COCKBURN SOUND MANAGEMENT COUNCIL

THE STATE OF OWEN ANCHORAGE:

COMMUNITY SUMMARY PAPER

February 2007

BACKGROUND

The State of Owen Anchorage study was commissioned by the Cockburn Sound Management Council (CSMC) as part of its expanded role in managing the waters of Owen Anchorage and its catchment. This study is the first major step in the development of strategies and actions for the management of this highly valued expanse of water.

INTRODUCTION

In August 2004, the Minister for the Environment announced the expansion of the Cockburn Sound Management Council's (CSMC) roles and responsibilities to include the waters of Owen Anchorage and its catchment. As a result, the Government has provided additional funding from 2005 to 2008 to support the Council's role in this area. A sub-committee of the CSMC, known as the Owen Anchorage Sub-Committee (OASC), has been established to coordinate the environmental management of Owen Anchorage (Figure 1).

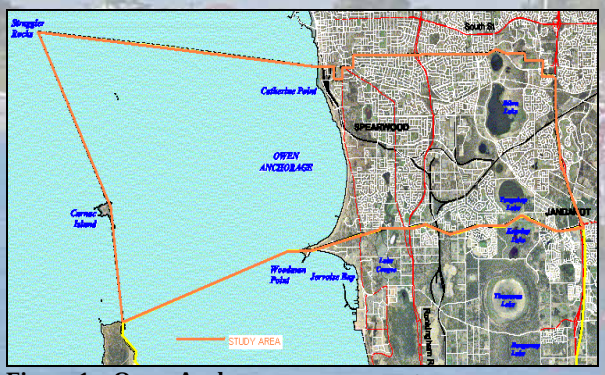

Figure 1 – Owen Anchorage management area

To develop an Environmental Management Plan (EMP) for the Owen Anchorage region, the OASC identified the need for a study on the 'State of the Owen Anchorage Environment'. The scope of the study was to provide up-to-date information on the pressures facing Owen Anchorage; the current state or condition of the environment and the current knowledge and management responses to the pressures identified.

Owen Anchorage has not experienced the degree of environmental degradation that occurred in Cockburn Sound between the mid-1950s and early 1980s, but it has still been affected by industrial discharges, domestic waste discharges, dredging of shipping channels, sub-tidal sand-mining, commercial and naval shipping activities, commercial fishing and recreational use.

MARINE COMPONENT

Pressures on the Marine Environment

The pressures on the marine environment of Owen Anchorage due to the many past and present activities occurring along the coastal strip and within the marine environment are shown in Figure 2.

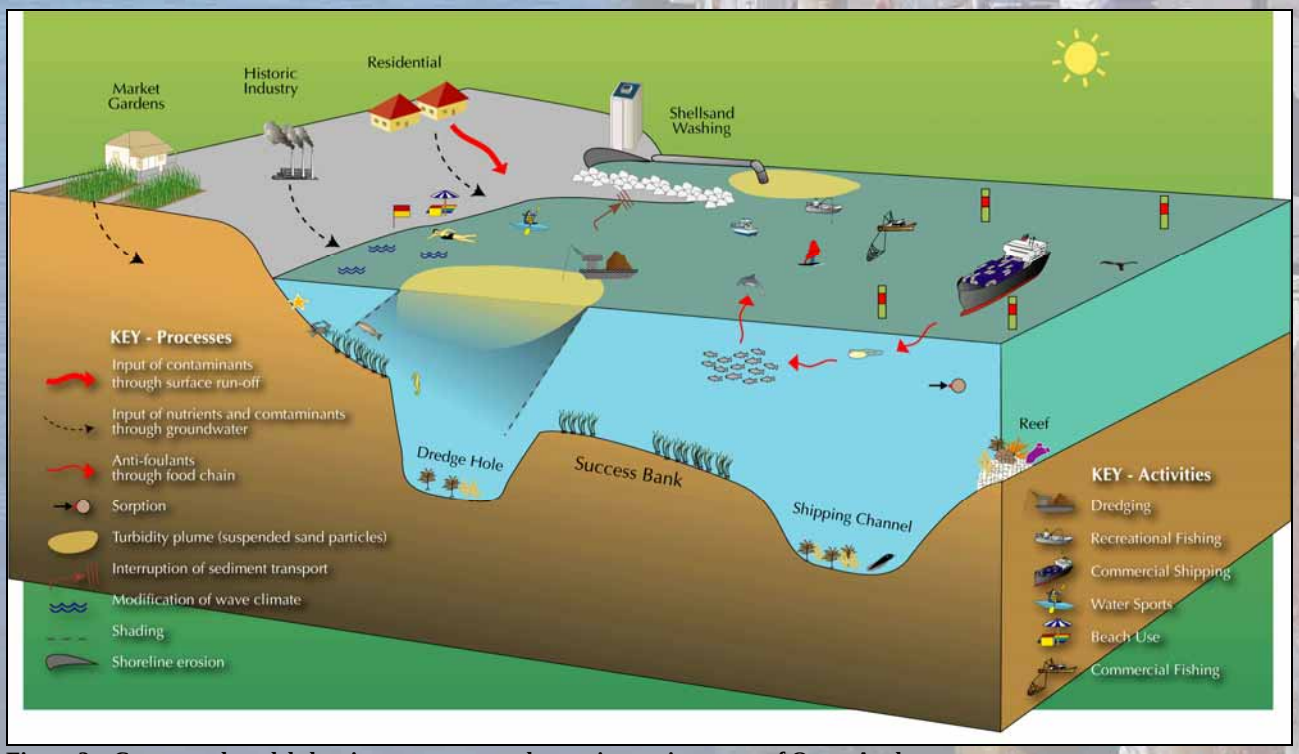

Figure 2 – Conceptual model showing pressures on the marine environment of Owen Anchorage

1. Coastal Structures

Man-made structures, such as groynes and breakwaters, along the Owen Anchorage shoreline (Figure 3) have significantly altered natural coastal processes.

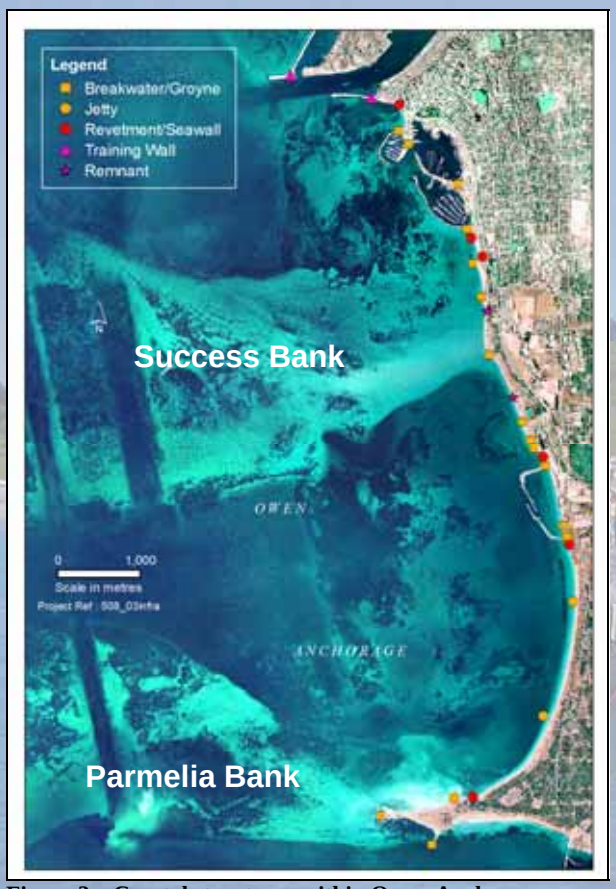

Figure 3 – Coastal structures within Owen Anchorage

These structures modify natural sand movement along the shoreline. In the northern half of the Owen Anchorage shoreline, the more significant structures are Catherine Point Groyne and the Power Station Breakwater, both of which restrict sand movement from Success Bank to Coogee Beach (North to South). To the south, the WAPET Groyne has significantly changed the sand movement at Woodman Point and restricted sand movement to Quarantine Beach.

The construction of the rock groynes for the Port Coogee Marina will alter the movement of sand along this section of shoreline, with approximately 33,000 m^3 of sand likely to be trapped annually by the northern groyne. However, it was concluded that beach stability can be maintained by periodic bypassing of sand from the north to the south of the development.

2. Dredging

Past and present dredging activities in Owen Anchorage include those of Fremantle Ports (deepening of shipping channels and ongoing maintenance dredging), and Cockburn Cement Limited (CCL) (shellsand dredging).

Dredging of a shipping channel through Success and Parmelia Banks first occurred between 1914 and 1918, during World War 1. The shipping channel was subsequently deepened/maintained in 1919, 1942-1945, 1955, 1967 and 1994. Fremantle Ports currently carries out maintenance dredging in the shipping channels every 2–3 years to maintain safe navigation.

CCL dredges shellsand from Success and Parmelia Banks for use in cement and lime production. CCL commenced dredging on Parmelia Bank in 1972, and on Success Bank in 1982. Dredging currently occurs within Stage 1 of a defined, two-stage, Long-Term dredge area (Figure 4). Environmental approval for this dredging was received on 8th July 2002.

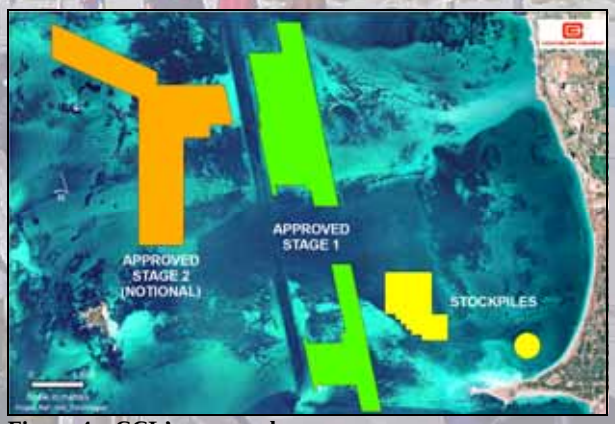

Figure 4 – CCL's approval areas

The environmental impacts resulting from the dredging activities in Owen Anchorage are discussed below.

a) Changes in wave climate

No work has been done on the impacts on wave climate due to dredging of Fremantle Port's shipping channels or the early years of CCL's operations. A wave climate model was developed and calibrated to simulate present-day wave conditions, and used to predict the likely effects upon sea conditions following CCL's Short- and Medium-Term dredging of Success Bank. The modelling indicated that wave characteristics following the dredging will not be significantly different from previous conditions, and this has been confirmed with wave measurements. Modelling of the effect of CCL's Long-Term dredging is presently underway.

Environmental Quality Criteria (EQC)

The environmental quality of Owen Anchorage has been assessed using EQC for water quality, sediment quality, seagrass health and seafood quality established for Cockburn Sound. Exceedence of Environmental Quality Guidelines (EQGs) indicates potential risk to environmental values and triggers further investigations. Exceedence of Environmental Quality Standards (EQSs) signifies an unacceptable risk to environmental values and triggers management actions to address the cause of the exceedence.

b) Increased exchange of seawater between Owen Anchorage and Cockburn Sound.

The highest rate of exchange of water between Owen Anchorage and Cockburn Sound currently occurs in winter. At present, surface waters (to a depth of 5–8 m) exchange freely between Cockburn Sound and the open waters to the north and west. Some exchange of water at depths between 5–8 m and 15 m already occurs through the Fremantle Ports shipping channel.

The completion of the 2nd shipping channel will have some influence on exchange of waters at depths from 8–15 m. A small overall improvement in water quality (as indicated by water clarity) might be expected in northern Cockburn Sound.

c) Loss of seagrass

Present total losses of seagrass due to dredging are estimated at 285 ha (Table 1). Presently there are 2,236 ha of seagrass in Owen Anchorage, of which approximately 2,204 ha are outside CCL's approved Stage 1 dredging area.

Table 1 - Loss of seabed habitat in shallow waters due to dredging activities in Owen Anchorage

Dredging activity	Period	Area dredged (hectares)	
		Total habitat	Seagrass
Fremantle Ports			
Shipping channel	1950s	125	85
Cockburn Cement Ltd			
2nd shipping channel	1972–1994	181	89
Short-tem area	1994–1996	67	4
Medium-term area	1996–2002	131	54
Long-term area – Stage 1	2002–2010	233	53
Long-term area – Stage 2 (notional)	2010 to ~2030	~350	0
Total		**1,087**	**285**

Despite losses due to dredging, overall seagrass cover actually increased by 295 ha between 1965 and 1972, and by a further 196 ha between 1972 and 1999. This increase was due to active colonisation and expansion of seagrass meadows.

Further significant seagrass loss due to dredging is unlikely, as CCL is presently dredging in 'pre-dredged' areas in its Stage 1 area (i.e. the seagrass is already removed), and will be moving to its Stage 2 area on West Success Bank in 2010 (where dredging must not cause any loss of seagrass).

d) Changes in water quality and clarity due to dredging and associated activities.

The largest and most persistent turbidity plumes are generated at CCL's wash plant jetty because of the number of turbidity-generating activities and the continuous nature of operations. The principal causes of turbidity at the wash plant jetty are vessel movement (effect of propeller wash), dumping of shellsand, operation of the reclaimer (i.e. pumping of sand from around the jetty to the wash plant on the shores of Woodman Point) and the discharge of wash water from the wash plant.

Turbidity impacts on seagrasses surrounding the wash plant at Woodman Point are monitored annually, with surveys of seagrass health and mapping of seagrass distribution undertaken to ensure that unacceptable impacts are not occurring. The seagrass beds surrounding the wash plant are generally healthy (as measured by shoot density) and comply with the EQC for either high or moderate protection areas.

The plume around the wash plant is, however, highly visible, with waters around the wash plant jetty noticeably 'milky' and opaque. This visual impact of the plume is due in part to the fact that it is 'fresher' than seawater, which means the discharged water floats as a surface layer on top of the seawater (Figure 5) before it is eventually mixed and diluted.

Figure 5 – Turbid plume at the woodman Point wash plant

3. Inputs of Nutrients and Contaminants

Various activities within Owen Anchorage and its catchment have, or presently still are, affecting its environmental quality to some degree via inputs of nutrients and contaminants, and these are discussed below.

a) Nutrient inputs

In the past, nutrient-related water quality in Owen Anchorage has been influenced by sewage discharged directly into Owen Anchorage (Robb jetty outfall) or indirectly via the Water Corporation's outfall at Woodman Point, by various industrial discharges (abattoirs, fellmongers) along the Owen Anchorage shoreline, by groundwater discharges and by Swan River flows.

Estimated nitrogen (the nutrient which controls marine growth) loads to Owen Anchorage for 1979, 1990 and 2006 are given in Figure 6. Estimated loads depend on the extent to which Swan River outflow enters Owen Anchorage (usually river waters move northwards), and

so Figure 6 provides two estimates based on different contributions from the Swan River. With either approach, total loads have decreased markedly since 1990, with industrial discharges exhibiting the most dramatic reductions.

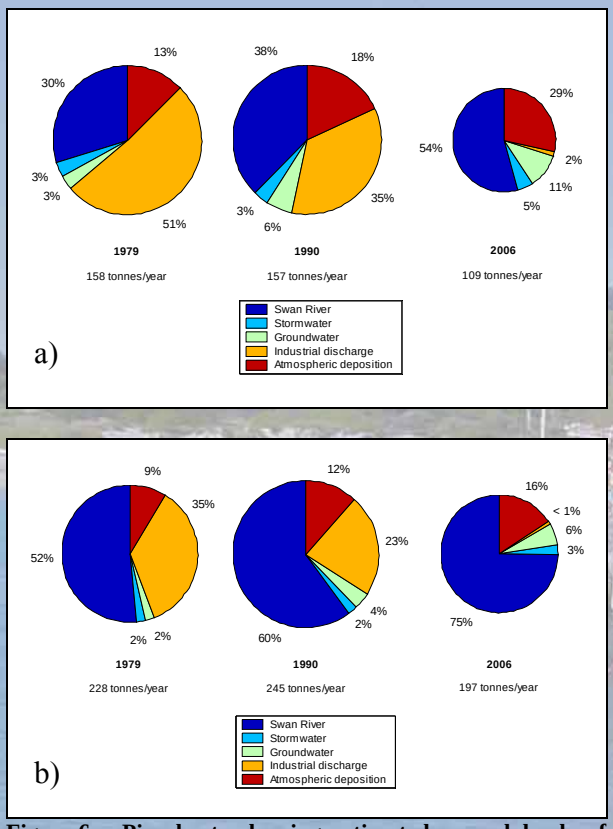

Figure 6 - Pie charts showing estimated annual loads of nitrogen into Owen Anchorage assuming (a) 10% of Swan River outflow reaches Owen Anchorage and (b) 25% of Swan River outflow reaches Owen Anchorage
Note: Pie chart area proportional to total annual load.

b) Contaminant inputs
Since industrial discharges stopped in 1998, contaminant loads to Owen Anchorage have declined significantly.

A recent sediment survey (2006) by the CSMC found levels of metals and organic contaminants were well below levels of concern. Nor was the boat antifoulant ingredient tributyltin (TBT) detected within Owen Anchorage sediments, although previous surveys have shown low levels to be present. The impacts of TBT can, however, be present in some marine biota long after the sediment contamination falls below sediment guidelines. The incidence and severity of imposex, the occurrence of induced male sex characteristics superimposed on normal female gastropods (marine snails), is widely used as an indicator of past and present TBT contamination. A recent survey of populations of the gastropod *Thais orbita* in Perth coastal waters, including South Mole and Fishing Boat Harbour in Fremantle, found 100% imposex at both sites, indicating that TBT-related impacts may still be occurring within Owen Anchorage.

4. Commercial and Naval Shipping
The waters of Owen Anchorage have been visited by national and international shipping since the 1830s, with upsurges in shipping traffic in the 1950s (dredging of shipping channels) and 1970s (construction of the naval base on Garden Island).

Commercial and naval shipping moving through the waters of Owen Anchorage could potentially affect the marine environment via (i) leaching of antifoulants from ships hulls, and (ii) introduction of foreign marine organisms.

A survey of introduced marine pests in Fremantle Ports waters carried out in 1999 as part of an Australian port survey programme included several sites in Owen Anchorage, including shipping channel markers and the Mewstone area. The survey found no pest species in Owen Anchorage but two targeted pest species in Cockburn Sound: the European fan worm *Sabella* cf. *spallanzanii* (throughout coastal waters), and the Asian date mussel *Musculista senhousia*.

5. Commercial and Recreational Fishing
Commercial and recreational fishing result in the direct removal of a relatively few 'target' species of fish. Depending on the fishing method used, there can also be losses due to by-catch (non-target species). Other pressures include fuel spills from boats; discharge of sullage; rubbish; loss of gear (nets, lines, hooks, sinkers etc); and habitat damage from propeller and hull scour, nets and anchors.

The 'Cockburn Sound' commercial fishery 'block' includes the waters of Cockburn Sound and Owen Anchorage. The fishing gear allowed in this area and the present level of fishing effort is not believed to be a major pressure on Owen Anchorage. The main management issue is likely to be the sustainability of the combined catches of commercial and recreational fishing as recreational fishing pressure increases.

6. Broadscale ('fundamental') Pressures

a) Climate change

The draft WA 2006 State of Environment report (EPA 2006) has concluded that climate change is occurring, and that WA's environment is highly vulnerable to further climate change. These climate changes include:

- Increasing air temperatures;
- Decreased rainfall; and
- Increasing sea surface temperatures, sea levels and degree of 'storminess'.

The banks and beaches of Owen Anchorage will be vulnerable to the effects of increased sea levels and degree of 'storminess'.

b) Population increase

Increased development of residential areas adjacent to Owen Anchorage, plus general population increase in the region (Perth's population is expected to reach 2 million by around 2025), is likely to lead to an increase in recreational pressure on Owen Anchorage.

State of the Marine Environment

1. Water Movement in Owen Anchorage

The waters of Owen Anchorage are well sheltered from offshore wave energy due to the physical barriers provided by Garden Island and Point Peron to the southwest, the Garden Island reef chain in combination with Success and Parmelia Banks to the west, and Fairway Bank (average 8 m) and the Fremantle moles and harbours to the north. As little as 10% of the offshore swell wave energy and 25-40% of total wave energy reaches the shoreline, depending on wave direction, shoreline aspect and location within Owen Anchorage.

2. Coastal Processes

a) Shoreline 'stability'

The shoreline is generally quite stable or accreting (i.e. accumulating sand). Years with significant winter storm activity (e.g. mid-1950s, early 1960s, mid-1970s, early and late 1980s, and especially 1996 and 1999) can result in short-term erosion in some areas. The majority of the shoreline has not exhibited any significant long-term erosion (see Figure 7 which shows changes in the position of the coastal vegetation line since 1942).

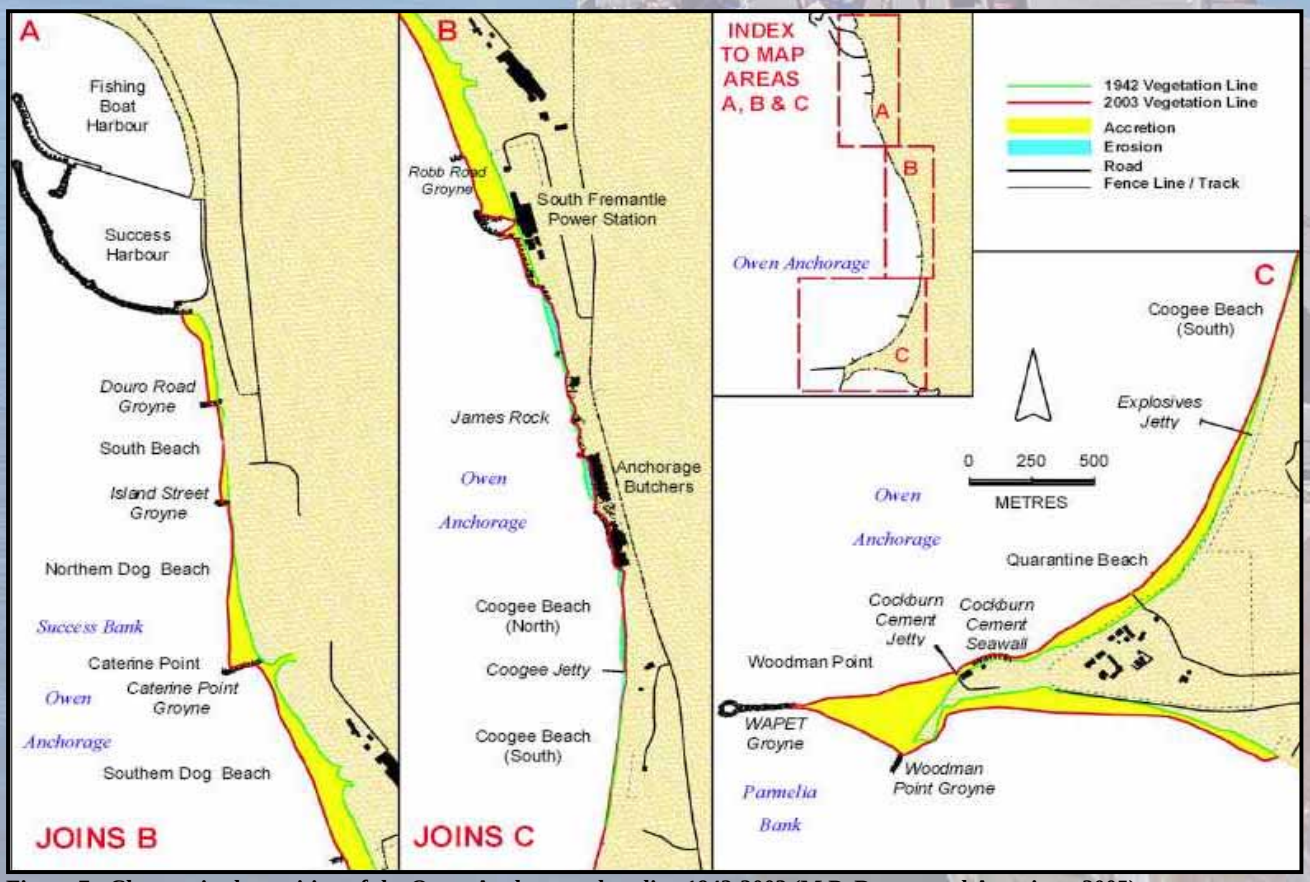

Figure 7 - Changes in the position of the Owen Anchorage shoreline 1942-2003 (M.P. Rogers and Associates 2005)

At places such as Quarantine Beach and near the South Fremantle Power Station, the vegetation line is now more than 100m seaward of the position in 1942.

b) Grey Sands

'Grey sands' (Figure 8) in Owen Anchorage have been identified as an issue by members of the public, with discharge of wash water from CCL's wash plant suggested as a possible cause. It is unlikely to be due solely to one cause. A combination of processes and activities within the Owen Anchorage region may be contributing to the discolouration of beach sediments. It is recognised that further investigations into the grey sands issue are required, both to determine potential sources and develop possible management measures.

Figure 8 – Beach and dune discolouration near the South Fremantle power station

3. Water Quality

Water quality has been measured weekly at sites OA1–10 (Figure 9) during 'summer' (December to March inclusive) for the last three years.

Figure 9 - Location of water quality monitoring sites

The following water quality parameters are measured: chlorophyll-a concentration, light attenuation coefficient, secchi disk depth, indicators of aesthetics (algal/plant material on surface, dead marine organisms visible, oil or other films on surface etc) and dissolved oxygen (DO) concentration.

a) Chlorophyll-a

The chlorophyll-a concentrations at OA1, OA2 and OA3 (for which long-term data is available) have generally declined since the 1970s and the median concentrations have remained below the EQG for high protection since the early 1980s. Data for all 10 sites for the last three years also meet the EQG for high protection. This indicates that nutrient enrichment is not occurring within Owen Anchorage, and that water quality is generally good.

b) Light attenuation

The light attenuation coefficient describes the amount of light which can penetrate the water column, and so provides a measure of water turbidity. Turbidity can be caused by suspended sediment particles or fine organic material. It is also affected by the amount of primary production occurring within waters, with high chlorophyll levels resulting in more turbid waters and therefore a higher light attenuation. Light attenuation gives an indication of the amount of light reaching seagrasses.

Data indicate that Owen Anchorage has some areas of relatively high turbidity during summer, even though chlorophyll-a concentrations meet the EQG for high protection areas. The long-term datasets from sites OA1, OA2 and OA3 show that the light attenuation coefficient recorded from these sites has improved since the late 1970s. However, the light attenuation coefficients recorded at OA1 each summer have remained close to the EQG for moderate protection areas, with the EQG exceeded during some surveys. The data suggests that factors other than primary production (chlorophyll) are causing slight elevations in turbidity.

c) Secchi depth

'Secchi disc' depth (or secchi depth) is a measure of water clarity, and was generally greater than 5 m (greater than water column depth at 5 sites) at all sites during summer 2005-06.

d) Aesthetics

A plume from the Swan River was observed to reach site OA8 in February 2006. Individual dead fish were recorded twice over this period, with the first observation identified as having been caught and released by an angler. A film was observed on the water surface only once; at site OA1 in February 2004.

e) Water column structure & Dissolved Oxygen
The water column at each site during summer was generally well mixed, with little vertical stratification (layering) in salinity or temperature observed during each survey.

The dissolved oxygen levels were found to remain high at each site (> 90% saturation) and vary little with depth.

f) Microbiological indicators
The Department of Health undertakes routine sampling of near shore recreational waters for bacteria (enterococci) approximately monthly through summer (November – April). Two principal components are required for assessing faecal contamination:

- assessment of evidence for the likely influence of faecal material; and
- counts of suitable faecal indicator bacteria (usually enterococci).

Since October 2002 waters along the shoreline of Owen Anchorage have generally been classified as 'uncontaminated'. Low levels of faecal bacteria were recorded off Coogee Beach in February 2003, March 2003, March 2005 and April 2004. Higher levels of contamination (substantial elevation in the risk of adverse health impacts) were recorded at Coogee Beach in October 2002 and April 2004.

Human faecal pollution is likely to be the main factor in determining the overall sanitary condition for an area. The most important sources of human faecal contamination include sewage, riverine inputs and contamination from bathers. Other potential sources include septic tanks near the shore (leaching directly into groundwater and then seeping into the recreational water), and shipping and local boating (including moorings and special events such as regattas). Indicator organism densities in recreational waters can also reach high levels after rainfall if animal wastes are washed into near shore waters or sewage overflows directly into a waterway or into stormwater. The occasional contamination events recorded from Owen Anchorage could also be related to seagull droppings, or the use of the beaches by dogs.

4. Marine Sediments
Contaminants discharged to marine environments typically accumulate in the sediments. There have been a number of surveys of sediment quality in Owen Anchorage in the last 12 years, and the results are discussed below.

a) Cockburn Sound Management Council (CSMC) sampling 2006
The Cockburn Sound Management Council (CSMC) coordinates an Environmental Quality Monitoring Program (EQMP) for the marine waters of Cockburn Sound and now Owen Anchorage. The CSMC's Environmental Management Plan (EMP) for Cockburn Sound recommends that sampling for toxicants in sediment be carried out every 3-5 years. Sediment cores were taken throughout Warnbro Sound, Cockburn Sound and Owen Anchorage in summer/autumn 2006, with the methodology in line which that outlined in the Manual of Standard Operating Procedures for Cockburn Sound. The sites sampled in Owen Anchorage are shown in Figure 10.

Figure 10 - CSMC sediment sampling sites in Owen Anchorage (2006)

Arsenic, chromium, copper, lead, nickel and zinc were detected in sediments at most sites, but did not exceed the EQG. Antimony, cadmium, mercury and silver were at levels below detection limits. The sediment samples were also analysed for a range of organics including polycyclic aromatic hydrocarbons (PAHs), pesticides and tributyltin . Very low levels of PAHs (below EQG's) were detected at some sites, whilst pesticides and tributyltin were at levels below detection limits at all sites.

b) Cockburn Cement Ltd monitoring, 2004
Monitoring of sediment quality was undertaken at nine sites (Figure 11) in autumn 2004 in accordance with the approved monitoring programme in CCL's EMP. No contaminants were found to exceed the EQG values.

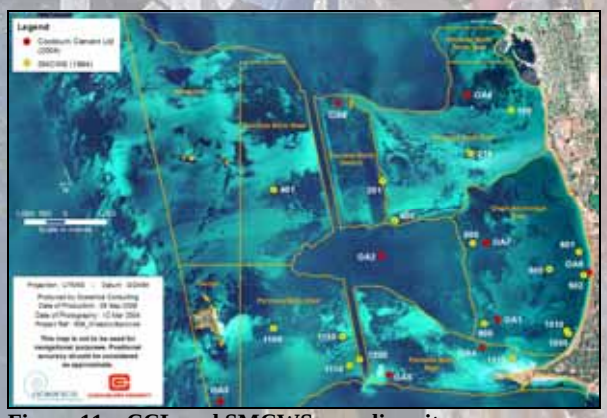

Figure 11 – CCL and SMCWS sampling sites

c) Southern Metropolitan Coastal Waters Study, 1994
A comprehensive investigation of organic pollutants and heavy metals in sediments and mussels was undertaken in 1994 as part of the Southern Metropolitan Coastal Waters Study (Figure 11). This study found concentrations of arsenic, chromium, mercury and tributyltin (TBT) above established guidelines (ISQG-Lows) at several sites throughout Owen Anchorage. The pesticides DDT and dieldrin were also above the trigger values at several sites across Owen Anchorage while polycyclic aromatic hydrocarbons (PAHs) were recorded at concentrations below trigger levels.

Having exhibited some contamination in the 1990s, predominantly mercury and tributyltin, the sediments within Owen Anchorage now appear to be uncontaminated, with mercury, tributyltin and pesticides not detected during the most recent sampling (CSMC 2006) and all metals and polycyclic aromatic hydrocarbons (PAHs) falling below the EQGs.

5. Marine Flora
The marine flora of Owen Anchorage includes seagrasses, seagrass epiphytes (algae that grow on seagrasses), reef algae (seaweeds) and phytoplankton (microscopic algae). Marine flora are important as they provide the basis of the food webs in Owen Anchorage.

a) Seagrasses
Seagrasses are the marine counterparts to terrestrial grasses. They are true flowering plants (unlike seaweeds) and have roots, rhizomes, leaves, flowers and fruits.
Seagrass ecosystems provide habitats for a wide variety of marine organisms. They form a complex habitat that algae and small fauna (eg marine snails) can attach themselves to, and that fish and crustaceans can shelter in. Seagrass meadows (Figure 12) are also a source of food and often provide important habitat for juvenile fish species valued by recreational anglers (eg King George Whiting).

Figure 12 – Seagrass meadow (*Posidonia sinuosa*)

There are six main 'meadow-forming' species: *Amphibolis griffithii*, *A. antarctica*, *Posidonia australis*, *P. sinuosa*, *P. angustifolia* and *P. coriacea*. These species dominate the extensive shallow areas (< 10 m) in Owen Anchorage, and form complex mixtures of species at varying densities that is quite unlike the 'single species' meadows of Cockburn Sound.

i. Seagrass cover
In 1999 and 2004 mapping of seagrass habitats in Owen Anchorage was undertaken for CCL. This work is part of CCL's Long-Term Shellsand Dredging EMP commitment for mapping marine habitats in Owen Anchorage, and forms the basis for long term monitoring of the impacts of shellsand dredging in Owen Anchorage. Survey techniques employed in the mapping of seagrasses during this study included the capture and semi-automated classification of aerial photography, side scan sonar, towed underwater video and SCUBA diving.

Changes in seagrass distribution analysed using aerial photographs from the years 1965, 1972, 1982, 1995 and 1999 found that seagrass meadows in Owen Anchorage are extremely dynamic, with constant changes in distribution and density. Both significant losses and gains in seagrass cover were found. The losses were due to dredging (Cockburn Cement Ltd, and Fremantle Ports Shipping Channels) and to natural causes (sand movement).

Between 1999 and 2004 the percentage of vegetated habitat within the entire study area remained constant at 32%. However, there were changes in vegetated coverage in each of the mapping subregions. The greatest gains in vegetated habitat were in Owen Anchorage East (+6%), and the western subregions of Success (+4%) and Parmelia (+4%) Banks. These gains appear to suggest widespread edge growth on existing meadows. The greatest losses of vegetated habitat were in Success Bank East (-9%) and Parmelia Bank East (-9%). The losses on Success Bank East were widespread and appeared to be natural, whereas losses in Parmelia Bank East were largely associated with CCL's approved dredging activity.

ii. Seagrass health
Shoot density counts are considered a reliable indicator of seagrass health for some species of *Posidonia*, with declines in densities a potential indicator of poor health due to nutrient enrichment (declines can also occur due to natural causes). For this reason, shoot density has been adopted as an indicator of seagrass health in the State Environmental Policy for Cockburn Sound (SEP). Environmental Quality Criteria (EQC) have been developed against which seagrass health can be measured.

Seagrass health monitoring has occurred in Owen Anchorage through a programme carried out by Cockburn Cement Ltd (CCL) since 2004 (Figure 13).

Figure 13 - Location of Owen Anchorage seagrass health monitoring sites

The shoot densities (*Posidonia sinuosa*) recorded from Owen Anchorage sites in 2006 were all generally similar. The median shoot densities recorded in 2006 all met the relevant standards established for Cockburn Sound.

Another project linked to CCL's EMP is the management of turbidity surrounding its wash plant at Woodman Point, at the southern end of Owen Anchorage. Prior to the 1970s there were dense healthy seagrass meadows at the site of the wash plant jetty, but localised losses have occurred due to dredging of the access channel to the wash plant jetty, plus ongoing turbidity generated by activities at the jetty. Seagrass health has been measured annually since 2002, using shoot and leaf density of *Posidonia sinuosa* at several fixed sites around Woodman Point (Figure 14).

Figure 14 - Location of wash plant seagrass health monitoring sites

In 2006 the lowest median shoot densities were recorded at sites A and SG1 (Figure 15). The shoot densities at the wash plant sites have generally been more variable between years than those recorded from the wider Owen Anchorage sites, but no consistent trend (decrease or increase) is evident, except a possible increase at site E.

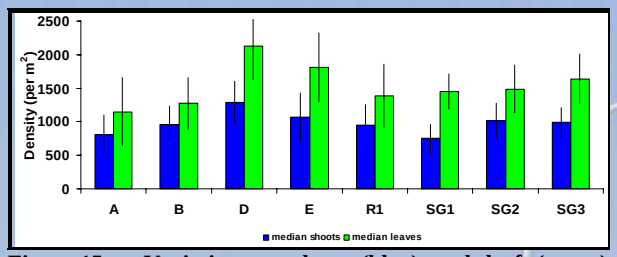

Figure 15 – Variation on shoot (blue) and leaf (green) density between wash plant sites (2006)

All sites around the wash plant met the high protection zone 'one year' EQC and most sites met the 'two consecutive years' EQC. Sites E and SG1 failed the high protection zone 'two year' EQC but met the moderate protection zone EQC.

In 1994 the Department of Environment and Conservation (DEC) commissioned an assessment of seagrass health at locations throughout the Fremantle – Warnbro Sound region. Since 1998 the survey of seagrass health has been repeated annually in January, on behalf of the DEC and the CSMC. Over this time the survey methodology has evolved from qualitative assessments to shoot counts in randomly placed quadrats to (from 2003) shoot counts in fixed quadrats. There are four sites located within Owen Anchorage (Figure 16).

Figure 16 - Location of DEC monitoring sites in Owen Anchorage

The density of seagrass shoots at each site has varied through time, but no site has exhibited a significant decrease in seagrass health since the beginning of the study, although the seagrass at Fish Rocks appears to be eroding from the south.

Comparison of the median shoot densities recorded from these sites in 2004, 2005 and 2006 shows that the EQS has been met at all sites except Carnac Island in 2004 (this site was moved following the 2004 survey due to a shift in seagrass assemblage from *P. sinuosa* to *P. australis* and *A. griffithii*).

b) Macroalgae
Patches of reef within Owen Anchorage were roughly mapped during the 2004 seagrass mapping project, with the larger reef areas to the west mapped from aerial photography in 1999. These reef areas are generally dominated by brown macroalgae (*Ecklonia radiata* and *Sargassum* spp.) although smaller patches exist that are dominated by other algae.

6. Marine Fauna
Marine fauna includes zooplankton, invertebrates living on surfaces (epifauna) or in sediments (infauna), fish, mammals (dolphins, sealions, whales) and seabirds. Mammals and seabirds are discussed below, with information on other fauna given within the full report.

a) Marine mammals
The Marine Conservation Branch (MCB) of the DEC have identified the distribution of the major marine fauna that are likely to come in direct conflict with humans in the Perth metropolitan area from Yanchep to Mandurah, namely whales, dolphins, sea lions, seabirds, little penguins and migratory waders.

Southern right whales migrate northwards to warmer waters in winter and migrate south in the Perth metropolitan area from September to November. The whales observed in the Perth metropolitan area represent only a small proportion of animals visiting southern Australia, with approximately 10-20 animals seen in the Perth metropolitan area each year. The females move close to the coast to give birth in small isolated bays/beaches, with a small proportion of females giving birth along the coast near Perth.

Around 200 bottlenose dolphins have been photo-identified within Cockburn Sound and Owen Anchorage. They have been studied since 1994 by researchers from Murdoch University's School of Veterinary and Biomedical Sciences and School of Biological Sciences.

The Australian sea lion, *Neophoca cinerea*, is the rarest of the five known species of sea lions. There are an estimated 2,700 to 3,400 individuals found in Western Australia and 1,000 of these are found specifically on the west coast. It is a listed marine species under the EPBC Act 1999, but this is currently under review to be upgraded to the "Vulnerable" status.

Males are almost exclusively observed in Perth, and can be found at haulout sites on Seal, Carnac, Penguin, Dyer and Little Islands and Burns Rock.

b) Seabirds
Little penguins, Bridled terns, Caspian terns and Crested terns breed on a number of islands in the Perth metropolitan area (including Penguin Island, Garden Island, and Carnac Island). It is estimated to be between 100 and 500 pairs of Fairy terns and less than 50 pairs of Roseate terns live and breed in the Perth Metropolitan area.

Pied cormorants breed in autumn and winter, on several of the Shoalwater Islands, Carnac, Garden and Dyer islands. Pied oystercatchers breed on Rottnest, Carnac and Penguin islands from July-October. Wedge-tailed shearwaters in the Perth metropolitan area breed on Carnac and Rottnest islands. A small number of waders (including ruddy turnstones and grey-tailed tattlers) are supported at Woodman Point.

Management Responses
1. State Government
The Southern Metropolitan Coastal Waters Study (SMCWS) was a comprehensive and detailed study initiated in 1991 to provide information to help manage contaminant discharges to Perth's southern coastal waters. The formation of the CSMC was a direct management response to the lack of coordination recognised in the Environmental Protection Authority's Bulletin 907, which in turn is based on a recommendation of the SMCWS.

The State Government has extended the management role of the CSMC to examine environmental and multiple use issues in Owen Anchorage, via an Owen Anchorage Sub Committee (OASC) established in July 2005. The key focus of the OASC is to prepare an Environmental Management Plan for Owen Anchorage and its catchment. The CSMC has received funding to expand its roles and responsibilities to include the waters and catchment of Owen Anchorage for the next three years.

A District Structure Plan (DSP) is to be prepared for the Cockburn Coast by the Western Australian Planning Commission, through the Department for Planning and Infrastructure (DPI). The DSP will aim to revitalise and change the zones from industrial to mixed use, mainly residential, in the area between the Island St Groyne and the northern boundary of the Port Coogee marina development.

2. Local Government
The City of Cockburn has a Coastal Management Strategy and a Coastal Works Plan endorsed by Council that addresses coastline works, foreshore rehabilitation and reserve management. The Coastal Works Plan is being implemented as funds allow.

The City of Cockburn has also recently released its State of the Environment report, and is currently undertaking the development of its Local Agenda 21 Plan which is part of the City of Cockburn's overall Sustainable Development Strategy.

3. Community
Community groups such as RecFishWest and the Conservation Council play a vital role as 'environmental

watchdogs' and in raising community awareness about environmental matters.

LAND COMPONENT

Pressures on Owen Anchorage due to Land Use

The historical and present use of the Owen Anchorage catchment may influence the waters of Owen Anchorage in a number of ways, including the input of contaminants and nutrients through groundwater or surface water sources and changes to the volumes of rainwater entering the groundwater or flowing into coastal waters.

A number of industries historically operated in the Owen Anchorage catchment including an abattoir, a tannery, a fellmongers and market gardens.

Copper, nickel and zinc were recorded in groundwater collected from the South Fremantle Landfill and South Fremantle Power Station sites at concentrations exceeding relevant marine or irrigation guidelines, whilst high concentrations of arsenic, chromium, iron and mercury were also recorded from some bores within and surrounding the South Fremantle landfill site. At the Port Catherine site and surrounds only nitrogen concentrations were measured, with high inorganic nitrogen concentrations recorded (≤ 8 mg/L) from several bores.

Most of the industrial and municipal wastewater discharges to Owen Anchorage have ceased since these estimates were made, while groundwater and surface drainage inputs are likely to have increased. It has been estimated that between 12 and 14 tonnes of nitrogen enters Owen Anchorage annually through groundwater inputs.

The DEC is currently investigating contaminant loads into Metropolitan coastal waters from surface water drainage. The Water Corporation of Western Australia undertook monitoring at a number of drains between Rockingham and Scarborough between 2002 and 2004 and found significant inputs of metals and nutrients to coastal waters.

Management Responses

The WA Planning Commission's 'Vision for Cockburn Coast' is intended to bring together the different planning and development initiatives in the area in an overall integrated framework.

The State's Contaminated Sites Act 2003 came into effect in Western Australia on December 1st 2006. This Act covers land, water (including groundwater) and contaminated sites which have the potential to present a risk of harm to human health, the environment or any environmental value.

The City of Cockburn has prepared a Coogee Beach Structure Plan to guide future planning and development of Coogee Beach and management of the coast.

Pressures on Owen Anchorage due to Social and Cultural Uses

1. Water Sports

Boat use can cause damage to the seabed from moorings, anchors and landings; discharge of sewage; oil spills; and litter.

Recreational boating pressure in Owen Anchorage will increase due to population increase, and DPI data indicate that boat ownership levels are increasing at a faster rate than population increases. There are several other factors that may influence recreational pressure on the Owen Anchorage area, including:

- increased recreational pressure when proposed developments along the coastal strip result in 'discovery' of the area by Perth's population as a close, high quality recreational asset;
- the considerable pressure on public boat ramps in Perth's coastal waters in general and the lack of a public boat ramp in Owen Anchorage; and
- increasing pressure on Perth's existing yacht clubs (coastal and river), and the lack of suitable facilities to host large yachting events.

2. Recreational Fishing

Recreational fishing can cause environmental pressure due to overfishing; damage to the seabed from fishing gear, moorings, anchors and landings; discharge of sewage; oil spills; and litter (lost fishing gear and rubbish). However, the types of fishing gear that recreational fishers are allowed to use is restricted, and damage to the seabed is minimal: most recreational fishing is static.

Recreational fishing pressure in Owen Anchorage has increased as population has increased, but fishers are also more environmentally aware. Over-exploitation of some species (integrated with commercial take) may be a concern with increasing recreational use.

3. Sailing

With the advent of a new marina at Port Coogee and the development of further recreational boating facilities near Fremantle, the pressure on Owen Anchorage is likely to increase.

4. Coastal Use

The main environmental pressures due to coastal uses are erosion and loss of foreshore, and the degradation of coastal vegetation. Dog faeces and rubbish can also affect water quality, and dogs on the beaches of Woodman Point Regional Park (where they are not allowed) are causing disturbance to seabirds.

The pressure on coastal areas will increase due to a combination of increased population pressure, decreasing access to the coast (e.g. Port Coogee development, and any future developments), and the 'discovery' of the

recreational attractions of the Owen Anchorage area discussed earlier.

5. Aesthetics/seascapes
No pressure is expected on Owen Anchorage due to passive recreation.

6. Heritage
No pressure is expected on Owen Anchorage due to either aboriginal or non-indigenous heritage values.

Management Responses
The DPI has a number of rules that concern safety when boating (giving way to other boats, skiing, swimmers etc), and pollution.

Recreational fishing is currently managed under the Fisheries Resources Management Act (1994) by means of licences, bag limits, minimum sizes and gear controls set by Fisheries WA and enforced by Fisheries Officers.

A Woodman Point Regional Park draft management plan has been prepared, with a final version to be released within the next 12 months.

Pressures on Owen Anchorage due to Economic Uses

1. Industry
The majority of industries once located along the coastal strip of Owen Anchorage have moved. Therefore there is little pressure on Owen Anchorage due to industry. The pressures resulting from the dredging operations of Cockburn Cement Ltd were discussed earlier under 'Pressures on the marine environment'.

2. Shipping
Although approximately 700 commercial vessels pass through Owen Anchorage each year (Figure 17), they spend little time within Owen Anchorage and are unlikely to cause much harm to the environment. The greatest likely impacts are the slow release of tributyltin (TBT) into the marine environment, the creation of temporary turbidity or the introduction of marine pests.

Figure 17 – Commercial vessel passing through Owen Anchorage

3. Commercial Fishing
There is little bycatch in the Cockburn Sound Fisheries, as nearly all species caught are marketed in the metropolitan area. The types of fishing gear that these two fisheries are allowed to use involve little damage to the environment. Pressures on fish stocks within Owen Anchorage may exist when commercial fishing is combined with increased recreational take.

4. Tourism
There is some potential for increased tourism to result in disturbance to marine wildlife, particularly dolphins (i.e. by feeding them), sea lions at haulout sites, and seabirds on islands and rocks. Tour boat and charter boat operators are, in general, experienced seamen, and unlikely to cause habitat damage by inadvertently straying into shallow waters.

Management Responses
Management of contamination of the marine environment will be achieved by the Environmental Management Framework being prepared for Perth's metropolitan coastal waters, and the EMP to be prepared for Owen Anchorage by the CSMC.

Management of the Cockburn Sound/Owen Anchorage Fishery is achieved via controls on access, boat size, catch size, and fishing gear that can be used (trawling has been banned since 1970). The crab fishery is managed under the Cockburn Sound (Crab) Management Plan, which restricts the season, sets minimum legal crab size (well above the sexual mature size) and catch size.

CCL's shellsand dredging operates under environmental approval for Long-Term dredging (2002). Ministerial Conditions and Proponent Commitments for this activity are combined in an EMP that addresses all of the potential impacts of CCL's operations. The EMP involves studies that have provided the majority of contemporary data which is available on the state of Owen Anchorage.

RESEARCH & INVESTIGATION PROGRAMME
The main environmental issues in Owen Anchorage are considered to be:

- Alteration of the shoreline (and coastal processes);
- Loss/alteration of benthic (seabed) habitat;
- Grey sands;
- Water quality (turbidity);
- Nutrient and contaminant inputs (via groundwater and stormwater); and
- Recreational use.

These issues drive the proposed Research and Investigation program which is outlined within the Technical Report.

ACKNOWLEDGEMENTS
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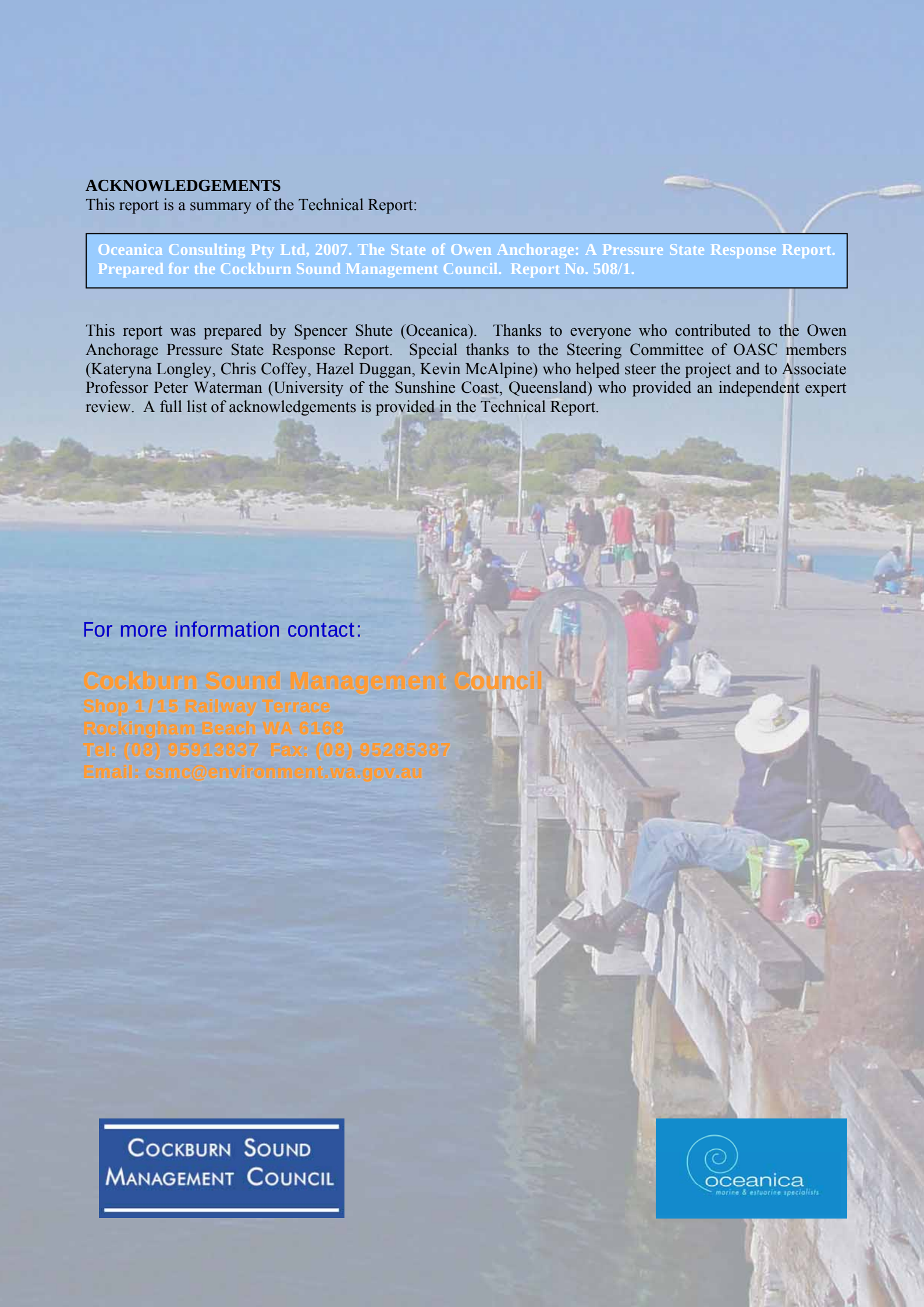

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COCKBURN SOUND MANAGEMENT COUNCIL

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