laterale		U	4
	Ptilothrix deusta		U	1
	Schoenus brevifolius		U	1
Davalliaceae	*Davallia solida var pyxidata*	Hare's Foot Fern	U	1
Dennstaedtiaceae	*Histiopteris incisa*	Bat's Wing Fern	U	1
	Pteridium esculentum	Bracken	U	5
Dicksoniaceae	*Calochlaena dubia*	Common Ground Fern	U	1
Dilleniaceae	*Hibbertia aspera*		U	2
	Hibbertia linearis		U	1
	Hibbertia scandens	Climbing Guinea Flower	U	5
	Hibbertia vestita		U	1
Dioscoreaceae	*Dioscorea transversa*	Native Yam	U	2
Dryopteridaceae	*Lastreopsis spp.*		U	1
Elaeocarpaceae	*Elaeocarpus obovatus*	Hard Quandong	U	2
	Elaeocarpus reticulatus	Blueberry Ash	U	2
Epacridaceae	*Epacris pulchella*		U	2
	Leucopogon ericoides		U	2
	Leucopogon margarodes		U	1
	Leucopogon parviflorus	Coastal Beard-heath	U	1
	Monotoca elliptica		U	1
	Trochocarpa laurina	Tree Heath	U	2
Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush	U	4
	Claoxylon australe	Brittlewood	U	1
	Croton verreauxii	Native Cascarilla	U	1
	Glochidion ferdinandi	Cheese Tree	U	1
	Glochidion ferdinandi var ferdinandi	Cheese Tree	U	1
	Omalanthus populifolius	Bleeding Heart, Native Poplar	U	1
	Phyllanthus virgatus		U	1
	Poranthera microphylla		U	1
Eupomatiaceae	*Eupomatia laurina*	Bolwarra	U	2
Fabaceae (Faboideae)	*Chorizema parviflorum*	Eastern Flame Pea	U	1
	Daviesia ulicifolia	Gorse Bitter Pea	U	1

Table B.2 List of plants observed within approximately 20 km of Saltwater Creek (NSW NPWS Wildlife Atlas) and their protected status under the TSC Act. E1 = Endangered, V= Vulnerable, I = Introduced, P13 = Protected Plants (NSW Wildlife Act, 1974) U = Unprotected. (nb: These data are only indicative and cannot be considered a comprehensive inventory, and may contain errors). Vulnerable and endangered species have been shaded.

	Scientific Name	Common Name	Legal Status	Count
	Derris involuta		U	1
	Desmodium brachypodum	Large Tick-trefoil	U	1
	Desmodium rhytidophyllum		U	2
	Desmodium varians	Slender Tick-trefoil	U	4
	Dillwynia retorta		U	3
	Glycine clandestina		U	3
	Glycine microphylla		U	1
	Glycine tabacina		U	1
	Gompholobium latifolium	Golden Glory Pea	U	1
	Gompholobium pinnatum	Pinnate Wedge Pea	U	2
	Hardenbergia violacea	False Sarsaparilla	U	5
	Hovea acutifolia		U	1
	Indigofera australis		U	2
	Jacksonia scoparia	Dogwood	U	1
	Kennedia rubicunda	Red Kennedy Pea	U	4
	Oxylobium arborescens	Tall Shaggy Pea	U	1
	Oxylobium robustum	Tree Shaggy Pea	U	1
	Pultenaea cunninghamii		U	1
	Pultenaea myrtoides		U	1
	Pultenaea retusa		U	2
Fabaceae (Mimosoideae)	*Acacia binervata*	Two-veined Hickory	U	1
	Acacia concurrens	Curracabah	U	1
	Acacia falciformis	Broad-leaved Hickory	U	1
	Acacia fimbriata	Fringed Wattle	U	1
	Acacia floribunda	White Sally	U	3
	Acacia implexa	Hickory Wattle	U	1
	Acacia longifolia subsp sophorae	Coastal Wattle	U	1
	Acacia maidenii	Maiden's Wattle	U	2
	Acacia myrtifolia	Red-stemmed Wattle	U	1
	Acacia oshanesii		U	1
	Acacia suaveolens	Sweet Wattle	U	1
	Acacia terminalis	Sunshine Wattle	U	1
	Acacia ulicifolia	Prickly Moses	U	2
	Archidendron grandiflorum	Pink Lace Flower	U	1
Flagellariaceae	*Flagellaria indica*	Whip Vine	U	1
Frankeniaceae	*Frankenia foliosa*		U	3
Gleicheniaceae	*Gleichenia dicarpa*		U	1
	Sticherus flabellatus	Umbrella Fern	U	1
Goodeniaceae	*Dampiera stricta*		U	1
	Goodenia rotundifolia		U	1
Haloragaceae	*Gonocarpus humilis*		U	1
	Gonocarpus tetragynus		U	1
	Gonocarpus teucrioides		U	1
Iridaceae	*Patersonia glabrata*		U	1
	Patersonia sericea		U	1
Lamiaceae	*Plectranthus parviflorus*		U	1
	Westringia amabilis		U	1
	Westringia blakeana		U	1
Lauraceae	*Cassytha glabella*		U	1
	Cinnamomum camphora	Camphor Laurel	U	2
	Cryptocarya rigida	Forest Maple	U	1
	Endiandra sieberi	Hard Corkwood	U	1
Lindsaeaceae	*Lindsaea linearis*	Screw Fern	U	1
	Lindsaea microphylla	Lacy Wedge Fern	U	2
Lobeliaceae	*Pratia purpurascens*	Whiteroot	U	4
Loganiaceae	*Logania pusilla*		U	2
Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush	U	1

Table B.2 List of plants observed within approximately 20 km of Saltwater Creek (NSW NPWS Wildlife Atlas) and their protected status under the TSC Act. E1 = Endangered, V= Vulnerable, I = Introduced, P13 = Protected Plants (NSW Wildlife Act, 1974) U = Unprotected. (nb: These data are only indicative and cannot be considered a comprehensive inventory, and may contain errors). Vulnerable and endangered species have been shaded.

	Scientific Name	Common Name	Legal Status	Count
	Lomandra filiformis ssp coriacea		U	1
	Lomandra filiformis ssp filiformis		U	2
	Lomandra hystrix		U	1
	Lomandra laxa		U	1
	Lomandra longifolia	Spiny-headed Mat-rush	U	7
	Lomandra multiflora ssp multiflora		U	2
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	U	4
	Geitonoplesium cymosum	Scrambling Lily	U	1
Lycopodiaceae	*Lycopodiella cernua*	Scrambling Clubmoss	U	1
Melastomataceae	*Melastoma affine*		U	1
Meliaceae	*Melia azedarach*	White Cedar	U	1
	Synoum glandulosum	Scentless Rosewood	U	1
Menispermaceae	*Sarcopetalum harveyanum*	Pearl Vine	U	1
	Stephania japonica		U	2
Monimiaceae	*Wilkiea huegeliana*	Veiny Wilkiea	U	1
Moraceae	*Ficus coronata*	Creek Sandpaper Fig	U	2
	Ficus obliqua		U	1
	Ficus rubiginosa	Port Jackson Fig, Rusty Fig	U	1
	Maclura cochinchinensis	Cockspur Thorn	U	1
Myoporaceae	*Myoporum insulare*	Boobialla	U	1
Myrsinaceae	*Aegiceras corniculatum*	River Mangrove	U	1
	Rapanea howittiana	Brush Muttonwood	U	1
	Rapanea variabilis	Muttonwood	U	1
Myrtaceae	*Acmena smithii*	Lilly Pilly	U	3
	Archirhodomyrtus beckleri	Rose Myrtle	U	2
	Callistemon pachyphyllus	Wallum Bottlebrush	U	1
	Callistemon salignus	Willow Bottlebrush	U	3
	Corymbia gummifera	Red Bloodwood	U	6
	Corymbia intermedia	Pink Bloodwood	U	18
	Corymbia variegata		U	1
	Eucalyptus acmenoides	White Mahogany	U	3
	Eucalyptus agglomerata	Blue-leaved Stringybark	U	2
	Eucalyptus ancophila		U	1
	Eucalyptus carnea	Thick-leaved Mahogany	U	9
	Eucalyptus eugenioides	Thin-leaved Stringybark	U	1
	Eucalyptus fusiformis		U	5
	Eucalyptus globoidea	White Stringybark	U	2
	Eucalyptus grandis	Flooded Gum	U	2
	Eucalyptus maculata	Spotted Gum	U	5
	Eucalyptus microcorys	Tallowwood	U	16
	Eucalyptus pilularis	Blackbutt	U	15
	Eucalyptus placita	A Grey Ironbark	U	1
	Eucalyptus planchoniana	Bastard Tallowwood	U	3
	Eucalyptus propinqua	Small-fruited Grey Gum	U	13
	Eucalyptus resinifera	Red Mahogany	U	1
	Eucalyptus robusta	Swamp Mahogany	U	3
	Eucalyptus siderophloia	Grey Ironbark	U	16
	Eucalyptus signata	Scribbly Gum	U	5
	Eucalyptus tereticornis	Forest Red Gum	U	2
	Eucalyptus umbra		U	4
	Leptospermum liversidgei		U	1
	Leptospermum polygalifolium		U	2
	Lophostemon confertus	Brush Box	U	7
	Melaleuca linariifolia		U	1
	Melaleuca quinquenervia	Paperbark	U	4
	Melaleuca styphelioides	Prickly-leaved Tea Tree	U	3
	Pilidiostigma glabrum		U	1

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	Scientific Name	Common Name	Legal Status	Count
	Rhodamnia rubescens	Scrub Turpentine	U	1
	Syncarpia glomulifera	Turpentine	U	4
	Syzygium oleosum	Blue Lilly Pilly	U	1
Oleaceae	*Notelaea longifolia*	Large Mock-olive	U	1
	Notelaea ovata		U	3
Orchidaceae	*Caladenia carnea*	Pink Fingers	U	1
	Cryptostylis subulata	Large Tongue Orchid	U	1
	Cymbidium suave	Snake Orchid	P13	1
	Erythrorchis cassythoides	Climbing Orchid	P13	1
	Genoplesium spp.		U	1
	Plectorrhiza tridentata	Tangle Orchid	U	1
	Thelymitra spp.		U	1
Oxalidaceae	*Oxalis chnoodes*		U	1
	Oxalis exilis		U	1
Phormiaceae	*Dianella caerulea*		U	5
	Dianella caerulea var caerulea		U	1
	Dianella caerulea var producta		U	1
Pittosporaceae	*Billardiera scandens*	Appleberry	U	4
	Citriobatus pauciflorus	Orange Thorn	U	1
	Pittosporum revolutum		U	1
	Pittosporum undulatum	Pittosporum	U	2
Poaceae	*Andropogon virginicus*	Whisky Grass	U	3
	Aristida vagans	Threeawn Speargrass	U	1
	Austrostipa pubescens		U	1
	Axonopus affinis	Narrow-leaved Carpet Grass	U	1
	Briza minor	Shivery Grass	U	1
	Cenchrus caliculatus	Hillside Burrgrass	U	1
	Cymbopogon refractus	Barbed Wire Grass	U	2
	Cynodon dactylon	Common Couch	U	1
	Digitaria didactyla	Queensland Blue Couch	U	1
	Digitaria parviflora	Small-flowered Finger Grass	U	3
	Entolasia marginata	Bordered Panic	U	2
	Entolasia stricta	Wiry Panic	U	7
	Eragrostis brownii	Brown's Lovegrass	U	1
	Hainardia cylindrica	Common Barbgrass	U	1
	Imperata cylindrica var major	Blady Grass	U	7
	Ischaemum australe		U	1
	Oplismenus imbecillis		U	3
	Panicum lachnophyllum	Don't Panic	U	1
	Panicum simile	Two-colour Panic	U	2
	Paspalidium distans		U	1
	Paspalum dilatatum	Paspalum	U	1
	Poa labillardieri var labillardieri	Tussock	U	1
	Poa sieberiana		U	1
	Sporobolus indicus	Parramatta Grass	U	1
	Themeda australis	Kangaroo Grass	U	3

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	Scientific Name	Common Name	Legal Status	Count
	Zoysia macrantha	Prickly Couch	U	1
Polygalaceae	*Comesperma volubile*		U	1
	Polygala japonica		U	1
Proteaceae	*Banksia aemula*		U	1
	Banksia integrifolia		U	1
	Banksia robur		U	1
	Banksia spinulosa var collina		U	1
	Lomatia silaifolia	Crinkle Bush	P13	1
	Persoonia conjuncta		U	1
	Persoonia levis	Broad-leaved Geebung	U	2
	Persoonia linearis	Narrow-leaved Geebung	U	1
	Persoonia media		U	1
	Persoonia sericea		U	1
	Persoonia spp.		U	3
	Persoonia stradbrokensis		U	3
Restionaceae	*Baloskion tetraphyllum*		U	2
Rhamnaceae	*Alphitonia excelsa*	Red Ash	U	2
Ripogonaceae	*Ripogonum album*	White Supplejack	U	1
Rosaceae	*Rubus fruiticosus*	Blackberry complex	U	1
	Rubus molluccanus var trilobus	Molucca Bramble	U	1
Rubiaceae	*Atractocarpus benthamianus*		U	1
	Canthium coprosmoides	Coast Canthium	U	1
	Durringtonia paludosa		U	4
	Galium binifolium		U	1
	Morinda jasminoides		U	2
	Pomax umbellata		U	3
Rutaceae	*Acronychia littoralis*	Scented Acronychia	E1	4
	Acronychia oblongifolia	Common Acronychia	U	1
	Boronia pinnata		P13	2
	Citrus x taitensis	Rough Lemon	U	1
	Nematolepis squamea subsp squamea	Satinwood	U	1
Santalaceae	*Exocarpos cupressiformis*	Native Cherry	U	1
	Thesium australe		V	4
Sapindaceae	*Cupaniopsis anacardioides*	Tuckeroo	U	1
	Dodonaea triquetra		U	3
	Guioa semiglauca		U	2
Sapotaceae	*Amorphospermum whitei*	Rusty Plum	V	1
Schizaeaceae	*Schizaea bifida*	Forked Comb Fern	U	1
Selaginellaceae	*Selaginella uliginosa*		U	1
Smilacaceae	*Smilax australis*	Sarsaparilla	U	2
	Smilax glyciphylla	Sweet Sarsparilla	U	3
Solanaceae	*Duboisia myoporoides*	Corkwood	U	1
	Solanum densevestitum		U	1
	Solanum mauritianum	Wild Tobacco Bush	U	1
	Solanum stelligerum	Devil's Needles	U	2
Sterculiaceae	*Rulingia dasyphylla*	Kerrawang	U	1
Surianaceae	*Guilfoylia monostylis*		U	1

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	Scientific Name	Common Name	Legal Status	Count
Thymelaeaceae	*Pimelea linifolia*		U	2
	Pimelea linifolia ssp linifolia		U	1
Ulmaceae	*Trema tomentosa var viridis*	Native Peach	U	1
Verbenaceae	*Clerodendrum tomentosum*		U	1
	Lantana camara	Lantana	U	5
Violaceae	*Hybanthus vernonii*		U	1
	Viola betonicifolia		U	1
	Viola hederacea	Ivy-leaved Violet	U	1
Vitaceae	*Cayratia clematidea*	Slender Grape	U	1
	Cissus antarctica	Water Vine	U	1
	Cissus hypoglauca	Giant Water Vine	U	1
	Cissus opaca	Small-leaved Water Vine	U	1
	Cissus sterculiifolia		U	1
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*		U	1
	Xanthorrhoea latifolia ssp latifolia		U	1
	Xanthorrhoea macronema		U	1
	Xanthorrhoea spp.		U	1

Table B.3 List of fish, birds, amphibians, mammals, reptiles and plants likely to occur within the vicinity of Saltwater Creek protected under the EPBC Act (1999). The list includes species classed as threatened ecological communities, threatened species, marine protected species and migratory species.

	Scientific Name	Common Name	Legal Status
Threatened Species			
Amphibia	*Litoria aurea*	Green and Golden Bell Frog	Vulnerable
	Mixophyes iteratus	Southern Barred Frog	Endangered
Aves	*Diomedea amsterdamensis*	Amsterdam Albatross	Endangered
	Diomedea antipodensis	Antipodean Albatross	Vulnerable
	Diomedea dabbenena	Tristan Albatross	Endangered
	Diomedea exulans	Wandering Albatross	Vulnerable
	Diomedea gibsoni	Gibson's Albatross	Vulnerable
	Lathamus discolor	Swift Parrot	Endangered
	Macronectes giganteus	Southern Giant-Petrel	Endangered
	Macronectes halli	Northern Giant-Petrel	Vulnerable
	Pterodroma leucoptera leucoptera	Gould's Petrel	Endangered
	Pterodroma neglecta neglecta	Kermadec Petrel (western)	Vulnerable
	Thalassarche bulleri	Buller's Albatross	Vulnerable
	Thalassarche cauta	Shy Albatross	Vulnerable
	Thalassarche impavida	Campbell Albatross	Vulnerable
	Thalassarche steadi	White-capped Albatross	Vulnerable
	Xanthomyza phrygia	Regent Honeyeater	Endangered
Chondrichthyes	*Carcharias taurus*	Grey Nurse Shark	Vulnerable
	Carcharodon carcharias	Great White Shark	Vulnerable
Mammalia	*Balaenoptera borealis*	Sei Whale	Vulnerable
	Balaenoptera musculus	Blue Whale	Endangered
	Balaenoptera physalus	Fin Whale	Vulnerable
	Chalinolobus dwyeri	Large-eared Pied Bat, Large Pied Bat	Vulnerable
	Dasyurus maculatus maculatus	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (sout	Vulnerable
	Eubalaena australis	Southern Right Whale	Endangered
	Megaptera novaeangliae	Humpback Whale	Vulnerable
Plant	*Acronychia littoralis*	Scented Acronychia	Endangered
	Cryptostylis hunteriana	Leafless Tongue-orchid	Vulnerable
	Thesium australe	Austral Toadflax, Toadflax	Vulnerable
Reptilia	*Chelonia mydas*	Green Turtle	Vulnerable
	Dermochelys coriacea	Leathery Turtle, Luth	Vulnerable
Marine birds covered by migratory provisions of the EPBC Act, 1999			
Aves	*Diomedea amsterdamensis*	Amsterdam Albatross	
	Diomedea antipodensis	Antipodean Albatross	
	Diomedea dabbenena	Tristan Albatross	
	Diomedea exulans	Wandering Albatross	
	Diomedea gibsoni	Gibson's Albatross	
	Macronectes giganteus	Southern Giant-Petrel	
	Macronectes halli	Northern Giant-Petrel	
	Pterodroma leucoptera leucoptera	Gould's Petrel	
	Puffinus pacificus	Wedge-tailed Shearwater	
	Thalassarche bulleri	Buller's Albatross	
	Thalassarche cauta	Shy Albatross	
	Thalassarche impavida	Campbell Albatross	
	Thalassarche melanophris	Black-browed Albatross	
	Thalassarche steadi	White-capped Albatross	
Marine species covered by migratory provisions of the EPBC Act, 1999			
Chondrichthyes	*Rhincodon typus*	Whale Shark	
Mammalia	*Balaenoptera musculus*	Blue Whale	
	Eubalaena australis	Southern Right Whale	
	Megaptera novaeangliae	Humpback Whale	
Reptilia	*Chelonia mydas*	Green Turtle	
	Dermochelys coriacea	Leathery Turtle, Luth	

Table B.3 List of fish, birds, amphibians, mammals, reptiles and plants likely to occur within the vicinity of Saltwater Creek protected under the EPBC Act (1999). The list includes species classed as threatened ecological communities, threatened species, marine protected species and migratory species.

	Scientific Name	Common Name	Legal Status
Terrestrial species covered by migratory provisions of the EPBC Act, 1999			
Aves	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	
	Hirundapus caudacutus	White-throated Needletail	
	Monarcha melanopsis	Black-faced Monarch	
	Monarcha trivirgatus	Spectacled Monarch	
	Myiagra cyanoleuca	Satin Flycatcher	
	Rhipidura rufifrons	Rufous Fantail	
	Xanthomyza phrygia	Regent Honeyeater	
Wetland species covered by migratory provisions of the EPBC Act, 1999			
Aves	*Gallinago hardwickii*	Latham's Snipe, Japanese Snipe	
	Rostratula benghalensis	Painted Snipe	
Species covered by marine provisions of the EPBC Act, 1999			
Aves	*Catharacta skua*	Great Skua	Listed
	Diomedea amsterdamensis	Amsterdam Albatross	Listed
	Diomedea antipodensis	Antipodean Albatross	Listed
	Diomedea dabbenena	Tristan Albatross	Listed
	Diomedea exulans	Wandering Albatross	Listed
	Diomedea gibsoni	Gibson's Albatross	Listed
	Gallinago hardwickii	Latham's Snipe, Japanese Snipe	Listed
	Haliaeetus leucogaster	White-bellied Sea-Eagle	Listed
	Hirundapus caudacutus	White-throated Needletail	Listed
	Lathamus discolor	Swift Parrot	*
	Macronectes giganteus	Southern Giant-Petrel	Listed
	Macronectes halli	Northern Giant-Petrel	Listed
	Monarcha melanopsis	Black-faced Monarch	Listed
	Monarcha trivirgatus	Spectacled Monarch	Listed
	Myiagra cyanoleuca	Satin Flycatcher	Listed
	Puffinus pacificus	Wedge-tailed Shearwater	Listed
	Rhipidura rufifrons	Rufous Fantail	Listed
	Rostratula benghalensis	Painted Snipe	Listed
	Thalassarche bulleri	Buller's Albatross	Listed
	Thalassarche cauta	Shy Albatross	Listed
	Thalassarche chlororhynchos	Yellow-nosed Albatross, Atlantic Yellow-nosed Albatr	Listed
	Thalassarche impavida	Campbell Albatross	Listed
	Thalassarche melanophris	Black-browed Albatross	Listed
	Thalassarche steadi	White-capped Albatross	Listed
Osteichthyes	*Acentronura tentaculata*	Pipehorse	Listed
	Festucalex cinctus	Girdled Pipefish	Listed
	Filicampus tigris	Tiger Pipefish	Listed
	Heraldia nocturna	-	Listed
	Hippichthys heptagonus	Reticulated Freshwater Pipefish	Listed
	Hippichthys penicillus	Steep-nosed Pipefish	Listed
	Hippocampus whitei	Crowned Seahorse	Listed
	Histiogamphelus briggsii	Briggs' Pipefish	Listed
	Lissocampus runa	Javelin Pipefish	Listed
	Maroubra perserrata	Sawtooth Pipefish	Listed
	Solegnathus dunckeri	Duncker's Pipehorse	Listed
	Solegnathus spinosissimus	Spiny Pipehorse	Listed
	Solenostomus cyanopterus	Blue-finned Ghost Pipefish	Listed
	Solenostomus paradoxus	Harlequin Ghost Pipefish	Listed
	Stigmatopora nigra	Black Pipefish	Listed
	Syngnathoides biaculeatus	Alligator Pipefish	Listed
	Trachyrhamphus bicoarctatus	Short-tailed Pipefish	Listed
	Urocampus carinirostris	Hairy Pipefish	Listed
	Vanacampus margaritifer	Mother-of-pearl Pipefish	Listed
Reptilia	*Chelonia mydas*	Green Turtle	Listed
	Dermochelys coriacea	Leathery Turtle, Luth	Listed

Table B.3 List of fish, birds, amphibians, mammals, reptiles and plants likely to occur within the vicinity of Saltwater Creek protected under the EPBC Act (1999). The list includes species classed as threatened ecological communities, threatened species, marine protected species and migratory species.

Scientific Name	Common Name	Legal Status
Hydrophis elegans	Elegant Seasnake	Listed
Pelamis platurus	Yellow-bellied Sea Snake	Listed

Table B.4: a) Fish caught using seine nets near the entrance to Saltwater Creek on 4/4/01. b) Summary of measurements (LCF) for species of economic importance. Life histories based on SPCC 1981. A= adult, J = juvenile, SJ = small juvenile, LJ = large juvenile. * = economically important fish species.

A)

Family Name	Common Name	Scientific Name	1	2	3	Total	% Contribution
Hemiramphidae	Snub-nosed garfish	*Arrhamphus sclerolepis*		6		6	3.97
Clupeidae	Southern herring	*Herklotsichthys castelnaui*		2	2	4	2.65
Platycephalidae	Dusky flathead*	*Platycephalus fuscus*			1	1	0.66
Ambassidae	Port Jackson perchlet	*Ambassis jacksoniensis*		14	2	16	10.60
Terapontidae	Crescent perch	*Terapon jarbua*		1		1	0.66
Sillaginidae	Sand whiting*	*Sillago ciliata*		17	3	20	13.25
Gerreidae	Silver biddy*	*Gerres subfasciatus*	5	48	17	70	46.36
Sparidae	Yellow-fin bream*	*Acanthopagrus australis*	1	3	2	6	3.97
	Tarwhine	*Rhabdosargus sarba*		8	1	9	5.96
Mugilidae	Flat-tail mullet*	*Liza argentea*			4	4	2.65
	Sand mullet*	*Myxus elongatus*	1	1		2	1.32
	Unidentified mullet	*Mugil* sp.			5	5	3.31
Scatophagidae	Spotted scat	*Scatophagus argus*		1		1	0.66
Gobiidae	Exquisite goby	*Favonigobius exquisites*		1		1	0.66
Mugilidae(?)	Unidentified fish larvae			4	1	5	3.31
TOTAL						151	

B)

Scientific name	Common name	Life history	(mm)	No.	Range	Mean (SE)
Acanthopagrus australis	Yellowfinned bream	SJ	<104			
		LJ	105-204	6	128-186	151(8.4)
		A	>204			
Gerres subfasciatus	Silverbiddy	SJ	<64	9	55-64	57(1)
		LJ	65-124	63	66-117	92(2)
		A	>125			
Liza argentea	Flat-tail mullet	SJ	<165	4	69-86	76(3.7)
		LJ	165-204			
		A	>205			
Mugulidae?	Mullet	J	<230	4	92-152	117(15)
		SA	230-320			
		A	>320			
Myxus elongatus	Sand mullet	SJ	<124	1	118	
		LJ	125-224	1	178	
		A	>225			
Platycephalus fuscus	Dusky flathead	SJ	<124	1	122	
		LJ	125-324			
		A	>325			
Rhabdosargus sarba	Tarwhine	SJ	<170	9	62-97	83(3.5)
		LJ	170-214			
		A	>214			
Sillago ciliata	Sand whiting	SJ	<144	19	34-117	91(5.2)
		LJ	145-244			
		A	>245	1	256	

Appendix C

Glossary of Terms

Appendix C Glossary of Terms

accretion	Deposition of sediment in the channel and on the banks of the estuary resulting in the growth of bars and other depositional features.
acid sulfate soil	Estuarine sediments in which metal sulfides (mainly pyrite) accumulate, and the subsequent dehydration of these sediments by evapotranspiration and/or disturbance which enables the oxidation of pyrite/sulfides to produce sulfuric acid.
algal bloom	The excessive growth of phytoplankton, generally caused by high nutrient levels. Can result in deoxygenation of the water mass, leading to the death of aquatic flora and fauna.
anoxic	A lack of oxygen in the water.
Australian Height Datum (AHD)	A common national plane of level corresponding approximately to mean sea level.
bathymetry	The measurement of depths of water; also information derived from such measurements.
benthos, benthic organisms	Organisms living in or on the bed of a waterbody.
catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
dissolved oxygen	Atmospheric oxygen that dissolves in water. The solubility of oxygen in water depends upon temperature and salinity.
ebb tide	The outflow of coastal waters from bays and estuaries caused by the falling tide.
estuarine processes	Those processes that affect the physical, chemical and biological behaviour of an estuary, e.g. predation, water movement, sediment movement, water quality, etc.
estuary	An enclosed or semi-enclosed body of water having an open or intermittently open connection to coastal waters in which water levels vary in a periodic fashion in response to ocean tides.
estuary management process	A sequence of activities starting with the formation of an Estuary Management Committee and culminating in the implementation of an Estuary Management Plan that will foster the balanced and sustainable use of estuaries.

flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream or river.
flood mitigation works	Structures that are designed to manage floodwaters (e.g. levees, retarding basins).
floodplain	The portion of a river valley, adjacent to the river channel, which is covered with water when the river overflows during floods.
flood tide	The inflow of coastal waters into bays and estuaries caused by the rising tide.
habitat	The places in which an organism lives and grows. Many estuarine organisms require different habitats at different stages of their life cycles.
hydraulic regime	The variation of estuarine discharges in response to seasonal freshwater inflows and diurnal tides.
levee	A man-made embankment or wall built to exclude floodwaters, or a natural embankment adjacent to a waterway built by the deposition of silt from floodwaters.
littoral drift processes	Wave, current and wind processes that facilitate the transport of sediments along a shoreline.
management plan	A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, problems, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.
mangroves	An intertidal plant community dominated by trees.
neap tides	Tides with the smallest range in a monthly cycle. Neap tides occur when the sun and moon lie at right angles relative to the earth (the gravitational effects of the moon and sun act in opposition on the ocean).
nutrients	Substances containing or conveying nourishment. Common nutrients are phosphorus and nitrogen.
phase lag	Difference in time of the occurrence between high (or low water) and maximum flood (or ebb) velocity at some point in an estuary.

recruitment	The addition of new members to an existing population, such as the settling of planktonic fish and crustacean larvae into seagrass beds.
riparian vegetation	Vegetation growing along banks of rivers, including the brackish upstream reaches of an estuary.
salinity	The total mass of dissolved salts per unit mass of water. Seawater has a salinity of about 35 g/kg or 35 parts per thousand.
salt wedge	The wedge-shaped body of saltwater that underlies freshwater in poorly-mixed estuaries.
sediment load	The quantity of sediment moved past a particular cross-section in a specified time.
shoaling	The influence of the seabed on wave behaviour. Such effects only become significant in water depths of 60m or less. Manifested as a reduction in wave speed, a shortening in wave length and an increase in wave height.
shoals	Shallow areas in an estuary created by the deposition and build-up of sediments.
spring tides	Tides with the greatest range in a monthly cycle, which occur when the sun, moon and earth are in alignment (the gravitational effects of the moon and sun act in concert on the ocean) .
tidal exchange	The proportion of the tidal prism that is flushed away and replaced with 'fresh' coastal water each tide cycle.
tidal excursion	The distance travelled by a water particle from low water slack to high water slack and vice versa.
tidal lag	The delay between the state of the tide at the estuary mouth (e.g. high water slack) and the same state of tide at an upstream location.
tidal limit	The most upstream location where a tidal rise and fall of water levels is discernible. The location of the tidal limit changes with freshwater inflows and tidal range.
tidal planes	A series of water levels that define standard tides, e.g. 'Mean High Water Spring' (MHWS) refers to the average high water level of spring tides.
tidal prism	The total volume of water moving past a fixed point on an estuary during each flood tide or ebb tide.

tidal propagation	The movement of the tidal wave into and out of an estuary.
tidal range	The difference between successive high water and low water levels. Tidal range is maximum during spring tides and minimum during neap tides.
tides	The regular rise and fall of sea level in response to the gravitational attraction of the sun, moon and planets. Tides along the New South Wales coastline are semi-diurnal in nature, i.e. they have a period of about 12.5 hours.
topography	The relief features or surface configuration of an area.
water quality	The suitability of the water for various purposes, as measured by the concentration or level of a wide variety of contaminants.

Appendix D

Definition of Tidal Planes

Appendix D Definition of Tidal Planes

For a detailed discussion on tides and tidal analysis see the National Tidal Facility website, www.ntf.flinders.edu.au, or the Manly Hydraulics Laboratory website, www.mhl.nsw.gov.au.

HHW(SS) – Higher High Water (Spring Solstices)

The highest of the high waters (or single high water) of any specified tidal day due to the declination effects of the moon and sun.

MHWS – Mean High Water Springs

The height of the MHWS is the average, throughout a year when the average maximum declination of the moon is 23.5°, of the heights of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is greatest.

MHW – Mean High Water

The average of all the high water heights observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum.

MHWN – Mean High Water Neaps

The height of the MHWN is the average, throughout a year when the average maximum declination of the moon is 23.5°, of the heights of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is least.

MSL – Mean Sea Level

The average level of the sea surface over a long period, preferably 18.6 years or more, or the average level which would exist in the absence of tides.

MLWN - Mean Low Water Neaps

The height of the MHWN is the average, throughout a year when the average maximum declination of the moon is 23.5°, of the heights of two successive low waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is least.

MLW – Mean Low Water

The average of all the low water heights observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum.

MLWS – Mean Low Water Springs

The height of the MHWN is the average, throughout a year when the average maximum declination of the moon is 23.5°, of the heights of two successive low waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is greatest.

ISLW – Indian Spring Low Water

The lowest level to which a tide will fall under exceptional, predictable, astronomical conditions. It seldom occurs. Meteorological and oceanographical influences, which cannot be predicted, can cause the tide to fall even lower.

MSR – Mean Spring Range
The difference obtained by subtracting the MLWS plane level from the MHWS plane level.

MNR – Mean Neap Range
The difference obtained by subtracting the MLWN plane level from the MHWN plane level.