Expansion of Jurien Gypsum Mining Operation Ml70/1161

CSR Gyprock Fibre Cement

Report and recommendations
of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 1219
May 2006

Environmental Impact Assessment Process Timelines

Date	Progress stages	Time (weeks)
19 December 2005	**Level of Assessment set (following any appeals upheld)**	**-**
7 March 2006	**Proponent Document Released for Public Comment**	**12 weeks**
3 April 2006	**Public Comment Period Closed**	**4 weeks**
11 April 2006	**Final Proponent response to the issues raised**	**1 week**
10 May 2006	**EPA report to the Minister for the Environment**	**4 weeks**

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Summary and recommendations

CSR Gyprock Fiber Cement proposes to mine a 53 ha area and process approximately 1.3 million tones of gypsum recovered from Mining Lease M70/1161 using the facilities currently employed for operations in the adjacent Mining Lease M70/750. This proposal involves dredging and will form a permanent hypersaline water body of approximately 4m maximum depth. Dredging operations are proposed to be undertaken every second year over a 2-4 week period to excavate approximately 100,000 tones of gypsum. This report provides the Environmental Protection Authority's (EPA's) advice and recommendations to the Minister for the Environment on the environmental factors relevant to the proposal.

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

The EPA is also required to have regard for the principles set out in section 4A of the *Environmental Protection Act 1986.*

Relevant environmental factors and principles

The EPA decided that the following environmental factor relevant to the proposal required detailed evaluation in the report:

(a) Wetlands.

There were a number of other factors which were very relevant to the proposal, but the EPA is of the view that the information set out in Appendix 3 provides sufficient evaluation.

The following principles were considered by the EPA in relation to the proposal:

(a) The precautionary principle;

(b) The principle of intergenerational equity;

(c) The principle of the conservation of biological diversity and ecological integrity; and,

(d) The principle of waste minimisation.

Conclusion

The EPA has considered the proposal by CSR Gyprock Fibre Cement to mine a 53 ha area and process approximately 1.3 million tonnes of gypsum.

The EPA notes that the proposal is located within the Beekeepers Nature Reserve, which is a "C" Class nature reserve under the *Conservation and Land Management Act 1984*, vested in the Conservation Commission of Western Australia.

The Department of Conservation and Land Management (CALM), representing the Conservation Commission, has advised that given the prime purpose of Beekeepers

Nature Reserve is nature conservation, its preferred position is that the mining activity not be expanded.

As matter of principle the EPA does not support development in nature reserves which would significantly impact on their conservation values, and concurs with CALM in this case that, on environmental grounds, it would be preferable that the extension not proceed.

Notwithstanding this, the EPA notes that existing Government policy provides for consideration of extensions to existing mining operations in nature reserves subject to appropriate environmental conditions and establishment of conservation benefits.

Gypsum Lake forms a part of the Leeman consanguineous suite of wetlands which has key features and values such as; a large wetland habitat, a diversity of habitats, waterfowl values, scientific value and rare features (V & C Semeniuk Research Group 1994). In addition, while it has not been subject to formal evaluation, Gypsum Lake is likely to be of "Conservation" Category under the EPA's wetland classification system (EPA 2005).

Importantly, Gypsum Lake provides significant habitat for both local and migratory bird species. Surveys carried out as part of the EPA's assessment indicated the lake was the most important lake for waterbirds in the system during winter and spring when the main lake bed is flooded.

The proposal has the potential to affect the lake's waterbird habitat values in a number of ways. Particularly, mining will reduce the lake bed area available for formation of algal mats which have a key role in primary production and hence the lake's ecology. The mining of gypsum also has the potential to affect the lake's fringing vegetation. Therefore, if the proposal is approved, conditions need to be imposed to ensure that impacts do not significantly affect the lake's waterbird habitat values. This applies particularly to the migratory bird species which use the lake. Local species are likely to be impacted less by changes to the lake.

The proponent has provided additional baseline information on aquatic flora and fauna of Gypsum Lake and its regional significance, as part of the response to public submissions (Dalcon Environmental, 2006). This work concluded that based on aquatic flora and fauna, Gypsum Lake was not unique in the region. However, the report also recognised the important role of algal mats in the lake ecology, and the need to ensure that mining did not significantly affect the hydrological cycle for the remainder of the lake.

While the assessments which have been done to date indicate it is not expected that the mining will significantly affect the lake's hydrological cycle, in view of the importance of the algal mats to the lake's ecology, the EPA considers that a cautious approach should be adopted. The EPA therefore recommends, that if approval is granted for the mining extension, it should be subject to a condition limiting the extent of further mining to approximately 12.7 ha, and that further mining be subject to investigation and monitoring demonstrating no significant impact on the lake's ecology and waterbird use.

The investigations should particularly address potential for the mining to alter both the water balance over the remainder of the lake and the formation of algal mats.

The EPA has therefore concluded that, if approval is granted for the proposal, it should be subject to implementation by the proponent of the their commitments and the recommended conditions set out in Appendix 4 and summarised in Section 4.

The proponent has recognised that the proposal should provide a net benefit to conservation by committing to an environmental offsets package that will contribute to CALM's conservation and research activities in the conservation estate in the Jurien region.

Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister notes that the proposal being assessed is for mining a 53 ha area and processing approximately 1.3 million tonnes of gypsum;
2. That the Minister considers the report on the relevant environmental factor and principles as set out in Section 3;
3. That the Minister notes that the EPA has concluded that, if approval is granted for the mining extension, approval should be subject to a condition limiting the extent of further mining to approximately 12.7 ha, and that further mining be subject to investigation and monitoring demonstrating no significant impact on the lake's ecology and waterbird use according to the recommended conditions set out in Appendix 4, and summarised in Section 4, and the proponent's commitments; and
4. That the Minister imposes the conditions and procedures recommended in Appendix 4 of this report.

Conditions

Having considered the proponent's commitments and information provided in this report, the EPA has developed a set of conditions that the EPA recommends be imposed if the proposal by CSR Gyprock Fibre Cement to mine a 53 ha area and process approximately 1.3 million tonnes of gypsum is approved for implementation. These conditions are presented in Appendix 4. Matters addressed in the conditions include the following:

(a) that the proponent shall fulfil the commitments in the Consolidated Commitments statement set out as an attachment to the recommended conditions in Appendix 4; and

(b) that a limit be placed on the extent of mining of gypsum to approximately 12.7 ha and that any further mining be subject to an investigation and monitoring demonstrating no significant impact on the lake's ecology and waterbird use; and,

(c) that the rehabilitation of the proposal area and the existing operation should adopt a comprehensive approach to planning, operation and rehabilitation of the mine so that a water body which is ecologically functional is created that is consistent with surrounding landforms.

Contents

1. Introduction and background

This report provides the advice and recommendations of the Environmental Protection Authority (EPA) to the Minister for the Environment on the environmental factor and principles relevant to the proposal by CSR Gyprock Fibre Cement to mine a 53 ha area and process approximately 1.3 million tonnes of gypsum.

The Jurien gypsum deposit is located within a saline wetland in the Shire of Dandaragan, approximately 10 km north of Jurien (Figure 1). The deposit lies wholly within the C Class Reserve 24496 (Beekeepers Nature Reserve) which was created for protection of flora and is vested with the Conservation Commission of Western Australia and managed by the Department of Conservation and Land Management (CALM).

The EPA set a level of assessment of Proposal Unlikely to be Environmentally Acceptable (PUEA) for this proposal on 19 September 2005. Following an appeal from the proponent, the Minister for the Environment remitted the proposal to the EPA and directed that the proposal be assessed more fully and more publicly. The Minister informed the EPA that it is appropriate that the proposal is assessed via a PER and asked that the assessment be undertaken expeditiously.

Further details of the proposal are presented in Section 2 of this report. Section 3 discusses the relevant environmental factor and principles relevant to the proposal. The Conditions and Commitments to which the proposal should be subject, if the Minister determines that it may be implemented, are set out in Appendix 4. Section 5 provides Other Advice by the EPA, Section 6 presents the EPA's conclusions and Section 7, the EPA's Recommendations.

Appendix 5 contains a summary of submissions and the proponent's response to submissions and is included as a matter of information only and does not form part of the EPA's report and recommendations. Issues arising from this process, and which have been taken into account by the EPA, appear in the report itself.

2. The proposal

The Jurien gypsum deposit is located in the Shire of Dandaragan, approximately 10km north of Jurien. The deposit lies wholly within the C Class Reserve 24496 (Beekeepers Nature Reserve) which was created for the protection of flora.

The main characteristics of the proposal are summarised in Table 1 below. A detailed description of the proposal is provided in Section 2 of the PER (CSR Gyprock Fibre Cement, 2006).

Table 1: Summary of key proposal characteristics

Element	Description
Project Life	Estimated 25 years
Size of deposit in expansion area	1.3 Mt
Depth of mine pit	4 m within salt lake
Water table depth	1–3 m (at bore sites)
Area of disturbance	53 ha
Mine operation	Monday to Friday (sunrise to sunset) Saturday – 6 a.m. to 4 p.m.
List of major components	*On site (during mining operation)* • bucket-wheel dredge • dredge pump • sea-container • tracked excavator • screen • 15t haulage trucks *On site (at all times)* • front-end loader • groundwater bores and bore pumps • work boat • 4.8 ha all-weather works area • material handling plant • stockpiles of gypsum
Ore mining rate	100,000 t every second year for 25 years
Solid waste materials	None
Water supply	Three existing shallow bores (<10 m) will extract groundwater within the limits of the current Water Abstraction Licence 111221 (<30,000 m^3/year).
Fuel storage capacity and quantity used	*During dredging (2–4 weeks every second year)* • require 1,500 L of diesel per day delivered regularly to site by fuel tankers. • storage on site in a 10,000-L fuel tank mounted in a fully self-contained, internally enclosed and bunded sea container designed to contain 120% of the contents of the fuel tank. *Non-dredging periods* • Fuel delivered to site only when required to refuel equipment (i.e. front-end loader etc).

The potential impacts of the proposal and their proposed management are summarised in Table 4-1 of the proponent's document.

Figure 1. Location Plan

Figure 2: Area X within ML70/1161, Jurien Gypsum Mining Proposal

3. Relevant environmental factor and principles

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and the conditions and procedures, if any, to which the proposal should be subject. In addition, the EPA may make recommendations as it sees fit.

The identification process for the relevant factor selected for detailed evaluation in this report is summarised in Appendix 3. The reader is referred to Appendix 3 for the evaluation of factors not discussed below. A number of these factors, such as dust and greenhouse gases, are very relevant to the proposal, but the EPA is of the view that the information set out in Appendix 3 provides sufficient evaluation.

It is the EPA's opinion that the following environmental factor relevant to the proposal requires detailed evaluation in this report:

(e) Wetlands.

The above relevant factor was identified from the EPA's consideration and review of all environmental factors generated from the PER document and the submissions received, in conjunction with the proposal characteristics.

Details on the relevant environmental factor and its assessment is contained in Section 3.1. The description of this factor shows why it is relevant to the proposal and how it will be affected by the proposal. The assessment of the factor is where the EPA decides whether or not a proposal meets the environmental objective set for the factor.

The following principles were considered by the EPA in relation to the proposal:

(a) The precautionary principle;

(b) The principle of intergenerational equity;

(c) The principle of the conservation of biological diversity and ecological integrity; and

(d) The principle of waste minimisation.

3.1 Wetlands

Description

The EPA is of the view that, as this proposal is for the extraction of gypsum from the surface of Gypsum Lake, the direct and other associated biophysical impacts of the proposal are best assessed in concert. To this end, the EPA has assessed impacts to algal mats, fringing flora and vegetation, waterbirds and other fauna as one relevant environmental factor, Wetlands.

Algal mats

Almost the entire surface of Gypsum Lake is covered by algal mats. Algal mats are very important components of salt-lake ecosystems and often are responsible for virtually all primary production as well as binding sediment at the surface. The algal

mats present on Gypsum Lake are predominantly cyanobacterial in composition, most likely dominated by *Microcoleus chthonoplastes* and *Oscillatoria sp*.

Two distinct types of algal mat were found in Gypsum Lake although they were very similar in physical characteristics and in species composition. Mat 1 was dominated by the diatom *Navicula sp*., while *Oscillatoria sp*. was the dominant taxon in mat 2 with *Microcoleus chthonoplastes* present.

Three halotolerant macrophyte species were observed in Gypsum Lake - *Lepilaena preissii*, the most dominant species, and *Ruppia sp.* and *Lepilaena sp*. which were not identified to species due to the lack of flowering/fruiting bodies. Oogonia (resistant reproductive structures) of the charophyte *Lamprothamnium sp*. were recorded in Gypsum Lake.

Fringing Flora and Vegetation

The proponent's two flora and vegetation surveys identified four vegetation units fringing Gypsum Lake. These fringing vegetation units were described as follows.

1. Low Woodland of *Casuarina obesa* and *Melaleuca brevifolia* over an Open Sedgeland of *Gahnia tridifa* in sandy clay.
2. Tall Open Scrub of *Melaleuca cardiophylla* over weeds or bare ground in sand.
3. Open Low Heath of *Lawrencia squamata* and *Samolus repens* over a Herbland of *Siloxerus multiflorus* in cracking mud.
4. Open Low Heath of *Halosarcia spp*. in clay.

The condition of the vegetation units surrounding Gypsum Lake varied between 'excellent' to 'good'. This may be due to limited public access to the lake edge due to the existing mining operation. Only one vegetation unit was assigned a vegetation condition of between 'good' to 'degraded'. This was the Tall Open Scrub of *Melaleuca cardiophylla* over weeds or bare ground in sand. Although there was good shrub cover, the understorey has largely been replaced by weeds.

Geraldton Carnation Weed (*Euphorbia terracina*), Maltese Cockspur (*Centaurea melitensis*) and several grass weed species were recorded on the main road into the existing mine.

Fauna

The proponent's fauna survey work did not locate within the proposed mining area the priority listed species Water Rat (*Hydromys chrysogaster)* nor any species of reptile, frog, or freshwater fish. The proponent's PER also did not survey for stygofauna present within or beneath the proposed mining area.

The proponent has committed to conducting a terrestrial invertebrate survey in the period between September and November 2006. This survey is expected to include a comparison of invertebrate populations in vegetation fringing Gypsum Lake both adjacent to the current mine and in areas adjacent to those proposed for future mining. Further details of the proposed terrestrial invertebrate survey are described in

Appendix F (*Proposed Outline for Terrestrial Invertebrate Survey at Lake Gypsum*) of the PER.

The aquatic invertebrates survey revealed that Gypsum Lake has a low diversity of invertebrate species, consisting mainly of copepods and ostracods. The proponent considered that the large numbers of ostracods and Coxiella snails observed in the field and the relatively high densities recorded in incubated mat trials suggest that Gypsum Lake is a highly productive system.

Both ostracods and Coxiella are excellent sources of food for waterbirds, especially when present in high numbers. It is likely that this lake is utilised by waterbirds for feeding during the wet season when these invertebrates are abundant and active.

Waterbirds
Waterbirds use the shallow areas of the lake primarily in winter and spring, when the natural lake surface around the mine area is flooded. Waterbirds observed in the spring 2005 survey were either foraging on the flooded flats or roosting on the shore of the mine pits.

Eight bird species, listed as migratory under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), were recorded on Gypsum Lake.

A survey conducted in January 2006 within several lakes immediately north of Gypsum Lake identified significant numbers of both the Hooded Plover (listed as a Priority 4 species by CALM) and the Red-Necked Stint (listed as migratory under the Commonwealth *Environment Protection and Biodiversity Act 1999*).

Surface water and Groundwater Hydrology
Gypsum Lake is an ephemeral salt lake which is primarily a local groundwater sink. The lake also acts as a recharge zone during winter when rain ponding on the surface infiltrates to the water table.

The recharge-discharge cycle of the salt lake results in a zone of groundwater mixing which is beneath the lake surface and above the deeper seawater interface in the superficial aquifer. The salinity within the mixing zone is variable across the lake and throughout the year, depending on permeability and extent of recharge.

The mining proposal creates a permanent water body, approximately 4 metres deep, within the mine area on Gypsum Lake. Bunds will be created around the mined area to stop surface water (from rainfall) in the remainder of the lake entering the mined area.

Rehabilitation

Rehabilitation of the site will mostly consist of reshaping of gypsum stockpiles and seeding with local species and reshaping of the mine pit edges. The new waterbody created as a result of mining will be surrounded by a permanent bund to prevent an inflow of water from the surface of the remaining undisturbed lake, which will be of higher elevation than the new waterbody.

CSR has made a commitment to develop and implement a 'closure management plan' to ensure that the post-mining landscape is stable and self-sustaining and that ecological functions are retained or reinstated where possible. Slopes on the lake would be constructed to prevent erosion and to provide a safe, easy access by birds and other fauna, and recreational users of the lake.

Submissions

Public and government agency submissions relating to impacts to the wetland from the proposal centred on:

- Impacts on algal mats, fringing vegetation, waterbirds, stygofauna, and rehabilitation,
- Impacts to wetland values, hydrology and water quality, aquatic invertebrate fauna, terrestrial invertebrate fauna and aquatic flora,
- Impacts to flora from groundwater extraction bores,
- The uniqueness and regional significance of Gypsum Lake, and
- Bunding of mine pit voids.

Assessment

The EPA's environmental objective for this factor is to maintain the integrity, ecological functions and environmental values of wetlands.

Algal mats

The major impact from this proposal is the removal of 53ha of the lake surface, almost all of which is covered by algal mats. The proponent has described the algal mats as responsible for most, if not all, primary production in Gypsum Lake. Most obviously, the significance of this primary production is evident from the large numbers of waterbirds that use the lake whenever surface water is present.

The results did not reveal any unique algal taxa in Gypsum Lake. Most of the species observed in the samples from Gypsum Lake were common to salt lakes and were represented in other lakes in the region.

The composition of the algal community is largely driven by its water chemistry and hydrological cycle. Any change in the influence of groundwater input to the remainder of the lake may impact the algal mats adversely and affect the overall productivity of the system. This would be significant for primary productivity in the lake.

Further investigations are required to better define the role and significance of algal mat communities to the ecosystem functioning of the hypersaline wetland and impacts of mining on the lake's surface.

Fringing Flora and Vegetation

The EPA considers that it is highly unlikely that the existing operation has created an impact on the fringing vegetation of Gypsum Lake following site visits to the area and advice from CALM. However, the EPA is concerned that the three permanent vegetation quadrats used to survey the fringing vegetation of the area were not

directly located within the fringing vegetation immediately adjacent to the existing operation. In order to confirm the opinion that no vegetation impacts have occurred to date from the existing operation further monitoring is required.

Waterbirds
The EPA is of the opinion that the creation of 4m deep mine voids will reduce the available habitat for waders and other waterbirds on Gypsum Lake.

Gypsum Lake provides significant habitat for both local and migratory bird species. The proponent's report (Bamford 2004), identified that Gypsum Lake was clearly the most important lake for waterbirds in the region and that "some intrinsic feature' of the shallow water resources of Gypsum Lake appears to be favoured by waterbirds.

The extension to the mining area will reduce the shallow areas of the lake where algal mats form which, potentially, may reduce the available food for migratory and other birds. If the proposal is approved, conditions should be imposed to ensure that impacts do not significantly affect the lake's waterbird habitat values. This applies particularly to the migratory bird species which use the lake. Local species are likely to be impacted less by changes to the wetland.

Fauna - Aquatic invertebrates
Salt lakes often have a highly distinctive and specialised invertebrate fauna. A significant issue in assessing the impacts of this proposal is determining what invertebrate fauna is present. The proponent's PER did not identify aquatic invertebrate fauna to species level nor did it show numbers of individuals found.

The subsequent study conducted on behalf of the proponent (Dalcon Environmental, 2006) revealed that the diversity of Gypsum Lake is quite low, dominated by copepods and ostracods and that no taxa found were unique to the lake. The flora and fauna of Gypsum Lake is not unique to the region with a high degree of replication in the other lakes of the region sampled.

Fauna - Terrestrial invertebrates
The terrestrial invertebrate fauna present in the fringing lake vegetation was not surveyed nor was an assessment of the regional context of this fauna given in the proponent's PER.

Surface water and Groundwater Hydrology
The mining has the potential to affect the surface water and groundwater hydrology of the lake. The lake's hydrology is likely to play a key role in the formation of algal mats and hence the lake's ecology and waterbird habitat values.

The Department of Water has advised that the mining is unlikely to affect the lake's hydrology outside of the mined area. The proponent considers that the monitoring and investigations which have been undertaken to date have not shown any significant impact of mining on the lake's hydrology.

Notwithstanding this, because of the likely importance of the hydrology to algal mat formation, the EPA considers that further investigation should be undertaken on the

role of the hydrology in algal mat formation and potential for the mining to significantly affect this.

Rehabilitation
The proposal will result in a rectangular 'post mining' lake landform with uniform graded slopes covering over one fourth of Gypsum Lake. Inspection of the bunds surrounding the existing excavation ponds revealed that some erosion from wind driven waves had occurred and that the bunds were largely bare gypsum with little, if any, vegetative cover.

The rehabilitation of the proposal area and the existing operation should adopt a comprehensive approach to planning, operation and rehabilitation of the mine so that a water body which is ecologically functional is created that is consistent with surrounding landforms. This may involve reshaping the resultant mine voids to create substantial shallow areas for wading birds to encourage the existing level of foraging and islands within the voids to provide secure areas for roosting by water birds.

Summary
The EPA notes that the proposal is located within the Beekeepers Nature Reserve, which is a "C" Class nature reserve under the *Conservation and Land Management Act 1984*, vested in the Conservation Commission of Western Australia.

CALM, representing the Conservation Commission, has advised that given the prime purpose of Beekeepers Nature Reserve is nature conservation, its preferred position is that the mining activity not be expanded.

As matter of principle the EPA does not support development in nature reserves which would significantly impact on their conservation values, and concurs with CALM in this case that, on environmental grounds, it would be preferable that the extension not proceed.

The EPA therefore considers that if approval is granted for the mining extension, a cautious approach should be adopted, and the mining extension should be subject to a condition limiting the extent of further mining to 12.7 ha (see Area "X" in Figure 2), and that any further mining be subject to investigation and monitoring demonstrating no significant impact on the lake's ecology and waterbird use.

Relevant environmental principles

In preparing this report and recommendations, the EPA has had regard for the object and principles contained in s4A of the *Environmental Protection Act (1986).* Appendix 3 contains a summary of the EPA's consideration of the principles.

4. Conditions and Commitments

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

In developing recommended conditions for each project, the EPA's preferred course of action is to have the proponent provide an array of commitments to ameliorate the impacts of the proposal on the environment. The commitments are considered by the EPA as part of its assessment of the proposal and, following discussion with the proponent, the EPA may seek additional commitments.

The EPA recognises that not all of the commitments are written in a form which makes them readily enforceable, but they do provide a clear statement of the action to be taken as part of the proponent's responsibility for, and commitment to, continuous improvement in environmental performance. The commitments, modified if necessary to ensure enforceability, then form part of the conditions to which the proposal should be subject, if it is to be implemented.

Proponent's commitments

The proponent's commitments as set in the PER and subsequently modified, as shown in Appendix 4, should be made enforceable. These include:

- Flora
- Wetlands and Surface Water
- Fauna
- Ground Water
- Heritage
- Post-mining Land Use & Closure

Recommended conditions

Having considered the proponent's commitments and the information provided in this report, the EPA has developed a set of conditions that the EPA recommends be imposed if the proposal by CSR Gyprock Fibre Cement is approved for implementation.

These conditions are presented in Appendix 4. Matters addressed in the conditions include the following:

(a) that the proponent shall fulfil the commitments in the Consolidated Commitments statement set out as an attachment to the recommended conditions in Appendix 4;

(b) that a limit be placed on the extent of mining of gypsum to approximately 12.7 ha and that any further mining be subject to an investigation and monitoring demonstrating no significant impact on algal mats, fringing vegetation or waterbird use of Gypsum Lake; and,

(c) that the rehabilitation of the proposal area and the existing operation should adopt a comprehensive approach to planning, operation and rehabilitation of the mine so that a water body which is ecologically functional is created that is consistent with surrounding landforms.

It should be noted that other regulatory mechanisms relevant to the proposal are:

- mining tenement conditions issued under the *Mining Act 1978*; and,

- Works Approval, Licence and/or Registration for this project under the provisions of Part V of the *Environmental Protection Act 1986*.

5. Other Advice

The EPA is aware that the existing government policy provides for continued action to progress mining applications within nature reserves where the application was made before 10 February 2001. This policy also requires that for mining applications both appropriate environmental conditions and the concept of net benefit to conservation should be applied.

A Retention Licence for this proposal was granted under the *Mining Act 1978* on 25 May 1999.

In order to meet the requirement that the proposal provides a net benefit to conservation the proponent has committed to an environmental offsets package that will contribute to CALM's conservation and research activities in the conservation estate in the Jurien region.

6. Conclusions

The EPA has considered the proposal by proposal by CSR Gyprock Fibre Cement to mine a 53 ha area and process approximately 1.3 million tonnes of gypsum.

The EPA notes that the proposal is located within the Beekeepers Nature Reserve, which is a "C" Class nature reserve under the *Conservation and Land Management Act 1984*, vested in the Conservation Commission of Western Australia.

CALM, representing the Conservation Commission, has advised that given the prime purpose of Beekeepers Nature Reserve is nature conservation, its preferred position is that the mining activity not be expanded.

As matter of principle the EPA does not support development in nature reserves which would significantly impact on their conservation values, and concurs with CALM in this case that, on environmental grounds, it would be preferable that the extension not proceed.

Notwithstanding this, the EPA notes that existing Government policy provides for consideration of extensions to existing mining operations in nature reserves subject to appropriate environmental conditions and establishment of conservation benefits.

A consanguineous suite of wetlands is recognised as 'a related suite of wetlands that occur in the same region, within the same setting, that have formed because of similar related factors' (V & C Semeniuk Research Group 1994). Gypsum Lake forms a part of the Leeman consanguineous suite of wetlands which is recognised as having key features and values such as; a large wetland habitat, recreation purposes, diversity of habitats, waterfowl values, scientific value and rare features (V & C Semeniuk Research Group 1994). In addition, while it has not been subject to formal evaluation, Gypsum Lake is likely to be of "Conservation" Category under the EPA's wetland classification system (EPA 2005).

Importantly, Gypsum Lake provides significant habitat for both local and migratory bird species. Surveys carried out as part of the EPA's assessment indicated the lake was the most important lake for waterbirds in the system during winter and spring when the main lake bed is flooded.

The proposal has the potential to affect the lake's waterbird habitat values in a number of ways. Particularly, the mining will reduce the lake bed area available for formation of algal mats which have a major role in primary production and hence the lake's ecology. The mining of gypsum also has the potential to affect the lake's fringing vegetation. Therefore, if the proposal is approved, conditions should be imposed to ensure that impacts do not significantly affect the lake's waterbird habitat values. This applies particularly to the migratory bird species which use the lake. Local species are likely to be impacted less by changes to the lake.

The proponent has provided additional baseline information on aquatic flora and fauna of Gypsum Lake and its regional significance, as part of the response to public submissions (Dalcon Environmental, 2006). This work concluded that based on aquatic flora and fauna, Gypsum Lake was not unique in the region. However, the report also recognised the important role of algal mats in the lake ecology, and the need to ensure that mining did not significantly affect the hydrological cycle for the remainder of the lake.

While the assessments which have been done to date indicate it is not expected that the mining will significantly affect the lake's hydrological cycle, in view of the importance of the algal mats to the lake's ecology, the EPA considers that a cautious approach should be adopted. The EPA therefore recommends, that if approval is granted for the mining extension, it should be subject to a condition limiting the extent of further mining to 12.7 ha and that any further mining be subject to investigation and monitoring demonstrating no significant impact on the lake's ecology and waterbird use.

The investigations should particularly address potential for the mining to alter the water balance over the remaining of the lake and algal mat formation.

The EPA has therefore concluded that, if approval is granted for the proposal, it should be subject to implementation by the proponent of their commitments and the recommended conditions set out in Appendix 4 and summarised in Section 4.

The proponent has recognised that the proposal should provide a net benefit to conservation by committing to an environmental offsets package that will contribute to CALM's conservation and research activities in the conservation estate in the Jurien region.

7. Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister notes that the proposal being assessed is for mining a 53 ha area and processing approximately 1.3 million tonnes of gypsum;

2. That the Minister considers the report on the relevant environmental factor and principles as set out in Section 3;
3. That the Minister notes that the EPA has concluded that it is unlikely that the EPA's objectives would be compromised, provided there is satisfactory implementation by the proponent of the recommended conditions set out in Appendix 4, and summarised in Section 4, including the proponent's commitments; and
4. That the Minister imposes the conditions and procedures recommended in Appendix 4 of this report.

Appendix 1

List of submitters

Organisations:
BGC Plasterboard/Fibre Cement
Conservation Council of WA (Inc.)
Wetlands Conservation Society
Wildflower Society of Western Australia (Inc).
Department of Conservation and Land Management
Department of Indigenous Affairs
Department of Environment

Individuals:
Mr Peter Woods
Mr Bernard Masters
Mr Bruce Simpson
Mr John Baas

Appendix 2

References

CALM (2003) *Establishment of a Comprehensive, Adequate and Representative Terrestrial Conservation Reserve System in Western Australia*, January 2003.

Dalcon Environmental 2006, *Baseline Study of Aquatic Flora and Fauna, Gypsum Lake, Beekeepers Reserve, Western Australia Spring 2005*, March 27, 2006.

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Appendix 3

Summary of identification of relevant environmental factors and principles

Preliminary Environmental Factors	Proposal Characteristics	Government Agency and Public Comments	Identification of Relevant Environmental Factors
BIOPHYSICAL			
Wetlands	The proposal will result in the excavation of 53ha of the wetland surface	Altering/destroying the existing wetland Significantly larger scale of works proposed.	Considered to be a relevant environmental factor.
Algal mats	The proposal has the potential to remove algal mats and or affect algal mats adjacent to the excavation area.	Removal of up to 53 ha of algal mats which are the primary production of the lake bed and help in binding the surface.	Considered to be a relevant environmental factor in concert with Wetlands.
Conservation areas - Beekeepers Nature Reserve	The proposal is for the excavation of 54ha of the lake surface within a nature reserve	Mining within a nature reserve is not supported by CALM nor the Conservation Commission.	Not considered to be a relevant environmental factor. See Section 5 Other Advice.
Fauna – waterbirds	The resultant habitat will be a permanent and relatively deep hypersaline water body.	Alteration of the lake would result in a wetland of reduced significance for waterbirds.	Considered to be a relevant environmental factor in concert with Wetlands.
Flora and Vegetation – fringing vegetation	The resultant habitat will be a permanent and relatively deep hypersaline water body.	Detrimental effects on fringing vegetation need to be considered, such as changes in ecological patterning that may result from possible hydrological, nutrient and sediment supply changes arising from the creation of the permanent bunded water body.	Considered to be a relevant environmental factor in concert with Wetlands.
Rehabilitation	Resultant landform will be a large change to the existing shallow lake landform. Rehabilitation will involve only the revegetation of bunds separating the excavation area from the rest of the lake and the hardstand/processing stockpile area.	The proponent should adopt a more comprehensive approach in mine planning, mine operation and mine rehabilitation in order to ensure that a landscape compatible and ecologically functional water body is created that is consistent with the surrounding landforms	Considered to be a relevant environmental factor in concert with Wetlands
Fauna - Stygofauna	Excavation of 4m deep mine voids over 53 ha	There has been no sampling to confirm the assumed absence of stygofauna. The proponent should commit to undertaking a preliminary sampling program for stygofauna as part of the implementation of the proposal. If stygofauna are present, a management plan should be	The proponent has committed to a stygofauna monitoring plan (including review of existing stygofauna data and site

Preliminary Environmental Factors	Proposal Characteristics	Government Agency and Public Comments	Identification of Relevant Environmental Factors
		prepared to ensure their protection during abstraction.	stygofauna investigations as per EPA Guidance No. 54). Not considered to be a relevant environmental factor
Water (surface and ground)	The resultant habitat will be a permanent and relatively deep hypersaline water body.	It could be expected that a localised increase in salinity of the water table would occur, but given that the groundwater is already hypersaline, it is unlikely to have a hugely detrimental effect upon the health of the aquifer.	Considered to be a relevant environmental factor in concert with Wetlands
POLLUTION			
Water quality (surface or ground)	Refueling of equipment and the storage of up to 10,000L of fuel in a tank mounted in a fully self-contained, internally enclosed and bunded sea container designed to contain 120% of the contents of the fuel tank.	No comments received from the public on this issue.	Not considered to be a relevant environmental factor
SOCIAL SURROUNDINGS			
Aboriginal and European Heritage	Excavation of 53ha may disturb unrecorded site of Aboriginal or European Heritage significance.	The proposed Aboriginal and European Heritage surveys should have already been completed. The area of the proposed mine expansion does not appear to have been subject to a heritage investigation. There may be the potential for unrecorded sites to exist.	The proponent is required to comply with the requirements of the *Aboriginal Heritage Act 1972*. The proponent has committed to conducting a heritage survey in accordance with an existing Aboriginal Heritage Protection Agreement prior to any ground disturbing work in connection with the project. Not considered to be a relevant environmental factor
Decommissioning	Excavation of 53ha of Gypsum	The planning and implementation process for post-mining rehabilitation	The proponent has committed to

Preliminary Environmental Factors	Proposal Characteristics	Government Agency and Public Comments	Identification of Relevant Environmental Factors
	Lake and the decommissioning of the hardstand and associated infrastructure.	is inadequately defined. The management commitment to "undertake rehabilitation using natural recruitment from brush obtained from the appropriate vegetation unit" should be removed and replaced with a commitment.	preparing a closure management plan to ensure that the post-mining landscape is stable and self-sustaining and ecological functions are retained or reinstated where possible. Considered to be a relevant environmental factor in concert with Wetlands

PRINCIPLES		
Principle	**Relevant Yes/No**	**If yes, Consideration**
1. The precautionary principle *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.* *In application of this precautionary principle, decisions should be guided by –* *(a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and* *(b) an assessment of the risk-weighted consequences of various options.*		
	Yes	The proponent has completed a number of investigations into the potential impacts of the proposal. The EPA has recommended that further investigations and monitoring be conducted to confirm that no significant impact on algal mats, fringing vegetation or waterbird use of Gypsum Lake is likely, prior to mining the whole of the 53ha area.
2. The principle of intergenerational equity *The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.*		
	Yes	A cautious approach is recommended where the proponent will be required to demonstrate that the proposal will not cause significant

PRINCIPLES		
Principle	**Relevant Yes/No**	**If yes, Consideration**
		impacts on algal mats, fringing vegetation or waterbird use of Gypsum Lake is likely, prior to mining the whole of the 53ha area.
3. The principle of the conservation of biological diversity and ecological integrity *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*		
	Yes	The proposal can be managed to protect the biological diversity of Gypsum Lake and ecological integrity of the Jurien - Coolimba lake system.
4. Principles relating to improved valuation, pricing and incentive mechanisms *(1) Environmental factors should be included in the valuation of assets and services.* *(2) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.* *(3) The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.* *(4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximize benefits and/or minimize costs to develop their own solution and responses to environmental problems.*		
	Yes	The product created from gypsum mining is recognised as being high quality and long-lasting and is designed to have a life of several generations.
5. The principle of waste minimisation *All reasonable and practicable measures should be taken to minimize the generation of waste and its discharge into the environment.*		
	Yes	The use of this high quality gypsum resource, with minimal impurities, leads to the generation of minimal waste products.

Appendix 4

Recommended Environmental Conditions and Proponent's Consolidated Commitments

STATEMENT OF CONDITIONS AND PROCEDURES APPLYING TO A PROPOSAL

EXPANSION OF JURIEN GYPSUM MINING OPERATION ML70/1161

Proposal: The mining of a 53 hectare area and processing of approximately 1.3 million tonnes of gypsum recovered from Mining Lease M70/1161 using the facilities currently employed for operations in the adjacent Mining Lease M70/750.

The proposal involves dredging and will form a permanent hypersaline water body of approximately four metres maximum depth. Dredging operations are proposed to be undertaken every second year over a 2 to 4 week period to excavate approximately 100,000 tonnes of gypsum. The proposal is further documented in schedule 1 of this statement.

Proponent: CSR Gyprock Fibre Cement Pty Ltd

Proponent Address: 21 Sheffield Road, WELSHPOOL WA 6106

Assessment Number: 1619

Report of the Environmental Protection Authority: Bulletin 1219

The proposal referred to in the report of the Environmental Protection Authority may be implemented, subject to the following conditions and procedures:

1 Proposal Description

1-1 The proponent shall implement the proposal as documented and described in schedule 1 of this statement subject to the conditions and procedures of this statement.

2 Proponent Environmental Management Commitments

2-1 The proponent shall fulfil the environmental management commitments contained in schedule 2 of this statement.

3 Proponent Nomination and Contact Details

3-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) of the *Environmental Protection Act 1986* is responsible for the implementation of the proposal.

3-2 The proponent shall notify the Chief Executive Officer of the Department of Environment (CEO) of any change of the name and address for the serving of notices or other correspondence within 30 days of such change.

4 Time Limit of Authorisation

4-1 The authorisation to implement the proposal provided for in this statement shall lapse and be void within five years after the date of this statement if the proposal to which this statement refers is not substantially commenced.

4-2 The proponent shall provide the CEO with written evidence which demonstrates that the proposal has substantially commenced on or before the expiration of five years from the date of this statement.

5 Compliance Reporting

5-1 The proponent shall submit to the CEO Compliance Reports in accordance with a schedule approved by the CEO.

5-2 The Compliance Reports shall be prepared in accordance with the compliance monitoring guidelines, and shall:

1. describe and provide evidence of the status of the implementation of the proposal;
2. include evidence of compliance with the conditions, procedures and commitments of this statement;
3. provide a review of the effectiveness of corrective and preventative actions contained in the environmental management plans and programs;
4. provide verifiable evidence of the fulfilment of requirements specified in the environmental management plans and programs;
5. identify all confirmed non-conformities and non-compliances and describe the related corrective and preventative actions taken; and
6. identify potential non-conformities and non-compliances and provide evidence of how these are being determined for corrective action.

5-3 The proponent shall make Compliance Reports publicly available on request.

6 Performance Review

6-1 The proponent shall submit a Performance Review report every five years after the start of production to the CEO, which addresses:

1. the major environmental issues associated with implementing the project; the environmental objectives for those issues; the methodologies used to achieve these; and the key indicators of environmental performance measured against those objectives;
2. the level of progress in the achievement of sound environmental performance, including industry benchmarking, and the use of best available technology where practicable;
3. significant improvements gained in environmental management, including the use of external peer reviews;

4. stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any on-going concerns being expressed; and
5. the proposed environmental objectives over the next five years, including improvements in technology and management processes.

7 Decommissioning

7-1 Prior to ground-disturbing activities, the proponent shall prepare a Preliminary Decommissioning Plan for approval by the Department of Environment, which describes the framework to ensure that the site is left in an environmentally acceptable condition, and provides:

1. the rationale for the siting and design of plant and infrastructure as relevant to environmental protection;
2. a conceptual description of the final landform at closure;
3. a plan for a care and maintenance phase; and
4. initial plans for the management of noxious materials.

7-2 At least six months prior to the anticipated date of closure, or at a time approved by the Environmental Protection Authority, the proponent shall submit a Final Decommissioning Plan designed to ensure that the site is left in an environmentally acceptable condition prepared on advice of the Environmental Protection Authority, for approval of the Department of Environment.

The Final Decommissioning Plan shall address:

1. removal or, if appropriate, retention of plant and infrastructure in consultation with relevant stakeholders;
2. rehabilitation of all disturbed areas to a standard suitable for the agreed new land use(s);
3. the stability and continual maintenance of all bund walls within and surrounding the resultant mine voids; and
4. identification of contaminated areas, including provision of evidence of notification and proposed management measures to relevant statutory authorities.

7-3 The proponent shall implement the Final Decommissioning Plan required by condition 7-2 until such time as the Minister for the Environment determines, on advice of the Department of Environment, that the proponent's decommissioning responsibilities are complete.

7-4 The proponent shall make the Final Decommissioning Plan required by condition 7-2 publicly available in a manner approved by the Department of Environment.

8 Impact on Gypsum Lake Ecosystem

8-1 Subject to condition 8-2, no ground-disturbing activity shall occur outside the area designated “X” on the attached Figure 2 which is contained within the following co-ordinates, in eastings and northings.

Point 0 (308548.210993000 Easting; 6657269.38807000 Northing)

Point 1 (308372.172229000 Easting; 6657296.58987000 Northing)
Point 2 (308346.964211000 Easting; 6657151.68618999 Northing)
Point 3 (308681.392212999 Easting; 6657107.23771999 Northing)
Point 4 (308772.409721000 Easting; 6657761.28646999 Northing)
Point 5 (308622.916848999 Easting; 6657780.59920000 Northing)

8-2 Where:

(a) a Wetland Ecology Research and Monitoring Programme ("the Programme") has been prepared and approved by the Minister for the Environment;

(b) the Minister for the Environment on advice of the Department of Conservation and Land Management is satisfied that the implementation of the Programme has demonstrated that ground-disturbing activity in the whole or part of the area within "ML70/1161", which is outside the area designated "X", on the attached Figure 2 will not significantly affect the viability of the Gypsum Lake ecosystem and the population of waterbirds using the lake; and

(c) the proponent has received the prior written advice of the Minister for the Environment that ground-disturbing activity may occur in the whole of the area designated "ML70/1161" on the attached plan 1, or such part of that area as is specified in the Minister's advice,

then ground-disturbing activity may occur in such part of the area designated "ML70/1161" on the attached Figure 2.

8-3 The proponent shall prepare the Wetland Ecology Research and Monitoring Programme referred to in condition 8-2 to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Conservation and Land Management and shall include / address in the Programme:

1. the surveying of fringing vegetation adjacent to mining leases ML 70/750 and ML 70/1161 on Gypsum Lake in accordance with the guidance provided in EPA Guidance No. 51 (*Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, June 2004*);

2. the surveying of the use of Gypsum Lake by waterbirds and migratory wading birds in accordance with the guidance provided in EPA Guidance No. 56 (*Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, June 2004*);

3. a determination of the role of algal mats in the ecological function of the Gypsum Lake ecosystem, especially where this function pertains to the use of Gypsum Lake by waterbirds and migratory wading birds;

4. monitoring of the physio-chemical parameters of Gypsum Lake (including salinity, temperature, dissolved oxygen, turbidity and nutrients) in conjunction with monitoring any changes to species richness, abundance distribution and community composition of the aquatic flora and fauna.

5. monitoring and assessment of the impacts on surfacewater and groundwater hydrology of the lake and impacts of any changes on algal mat communities.

8-4 The proponent shall implement the Wetland Ecology Research and Monitoring Programme referred to in condition 8-2.

8-5 The proponent shall make the Wetland Ecology Research and Monitoring Programme referred to in condition 8-2 publicly available in a manner approved by the Department of Environment.

Notes

1. The CEO may seek the advice of the Environmental Protection Authority, government agencies and relevant parties, as necessary, for the preparation of written notice to the proponent.

2. The proponent shall relinquish the nomination following the procedure under section 38(6a) of the *Environmental Protection Act 1986*.

3. The proponent is required to apply for a Works Approval and Licence for this project under the provisions of Part V of the *Environmental Protection Act 1986*.

Schedule 1

The Proposal (Assessment No. 1619)

The mining of a 53 hectare area and processing of approximately 1.3 million tonnes of gypsum recovered from Mining Lease M70/1161 using the facilities currently employed for operations in the adjacent Mining Lease M70/750.

The proposal involves dredging and will form a permanent hypersaline water body of approximately 4 metres maximum depth. Dredging operations are proposed to be undertaken every second year over a 2 to 4 week period to excavate approximately 100,000 tonnes of gypsum.

The proposal is located within a saline wetland in the Shire of Dandaragan, approximately 10 kilometres north of Jurien, as shown in Figure 1 (attached).

The plant includes:

- bucket-wheel dredge;
- dredge pump;
- tracked excavator;
- screen;
- 15t haulage trucks;
- front-end loader;
- groundwater bores and bore pumps;
- 4.8ha all-weather works area;
- material handling plant; and
- stockpiles of gypsum.

The main characteristics of the proposal are summarised in Table 1 below.

Table 1 - Key Proposal Characteristics (Assessment No. 1619)

Characteristic	Description
Project Life	Estimated 25 years
Size of deposit in expansion area	1.3 Mt
Depth of mine pit	4 m within salt lake
Water table depth	1–3 m (at bore sites)
Area of disturbance	53 ha
Mine operation	Monday to Friday (sunrise to sunset) Saturday – 6 a.m. to 4 p.m.
List of major components	*On site (during mining operation)* • bucket-wheel dredge • dredge pump • sea-container • tracked excavator • screen • 15t haulage trucks *On site (at all times)* • front-end loader • groundwater bores and bore pumps • work boat • 4.8 ha all-weather works area • material handling plant • stockpiles of gypsum
Ore mining rate	100,000 t every second year for 25 years
Solid waste materials	None
Water supply	Three existing shallow bores (<10 m) will extract groundwater within the limits of the current Water Abstraction Licence 111221 (<30,000 m^3/year).
Fuel storage capacity and quantity used	*During dredging (2–4 weeks every second year)* • require 1,500 L of diesel per day delivered regularly to site by fuel tankers. • storage on site in a 10,000-L fuel tank mounted in a fully self-contained, internally enclosed and bunded sea container designed to contain 120% of the contents of the fuel tank. *Non-dredging periods* • Fuel delivered to site only when required to refuel equipment (i.e. front-end loader etc).

Abbreviations:

T - tonnes
Mt – Mega tonnes
m – metres
ha – hectares
L – L

Figures (attached)

1 Site location, Gypsum Lake area
2 Site layout

Figure 1: Site location, Gypsum Lake area

Figure 2: Site layout

Schedule 2

Proponent

Environmental Management Commitments

February 2006

EXPANSION OF JURIEN GYPSUM MINING OPERATION ML70/1161

(Assessment No. 1619)

CSR GYPROCK FIBRE CEMENT PTY LTD

EXPANSION OF JURIEN GYPSUM MINING OPERATION ML70/1161 (Assessment No. 1619)

Proponent's Consolidated Environmental Management Commitments

No.	Topic	Actions	Objective(s)	Timing	Advice From
1	Flora	Develop and implement a **Flora Management Plan** to: a. ensure that mining is only undertaken in the unvegetated portion of the lake b. maintain the 20 m – 30 m mine-to-vegetation gypsum buffer at all times c. use the existing hardstand area, access road, bores and water transfer pipelines for the proposed extension d. undertake rehabilitation using natural recruitment from brush gained from the appropriate vegetation unit for the location e. monitor the fringing vegetation and higher-slope vegetation through the use of photo points and permanent quadrats f. review monitoring data g. develop a plan to reduce groundwater pumping rates and investigate alternative options if detrimental effects on vegetation are observed	Minimise native vegetation clearing. Ensure existing level of biodiversity is maintained throughout mining operations and post-closure.	a. During operations b. During operations and at closure c. During operations d. During operations e. Annually f. Annually g. During mining operations h. As required. i. During operations. j. During mining operations, at	a. N/A b. NA c. NA d. CALM e. CALM f. CALM g. CALM h. NA i. NA j. CALM / Shire of Dandaragan k. CALM

No.	Topic	Actions	Objective(s)	Timing	Advice From
		h. maintain a record of the vehicle and equipment inspections and wash-downs undertaken for the duration of the mining activities to ensure vehicles are clean prior to entering site. i. transport gypsum using dedicated trucks to minimise the risk of spread of Phytophthora dieback. j. undertake a weed-control program for access road and other areas as required. k. additional surveying of flora around Lake Gypsum to be completed in spring 2006.		closure and post-closure if required. k. Spring 2006	
2	Wetlands and Water (Surface)	Develop and implement a **Wetlands and Water (surface) Management Plan** to: a. monitor and maintain the bund to ensure its stability. b. direct process wash-water into the excavated pit and allow it to remain as a permanent water body. c. monitor water chemistry d. monitor aquatic flora and macroinvertebrate fauna e. review monitoring results f. manage hydrocarbons and other hazardous substances in accordance with the existing CSR Gypsum Mine Operation Environmental Commitments.	Ensure that the hydrology of Lake Gypsum is not compromised and ensure no net loss of wetland functions and values.	a. Monthly during operations and after significant rainfall events post-closure. b. During operations c. Monthly for first two years of operations, quarterly thereafter d. Annually e. Annually	a. NA b. CALM c. CALM d. CALM e. CALM f. NA

No.	Topic	Actions	Objective(s)	Timing	Advice From
				f. During operations	
3	Fauna	Develop and implement a **Fauna Management Plan** which includes programs to: a. operate the mine during daylight hours only to minimise light spill. b. conduct a waterbird survey at the beginning of spring during operation of the mine to better understand bird usage and any potential impacts. c. conduct annual aquatic invertebrate monitoring during the wet season. d. monitor stygofauna (including review of existing stygofauna data and site stygofauna investigations as per EPA Guidance No. 54). e. review monitoring results f. monitor the condition of the bund regularly and undertake appropriate action if deterioration is identified g. terrestrial invertebrate survey to be completed in spring 2006.	Minimise the impact on vertebrate and invertebrate fauna within the mine development area and surrounds.	a. During operations. b. Annually c. Annually d. Within one year of commencement of operations e. Annually f. Monthly during operations and after significant rainfall events a closure g. Spring 2006	a. NA b. CALM c. CALM d. CALM/WA Museum e. CALM/WA Museum f. CALM/DoIR g. CALM/WA Museum
4	Water (Ground)	Develop and implement a **Groundwater Management Plan** which includes programs to: a. maintain compliance with current WRC	Ensure the groundwater level and quality are appropriate for the	a. During operations b. Monthly	a. NA b. NA c. DoW

No.	Topic	Actions	Objective(s)	Timing	Advice From
		groundwater abstraction licences. b. monitor the depth and quality (pH and EC) of groundwater in the existing 20 pyrometers c. review monitoring results d. reduce pumping rates and investigate alternative options if detrimental effects on the groundwater are noted e. incorporate a residual gypsum 'barrier' along the western and northern margin of the proposed new mining area to maintain the current groundwater regime and groundwater quality outside of the mining area.	intended land use and acceptable standards are maintained	during operations and quarterly for first two years after closure c. Annually d. As required	d. DoW
5	Heritage	Develop and implement a **Heritage Management Plan** which includes programs to: a. conduct an Aboriginal heritage survey as part of native title negotiations to confirm the presence or absence of significant sites. b. conduct a European heritage survey.	Ensure that Aboriginal and European heritage sites are preserved.	a. Prior to operations commencing and during operations if applicable. b. Prior to operations commencing and during operations if applicable.	a. DIA, NNTT b. Environment Australia, WA Heritage Council.
6	Post-mining Land Use &	Develop and implement a **Closure Management Plan** which includes programs to:	Ensure that the post-mining landscape is	a. Prior to mining	a. CALM, DoIR and

No.	Topic	Actions	Objective(s)	Timing	Advice From
	Closure	a. develop and implement a mine closure plan including clear and achievable closure and rehabilitation criteria. b. Ensure the closure plan complies with the requirements of the existing mine closure plan and rehabilitation criteria.	stable and self-sustaining and ecological functions are retained or reinstated where possible.	operations commencing and at and post-closure b. During operations, at closure and post-closure	other relevant stakeholders. b. NA

Abbreviations

CALM = Department of Conservation and Land Management
DIA = Department of Indigenous Affairs
DoIR = Department of Industry and Resources
DoW = Department of Water
NA = Not applicable
NNTT = National Native Title Tribunal

Appendix 5

Summary of Submissions and
Proponent's Response to Submissions

JURIEN GYPSUM MINE
PHASE 2 ML 70/1161

Summary of Public Submissions and response to submissions

Prepared for:

CSR GYPROCK FIBRE CEMENT
19 Sheffield Rd
WELSHPOOL WA 6106

Prepared by:

Kellogg Brown & Root Pty Ltd
ABN 91 007 660 317
Enter the address
Telephone 08 9278 4100, Facsimile 08 9278 4200

11 April 2006

PEN157-G-REP-005, Rev B

Acknowledgments

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Limitations Statement

The sole purpose of this report and the associated services performed by Kellogg Brown & Root Pty Ltd (KBR) is to prepare a report in accordance with the scope of services set out in the contract between KBR and CSR Gyprock Cement ('the Client'). That scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

KBR derived the data in this report primarily from examination of reports and records in the public domain. The passage of time, manifestation of latent conditions or impacts of future events may require further exploration at the site and subsequent data analysis, and re-evaluation of the findings, observations and conclusions expressed in this report.

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Revision History

Revision	Date	Comment	Signatures		
			Originated by	Checked by	Authorised by
A	11/04/06	Issued for internal review	HG	JR	HG
B	11/04/06	Issued for client review			

CONTENTS

1 Summary of Public Submissions and response to submissions

A total of 11 submissions were received from the following, covering a wide range of environmental factors.

Dr Peter Woods

Department of Indigenous Affairs

5 X anonymous submitters

Department of Environment (DoE)

Department of Conservation and Land Management (CALM)

Department of Environment - Wetlands Program

Conservation Council of WA (CCWA)

CSR Responses to issues raised in the submissions.

The issues have been collated and summarised from the submissions received and as far as is possible grouped according to the environmental factors listed in section 4 of the Public Environmental review (PER).

One of the issues raised concerns the availability of data from the Aquatic survey carried out on the Leeman Lakes system. The final report from this study is appended.

Factor - Social. Issue - Government policy

Raised by various submitters

It is government policy not to allow mining in the conservation estate.

Response

It is current government policy not to allow any new mining developments in the conservation estate. The policy allows for continuation of existing tenements. ML70/1160 is the conversion of a retention licence that was in place at the time the current government policy was adopted. This proposal is consistent with current government policy.

Factor - Social. Issue - Sources of Gypsum

Raised by an anonymous submitter, CCWA and DoE Wetlands Program

Gypsum is a relatively abundant material and should be sourced from less sensitive areas or produced as a by-product of fertiliser production by CSBP. It is not acceptable to mine a nature reserve for such an abundant material.

The PER fails to provide information on alternative sites that may have a lesser environmental impact.

Response

The available deposits in South West WA are generally located in nature reserves and are of insufficient quality or quantity for use in the CSR Welshpool plant. This was discussed in the PER in section 1.5.1, where alternative sites were listed and assessed as to their suitability. The gypsum by-product from fertiliser manufacture is unsuitable for use as a raw material for Gyprock manufacture because of its high radioactive content. This was discussed in the PER in section 1.5.1 option B.

Factor - Social. Issue - Value of Gypsum

Raised by Dr Peter Woods

Basic raw materials (eg Gypsum) are not high value and therefore proximity to market is a major issue. Having basic raw materials close to Perth is a benefit to the community, and the Jurien deposit is the closest high quality resource known at this time. Gypsum provides an essential raw material for the housing industry of Western Australia.

Gypsum is also used in agriculture; in the treatment of hard-setting clays, as a source of calcium for dairy farm soils and as a source of sulphur for sandy soils on the Swan Coastal Plain. Thus any source of Gypsum in the south west is of value to the agricultural Industry.

Response

CSR conducted an extensive search for a quality source of Gypsum to supply its Welshpool Gyprock plant, prior to acquiring the Jurien resource. The Jurien resource is the best available in south west WA and will support the requirements of the Welshpool plant for the next twenty years. The Welshpool plant employs 50 direct employees.

Factor - Fauna. Issue - Impact on birdlife

Raised by an anonymous submitter

Lake Gypsum is an important waterbird habitat on the mid west coast and is a recognised stopover point for migratory birds. It has good fringing vegetation for roosting and highly productive algal mats which make it an ideal waterbird habitat. The proposed mining operations would have a major impact on Lake Gypsum and could result in the loss of half the available habitat. Deep water will not be suitable for the thousands of waders that currently use this lake for feeding and loafing.

Response

Monitoring to date has shown that the mine void with water in it appears to attract the birds, thus casting doubt on the above assertion. The claim that "thousands" of birds use the lake is not supported by the monitoring surveys. The Lake is part of a chain of lakes that is utilised by a transient population of birds. The size of the disturbance in

the context of the total lake system is very small and will not have an appreciable impact on the birds that currently use the lake system. The mine lake has been observed to support nesting swans and other species, something that would not be possible without the water body created by the mining activity.

Factor - Fauna. Issue - Fauna monitoring

Raised by CALM

The proponent's management commitment in relation to bird monitoring is inadequate as it only provides a commitment for three years monitoring. The monitoring should be extended to the life of the mine.

Response

CSR has committed to a monitoring program for the life of the mine. CALM will be consulted on the structure and content of the monitoring program.

Factor - Fauna. Issue - Stygofauna

Raised by CALM

There has been no sampling to confirm the assumed absence of stygofauna.

Response

Water abstraction has been occurring at the mine since 1993. No additional water bores are planned to support the mine expansion as production will be maintained at existing rates. It is planned to check the existing bores for stygofauna in 2006. Should the presence of stygofauna be confirmed, the inference that must be drawn then is that the current operations are not impacting the stygofauna that are present.

Factor - Fauna. Issue - Project timing

Raised by CALM

CALM would like further information on project timing and impact on waterbirds.

Response

The project is a small operation, requiring very little equipment and people on site. It is not of such a scale that the mining operations (when they are operating) will impact on birds using the lake. Birds frequently use the mine lake during operations. CSR will consult with CALM on operating times; however the risk of disturbance to birds is very low at any time. Gypsum Lake is a part of a larger system of lakes that is used by birds. The mine impact, when considered in the regional context of the lake chain, is minimal.

Factor - Fauna. Issue - Environmental Benefits

Raised by an anonymous submitter

The permanent water body created as a result of mining has the potential to provide useful waterbird roosting and nesting habitat. For example, the construction of islands free from terrestrial predators, while alienating some of the gypsum resource, would create useful habitat which currently doesn't exist in the general area.

Response

CSR is investigating the possibility of creating islands on the water body for this very purpose.

Factor - Fauna. Issue - Fauna habitat

Raised by an anonymous submitter

Information contained in The Mammals of Australia (1995) by Ronald Strahan states: "The Water-rat usually lives in the vicinity of permanent bodies of fresh or brackish water and even on some marine beaches", it is highly unlikely that this species occurs within the Lake Gypsum area. If it does exist, it would do so only by virtue of the permanent water body created by mining.

Response

CSR is not aware of any reports of this species being present in the area.

Factor - Fauna. Issue - Water Birds

Raised by DoE Wetlands Program

It should be recognised that the deep mine pits provide minimal suitable habitat for waders.

Response

Bird counts on Lake Gypsum since mining commenced in 1993 indicate that the open water created by the mine attracts birds. Waders also use the mine void, even when there is water in nearby lakes. This use by the birds indicates that the water-filled mine void may be of more use to the birds than generally expected.

Factor Fauna. Issue - Aquatic fauna

Raised by DoE Wetlands Program

It is unclear whether the existing aquatic invertebrate fauna of the wetland will be able to survive in the deep hypersaline ponds. A comparison of the aquatic flora and fauna and the current mined ponds may provide an indication of the species change that would be expected through implementation of the proposal.

Response

The water-filled mine void will be permanent. The lake currently contains water on a seasonal basis. The depth of water in the lake each season is dependent upon rainfall received during the year. Given the transient nature of the existing water in the lake it is a realistic expectation that the ephemeral aquatic invertebrate will be unlikely to inhabit the water-filled mine void.

Factor - Fauna. Issue - Water birds

Raised by an anonymous submitter

The deep water created by the mine would have vastly less utility for water birds compared with its current status in un-mined areas as shallow undisturbed perennial water habitat.

Response

The current lake does not contain a perennial water body, it is ephemeral in nature. The bird counts carried out by the mine operators since 1993 show that the mine lake has quite a lot more utility to birds than this submission indicates.

Factor - Flora and Fauna. Issue - Sampling times for studies

Raised by an anonymous submitter

The PER does not properly acknowledge the problem of limited and inappropriate sampling times.

Response

The sampling times for the studies for the PER were all determined in consultation with CALM, as were the methodologies for the studies.

Factor - Flora. Issue - Area affected by mining

Raised by CALM

Halosarcia species were not accurately identified in the flora and vegetation survey of the proposed area. CALM recommends further survey work on the halophytic communities on Gypsum Lake to be undertaken at the appropriate time and that vouchered plant specimens be submitted to the WA herbarium.

Response

At the request of the EPA, additional flora monitoring has been requested around the proposed mining area. This request by CALM will accommodated within the additional flora monitoring regime.

Factor - Flora. Issue - Flora and Vegetation

Raised by CALM

CALM considers that the steps outlined in the PER for monitoring impacts of the proposal on vegetation surrounding Gypsum Lake are inadequate as they do not incorporate provision for monitoring of impacts relating to mining in addition to impacts from groundwater pumping and do not include sufficient sites to detect changes that may result from mining.

Response

CSR has located additional flora monitoring quadrats around the lake, specifically at the request of the EPA (EPA letter dated 9 Feb 2006). CSR has committed to a monitoring program for the life of the mine. CALM will be consulted on the structure and content of the monitoring program.

Factor - Flora. Issue - Flora impacts of bores

Raised by CALM

CALM suggest that the vegetation covering the bores no longer used could conceivably consist of opportunistic colonisers that are not dependent on groundwater.

Response

This is speculation by CALM. The statement assumes that the existing vegetation is dependant upon groundwater and that the vegetation that has covered the disused bores is not the same as previously. Inspection of the sites confirms that the recovering vegetation is no different to the immediate surrounding vegetation that was not disturbed when the bores were originally installed. In addition the flora report by Bennett commented on the lack of introduced weed species in the mine vicinity.

Factor Flora. Issue - Vegetation impact

Raised by an anonymous submitter

The PER provides no serious argument that there might be no effects on adjacent vegetation and fringing lake complexes via for instance major water level changes and other unforseen hydrogeological effects via a major extension of the deep mine lake. It also underplays adjacent reserve values such as adjacent outlier species populations such as the very nearby most southerly distribution of *Eucalyptus obtusiflora*

Response

The *Eucalyptus obtusiflora* population was left undisturbed when the mining commenced in 1993 by the placing of the access road in such a manner that it did not disturb the population. Studies undertaken in support of the PER show the current mining operations have not had a significant impact on the surrounding vegetation units. Hydrogeological studies have concluded that there will be very little, if any, impact on groundwater. This view is supported by the submission from the DoE hydrologist in a memo dated 27/03/06.

Factor - Land. Issue - Character of Lake Gypsum

Raised by Dr Peter Woods

Lake Gypsum is not unique. It is typical of ephemeral wetlands in Western Australia and is little different from the other lakes in the region.

Response

The research undertaken when preparing the Public Environmental Review supports this statement. Additional reports received since the PER was released for public review have served to reinforce this point of view. A report prepared by Dalcon Environmental (2006) provides the following statement in the conclusion "*Gypsum Lake, in terms of the other lakes in the area, is less diverse and does not seem to hold any taxa unique to the area*".

Factor - Land. Issue - Area affected by mining

Raised by Dr Peter Woods

The PER overstates the area impacted by mining. The actual area impacted will be 38.5% not 47% as stated in the PER.

Response

The calculations for the total area impacted included the 20 - 30 m buffer zone on the Western edge of the lake; this impacted the calculation. The information provided by Dr Woods is correct if it is assumed that the buffer zone is not impacted.

Factor - Land. Issue - Impact of mining

Raised by CALM

It is CALM's view that any anthropomorphic modifications to a natural system, located within a nature reserve, are undesirable. CALM does not consider that there is sufficient evidence to support the view that the current mine is not adversely impacting the health of the system.

Response

The nature reserve in question (Beekeepers) has been subjected to considerable anthropomorphic modification over time with unauthorised access by off-road vehicles and use by other users (eg Beekeepers, oil and gas developments, recreational users etc). CALM's view does not take account of the current and historical use that Beekeepers Reserve has been put to.

The studies carried out in support of the PER have not demonstrated a significant impact on the system surrounding Gypsum Lake. They have shown the vegetation around the current mining operations to be healthy. A beneficial impact of the mine has been to control unauthorised use of the nearby area through encouraging users of the area to use the road constructed to service the mine.

Factor - Land. Issue - Environmental Offsets

Raised by DoE Wetlands Program, CCWA

The PER has not provided any specific details on the proposed offset, apart from stating that CSR will make a financial contribution to the Nature Conservation and National Parks Trust Account.

Response

The quantum of the offset was agreed with CALM. The monies provided by CSR will be used by CALM for research activities in the Jurien area. They will enable CALM to fund a full time research officer at Jurien Bay.

Factor - Land. Issue - Conservation value

Raised by DoE Wetlands Program

Lake Gypsum is considered to have the values equivalent of Conservation category wetlands, which are recognised as 'critical assets'. The EPA presumes against recommending approval for proposals that are likely to have significant adverse impacts to 'critical assets'.

Response

This is speculative. Lake Gypsum has not been assessed as to its conservation category status therefore it is not possible to state whether it is or is not a 'critical asset'.

Factor - Wetlands. Issue - Cumulative environmental impact

Raised by DoE Wetlands Program

The PER has not addressed any potential cumulative environmental impacts. The wetland may be currently retaining ecological and hydrological functions outside of the current mining area and additional disturbance may potentially destabilise the wetland system as a whole. A worst case scenario may potentially result in some species not visiting the lake due to unsuitable conditions.

Response

This is speculation. The vegetation surrounding the existing mine has been shown to be in excellent health. There are no indications that a scenario such as that described could occur. CSR will be monitoring the health of the surrounding vegetation units as part of the ongoing mine operations. Both CALM and DoE will be consulted on the design of the monitoring program.

Factor - Wetlands. Issue - Area affected by mining

Raised by CALM

The physio-chemical, aquatic flora and aquatic invertebrate fauna data presented for the wetlands that have been sampled is at an insufficient level of detail to enable assessment of the conservation values of individual wetlands in a regional context.

Response

The final report covering this issue is appended. A copy of the report has previously been forwarded to CALM.

Factor - Wetlands. Issue - Regional significance

Raised by CALM

The PER does not recognise the regional significance of Gypsum Lake for waterbirds or address investigation and protection of the main attributes that contribute to its habitat significance.

Response

The studies undertaken (Flora, Fauna and Lake Ecology) to support the PER place Gypsum Lake in the regional context. These studies were undertaken at the request of CALM using methodologies recommended by CALM. Counts of waterbird use over the life of the existing mine indicate that the water body created by the mine is a factor in attracting birds to Lake Gypsum.

Factor - Water.Issue - groundwater

Raised by DoE Wetlands Program

The PER states that a 'horizontal separation of the water in the open void from the shallow groundwater lenses in the area will be achieved by retaining a 20 to 30 m gypsum buffer width, which will prevent mixing of the water in the final void with other groundwater. However, figure 2.1 illustrates that the proposed mining activities extend beyond the limit of crystalline gypsum, which does not provide a gypsum buffer between the void and the remaining natural wetland.

Response

This comment shows that the data has been misinterpreted. The 20-30m buffer is between the gypsum and the western shore of the lake. Protection of the lake surface on the Eastern side will be provided for by the bund as discussed earlier. The entire lake contains gypsum, not all of it is crystalline.

Factor - Water.Issue - Potential effects of mining

Raised by CALM

The PER does not adequately evaluate or address the potential effects of mining on the groundwater and surface water hydrology, chemistry or biota of Gypsum Lake. CALM is also concerned that sufficient gypsum is left to "buffer" the lake to ensure it retains its current nature.

Response

The studies undertaken in support of the PER were undertaken at the suggestion of CALM in the first instance. In most cases the methodology used was that recommended or required by CALM. The groundwater report appended to the PER addresses the groundwater issue with the findings supported by the submission from the DoE Hydrologist in a memo dated 27/03/06. Water chemistry and biota studies have been supplemented by a report from Dalcon Environmental (appended). The Dalcon Environmental report examined Lake Gypsum in the regional context (as requested by CALM) and reported that "Gypsum Lake in terms of the other lakes in the area is less diverse, and does not seem to hold any taxa unique to the area".

An indication of potential effects of the proposed mining expansion can be gained from examination of the area surrounding the existing mine. Monitoring of the area has not shown any detrimental effect.

The area selected for mining contains the highest quality gypsum. The entire lake contains gypsum as does the buffer that will be left on the Western side of the mine. There will be sufficient gypsum left to "buffer" the lake after mining ceases.

Factor - Water.Issue - Area affected by mining

Raised by CALM

The proponent's commitment to monitoring surface water is ambiguous with respect to the duration of long-term monitoring. CALM considers that commitments relating to surface and groundwater monitoring should be incorporated in a formal monitoring program prepared to CALM's requirements

Response

Groundwater monitoring is already undertaken. CSR is able to provide all the data collected to date to CALM for analysis. CSR is happy to consult CALM on incorporating surface water monitoring into the current program.

Factor - Water.Issue - Area affected by mining

Raised by CALM

The management commitments for monitoring the aquatic environment do not provide enough detail in relation to variables that will be monitored, and trigger values that will initiate management responses. CALM recommends that the proponent develop specific measures and criteria for monitoring and managing the aquatic environment.

Response

CSR has committed to a monitoring program for the life of the mine. CALM will be consulted on the structure and content of the monitoring program.

Factor Water. Issue - Hydrology and water quality

Raised by DoE Wetlands Program

Are the proposed 500mm high by 5m wide bunds adequate to protect the wetland from breaches of hypersaline water during a storm event?

Response

The water body left behind in the mine void rests at a lower level than the surface of the lake. The purpose of the bund is to prevent the water from the lake emptying into the mine void.

Factor - Water.Issue - Groundwater abstraction

Raised by DoE Wetlands Program

If the current abstraction is less than the approved extraction levels, any increase in water use over a longer period of time may result in adverse impacts.

Response

The water licence covers existing requirements. No increase in water usage is required to maintain production levels at current rates. Water use will not increase over time.

Factor - Decommissioning. Issue - Mine Closure

Raised by DoE Wetlands Program

It is noted that CSR has committed to battering the pit slopes when the mine is decommissioned. The PER should discuss whether modification to the bunds will impact their effectiveness in separating the hypersaline water in the void and the waters of the natural wetland

Response

In battering the pit slopes, the bunds will not be modified. As previously stated the purpose of the bund is to prevent the lake water from draining into the mine void as the water level in the mine void is lower than the lake surface.

Factor - Decommissioning. Issue - Rehabilitation

Raised by CALM

The planning and implementation process for post-mining rehabilitation is inadequately defined. The management commitment to "*undertake rehabilitation using natural recruitment from brush obtained from the appropriate vegetation unit*"

should be removed and replaced with a commitment to develop a rehabilitation management plan to CALM's requirements.

Response

The mine has an anticipated life of 20 to 25 years. A mine closure plan is a requirement of the Department of Industry and Resources and will be progressively developed over the mine life. CALM will be consulted in the development of the mine closure plan.

Factor - Heritage. Issue - Aboriginal and European Heritage

Raised by Department of Indigenous Affairs and DoE Wetlands Project.

The proposed Aboriginal and European Heritage surveys should have already been completed. The area of the proposed mine expansion does not appear to have been subject to a heritage investigation. There may be the potential for unrecorded sites to exist.

Response

Aboriginal heritage is not a matter the subject of the EPA assessment or an issue to be considered under the Environment Protection Act. However, the Company first met with the Yued Native Title Working Group on 27 January 2004 and provided them with a briefing about the proposed extension of the Gypsum Mining Project at Jurien Bay.

At that meeting it was agreed that the parties would enter into an Aboriginal Heritage Protection Agreement under which up to 6 representatives of the Yued People and their anthropologist will undertake an Aboriginal site avoidance survey to be carried out over all areas where ground disturbing works are to be undertaken.

The Agreement also provides for an archaeological survey, if required, and contains procedures for monitoring and dealing with Aboriginal skeletal remains in the unlikely event such remains are uncovered by the mining operation. It should be noted that the proposed mining operations are located entirely upon the bed of a large, ephemeral salt lake and will not impact on the surrounding dune system. As such there is a very low probability that any archaeological material or skeletal remains will be encountered.

The Heritage Protection Agreement was finalised in March 2004. The heritage survey work will be undertaken under the terms of this Agreement prior to any ground disturbing work in connection with the project.

Mining Lease Application M70/1161, upon which the project will be developed, is subject to a native title claim by the Yued People (WC97/71). The State has issued a notice under Section 29 of the Native Title Act and the parties have been in negotiations since January 2004.

In February 2006 the Company agreed in principle to the terms of a Jurien Bay Mining Project Agreement as proposed by the Yued People at a previous negotiation meeting. A draft agreement has been prepared and is under consideration by both parties as at the end of March 2006.

There are no European heritage sites within the proposed mining area.

Factor - Social. Issue - Environmental Benefits

Raised by an anonymous submitter

It is important to emphasise the benefits that the existing mining proposal has brought to the general area around Lake Gypsum. The track into the mine site was upgraded, allowing the closure and revegetation of numerous unauthorised tracks. Further this new access road has acted as a firebreak, as a fire track during times of wildfire emergency and it has allowed the population of *Eucalyptus obtusiflora* to be better protected than in the past, thanks to a flora survey at the time of planning for the track which allowed this restricted eucalypt to be better protected against wildfire and illegal track creation.

Response

CSR agrees with the statement by the submitter.

Factor - Social. Issue - Social Impact

Raised by an anonymous submitter

We have no objections to the proposal. We also support the cooperation which exists between the proponent and the Shire in providing facilities in the area. In the event that the proposal proceeds as set out in the PER, we would not like to see any situation develop in which the users of Reserve 19206 would be adversely affected.

Response

CSR is committed to a continuing cooperative working relationship with the local Shire. The proposal will not affect users of Reserve 19206.

Factor - Economic. Issue - Alternative sources

Raised by CALM

CALM suggest that quantitative data on available gypsum volumes and quality should be provided by the proponent to support the claim that there are no viable alternatives to mining at Gypsum Lake

Response

CSR has researched this issue thoroughly, as described in the PER at 1.5.1. If there were alternative sources available, CSR would be accessing them.

Appendix A

BASELINE STUDY OF AQUATIC FLORA & FAUNA GYPSUM LAKE BEEKEEPERS RESERVE

Dalcon Environmental

March 2006

Dalcon Environmental
Marine & Freshwater
Scientists

Baseline Study of Aquatic Flora & Fauna
Gypsum Lake
Beekeepers Reserve
Western Australia
Spring 2005

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Baseline Study of Aquatic Flora & Fauna
Gypsum Lake
Beekeepers Reserve
Western Australia
Spring 2005

Background

Dalcon Environmental was approached by Kellogg Brown & Root Pty Ltd (KBR) to undertake a baseline field survey of the aquatic flora and fauna of a salt lake (Gypsum Lake) in Beekeepers Nature Reserve, located 10 km north of Jurien Bay, Western Australia. Currently, CSR Gyprock Fibre Cement hold a mining lease (Mining Lease M 70/750) for the extraction of gypsum which occupies approximately 12% (24 ha) of the lakes surface. CSR has sought approval to implement a change in the mining method which would result in more intensive but less frequent mining activities. CSR is also seeking approval to expand the current mining operations into the area covered by a Retention Licence, Retention Licence 70/2. Further details can be found in the Notice of Intent document (Kellogg, Brown & Root, 2003).

The purpose of this survey was to acquire baseline information on the aquatic flora and fauna of Gypsum Lake, to comment on any potential impacts on the aquatic flora and fauna which may occur if changes to the method, timing and scale of mining operations on the lake were to occur, and to comment on the significance of the aquatic flora and fauna of Gypsum Lake in a regional context, i.e. compared to other similar lakes in the region. The field survey was conducted in spring 2005 during September and November.

Gypsum Lake is located within Beekeepers Nature Reserve (C Class Reserve 24496). The lake occupies an area of approximately 200 ha and is 2 km long in a north-south direction and 1 km wide at its widest point. Two locations were chosen to be sampled in this lake (Figure 1).

Nine other lakes in the region also sampled to provide the required regional perspective. Eight of these lakes, located on the eastern side of Indian Ocean Drive, form a discontinuous chain spanning approximately 45km in a north south direction. The remaining lake, close to the northern-most limit of those sampled, was located on the western side of Indian Ocean Drive (Figure 1). Several other lakes in the region were also selected as potential sampling sites, but could not be accessed.

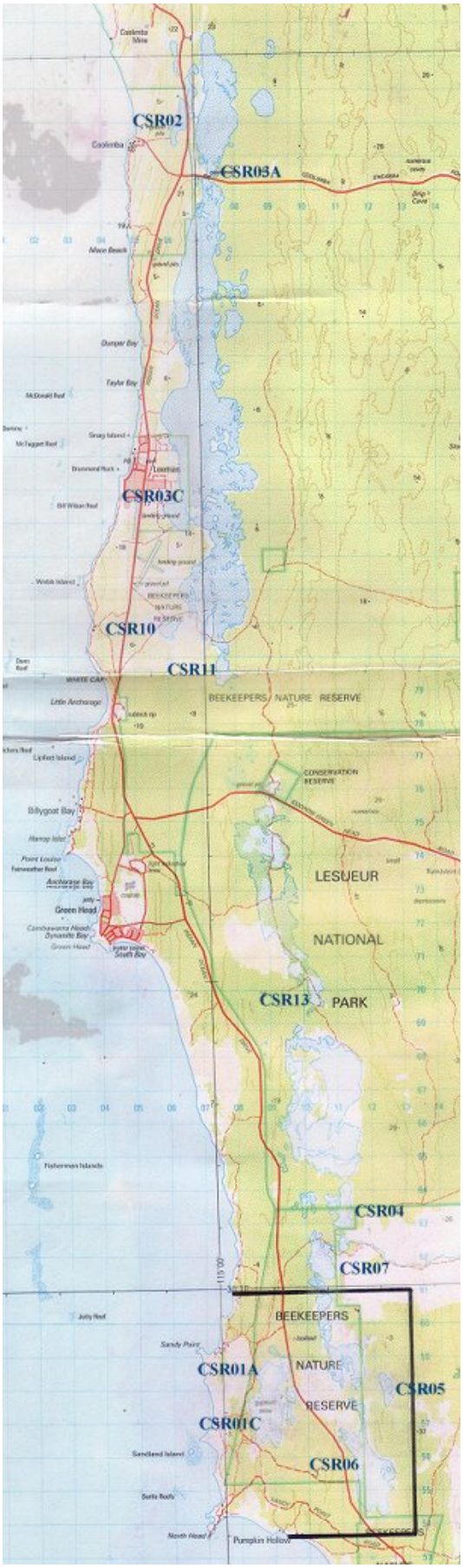


Figure 1: Location of sampling sites for Gypsum Lake and nearby salt lakes (map not to scale).

Materials and Methods

Sampling was carried out between the 12th and 14th of September 2005, due to poor accessibility to some lakes another sampling run was undertaken on the 3rd and 4th of November 2005. As water was present in all bar two of the sites (CSR10 and CSR11 were moist but no surface water was present) samples were taken in situ, preserved and analysed in the laboratory.

Samples taken included water and sediment chemistry, phytoplankton, macrophytes, benthic algal mats, benthic diatoms, macroinvertebrates and zooplankton. Table 1 lists the parameters sampled at each lake.

Table 1: Parameters sampled at each site.

Parameter	CSR01A	CSR01C	CSR02	CSR03A	CSR03C	CSR04	CSR05	CSR06	CSR07	CSR10	CSR11	CSR13
Water Chemistry	√	√	√	√	√	√	√	√	√			√
Sediment Chemistry	√	√	√	√	√	√	√	√	√	√	√	√
Phytoplankton	√	√	√	√	√	√	√	√	√			√
Macrophytes	√	√	√	√	√	√	√	√	√			√
Benthic Algal Mats	√	√	√	√	√	√	√	√	√	√	√	√
Benthic Diatoms	√	√	√	√	√	√	√	√	√	√	√	√
Macroinvertebrates	√	√	√	√	√	√	√	√	√			√
Zooplankton	√	√	√	√	√	√	√	√	√			√

Chemical Analyses

Water temperature, depth, turbidity, oxidation reduction potential, pH, electrical conductivity, dissolved oxygen and salinity were measured in situ using a Yeokal 611 probe. All other water chemistry parameters were collected according to the Marine and Freshwater Research Laboratories (MAFRL) standard collection protocol which can be made available upon request. Samples were sent to MAFRL upon return to the laboratory for analysis. The following parameters were analysed:

Water chemistry – total dissolved solids, silicate, chloride, sulphate, calcium, potassium, magnesium, sodium, total organic carbon, nitrite, ammonia, orthophosphate, nitrate + nitrite, total dissolved phosphorus, total dissolved nitrogen, total phosphorus, total nitrogen, colour, chlorophyll a, chlorophyll b, chlorophyll c, chlorophyll, phaeophytin and total suspended solids.

Sediment chemistry – calcium, potassium magnesium, sodium, total Kjeldahl nitrogen, total phosphorus, total organic carbon, chlorophyll a, chlorophyll b, chlorophyll c, chlorophyll, phaeophytin, % loss on ignition, pH, electrical conductivity, chloride, extractable chloride, sulphate, extractable sulphate, ammonia, ortho phosphorus, nitrate plus nitrite, ammonia, extractable ortho phosphorus and extractable nitrate plus nitrite.

Microserve Laboratories Pty Ltd analysed the water samples for carbonate, bicarbonate, and total alkalinity and the sediment samples for carbonate and bicarbonate.

Phytoplankton

Water samples were collected using a 20µm plankton net over a 50m tow and preserved in situ using Lugols Algal Preservative prior to delivery to Dalcon Environmental. The tow was carried out to include all possible habitat types in accordance with CALM procedures. Due to the shallow nature of all the lakes it was not possible to collect quantitative samples.

Upon return to Dalcon Environmental samples were analysed using a Sedgewick Rafter Counting Chamber, under an Olympus CK2 inverted photomicroscope at 400x magnification. Microalgal taxa were identified to genus or species level wherever possible using a range of specialised texts. Digital images were taken of all taxa encountered for reference and subsequent identification if required. Results given are qualitative and represent the relative abundance of taxa only (% composition).

Macrophytes

Observations were made as to the presence of submerged macrophytes, based on the macrophytes in the sampling area. Two samples of each of the different macrophytes observed were taken and samples were dried and pressed, whilst the second sample was preserved with Transeau's Algal Preservative (6 parts water, 3 parts ethanol, 1 part formalin) prior to delivery to the laboratory. Upon return to Dalcon Environmental the samples were identified and recorded as presence/absence.

Benthic Algal Mats

Samples for the analysis of benthic algal mats were collected by scraping a collection jar along the lake bed collecting the upper 2 cm of sediment until the jar was full. Samples were labelled at each site and preserved using Transeau's Algal Preservative prior to delivery to the laboratory.

Upon return to Dalcon Environmental the microalgal analysis of the preserved mat samples was undertaken using an Olympus CK2 inverted photomicroscope at a magnification of 400x. Small amounts of mat sample were placed on a microscope slide with a drop of deionised water and teased apart, a coverslip was added and the sample was analysed qualitatively (absent, present, abundant). This process was repeated several times for each sample.

Microalgal taxa were identified to genus or species level wherever possible using a range of specialised texts. Digital images were taken of all taxa encountered for reference and subsequent identification if required.

Benthic Diatoms

Acid-cleared Algal Mats – Microalgae (Diatoms)

The basis of diatom taxonomy is the morphological features of the silica cell wall (frustule). The often fine patterns and striations on the diatom frustule cannot be adequately observed with fresh or preserved specimens as they are obscured by the organic contents of the diatom cell. In order to be able to observe these morphological features, the sample must first be cleaned (or cleared) using a strong oxidising agent such as concentrated acid or hydrogen peroxide to remove all organic matter leaving only the silica cell wall of the diatom.

Permanent slides of cleared diatom material were made according to John (1983). A small amount (5 to 10 g) of the dried material set aside for diatom analysis was placed into a clean 50 ml Pyrex beaker to which approximately 30 ml of concentrated nitric acid was added. The beakers were placed onto a hot plate and heated until they were about to boil. Samples were then removed from the heat and the beakers were topped up with deionised water and left overnight to settle. The supernatant was then siphoned off and the diatom frustules were resuspended in deionised water and left to settle for at least 3 hours. The supernatant was again siphoned off down to a volume of about 10 ml which was then transferred to a clean plastic centrifuge tube. Diatom cells were further cleaned of any acid remnant by centrifuging the sample for 5 minutes, siphoning off the supernatant and resuspending the diatom cells in deionised water. Samples were centrifuged up to 5 times until a clear ash-coloured cleared diatom sample was visible at the bottom of the centrifuge tube.

A small amount of the cleaned diatom sample was then pipetted onto a clean 22 mm x 22 mm glass cover slip on a hot plate at high temperature (80ºC). As the sample evaporated, care was taken to ensure that the sample was evenly spread over the entire surface of the cover slip. Once evaporated, the cleared diatom frustules were firmly attached to the cover slip.

A small drop of the diatom mounting medium Naphrax® (refractive index ≥1.74) was added to the centre of a standard microscope slide and the cover slip with the evaporated diatom frustules was placed onto the drop of mounting medium (diatom frustules on the downward side). The slide was then placed on the hotplate and left until the mounting medium had stopped boiling and all of the solvent had evaporated. The slide was then removed from the hotplate and mounting medium was allowed to cool and solidify. These slides can be kept indefinitely.

Three replicate slides were made from each sample; two from each sample were retained by Dalcon Environmental for analysis.

Analysis of the permanent diatom slides was undertaken using a Leitz Laborlux S compound photomicroscope using oil immersion techniques at a magnification of 1000x. Each slide was scanned until a minimum of 200 frustules had been counted. As the samples contained a large amount of fine clay it was extremely difficult to produce slides for quantitative analysis. For this reason the results were qualitative only with the relative abundance (%) of each diatom taxon encountered recorded.

Diatom taxa were identified to at least genus level and to species level wherever possible using a range of specialised texts. Digital images were taken of all taxa encountered for reference and subsequent identification if required.

Benthic Macroinvertebrates

Benthic macroinvertebrates were collected according to CALM's standard protocol. 50m tows were undertaken using a 250 μm kick net. The samples were taken from all possible representative habitats, the net used a scraping attachment to scrape the top of the sediment the sediment was also disturbed as it was collected. The samples were transferred to a bucket and preserved using formalin in situ.

Upon return to Dalcon Environmental the samples were sieved through a 212 μm sieve to remove fine silt and formalin. The samples were then preserved with ethanol until analysis. The sample was analysed using a stereomicroscope for presence/absence of macroinvertebrates. Representatives of each taxon found, were removed and retained as voucher specimens. Taxa were identified to species where possible, but in some case this was not possible due to the condition of the animal (poor condition, juvenile).

Zooplankton

Water samples were collected using a 50μm plankton net over a 50m tow and preserved in situ using Formalin prior to delivery to Dalcon Environmental. The tow was carried out to include all possible habitat types in accordance with CALM procedures. Due to the shallow nature of all the lakes it was not possible to collect quantitative samples.

Upon return to Dalcon Environmental the samples were sieved using a 45 μm sieve, and some samples were split using a Folsom Plankton Splitter due to the high density of animals present. The samples were analysed using a sorting chamber, under a stereomicroscope. Taxa were identified to genus or species level wherever possible using a range of specialised texts, and voucher specimens were retained. Results given are qualitative and represent the relative abundance of taxa only.

Results

All data is available in the appendices of this report.

Chemical and Nutrient Data

The water chemistry data shows a high level of similarity between the lakes, as seen in the cluster analysis (Appendix 10) there was greater than 75% similarity. With CSR05 being the only lake that was markedly different with very high salinity, and generally poorer water conditions. Gypsum Lake was similar to site CSR03, which were part of a large salt lake located 20km north of Gypsum Lake. This chain spans approximately 19km and was analysed north of the causeway (CSR03A) and south of the township of Leeman (CSR03C). Sites CSR02, CSR04, CSR07 and CSR13 were marginally less saline than Gypsum Lake and had a lower major ion content to Gypsum Lake and CSR03. For this reason these sites clustered separately. Based on the total organic carbon, total nitrogen and NO_3 CSR13 was the most productive of the lakes. There was no water chemistry data available for lakes CSR10 and CSR11 as these were dry at the time of sampling.

Sediment chemistry was also analysed, and a similarity of greater then 75% was found between 7 of the sites (CSR07, CSR02, CSR04 and CSR003). CSR05 once again was found to be quite dissimilar to Gypsum Lake as were CSR06, CSR10, CSR11 and CSR13. Separation of these lakes seems to due to markedly lower levels of sodium, calcium, potassium, magnesium and ammonia present in the sediment.

It should be noted that CSR10 and CSR11 were dry at the time of collection and thus the results may vary from the other lakes.

Whilst the turbidity varied greatly between sites it should be noted that all lakes contained very fine silt and were shallow, which caused the sediment to stir very easily, therefore the turbidity measurements may have been compromised. Turbidity was not taken into account when doing the cluster analysis for this reason.

Phytoplankton

As the lakes were very shallow it was difficult to collect quantitative samples of phytoplankton.

The phytoplankton diversity was similar in most sites with CSR03A having a low diversity due to the presence of just two diatom taxa, *Amphora* sp. 013 and Diatom 004 (Appendix 4), in abundance. A cluster analysis of the phytoplankton indicated a high level of similarity between the salt lakes with the exception of CSR03A.

Salt lakes often have a lower diversity than freshwater lakes due to the high salinity, which was illustrated by the diatoms observed in the phytoplankton community, with a number of species particulary *Amphora coffaeoformis*, *Cylindrotheca closterium*, *Hantzschia* sp. 001 and *Rhopalodia* sp. 001 preferring higher salinities. As the lakes were extremely shallow there is the possibility that the phytoplankton samples were contaminated by algae present in the sediment. Taxa like *Lyngbya* sp., *Chroococcus* sp. and coccoid cyanobacteria 002 are commonly found in the benthic mats that grow in salt lakes.

Macrophytes

The 3 macrophytes observed were halotolerant species commonly occurring in saline lakes. The macrophytes were dominated in all instances by *Lepilaena preissii* (Appendix5) which formed dense patches to meadows in the majority of the lakes, and was flowering in most lakes during the first site

visit. Other submerged macrophytes were found in the area consisted of *Ruppia* sp. and *Lepilaena* sp. which were not identified to species due to the lack of flowering/fruiting bodies, and three species of *Lamprothamium* sp. were found in CSR04, CSR06 and CSR13. *Lamprothamium* was only observed in 3 lakes, but oogonia were noted in all lakes during the analysis of the macroinvertebrates. The identification of the *Lamprothamium* was not resolved further than genus due to a lack of taxonomic research on Western Australian charophytes. All the macrophytes sampled were in the shore margin up to 30 m into the lake at each site. Due to the size of the lakes and the sediment type macrophytes growing out of this area were not sampled and can not be commented on.

Benthic Algal Mats

Benthic Algal Mats (BAM's) are common components of saline lakes. BAM's have two major functions in a salt lake, binding sediment, and primary production, thus playing a major role in the lake ecology.

The BAM's were predominantly cyanobacterial in composition, although as the mats were not analysed quantitatively the reference to dominance is a subjective observation. The algal mats found in Gypsum Lake were not significantly different to the mats found in the surrounding lakes, with the dominant taxa in CSR01A *Microcoleus chthonoplastes* and *Oscillatoria* sp. 001. These taxa are commonly found in salt lake mats and were found in CSR02 and CSR03A. Two distinct types of algal mat were found in Gypsum Lake (CSR01A/CSR01C). Both mats found at CSR01A were very similar in physical characteristics (Table 2) and in species composition. Mat 2, CSR01C had similar physical characteristics to the mats at CSR01A, but varied slightly in terms of the dominant taxon. CSR01C mat 2 was similar to mat 1 at CSR01A, whilst *Microcoleus chthonoplastes* was present *Oscillatoria* sp. was the dominant taxon. It was possible that CSR01A mat 1, 2 and CSR01C mat 2 was the same mat, with slight variations in community composition. Mat 1 was dominated by the diatom *Navicula* sp. 011.

Table 2: Benthic algal mat physical characteristics summary (based on in situ observations).

Features	**CSR01A**		**CSR01C**		**CSR02**		
Algal Mat Type	**1**	**2**	**1**	**2**	**1**	**2**	**3**
Colour							
Pink	√		√	√	√		√
Grey	√	√	√	√	√		√
Black				√		√	√
Green							
Appearance							
Slimy/Gelatinous							
Pustular							
Crust - like		√					
Raised	√		√		√		
Flat		√		√		√	√
Cohesive	√	√	√	√	√	√	√
Thickness							
> 2mm	√	√	√	√	√	√	√
< 2mm							
Dominant Taxa	- *Microcoleus chthonoplastes*	- *Microcoleus chthonoplastes*	- *Oscillatoria* sp. 001	- *Navicula* sp. 011	- Cyanobacteria 001	- Cyanobacteria 001	- *Microcoleus chthonoplastes*

Features	CSR03A		CSR03C	CSR04	CSR05	CSR06	
Algal Mat Type	**1**	**2**	**1**	**1**	**1**	**1**	**2**
Colour							
Pink		√	√				√
Grey			√				√
Black	√			√	√	√	√
Green	√			√			
Appearance							
Slimy/Gelatinous				√	√	√	
Pustular							
Crust - like							√
Raised		√					
Flat	√		√				
Cohesive	√	√	√	√	√	√	√
Thickness							
> 5 mm	√	√					√
< 5 mm				√	√	√	
Dominant Taxa	- *Microcoleus chthonoplastes* - *Amphora* spp.	- *Microcoleus chthonoplastes*	- few algal cells - held together by fibrous material (eg plant roots)	- Filamentous Cyanobacteria 014	- *Nostoc* sp. 001	- *Nostoc* sp. 001	- *Chroccoccus* sp. 002 - *Cylindrotheca closterium*

Features	CSR07	CSR10	CSR11		CSR13
Algal Mat Type	**No Algal Mat**	**1**	**1**	**2**	**1**
Colour					
Pink					√
Grey		√			
Black		√	√	√	√
Green					
Appearance					
Slimy/Gelatinous					
Pustular			√		
Crust - like		√		√	
Raised					
Flat					√
Cohesive		√	√	√	√
Thickness					
> 5 mm		√	√	√	
< 5 mm					√
Dominant Taxa		- Coccoid Cyanobacteria 002	- *Chroccoccus* sp. 009	- *Chroccoccus* sp. 009	- Coccoid Cyanobacteria 002

Diatoms

The diatoms were sampled from all possible benthic substrates (sediment and algal mats) to obtain a representative data set. The diatoms were analysed qualitatively due to the large amount of fine particulate matter in particular clay that remained after acid digestion.

Diatoms are often used as tools in bioassessment as they have specific ecological preferences, which have been well documented. Overall the diatom richness and diversity was low (in part due to the difficultly of analysis) but was representative of coastal saline lakes.

The majority of taxa found are indicative of high salinities in particular *Amphora coffaeaformis, A. ventricosa*, *Cyclotella meneghiniana*, *Navicula cincta* and *Brachysira serians* (John 2000, Lowe 1974).

The total diatom richness per site ranged from 3 to 17 taxa. Both CSR01 sites were in the lower half of the 12 sites sampled for diatom richness, site CSR01A had the second lowest richness (5 taxa) and site CSR01C had the sixth lowest richness of 11 taxa.

Diversity per site ranged from 0.1259 to 0.5517. Both CSR01 site were also in the lower half of the 12 sites sampled for diatom diversity, site CSR01A had the third lowest average diversity (0.1953) and site CSR01C had the fifth lowest average diversity of 0.2864.

The diatom community of Gypsum Lake is similar to but less diverse than that of most other lakes sampled within the region. All taxa recorded in Gypsum Lake were recorded from at least one other lake in the region with the exception of *Diploneis ovalis* (1 cell recorded, 0.44%, at CSR01C-Algal Mat 2).

Macroinvertebrates

The macroinvertebrate community was sampled qualitatively and recorded as present or absent. Both CSR01 sites were similar in composition with the dominant taxa *Calomoecia clittellata*, *Diacypris* sp. 001 and *Daphniopsis* sp. 001. These taxa are common in salt lake communities and have been recorded in Lake Eganu situated 20km south west of Coorow (Cale 2004). Both sites had moderate species richness of 17 (CSR01A) and 19 (CSR01C) with the highest richness recorded at CSR13 with 26 taxa, this was possibly due to the fresher nature of the water (salinity approximately 18ppt).

All taxa recorded in the Gypsum Lake sites were found in other lakes with the exception of Amphipod 005 which was unidentifiable beyond class due to the poor condition of the animal and Hemipteran 001, which was possibly a terrestrial aphid.

Parartemia extracta, which has been recorded in lakes near Corrigin and Wongan Hills and appears to be rare (Timms 2004), was only recorded from one lake, CSR07. *Parartemia* cysts were observed in a few of the samples but were not abundant, a separate investigation would need to be undertaken to determine whether there were *Parartemia* cysts in Gypsum Lake and their viability, as no adult or juvenile *Parartemia* were recorded for Gypsum Lake.

Most sites had an abundance of *Coxiella*, a gastropod common in saline waters. There was a noticeable decrease in Coxiella at CSR13. A number of marine gastropods were also observed in the Gypsum Lake sites but were not recorded as they are part of the remnant marine organisms and were long dead.

Zooplankton

The zooplankton composition was similar between all sites, with the dominant zooplankton being copepods and ostracods. All sites had relatively low diversity, with CSR04, CSR07 and CSR13 having the greatest diversity and sites CSR04 and CSR13 having the highest richness. As can be seen in the cluster analysis (appendix 10) there were 2 distinct groups of lakes based on the dominant taxa found. The first grouping was CSR01A, CSR01C, CSR04, CSR06 and CSR07. CSR01A, CSR01C and CSR06 had a high degree of similarity (>82%) due to a high density of *Calomoecia clittellata* and generally low diversity. CSR04 and CSR07 which had a similarity of approximately 60% to CSR01A and CSR01C was dominated by *Calomoecia clittellata* and *Diacypris* sp. 001, these two sites also had a higher degree of diversity. The second grouping was based on the presence of the ostracod *Diacypris* sp. 001. CSR02, CSR05, CSR03A and CSR03C were highly dominated by *Diacypris* sp. 001 which consisted of over 50% of the population. CSR13 was the freshest of the lakes and recorded a high population of rotifers, which led to site CSR13 being isolated from the two major groups.

Conclusion

Chemistry

The water and sediment chemistry of Gypsum Lake reflects that of a natural salt lake and from the results obtained in this report is similar to the surrounding salt lakes in the area. Gypsum Lake is highly similar to CSR03 a large chain salt lake to the north of Gypsum Lake.

The chemistry of Gypsum Lake was similar at both sites with marginally higher levels of silicate chloride and sulphate and bicarbonate in the sediment at CSR01A which is within the proposed mining lease.

The chemistry of the lake is reflected in most of the surrounding salt lakes and is not unique to Gypsum Lake. As long as the current hydrological cycle of the unmined portion of the lake (including wetting/drying cycles, freshwater/groundwater inputs etc) is not altered significantly from the current situation, it is unlikely that there will be a significant change in water chemistry due to the expansion of the mining lease.

Phytoplankton

Phytoplankton populations are highly variable in nature, which was reflected in the results. The results did not reveal any unique taxa in Gypsum Lake. Most of the species observed in the samples for Gypsum Lake were common to salt lakes and were represented in other lakes in the region.

The composition of the algal community is largely driven by water chemistry/hydrological cycle and as long as the current hydrological cycle of the unmined portion of the lake (including wetting/drying cycles, freshwater/groundwater inputs etc) is not altered significantly from the current situation, it is unlikely that there will be a significant change in phytoplankton due to the expansion of the mining lease.

Macrophytes

The macrophytes found in Gypsum Lake were located extensively within the lake and the surrounding lakes in the region. It has been demonstrated that the dominant macrophyte *Lepilaena preissii* can tolerate a range of salinities found in CSR13 with a salinity of 18ppt to CSR05 with a salinity of 60ppt.

The composition of the macrophyte community is largely driven by water chemistry/hydrological cycle and as long as the current hydrological cycle of the unmined portion of the lake (including wetting/drying cycles, freshwater/groundwater inputs etc) is not altered significantly from the current situation, it is unlikely that there will be a significant change in macrophyte communities or extent due to the expansion of the mining lease.

Benthic Algal Mats

The algal mats in Gypsum Lake covered much of the lake surface, this was also the case for most of the other lakes sampled in the region as can clearly be seen in aerial photographs of the region. The algal mats recorded were similar in composition in all lakes sampled.

As reported in the previous study of Gypsum Lake (Dalcon Environmental 2004) Grey *et al*. (1990) suggests that for any thickness of benthic microbial mat to remain on the floor of a lake, sedimentation rates must be high. This requires considerable rainfall or substantial groundwater discharge. Given that rainfall is not high in this region, it is likely that groundwater discharge is important in determining the distribution and occurrence of these algal mats.

Whilst the wetting and drying cycle of the lake as a result of rainfall and evaporation is unlikely to change if the current mining operations are expanded any decrease in the groundwater influence over the remainder of the lake may impact the algal mats adversely and affect the overall productivity of the system. This would be significant since these mats are the driving force for virtually all productivity in the lake.

Diatoms

Diatom populations are highly variable in nature, which was reflected in the results. The results did not reveal any unique taxa in Gypsum Lake. Most of the species observed in the samples for Gypsum Lake were common to salt lakes and were well represented in other lakes in the region. All the lakes in the region contained a diatom flora characteristic of coastal saline systems.

The composition of the diatom community is largely driven by water chemistry/hydrological cycle and as long as the current hydrological cycle of the unmined portion of the lake (including wetting/drying cycles, freshwater/groundwater inputs etc) is not altered significantly from the current situation, it is unlikely that there will be a significant change in diatom communities or extent due to the expansion of the mining lease.

Macroinvertebrates

The macroinvertebrate community of Gypsum Lake is dominated by copepods and ostracods, which were also the dominant taxa in the zooplankton samples. The diversity of Gypsum Lake is quite low, and no taxa unique to Gypsum Lake being recorded, the macroinvertebrate fauna of Gypsum Lake was similar to the large lake chain CSR03.

Based on the results I cannot foresee a significant loss in macroinvertebrates in Gypsum Lake or in a regional context if expansion to the mining lease were to proceed.

Zooplankton

Zooplankton composition was similar in most of the salt lakes in the region. The results did not reveal any unique taxa in Gypsum Lake or any taxa present in numbers significantly higher than in any of the other lakes. All of the species observed in the samples for Gypsum Lake were represented in other lakes in the region. The major taxa found were Copepods and Ostracods, both are seasonal, being able to repopulate after desiccation and exist in high numbers in most of the lakes sampled.

The composition of the macroinvertebrate community is largely driven by water chemistry/hydrological cycle and as long as the current hydrological cycle of the unmined portion of the lake (including wetting/drying cycles, freshwater/groundwater inputs etc) is not altered significantly from the current situation, it is unlikely that there will be a significant change in macroinvertebrate communities or extent due to the expansion of the mining lease.

Based on this sampling occasion where 8 sites (CSR03 was split into 2 lakes, site A above the causeway and site C below the causeway) were sampled in full during the wet cycle of the lakes it was found that Gypsum Lakes flora and fauna was not unique to the region with a high degree of replication in the lakes of the region. CSR03 and CSR06 are two lakes that closely resemble Gypsum Lake in both flora and fauna. Whilst being a fairly productive lake with extensive algal mats and a high zooplankton density Gypsum Lake in terms of the other lakes in the area is less diverse, and does not seem to hold any taxa unique to the area.

Gypsum Lakes flora and fauna are heavily reliant on the natural wetting and drying cycle and water chemistry of the lake. As long as the hydrological cycle of the lake is not altered by the mining process no foreseeable change in Gypsum Lakes flora and fauna communities can be seen as a result of the expansion of the mining lease.

Appendices

Appendix 1 – Physico-chemical data.

	Date	Time		Water Temp °C	Depth cm	Dissolved Oxygen %	Dissolved Oxygen mgL^{-1}	Ec mS/cm
CSR01A	14/09/2005	0735	Physico-Chemical Data (Water)	14.28	15	102.1	7.6	73.90
CSR01C	14/09/2005	1000		14.35	20	110.5	8.0	72.86
CSR02	12/09/2005	1045		16.40	20	154.7	12.8	41.37
CSR03A	12/09/2005	1330		24.10	5	129.5	8.7	72.50
CSR03C	12/09/2005	1600		20.00	60	144.4	10.1	67.79
CSR04	13/09/2005	1345		20.10	20	153.8	11.4	53.39
CSR05	4/11/2005	0900		21.50	4	24.3	1.6	80.00
CSR06	3/11/2005	1743		25.49	17	132.4	8.7	50.70
CSR07	13/09/2005	1030		15.84	20	115.3	9.2	53.57
CSR10	3/11/2005	1100		No Water Present				
CSR11	3/11/2005	1236						
CSR13	3/11/2005	1500		29.80	9	148.7	10.2	30.40

	Date	Time		Salinity ppt	Turbidity ntu	pH	ORP mV
CSR01A	14/09/2005	0735	Physico-Chemical Data (Water)	50.94	600.0	8.50	268
CSR01C	14/09/2005	1000		50.20	20.9	8.32	258
CSR02	12/09/2005	1045		26.50	17.0	9.79	307
CSR03A	12/09/2005	1330		49.94	44.7	8.16	240
CSR03C	12/09/2005	1600		46.17	9.7	8.33	236
CSR04	13/09/2005	1345		32.20	18.5	9.57	215
CSR05	4/11/2005	0900		60.00	Too Shallow	8.18	255
CSR06	3/11/2005	1743		33.33	6.5	9.94	199
CSR07	13/09/2005	1030		35.30	10.7	9.31	204
CSR10	3/11/2005	1100		No Water Present			
CSR11	3/11/2005	1236					
CSR13	3/11/2005	1500		18.87	15.4	9.27	282

Appendix 2 – Water chemistry data

	Date	Time		TDS g/L	Silicate µg.Si/L	Chloride mg/L	SO_4 mg/L
Reporting Limit				<0.05	<2	<1	<1
CSR01A	14/09/2005	0735	Nutrient-Chemical Data (Water)	59.4	4000	31000	6300
CSR01C	14/09/2005	1000		56.6	3000	30000	6100
CSR02	12/09/2005	1045		28.4	370	14000	3800
CSR03A	12/09/2005	1330		54.5	4800	29000	4800
CSR03C	12/09/2005	1600		48.2	8300	26000	4000
CSR04	13/09/2005	1345		37.1	720	20000	3300
CSR05	4/11/2005	0900		96.9	5200	54000	10000
CSR06	3/11/2005	1743		34.2	180	22000	5500
CSR07	13/09/2005	1030		36.8	460	20000	3500
CSR10	3/11/2005	1100		No Water Present			
CSR11	3/11/2005	1236					
CSR13	3/11/2005	1500		20.7	2400	11000	3800

	Date	Time		Ca mg/L	K mg/L	Mg mg/L	Na mg/L
Reporting Limit				<0.001	<0.05	<0.005	<0.05
CSR01A	14/09/2005	0735	Nutrient-Chemical Data (Water)	940	510	1200	10000
CSR01C	14/09/2005	1000		970	490	1200	10000
CSR02	12/09/2005	1045		540	260	630	4800
CSR03A	12/09/2005	1330		970	430	920	9700
CSR03C	12/09/2005	1600		870	360	800	9800
CSR04	13/09/2005	1345		600	320	850	6800
CSR05	4/11/2005	0900		1100	810	3100	23000
CSR06	3/11/2005	1743		560	440	1500	9100
CSR07	13/09/2005	1030		870	220	820	6500
CSR10	3/11/2005	1100		No Water Present			
CSR11	3/11/2005	1236					
CSR13	3/11/2005	1500		920	260	590	5300

	Date	Time		NP-TOC mg.C/L	NO2 µg.N/L	Ammonia µg.N/L	Ortho-P µg.p/L
Reporting Limit				<0.5	<2	<3	<2
CSR01A	14/09/2005	0735	Nutrient-Chemical Data (Water)	19	<2	28	8
CSR01C	14/09/2005	1000		18	<2	27	11
CSR02	12/09/2005	1045		22	<2	10	3
CSR03A	12/09/2005	1330		26	<2	20	8
CSR03C	12/09/2005	1600		15	<2	14	7
CSR04	13/09/2005	1345		18	<2	14	3
CSR05	4/11/2005	0900		63	3	43	17
CSR06	3/11/2005	1743		26	<2	12	6
CSR07	13/09/2005	1030		18	<2	28	3
CSR10	3/11/2005	1100		No Water Present			
CSR11	3/11/2005	1236					
CSR13	3/11/2005	1500		35	<2	9	4

	Date	Time		NO_3+NO_2 µg.N/L	Total-DP µg.P/L	Total-DN µg.N/L	Total-P µg.P/L
Reporting Limit				<2	<5	<50	<5
CSR01A	14/09/2005	0735	Nutrient-Chemical Data (Water)	9	14	1700	28
CSR01C	14/09/2005	1000		6	12	1500	21
CSR02	12/09/2005	1045		2	14	2200	23
CSR03A	12/09/2005	1330		6	14	2200	28
CSR03C	12/09/2005	1600		5	12	1200	19
CSR04	13/09/2005	1345		10	11	1100	14
CSR05	4/11/2005	0900		38	28	2300	42
CSR06	3/11/2005	1743		4	15	1900	16
CSR07	13/09/2005	1030		9	9	1600	42
CSR10	3/11/2005	1100		No Water Present			
CSR11	3/11/2005	1236					
CSR13	3/11/2005	1500		6	9	2600	11

	Date	Time		Total-N µg.N/L	Colour Gilvin 440nm	Chloro 'a' µg/L	Chloro 'b' µg/L
Reporting Limit				<50	<0.1	<0.1	<0.1
CSR01A	14/09/2005	0735	Nutrient-Chemical Data (Water)	1900	0.5	0.4	<0.1
CSR01C	14/09/2005	1000		1700	0.6	0.2	<0.1
CSR02	12/09/2005	1045		2200	1.7	0.1	<0.1
CSR03A	12/09/2005	1330		2400	1.1	5.3	<0.1
CSR03C	12/09/2005	1600		1200	0.3	0.3	<0.1
CSR04	13/09/2005	1345		1100	2.0	0.4	<0.1
CSR05	4/11/2005	0900		2500	7.7	0.9	0.7
CSR06	3/11/2005	1743		2000	0.7	0.2	0.2
CSR07	13/09/2005	1030		1700	1.3	<0.1	<0.1
CSR10	3/11/2005	1100		No Water Present			
CSR11	3/11/2005	1236					
CSR13	3/11/2005	1500		2800	2.0	0.8	0.4

	Date	Time		Chloro 'c' µg/L	Chlorophyll µg/L	Phaeophytin µg/L	TSS mg/L
Reporting Limit				<0.1	<0.1	<0.1	<5
CSR01A	14/09/2005	0735	Nutrient-Chemical Data (Water)	0.1	0.2	<0.1	38
CSR01C	14/09/2005	1000		<0.1	0.2	<0.1	26
CSR02	12/09/2005	1045		<0.1	0.1	<0.1	14
CSR03A	12/09/2005	1330		0.6	0.5	<0.1	124
CSR03C	12/09/2005	1600		<0.1	0.4	<0.1	19
CSR04	13/09/2005	1345		<0.1	0.4	<0.1	17
CSR05	4/11/2005	0900		1.1	<0.1	0.7	60.4
CSR06	3/11/2005	1743		0.4	<0.1	<0.1	6.4
CSR07	13/09/2005	1030		<0.1	0.1	<0.1	14
CSR10	3/11/2005	1100		No Water Present			
CSR11	3/11/2005	1236					
CSR13	3/11/2005	1500		0.9	<0.1	<0.1	12.5

	Date	Time		Carbonate mg/L	Bicarbonate mg/L	Total Alkalinity to pH 4.5 mg.$CaCO_3$/L
Reporting Limit				<1	<1	
CSR01A	14/09/2005	0735	Nutrient-Chemical Data (Water)	<1	130	100
CSR01C	14/09/2005	1000		<1	120	95
CSR02	12/09/2005	1045		48	<1	81
CSR03A	12/09/2005	1330		<1	110	86
CSR03C	12/09/2005	1600		8	110	100
CSR04	13/09/2005	1345		28	29	70
CSR05	4/11/2005	0900		<1	180	140
CSR06	3/11/2005	1743		54	23	110
CSR07	13/09/2005	1030		26	39	75
CSR10	3/11/2005	1100		No Water Present		
CSR11	3/11/2005	1236				
CSR13	3/11/2005	1500		7	16	25

Appendix 3 – Sediment chemistry data

	Date	Time		Ca mg/kg	K mg/kg	Mg mg/kg	Na mg/kg
Reporting Limit				<10	<5	<2	<10
CSR01A	14/09/2005	0735	Sediment Chemistry	280000	1100	22000	17000
CSR01C	14/09/2005	1000		330000	620	19000	9500
CSR02	12/09/2005	1045		310000	1300	43000	16000
CSR03A	12/09/2005	1330		410000	360	19000	8700
CSR03C	12/09/2005	1600		240000	1600	27000	37000
CSR04	13/09/2005	1345		170000	5100	13000	20000
CSR05	4/11/2005	0900		4500	22	1300	690
CSR06	3/11/2005	1743		5700	16	880	520
CSR07	13/09/2005	1030		340000	500	22000	8800
CSR10	3/11/2005	1100		5100	46	980	1100
CSR11	3/11/2005	1236		4300	41	1000	1300
CSR13	3/11/2005	1500		4800	20	710	370

	Date	Time		TKN mg.N/g	Total P mg.P/g	TOC % C	Chlorophyll mg
Reporting Limit				<0.1	<0.05	<0.4	<0.01
CSR01A	14/09/2005	0735	Sediment Chemistry	1.1	0.18	1.0	0.05
CSR01C	14/09/2005	1000		0.6	0.21	0.6	0.23
CSR02	12/09/2005	1045		4.2	0.64	3.6	0.05
CSR03A	12/09/2005	1330		0.2	0.29	<0.4	0.02
CSR03C	12/09/2005	1600		4.4	0.20	3.2	0.89
CSR04	13/09/2005	1345		2.4	0.40	1.7	<0.01
CSR05	4/11/2005	0900		0.5	0.12	<0.4	0.06
CSR06	3/11/2005	1743		0.8	0.31	<0.4	0.02
CSR07	13/09/2005	1030		0.4	0.27	<0.4	0.03
CSR10	3/11/2005	1100		1.7	0.18	1.2	0.17
CSR11	3/11/2005	1236		1.5	0.11	1.1	0.05
CSR13	3/11/2005	1500		1.7	0.11	1.5	0.05

	Date	Time		Phaeophytin mg	Chloro 'a' mg	Chloro 'b' mg	Chloro 'c' mg
Reporting Limit				<0.01	<0.01	<0.01	<0.01
CSR01A	14/09/2005	0735	Sediment Chemistry	0.04	0.09	<0.01	0.03
CSR01C	14/09/2005	1000		0.08	0.29	0.04	0.27
CSR02	12/09/2005	1045		0.06	0.10	0.03	0.08
CSR03A	12/09/2005	1330		<0.01	0.03	<0.01	0.01
CSR03C	12/09/2005	1600		<0.01	0.95	<0.01	<0.01
CSR04	13/09/2005	1345		0.18	0.13	<0.01	0.01
CSR05	4/11/2005	0900		<0.01	0.08	0.07	0.10
CSR06	3/11/2005	1743		0.01	0.04	0.01	0.03
CSR07	13/09/2005	1030		0.02	0.05	<0.01	0.03
CSR10	3/11/2005	1100		<0.01	0.18	0.24	0.32
CSR11	3/11/2005	1236		<0.01	0.04	0.06	0.11
CSR13	3/11/2005	1500		0.02	0.08	0.02	0.07

	Date	Time		% Loss on Ignition @ 550°C	% Loss on Ignition @ 1000°C	1:10 pH	1:10 Ec mS/cm
Reporting Limit							
CSR01A	14/09/2005	0735	Sediment Chemistry	18	16	8.2	5.8
CSR01C	14/09/2005	1000		12	25	8.4	4.8
CSR02	12/09/2005	1045		20	24	8.3	4.1
CSR03A	12/09/2005	1330		5	38	9.2	2.3
CSR03C	12/09/2005	1600		21	20	7.8	9.8
CSR04	13/09/2005	1345		19	12	8.2	4.7
CSR05	4/11/2005	0900		9	22	9.0	4.6
CSR06	3/11/2005	1743		6	34	8.8	2.6
CSR07	13/09/2005	1030		5	31	9.1	2.4
CSR10	3/11/2005	1100		16	21	8.4	9.3
CSR11	3/11/2005	1236		11	21	7.8	3.9
CSR13	3/11/2005	1500		19	13	8.3	10.5

	Date	Time		1:10 Chloride mg/L	Extractable Chloride mg/g Dry Weight	1:10 SO_4 mg/L	Extractable Sulphate mg/g Dry Weight
Reporting Limit				<1		<1	
CSR01A	14/09/2005	0735	Sediment Chemistry	1000	17.0	1700	28.0
CSR01C	14/09/2005	1000		740	10.0	1600	21.0
CSR02	12/09/2005	1045		800	16.0	1000	20.0
CSR03A	12/09/2005	1330		610	7.8	120	1.5
CSR03C	12/09/2005	1600		2600	54.0	2200	46.0
CSR04	13/09/2005	1345		1200	25.0	550	12.0
CSR05	4/11/2005	0900		1400	19.0	300	4.0
CSR06	3/11/2005	1743		660	9.0	250	3.0
CSR07	13/09/2005	1030		630	8.4	140	1.9
CSR10	3/11/2005	1100		3200	52.5	360	5.9
CSR11	3/11/2005	1236		470	6.0	1600	22.0
CSR13	3/11/2005	1500		2700	37.0	2400	32.0

	Date	Time		1:10 Ammonia µg.N/L	1:10 Ortho-P µg.P/L	1:10 NO_3+NO_2 µg.N/L	Extractable Ammonia µg/g Dry Weight
Reporting Limit				<3	<2	<2	
CSR01A	14/09/2005	0735	Sediment Chemistry	200	3	3	3.40
CSR01C	14/09/2005	1000		250	3	5	3.40
CSR02	12/09/2005	1045		570	22	10	11.00
CSR03A	12/09/2005	1330		85	3	<2	1.10
CSR03C	12/09/2005	1600		700	38	9	15.00
CSR04	13/09/2005	1345		200	11	3	4.30
CSR05	4/11/2005	0900		83	3	10	1.10
CSR06	3/11/2005	1743		<3	3	3	<0.04
CSR07	13/09/2005	1030		160	3	2	2.10
CSR10	3/11/2005	1100		48	3	91	0.79
CSR11	3/11/2005	1236		7	6	6	0.10
CSR13	3/11/2005	1500		6	3	93	0.07

	Date	Time		Extractable Ortho-P µg/g Dry Weight	Extractable NO_3+NO_2 µg/g Dry Weight	Carbonate mg/L	Bicarbonate mg/L
Reporting Limit						<1	<1
CSR01A	14/09/2005	0735	Sediment Chemistry	0.05	0.05	6	37
CSR01C	14/09/2005	1000		0.04	0.06	<1	28
CSR02	12/09/2005	1045		0.44	0.20	<1	57
CSR03A	12/09/2005	1330		0.03	0.02	2	25
CSR03C	12/09/2005	1600		0.80	0.18	9	71
CSR04	13/09/2005	1345		0.22	0.06	<1	78
CSR05	4/11/2005	0900		0.04	0.14	6	35
CSR06	3/11/2005	1743		0.03	0.05	2	52
CSR07	13/09/2005	1030		0.04	0.03	<1	39
CSR10	3/11/2005	1100		0.05	1.50	<1	39
CSR11	3/11/2005	1236		0.07	0.07	<1	63
CSR13	3/11/2005	1500		0.04	1.20	<1	61

Appendix 4 – Phytoplankton data

PHYTOPLANKTON Relative Abundance Data Sheet

Sample	CSRO1A	CSR01C	CSR02	CSRO3A	CSRO3C	CSR04	CSR05	CSR06	CSRO7	CSR13
Sample Type	Phyto	Phyto	Phyto	Phyto	Phyto	Phyto	Phyto	Phyto	Phyto	Phyto
Collection Date	14/09/05	14/09/05	12/09/05	12/09/05	12/09/05	13/09/05	04/11/05	03/11/05	13/09/05	03/11/05
Taxon										
Bacillariophyceae (Diatoms)	**7.37%**	**7.14%**	**27.14%**	**96.54%**	**21.74%**	**9.06%**	**20.00%**	**3.59%**	**7.35%**	**1.97%**
Amphora coffaeaformis	2.11%	0.79%				0.32%	3.48%		0.89%	0.79%
Amphora sp. 011		0.79%	1.43%		1.09%	0.65%	0.43%	0.60%	0.67%	
Amphora sp. 012	1.05%			78.61%	14.13%				0.89%	
Amphora sp. 013			14.29%			0.65%	0.87%		1.34%	
Cocconeis sp. 001									0.67%	
Diatom 001		0.40%								
Diatom 002		0.40%								
Diatom 003				3.24%	3.26%					
Diatom 004				12.78%	3.26%					
Diatom 005	1.05%	1.19%	1.43%	1.90%		0.32%			1.56%	
Diatom 006								0.60%		
Cylindrotheca closterium	1.05%	0.40%					0.43%			
Entomoneis sp. 002						0.65%	0.43%		0.22%	
Hantzschia sp. 001							0.43%			0.20%
Navicula sp.	1.05%	0.79%					0.87%			
Navicula sp. 010	1.05%		4.29%				0.43%		0.22%	0.20%
Navicula sp. 011			1.43%				0.43%			
Navicula sp. 012								2.40%	0.22%	
Navicula sp. 013									0.22%	
Navicula sp. 014			1.43%			0.32%	1.30%			0.79%
Nitzschia sp. 002			1.43%						0.22%	
Nitzschia sp. 003		0.79%								
Pleurosigma sp. 001		0.40%				1.29%	10.87%		0.22%	
Rhopalodia sp. 001		1.19%	1.43%			4.85%				
Chlorophyceae (Green Algae)	**27.37%**	**34.92%**	**21.43%**		**9.78%**	**11.97%**		**13.77%**	**24.94%**	**3.35%**
Chlorophyte 001										2.36%
Chlorophyte 002			17.14%		1.09%					
Chlorophyte 003	10.53%	3.97%				11.97%		2.40%	24.94%	0.98%
Cladophora sp.								X		
Oocystis sp. 001	16.84%	30.95%	4.29%		8.70%			11.38%		
Cryptophyceae (Cryptomonads)	**1.05%**	**1.59%**				**0.32%**	**3.04%**	**17.37%**	**15.81%**	
Cryptomonas sp. 001	1.05%						0.87%	0.60%	12.03%	
Cryptomonas sp. 002		1.59%				0.32%	2.17%	16.77%	3.79%	
Dinophyceae (Dinoflagellates)				**0.04%**	**2.17%**					**11.42%**
Peridinium sp. 007				0.04%	2.17%					11.42%
Cyanobacteria (Blue-Green)	**58.95%**	**37.30%**	**51.43%**	**3.43%**	**66.30%**	**78.64%**	**76.96%**	**56.29%**	**51.89%**	**83.27%**
Anabaena sp. 001			31.43%			17.15%				
Aphanothece sp. 001						9.06%				
Chroococcus sp. 002		1.59%						2.40%		
Chroococcus sp. 003			12.86%							
Chroococcus sp. 006								1.20%		
Chroococcus sp. 007								1.20%		
Chroococcus sp. 009									0.45%	
Chroococcus sp. 010										47.44%
Coccoid Cyanobacteria 002		6.75%			16.30%		1.74%	7.19%	0.89%	
Coccoid Cyanobacteria 005	13.68%					3.88%		21.56%	12.92%	
Filamentous Cyanobacteria 008	3.16%			0.19%	6.52%	2.59%	3.91%		1.11%	0.59%
Filamentous Cyanobacteria 012							0.87%		0.22%	
Filamentous Cyanobacteria 013				3.17%	20.65%					9.45%
Lyngbya sp. 001			1.43%	0.04%						
Oscillatoria sp. 001 (t)						0.32%			0.22%	
Phormidium sp. 001 (t)	1.05%									
Spirulina sp. 001			5.71%	0.04%						
Synechococcus sp. 002										0.39%
Synechocystis sp. 002	41.05%	28.97%			22.83%	45.63%	70.43%	22.75%	36.08%	25.39%
Unidentified Algae	**5.26%**	**19.05%**						**8.98%**		
Flagellate 004	3.16%	2.38%								
Flagellate 005		13.49%						8.98%		
Unknown 004		3.17%								
Unknown 005	2.11%									

Key - [X] specimen hand collected from the lake, not recorded in the net tow sample. Note: this is a qualitative analysis only, percentages given are relative abundance only.

MACROPHYTES Presence/Absence Data Sheet

Sample	CSRO1A	CSR01C	CSR02	CSRO3A	CSRO3C	CSR04	CSR05	CSR06	CSRO7	CSR13
Sample Type	M. Phytes	M. Phytes	M. Phytes	M. Phytes	M. Phytes	M. Phytes	M. Phytes	M. Phytes	M. Phytes	M. Phytes
Collection Date	14/09/05	14/09/05	12/09/05	12/09/05	12/09/05	13/09/05	04/11/05	03/11/05	13/09/05	03/11/05
Taxon										
Charaphytes (Stoneworts)										
Lamprothamium sp. 001						1				
Lamprothamium sp. 002										1
Lamprothamium sp. 003								1		
Angiosperms (Flowering Plants)										
Lepilaena preissii	1	1	1	1	1	1	1	1	1	1
Lepilaena sp.	1	1						1		
Ruppia sp.						1				

Key - [1] present. Note: this is a qualitative analysis only.

Appendix 6 – Benthic algal mat data

ALGAL MAT Presence/Absence Data Sheet

Sample	CSRO1A	CSRO1A	CSRO1C	CSRO1C	CSR02
Algal Mat Description	1-Pink/Grey Benthic	2-Grey Benthic	1-Pink/Grey Benthic	2-Pink/Grey/Black Benthic	1 -Pink/Grey Benthic
Sample Type	Algal Mats	Algal Mats	Algal Mats	Algal Mats	Algal Mats
Collection Date	14/09/05	14/09/05	14/09/05	14/09/05	12/09/05
Taxon					
Bacillariophyceae (Diatoms)					
Amphora sp. 012			1		
Amphora spp.		1			
Cocconeis sp. 001					
Cylindrotheca closterium					
Diatom 002				1	
Hantzschia sp. 001					
Mastogloia spp.				1	
Navicula sp. 010					1
Navicula sp. 011			2	1	
Navicula spp.		1			
Nitzschia spp.		1			
Pleurosigma sp. 001					
Rhopalodia sp. 001					
Chlorophyceae (Green Algae)					
Chlorophyte 001					
Chlorophyte 004					
Oocystis sp. 001					
Cyanobacteria (Blue-Green Algae)					
Chroococcus sp. 002					
Chroococcus sp. 004			1		
Chroococcus sp. 005					
Chroococcus sp. 007		1			
Chroococcus sp. 009					1
Chroococcus sp. 011					
Coccoid Cyanobacteria 002		1	1	1	
Coccoid Cyanobacteria 004					
Coccoid Cyanobacteria 006					1
Cyanobacteria 001					2
Filamentous Cyanobacteria 001					1
Filamentous Cyanobacteria 002	1				1
Filamentous Cyanobacteria 003	1	1			
Filamentous Cyanobacteria 006		1	1		
Filamentous Cyanobacteria 008					
Filamentous Cyanobacteria 010			1		1
Filamentous Cyanobacteria 013					
Filamentous Cyanobacteria 014					
Filamentous Cyanobacteria 015					
Lyngbya sp. 001					
Microcoleus chthonoplastes	2	2		1	
Nostoc sp. 001					
Oscillatoria sp. 001		1		2	

Key - [1] present, [2] dominant. Note: this is a qualitative analysis only.

ALGAL MAT Presence/Absence Data Sheet

Sample	CSR02	CSR02	CSR03A	CSR03A	CSR03A
Algal Mat Description	2-Black Benthic	3-Pink/ Grey Benthic	Pink Green Slime	1-Black/Green Benthic	2-Pink Raised Benthic
Sample Type	Algal Mats	Algal Mats	Floating Scum	Algal Mats	Algal Mats
Collection Date	12/09/05	12/09/05	04/11/05	03/11/05	13/09/05
Taxon					
Bacillariophyceae (Diatoms)					
Amphora sp. 012					
Amphora spp.	1	1	2	2	1
Cocconeis sp. 001					
Cylindrotheca closterium					
Diatom 002					
Hantzschia sp. 001				1	
Mastogloia spp.					
Navicula sp. 010	1	1			
Navicula sp. 011				1	1
Navicula spp.					
Nitzschia spp.				1	1
Pleurosigma sp. 001					
Rhopalodia sp. 001					
Chlorophyceae (Green Algae)					
Chlorophyte 001					
Chlorophyte 004					
Oocystis sp. 001					
Cyanobacteria (Blue-Green Algae)					
Chroococcus sp. 002					
Chroococcus sp. 004					
Chroococcus sp. 005					
Chroococcus sp. 007					
Chroococcus sp. 009		1			
Chroococcus sp. 011	1				
Coccoid Cyanobacteria 002	1	1			
Coccoid Cyanobacteria 004	1	1			
Coccoid Cyanobacteria 006					
Cyanobacteria 001	2	1			
Filamentous Cyanobacteria 001				1	
Filamentous Cyanobacteria 002					
Filamentous Cyanobacteria 003					
Filamentous Cyanobacteria 006					
Filamentous Cyanobacteria 008		1			
Filamentous Cyanobacteria 010	1	1			
Filamentous Cyanobacteria 013			1	1	
Filamentous Cyanobacteria 014			1		
Filamentous Cyanobacteria 015				1	1
Lyngbya sp. 001					
Microcoleus chthonoplastes		2		2	2
Nostoc sp. 001					
Oscillatoria sp. 001					

Key - [1] present, [2] dominant. Note: this is a qualitative analysis only.

ALGAL MAT Presence/Absence Data Sheet

Sample	CSR03C	CSRO4	CSR05	CSR06	CSR06
Algal Mat Description	Pink/Grey Benthic	Slimy Black Benthic	Slimy Black Benthic	1-Slimy Black Benthic	2-Pink/Grey/Black Benthic
Sample Type	Algal Mats	Algal Mats	Algal Mats	Algal Mats	Algal Mats
Collection Date	13/09/05	12/09/05	04/11/05	12/09/05	12/09/05
Taxon					
Bacillariophyceae (Diatoms)					
Amphora sp. 012					
Amphora spp.	1	1			
Cocconeis sp. 001					
Cylindrotheca closterium					2
Diatom 002					
Hantzschia sp. 001					
Mastogloia spp.					
Navicula sp. 010					
Navicula sp. 011			1		1
Navicula spp.		1			
Nitzschia spp.					1
Pleurosigma sp. 001		1			
Rhopalodia sp. 001		1			
Chlorophyceae (Green Algae)					
Chlorophyte 001					
Chlorophyte 004				1	
Oocystis sp. 001				1	
Cyanobacteria (Blue-Green Algae)					
Chroococcus sp. 002					2
Chroococcus sp. 004					
Chroococcus sp. 005					1
Chroococcus sp. 007					
Chroococcus sp. 009					1
Chroococcus sp. 011					
Coccoid Cyanobacteria 002	1				1
Coccoid Cyanobacteria 004					
Coccoid Cyanobacteria 006					
Cyanobacteria 001					
Filamentous Cyanobacteria 001				1	
Filamentous Cyanobacteria 002					
Filamentous Cyanobacteria 003					
Filamentous Cyanobacteria 006					
Filamentous Cyanobacteria 008			1	1	
Filamentous Cyanobacteria 010					
Filamentous Cyanobacteria 013					
Filamentous Cyanobacteria 014		2			
Filamentous Cyanobacteria 015					
Lyngbya sp. 001		1			
Microcoleus chthonoplastes					
Nostoc sp. 001			2	2	
Oscillatoria sp. 001	1				

Key - [1] present, [2] dominant. Note: this is a qualitative analysis only.

ALGAL MAT Presence/Absence Data Sheet

Sample	CSR010	CSR011	CSR011	CSR13
Algal Mat Description	Grey/Black Benthic	1-Pustular/Black Benthic	2-Crusty Black/Grey Benthic	Pink/Black Benthic
Sample Type	Algal Mats	Algal Mats	Algal Mats	Algal Mats
Collection Date	13/09/05	03/11/05	03/11/05	03/11/05
Taxon				
Bacillariophyceae (Diatoms)				
Amphora sp. 012				
Amphora spp.			1	1
Cocconeis sp. 001				1
Cylindrotheca closterium				
Diatom 002				
Hantzschia sp. 001				
Mastogloia spp.		1		
Navicula sp. 010	1		1	
Navicula sp. 011				1
Navicula spp.				
Nitzschia spp.				
Pleurosigma sp. 001				
Rhopalodia sp. 001				
Chlorophyceae (Green Algae)				
Chlorophyte 001				1
Chlorophyte 004				
Oocystis sp. 001				
Cyanobacteria (Blue-Green Algae)				
Chroococcus sp. 002				
Chroococcus sp. 004				
Chroococcus sp. 005				
Chroococcus sp. 007				
Chroococcus sp. 009	1	2	2	
Chroococcus sp. 011		1		
Coccoid Cyanobacteria 002	2	1	1	2
Coccoid Cyanobacteria 004				
Coccoid Cyanobacteria 006		1		
Cyanobacteria 001	1	1	1	
Filamentous Cyanobacteria 001				
Filamentous Cyanobacteria 002				
Filamentous Cyanobacteria 003				
Filamentous Cyanobacteria 006				1
Filamentous Cyanobacteria 008	1			
Filamentous Cyanobacteria 010				
Filamentous Cyanobacteria 013	1			
Filamentous Cyanobacteria 014				
Filamentous Cyanobacteria 015				
Lyngbya sp. 001				
Microcoleus chthonoplastes				
Nostoc sp. 001				
Oscillatoria sp. 001		1		

Key - [1] present, [2] dominant. Note: this is a qualitative analysis only.

Appendix 7 – Diatom data

DIATOM Relative Abundance Data Sheet

Sample	CSRO1A	CSRO1A	CSR01C	CSR01C	CSR02	CSR02	CSR02	CSRO3A	CSRO3A	CSRO3C
Sample Type	1-Algal Mat	2-Algal Mat	1-Algal Mat	2-Algal Mat	1-Algal Mat	2-Algal Mat	3-Algal Mat	1-Algal Mat	2-Algal Mat	Algal Mat
Collection Date	14/09/05	14/09/05	14/09/05	14/09/05	12/09/05	12/09/05	12/09/05	12/09/05	12/09/05	12/09/05
Taxon										
Bacillariophyceae (Diatoms)										
Amphora coffaeaformis	14.00%	4.14%	0.08%		3.93%	6.63%	6.06%	25.11%	7.10%	
Amphora sp. 011	3.33%		0.41%	0.44%	0.11%	2.04%	68.17%		0.22%	0.35%
Amphora sp. 013					0.11%		0.13%	0.15%		
Amphora sp. 014										
Amphora sp. 015										
Amphora veneta					24.94%	0.51%				
Amphora ventricosa					7.42%	40.31%	10.70%	11.74%	27.31%	4.68%
Brachysira serians										
Cocconeis sp. 001					7.42%					
Cyclotella meneghiniana					0.22%		0.13%		0.22%	0.09%
Diploneis ovalis				0.44%						
Entomoneis sp. 005										
Eunotia exigua										
Eunotia pectinalis										
Fragilaria sp. 001										
Fragilaria sp. 002	0.67%									
Gyrosigma sp. 001										
Hantzschia sp. 001			0.14%			0.51%	0.13%			
Mastogloia sp. 001			0.02%	10.13%				4.01%	0.22%	0.17%
Mastogloia sp. 003			0.03%							2.69%
Mastogloia sp. 005		3.25%								3.90%
Mastogloia sp. 006			2.53%	0.44%				0.15%		0.09%
Mastogloia sp. 007			0.12%							2.86%
Mastogloia sp. 008			34.61%							1.13%
Navicula cincta	82.00%	92.60%	61.17%	87.67%	55.84%	50.00%	14.56%	43.09%	60.00%	69.84%
Navicula elegans				0.44%			0.13%			
Navicula sp. 012									0.22%	0.09%
Nitzschia sp. 003								2.23%	0.22%	0.09%
Rhopalodia sp. 001			0.90%	0.44%						
Stauroneis pachycephala										
Synedra sp. 002								13.52%	4.52%	14.04%
Synedra sp. 003										
RICHNESS	**4**	**3**	**10**	**7**	**8**	**6**	**8**	**8**	**9**	**13**
(total)	**5**		**11**		**10**			**11**		**13**
DIVERSITY	**0.2540**	**0.1366**	**0.3701**	**0.2028**	**0.5271**	**0.4456**	**0.4278**	**0.6362**	**0.4580**	**0.4780**
(average)	**0.1953**		**0.2864**		**0.4668**			**0.5471**		**0.478**

Note: this is a qualitative analysis only, percentages given are relative abundance only.

DIATOM Relative Abundance Data Sheet

Sample	CSR04	CSR04	CSR05	CSR05	CSR06	CSR06	CSR06	CSRO7	CSR010	CSR010
Sample Type	Algal Mat	Diatom Sediment	Algal Mat	Diatom Sediment	1-Algal Mat	2-Algal Mat	Diatom Sediment	Diatom Sediment	Algal Mat	Diatom Sediment
Collection Date	13/09/05	13/09/05	04/11/05	04/11/05	03/11/05	03/11/05	03/11/05	13/09/05	03/11/05	03/11/05
Taxon										
Bacillariophyceae (Diatoms)										
Amphora coffaeaformis	4.79%	16.49%	15.78%	20.62%	6.01%	56.06%	5.92%		0.11%	2.33%
Amphora sp. 011	0.25%	0.13%	0.41%	1.03%	2.46%	4.04%			0.15%	
Amphora sp. 013	0.25%	0.03%	0.20%		2.24%				0.04%	
Amphora sp. 014						0.17%				
Amphora sp. 015									0.04%	
Amphora veneta							0.35%			13.95%
Amphora ventricosa	55.92%	10.58%	59.43%	26.80%	69.97%	22.90%		92.96%	35.98%	2.33%
Brachysira serians					0.07%				0.04%	
Cocconeis sp. 001	3.02%	49.50%			9.33%	0.17%	12.54%	1.41%	0.04%	
Cyclotella meneghiniana	0.50%		0.61%		4.92%		5.92%			
Diploneis ovalis										
Entomoneis sp. 005									0.07%	
Eunotia exigua					0.07%					
Eunotia pectinalis	0.50%									
Fragilaria sp. 001		0.10%							52.61%	
Fragilaria sp. 002									0.76%	
Gyrosigma sp. 001		0.20%		4.12%					0.04%	
Hantzschia sp. 001	0.50%	0.07%	0.61%	1.03%			6.97%		0.04%	
Mastogloia sp. 001										
Mastogloia sp. 003										
Mastogloia sp. 005										
Mastogloia sp. 006										
Mastogloia sp. 007										
Mastogloia sp. 008										
Navicula elegans					0.07%			5.63%		27.91%
Navicula sp. 001	33.50%	22.46%	22.75%	37.11%	4.78%	16.50%	62.37%		10.02%	53.49%
Navicula sp. 012	0.25%	0.03%	0.20%	9.28%		0.17%	5.57%		0.04%	
Nitzschia sp. 003							0.35%			
Rhopalodia sp. 001		0.40%								
Stauroneis pachycephala	0.25%				0.07%					
Synedra sp. 002	0.25%									
Synedra sp. 003									0.04%	
RICHNESS	**12**	**11**	**8**	**7**	**11**	**7**	**8**	**3**	**15**	**5**
(total)	**15**		**9**		**15**			**3**	**17**	
DIVERSITY	**0.4768**	**0.5553**	**0.4551**	**0.6483**	**0.4911**	**0.4869**	**0.5540**	**0.1259**	**0.4424**	**0.4954**
(average)	**0.5161**		**0.5517**		**0.5107**			**0.1259**	**0.4689**	

Note: this is a qualitative analysis only, percentages given are relative abundance only.

DIATOM Relative Abundance Data Sheet

Sample	CSR11	CSR11	CSR11	CSR13	CSR13
Sample Type	1-Algal Mat	2-Algal Mat	Diatom Sediment	1-Algal Mat	Diatom Sediment
Collection Date	03/11/05	03/11/05	03/11/05	03/11/05	03/11/05
Taxon					
Bacillariophyceae (Diatoms)					
Amphora coffaeaformis	1.90%	7.14%		0.27%	
Amphora sp. 011					0.13%
Amphora sp. 013			8.33%		0.13%
Amphora sp. 014					0.13%
Amphora sp. 015	5.71%			99.19%	0.51%
Amphora veneta			8.33%		
Amphora ventricosa				0.54%	84.02%
Brachysira serians					
Cocconeis sp. 001					
Cyclotella meneghiniana					
Diploneis ovalis					
Entomoneis sp. 005					0.13%
Eunotia exigua					
Eunotia pectinalis					
Fragilaria sp. 001					0.26%
Fragilaria sp. 002					
Gyrosigma sp. 001					0.38%
Hantzschia sp. 001	0.95%		8.33%		
Mastogloia sp. 001					
Mastogloia sp. 003					
Mastogloia sp. 005					
Mastogloia sp. 006					
Mastogloia sp. 007					
Mastogloia sp. 008					
Navicula cincta	90.48%	92.86%	75.00%		14.19%
Navicula elegans					
Navicula sp. 012					0.13%
Nitzschia sp. 003					
Rhopalodia sp. 001	0.95%				
Stauroneis pachycephala					
Synedra sp. 002					
Synedra sp. 003					
RICHNESS	**5**	**2**	**4**	**3**	**10**
(total)		**7**		**11**	
DIVERSITY	**0.1816**	**0.1118**	**0.3635**	**0.0228**	**0.2300**
(average)		**0.2190**		**0.1264**	

Note: this is a qualitative analysis only, percentages given are relative abundance only.

Appendix 8 – Macroinvertebrate data

MACROINVERTEBRATE Presence/Absence Data Sheet

Sample	CSR01A	CSR01C	CSR02	CSR03A	CSR03C	CSR04	CSR05	CSR06	CSR07	CSR13
Sample Type	Benthic M-Invert	Benthic M-Invert	Benthic M-Invert	Benthic M-Invert	Benthic M-Invert	Benthic M-Invert	Benthic M-Invert	Benthic M-Invert	Benthic M-Invert	Benthic M-Invert
Collection Date	14/09/05	14/09/05	12/09/05	12/09/05	12/09/05	13/09/05	04/11/05	03/11/05	13/09/05	03/11/05
Taxon										
Zygoptera (Damselflies)										
Austrolestes annulosus										1
Coleoptera (Beetles)										
Berosus sp. 001 (larvae)			1				1	1	1	1
Berosus sp. 002 (adult)			1						1	1
Coleoptera 001 (adult)										1
Haliplus sp. 001 (larvae)										1
Rhantus sp. 001 (adult)										1
Hemiptera (True Bugs)										
Hemipteran 001	1									
Diptera (True Flies)										
Aedes sp. 001			1			1				
Ceratopogonidae 001		1		1	1	1		1		1
Diptera 001	1	1	1	1						
Mosquito Pupa 001	1								1	
Mosquito Pupa 002									1	
Polypedilum nubifer		1	1	1	2	1		1	1	1
Procladius paludicola			1	1		1	1	1	1	
Stratiomyidae 001			1			1				
Tabanidae 001	1				1					
Tabanidae 002			1			1				1
Copepoda (Copepods)										
Calomoecia clittellata	3	3	2		1	3	1	3	3	1
Harpacticoid 001		2			1			3	1	1
Microcyclops sp. 001	1	1			1				1	
Cladocera (Water Fleas)										
Daphniopsis sp. 001	2	3	1		1	3		2	2	
Amphipoda (Scuds)										
Amphipod 005	1									
Austrochiltonia sp. 001			1			3		1		3
Isopoda (Water Slaters)										
Haloniscus searlei		1	1		1	2	1	1	1	1
Ostracoda (Seed Shrimp)										
Diacypris sp. 001	3	3	3	1	3	3	3	2	3	1
Platycypris baueri	3	3	1	1	3	2	1	3	2	
Australocypris insularis	2		1	1	2		1		2	1
Australocypris robusta		2	1	1	1	3			1	
Cyprinotus edwardi	1	1	1		1					3
Mytilocypris mytilodies						1				1
Gastropoda (Snails)										
Cochlicella barbara		1			1					
Coxiella sp. 001	2	3	2	2	3	1	2	2	2	1
Coxiella sp. 002	1	1	1		1	3	1	1	2	1
Foraminifera (Forams)										
Globorotalia sp. 001	2	2	1		2	1	3		1	2
Foraminifera 002	1	1			1					
Foraminifera 003					1					
Foraminifera 004								1		
Polychaeta (Bristleworms)										
Sabellidae 001	1	1			2	2	2	2	2	2
Nematoda (Round Worm)										
Nematode 001							1			1
Epiproctophora (Dragonflies)										
Hemianax papuensis										1
Oligochaeta (Segmented Worm)										
Megadrile 001		1	1	1	1	1	1	1	2	1
Lepidoptera (Aquatic Catepillars)										
Nymphulinae 001										1
Trichoptera (Caddisflies)										
Trichoptera 001										1
Anostraca (Brine Shrimp)										
Parartemia extracta									1	
Fish										
Fish 001					1					

Key - [1] animals present <100, [2] animals present 100-1000, [3] animals present > 1000. Animals highlighted red represent the dominant taxa present.
Note: this is a qualitative analysis only.

Appendix 9 – Zooplankton data

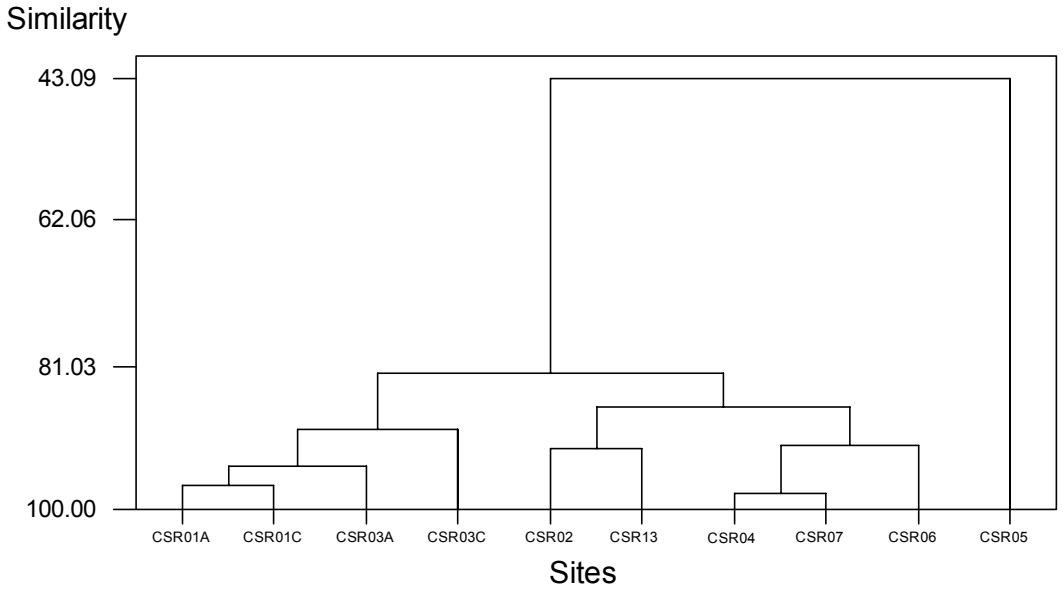
ZOOPLANKTON Relative Density Data Sheet

Sample	CSR01A	CSR01C	CSR02	CSR03A	CSR03C	CSR04	CSR05	CSR06	CSR07	CSR13
Sample Type	Zoop	Zoop	Zoop	Zoop	Zoop	Zoop	Zoop	Zoop	Zoop	Zoop
Collection Date	14/09/05	14/09/05	12/09/05	12/09/05	12/09/05	13/09/05	04/11/05	03/11/05	13/09/05	03/11/05
Taxon										
Zygoptera (Damselflies)										**0.21%**
Austrolestes annulosus										0.21%
Coleoptera (Beetles)			**0.01%**			**0.01%**				
Berosus sp. 002 (adult)			0.01%			0.01%				
Hemiptera (True Bugs)				**0.40%**						
Hemipteran 001				0.40%						
Diptera (True Flies)						**0.03%**	**0.06%**	**0.02%**	**0.01%**	**0.31%**
Mosquito larvae 001						0.01%				
Mosquito pupa 001							0.04%	0.01%	0.01%	
Procladius paludicola							0.02%	0.01%		0.31%
Stratiomyidae 001						0.01%				
Copepoda (Copepods)	**85.39%**	**88.56%**	**10.62%**	**3.21%**	**6.17%**	**40.85%**	**17.72%**	**76.54%**	**34.17%**	**4.06%**
Calomoecia clittellata	83.16%	84.67%	3.05%	2.41%	1.23%	37.16%	14.86%	73.58%	30.49%	3.02%
Copepod Nauplii 001	1.86%	3.67%	1.21%			0.01%			0.46%	
Copepod Nauplii 002			1.38%	0.40%		1.91%		0.01%	0.62%	0.21%
Cyclopoid 001						0.03%				
Harpacticoid 001	0.24%		4.32%	0.40%	4.94%	1.08%	2.86%	2.91%	2.28%	0.63%
Harpacticoid 002						0.28%				
Microcyclops sp. 001	0.13%	0.22%	0.66%			0.39%		0.04%	0.32%	0.21%
Cladocera (Water Fleas)	**2.69%**	**9.35%**	**4.42%**	**0.80%**		**14.69%**	**0.02%**	**7.07%**	**6.68%**	
Daphniopsis sp. 001	2.69%	9.35%	4.42%	0.80%		14.69%	0.02%	7.07%	6.68%	
Amphipoda (Scuds)						**1.03%**				**8.65%**
Austrochiltonia sp. 001						1.03%				8.65%
Isopoda (Water Slaters)						**0.02%**	**0.04%**			**0.10%**
Haloniscus searlei						0.02%	0.04%			0.10%
Ostracoda (Seed Shrimp)	**11.79%**	**2.09%**	**84.89%**	**95.18%**	**75.31%**	**40.16%**	**81.79%**	**16.06%**	**35.49%**	**26.88%**
Diacypris sp. 001	10.89%	1.92%	84.38%	52.61%	56.79%	39.90%	80.16%	15.49%	34.81%	12.19%
Platycypris baueri	0.69%	0.15%	0.25%	40.96%	12.35%	0.06%	1.61%	0.45%	0.51%	0.21%
Australocypris insularis	0.20%	0.02%	0.23%	1.61%	6.17%	0.18%		0.12%	0.12%	
Austrolocyprius robusta			0.02%			0.03%	0.02%		0.05%	
Cyprinotus edwardi										14.48%
Gastropoda (Snails)		**0.01%**	**0.06%**		**3.70%**	**2.52%**	**0.06%**	**0.22%**	**23.59%**	**10.42%**
Coxiella sp. 001		0.01%				0.03%	0.04%			0.83%
Coxiella sp. 002			0.06%		3.70%	2.49%	0.02%	0.22%	23.59%	9.58%
Foraminifera (Forams)					**12.35%**	**0.53%**	**0.31%**	**0.08%**		**6.15%**
Globorotalia sp. 001					12.35%	0.53%	0.31%	0.08%		6.15%
Polychaeta (Bristleworms)					**2.47%**	**0.03%**	**0.02%**			**0.10%**
Sabellidae 001					2.47%	0.03%	0.02%			0.10%
Rotifera (Wheel Animalcules)	**0.13%**		**0.01%**			**0.15%**			**0.05%**	**42.92%**
Rotifer 001	0.13%		0.01%			0.15%			0.05%	42.92%

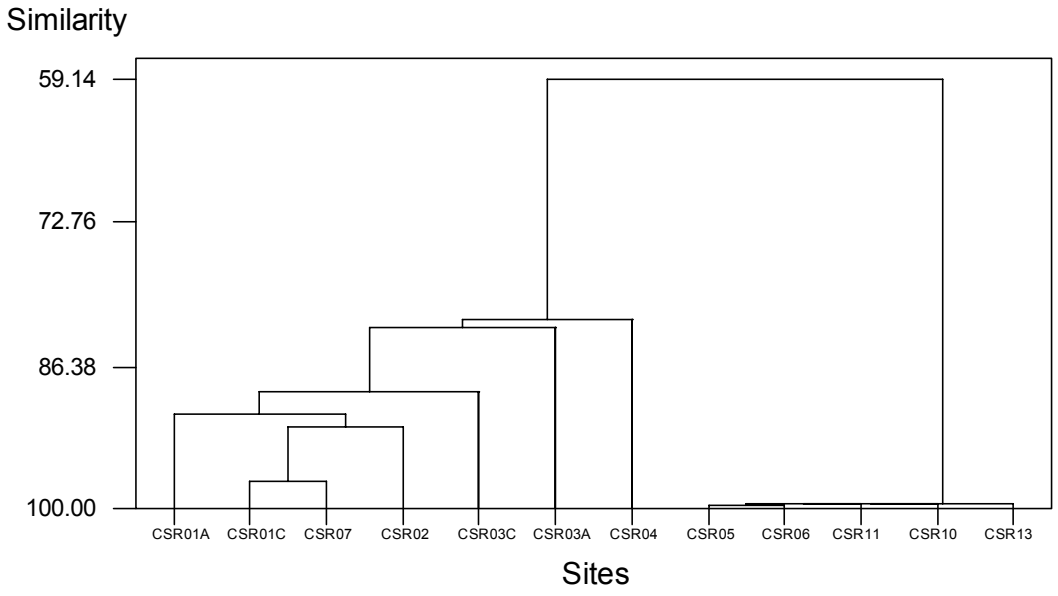
Note: this is a qualitative analysis only, percentages given are relative abundance only.

Appendix 10 - Cluster Analysis results

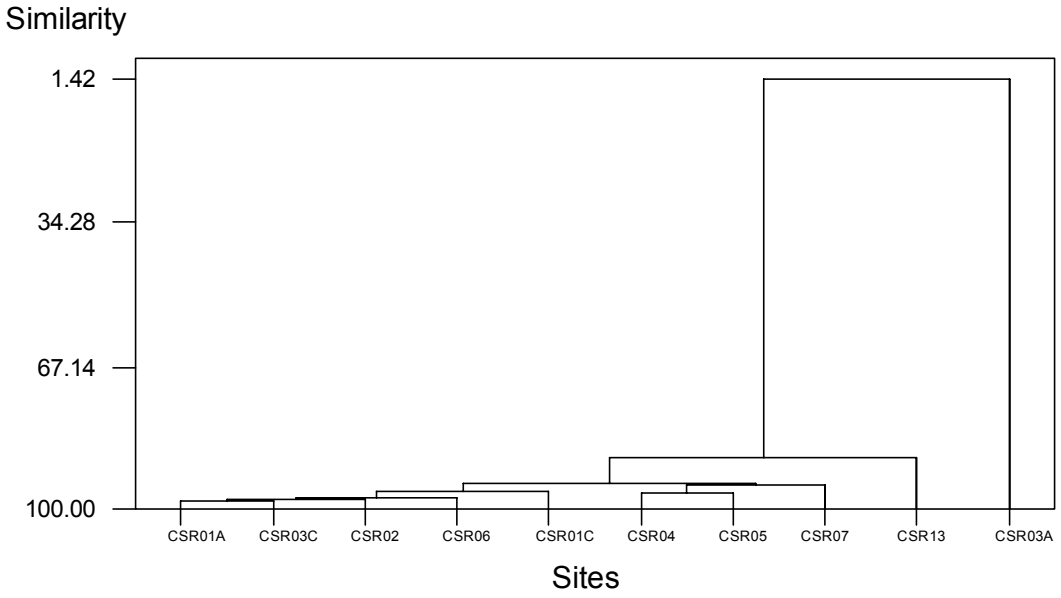
Cluster Analysis for Water Chemistry



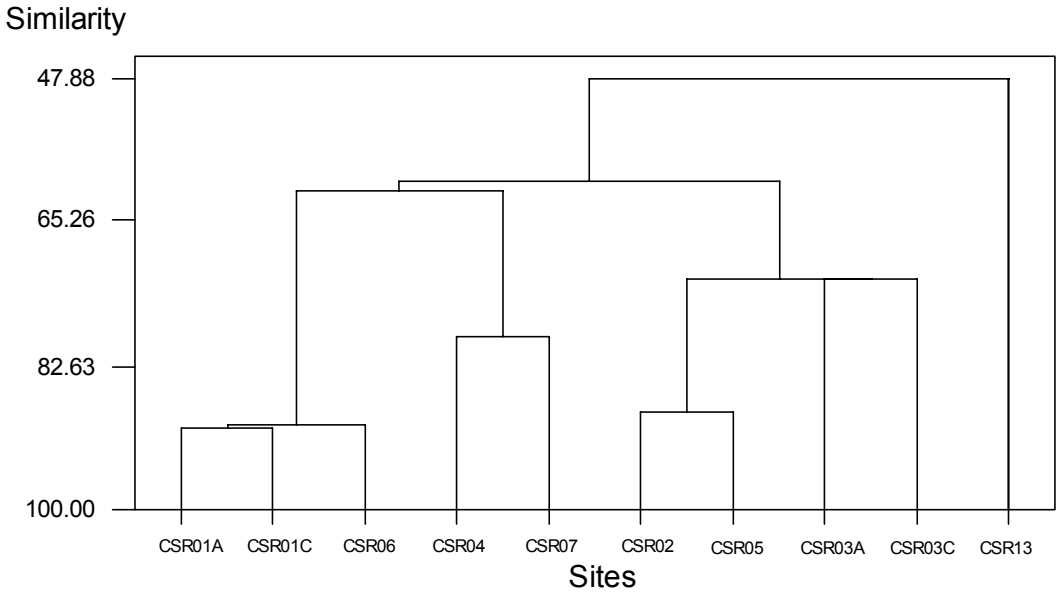
Cluster Analysis for Sediment Chemistry



Cluster Analysis for Phytoplankton



Cluster Analysis for Zooplankton



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