THE PINK LAKE HYDROLOGICAL STUDY GROUP REPORT

Department of Conservation and Environment
Perth, Western Australia
Bulletin 262 May 1986

THE REPORT ON INVESTIGATIONS INTO THE HYDROLOGY & USE OF PINK LAKE AT ESPERANCE

BY THE PINK LAKE HYDROLOGICAL STUDY GROUP TO THE HON MINISTER FOR LANDS & THE ESPERANCE SHIRE COUNCIL

The Study Group consisted of

Mr D Galloway (Convener)	Department of Conservation and Environment
Mr T Bestow	Geological Survey, Department Mines
Mr I Loh	Water Authority of Western Australia

Consulting work was conducted by

D Hurle & Associates

Department of Conservation and Environment
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CONTENTS

FIGURES

1. SUMMARY OF CONCLUSIONS

The hydrological study of Pink Lake has produced results from which its future use can be planned for the next ten years.

In summary, the Study Group found that:

1. the annual salt production should be limited to a maximum of 14 000 tonnes per year;

2. the investigation of the use of the Lake for the production of alga should be permitted to proceed provided any ponds used in the investigations are sealed and no discharge to the Lake occurs;

3. a close control should be maintained over the land use surrounding the Lake; and

4. it is unlikely that the extraction of groundwater for the town of Esperance will have a detrimental effect on the Lake. The impact of extraction of groundwater will continue to be monitored.

The details of these and related recommendations are found in Section 5.

Because the study was conducted on a limited budget, all the above recommendations can be modified or altered if further studies increase the understanding of the hydrology of the Lake. Details of further studies which should be undertaken are included in this report.

2. BACKGROUND

Pink Lake is a highly saline lake four kilometres west of Esperance. For many years its pink colouration has been a tourist attraction. Harvesting the salt has been the basis of a small local industry producing salt for the domestic and agricultural markets.

2.1 GEOGRAPHY AND CLIMATE

Pink Lake (Lake Spencer) is situated approximately four kilometres to the west of the township of Esperance in the south of Western Australia (Figures 1 and 2). The land in this region is generally very flat with typical surface elevations ranging from about two to 30 metres above sea level. The coast is indented with numerous rocky headlands. The Lake is separated from the coast in the south and south-east by low sand dunes. To the north and north-west, surface gradients are smaller and surface-water drainage is poorly defined. Pink Lake is less than one kilometre south-west of Lake Warden, which is considerably less saline. Surface drainage between the lakes would be negligible due to the construction of the railway embankments.

Annual rainfall varies from about 700 mm near the coast decreasing northwards to less than 400 mm per year some 70 kms inland. The average annual pan evaporation exceeds average rainfall by more than one metre per year. Rainfall is strongly seasonal and falls in winter. It often exceeds measured evaporation in May through to August.

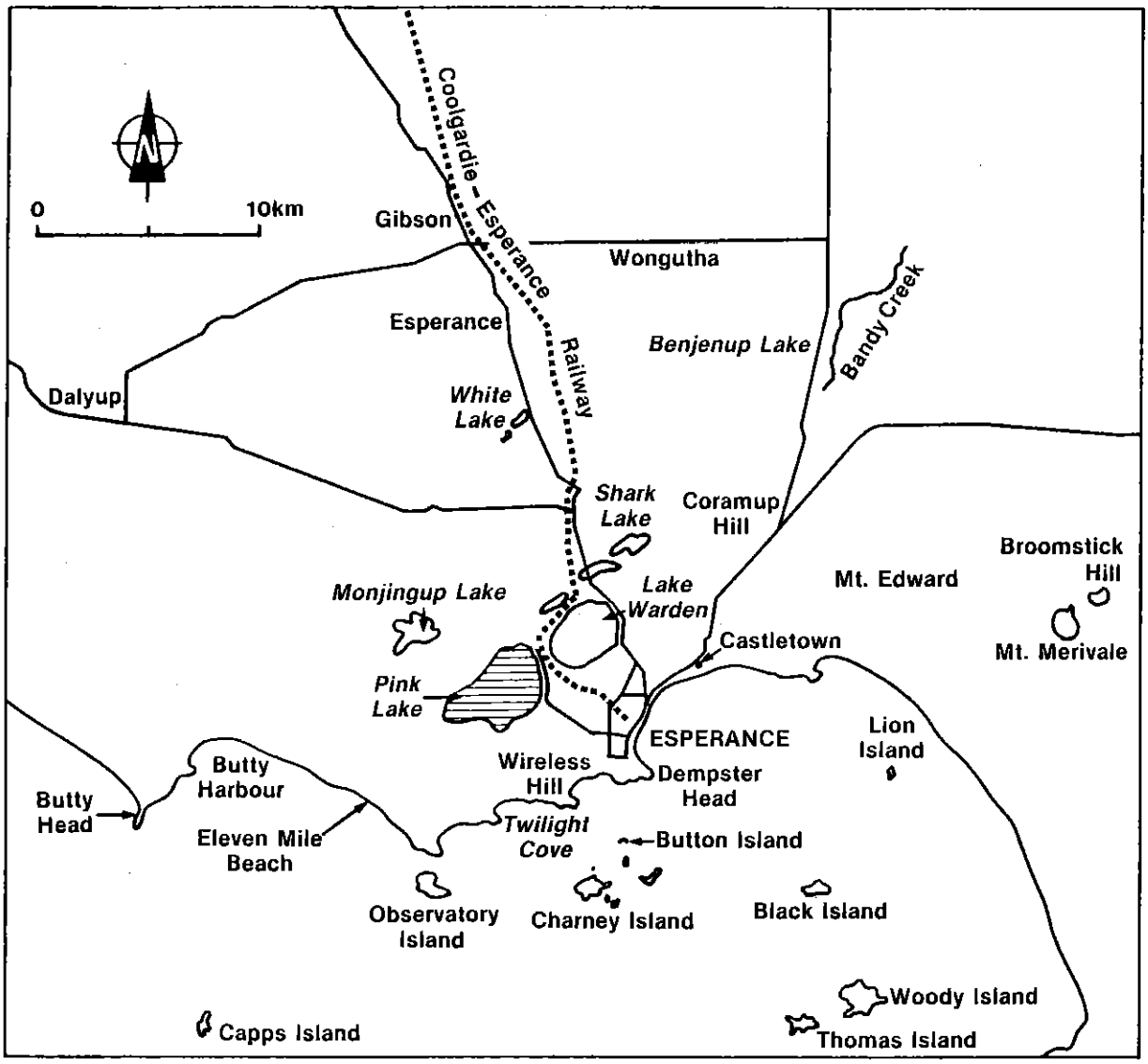

Figure 1 General location plan.

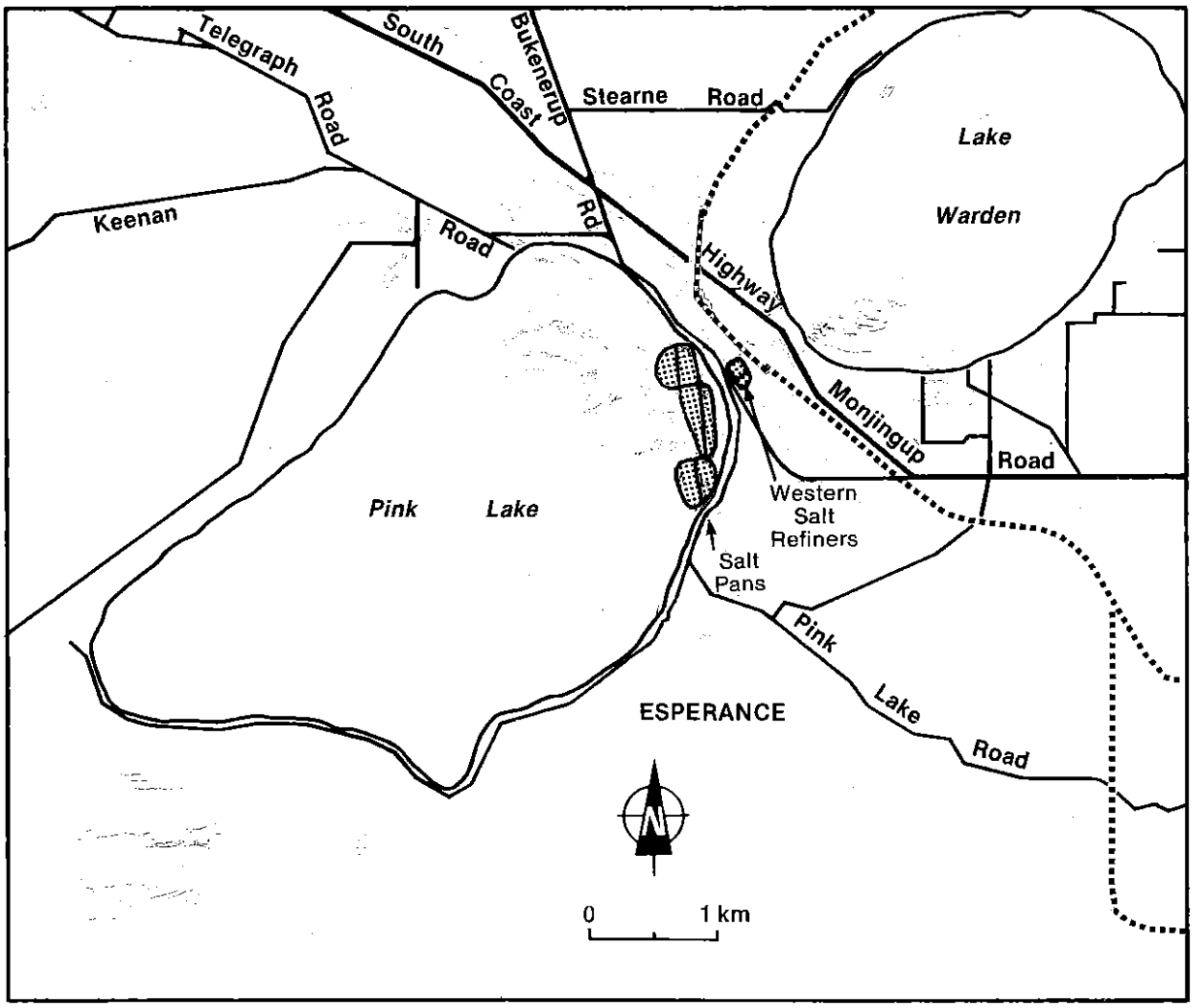

Figure 2 Plan of study area.

2.2 GEOLOGY

Regional geological mapping has been undertaken by the Mines Department (1). Within the area of the Pink Lake, the Precambrian basement of genisses and granites is exposed locally on the north-western edge. The lake-bed is covered by silt and clay alluvial material. These materials are locally underlain by the siltstones, claystones and sandstones of the Tertiary Pallinup and Werrilup Formations which overlie the Precambrian basement; but it is unknown whether the lake-bed is sufficiently incised to intersect these formations.

The soils surrounding the Lake to the south and south-west are Quaternary coastal dune sands which overlie the Pallinup formation. Groundwaters encountered in these sands are generally of higher quality (potable) and of higher yield than in the underlying materials, and provide the water supply for the town of Esperance.

To the north and north-west of the Lake, less is known about the geohydrology due to the fact that groundwaters are generally more saline (greater than 5 000 mg/per litre) and of little use for farm or stock water supplies.

Bore drilling records held by the State Geological Survey were examined to define the geological conditions experienced near Pink Lake.

2.3 THE STUDY GROUP

In 1983, a company, Vitamins Australia Ltd, proposed to utilise part of this highly saline lake to cultivate an indigenous alga *Dunaliella salina*. This additional interest provoked the Esperance Shire Council to express its concern to the Department of Conservation & Environment (DCE) as to the potential for disruption to the Lake by any of the then current, or proposed future, uses. DCE advised the Shire that a hydrological study would be necessary before any informed assessment could be made of the impact of developments.

The Shire approached State Cabinet which gave the undertaking that the State would provide $20 000 toward a hydrological study.

The study was co-ordinated and overseen by a Study Group consisting of:

Mr D Galloway	DCE;
Mr I Loh	Water Authority of Western Australia (then Public Works Department); and
Mr T Bestow	Geological Survey, Department of Mines.

The Group sought additional funding from both of the Lake's commercial users Western Salt Refiners Pty Ltd and Vitamins Australia Ltd, each for a contribution of $20 000 toward the study. This, with the contribution from the State, made an overall budget of $60 000.

This was a modest budget for this type of project and the Group recognised that the study would only provide results with order of magnitude accuracy.

It was considered that this would be sufficient to make realistic recommendations for the use of the Lake for the next ten years. However, it would not answer all the questions that could be raised about the Lake's hydrology. To do this would require extra expenditure which would be warranted only if the uses were to change significantly. The Group considers it has achieved the objective of obtaining a hydrological study from which useful recommendations can be made while staying within a modest budget.

3. LAKE USES AND INTERACTIONS

The Lake is the subject of multiple uses. The potential conflicts between uses identified by the Group were as follows.

3.1 TOURIST ATTRACTION

Various bacteria and alga in the Lake respond to the high salinity by turning red or pink. This gives its pinkish tint which creates a tourist attraction for visitors to Esperance.

The Lake's biota is dependent upon both salinity and nutrient levels. If either of these are seriously disrupted, the pink colour could disappear with the resultant loss in tourist trade.

3.2 SALT PRODUCTION

For many years, the Lake has been used by Western Salt Refiners Ltd for harvesting salt. In the early 1980s, production was stepped up to approximately 10 000 tonnes per year. It was feared that the nett export of salt could result in a reduction of lake salinity with a consequential reduction or loss of the pink colouration.

3.3 WATER SUPPLY

The Water Authority of Western Australia draws potable water from aquifers to the south-east of the Lake. It was thought that this aquifer and the Lake could be connected. It was possible that draw-down on these aquifers could result in salt water intrusion from Pink Lake, and a lowering of the Lake's water level. The Water Authority is managing groundwater abstraction with the objective of minimising this intrusion to ensure the quality of the fresh groundwater resource is not degraded.

3.4 ALGA CULTIVATION

Vitamins Australia Ltd proposed to cultivate one of the indigenous alga in ponds built on the lake-bed. It was proposed to initially fill these ponds with lake brine and, by controlling the salinity and nutrient levels of the ponds, enhance the growth of *D. salina*. At high salinities, this alga produces large quantities of β-carotene, a substance with a potential market in the food colouring and vitamin industry. It was suspected that if nutrients from these ponds were allowed to enter the Lake, it could result in an ecological imbalance occuring in the lake's biota and the pink colour disappearing. Western Salt Refiners Ltd expressed particular concern that an increase in nutrients could result in an increase in the population of a mucilaginous bacteria which could spoil the salt production.

3.5 SURROUNDING LAND USES

Residents who live and farm around the Lake have complained of noise from the salt works. They feared the introduction of an alga cultivation industry would bring further disruption to their neighbourhood.

The surface waters which drain into the Lake pass over farming land and flow near the main road and rail access to Esperance. There was the possibility that nutrient run-off from farm fertilisers, or a road or rail accident, could result in the dumping of fertiliser and/or biocides into the Lake's catchment with the ensuing detriment to the lake.

4. THE GROUP'S APPROACH

After considering these potential conflicts, the Group considered that these could be progressed toward resolution by conducting a hydrological study to determine the following:

1. the total water and salt storage within the lake system and in the sedimentary soils beneath the Lake surface;

2. an estimate of the salt and water balance components in terms of inflows from surface and groundwater and losses by evaporation and salt harvesting; and

3. any significant nutrient inflows to the Lake from drainage from agricultural lands.

After appropriate tendering, Dennis Hurle and Associates were retained as hydrological consultants to conduct this study. The report of the hydrological consultant is contained in the Appendix to this Bulletin published as DCE Technical Series No 4.

5. CONCLUSIONS & RECOMMENDATIONS

5.1 SALT STORAGE

The hydrological study found in the year of study that there was an estimated 1.1 million tonnes of salt on the surface of the Lake. This is thought to be typical of the season-to-season surface salt-store.

Following a test drilling program, it was estimated that the sediments below the Lake could contain up to 18 million tonnes of salt. This figure is only a rough estimate because:

1. problems of accessability limited the location and number of bore holes which could be drilled across the Lake to verify the thickness of sediments; and

2. there is insufficient data from existing geological surveys on the sub-surface structure of the sediments below the Lake.

Salt inflow into the Lake is estimated to be about 800 tonnes per year from surface stream flow, and approximately 5 500 tonnes per year from groundwater flows. This is a highly conservative estimate. It can be shown (see calculation in the Appendix to this Bulletin published as DCE Technical Series No 4) that, by varying the parameters of the calculation within the margin of errors in the various measurements and estimates, the replenishment of salt could be much higher. Assuming a surface salt-storage of 1.1×10^6 tonnes

per year, and an annual replenishment of 6 300 tonnes per year, the Group recommends that the salt removed from the Lake be set at a total of 14 000 tonnes per year. This constitutes only a 0.7% annual depletion of the Lake's estimated surface salt store, which is not considered to be significant, or likely to be detrimental to the Lake's quality.

This limit should apply for ten years after which it should be re-assessed. If at any time there is demand for more salt to be harvested, investigations should be conducted into the following matters before production is permitted to increase:

1. a more detailed estimate of the volume of sediments below the Lake;

2. an accurate determination of the rate of inflow of groundwater into the Lake; and

3. the use of brine from below the Lake to replenish the salt crystalisers (ponds) rather than pumping from the Lake's surface.

It is also recommended that the limit on salt production should be administered as part of the lease under which the salt producers operate.

5.2 NUTRIENTS

There was very little investigation of the fate of nutrients in the Lake. Observation showed that it has an extremely diverse and unusual biota.

Samples of water entering the Lake indicated that it is likely that only very low levels of nutrients were entering from surrounding catchments.

Infiltration tests on the Lake's surface indicate there may be a potentially high loss rate from the brine ponds. This is consistent with the behaviour of the brine in the salt crystalisers as reported by Western Salt Refiners Pty Ltd.

Based upon the apparently low nutrient input to the Lake and the high infiltration rate, the Group recommends that the investigation of the Lake's use for the cultivation of alga be permitted to proceed; subject to any ponds which are constructed being sealed to prevent loss of brine solution and nutrients into the main body of the Lake.

If in the future there is a requirement for large-scale ponds for which sealing is uneconomical, the Company should demonstrate to the satisfaction of the EPA that the proposed ponds are self-sealing, and there will not be a loss of solution or nutrients to the main body of the Lake.

5.3 SURROUNDING LAND USES

From the preliminary studies undertaken, it appears that the current surrounding land uses are not having a major impact on the quality of the Lake. It is recognised, however, that a major weather episode could result in flood conditions with a large flow of water into the Lake. This may

result in a change in the Lake's biota with a resultant loss of colour. This is reported to have occurred at various times. It is recommended that the use of the land surrounding the Lake continue as at present. If any major land use changes are proposed within the Lake's catchment, such as:

1. clearing for agricultural land;

2. housing subdivisions with septic tanks; and

3. intensive agricultural developments (piggeries, chicken farms);

their impact should be investigated with the proponent satisifying the EPA that the development will not have a negative impact on the Lake, before the development be permitted to proceed.

It is also recommended that contingencies be prepared by the Shire in the event of a road or rail accident releasing fertilisers or biocides to the environment in the vicinity of the Lake.

Because of public complaints, the Group recommends that Western Salt Refiners Pty Ltd investigates ways of minimising the noise from its operations.

5.4 WATER SUPPLY

The Public Works Department (now Water Authority Western Australia) has carried out groundwater modelling for the aquifer from which the Esperance town is supplied. It is thought that this aquifer discharges into Pink Lake. Extraction of groundwater for Esperance town water supply is predicted to cause reductions in inflow to the Lake. However, the Water Authority of Western Australia does not expect that this will cause a reversal of groundwater flow from the Lake; this would be contrary to the objective of minimising the possibility of saline intrusion in to the adjacent fresh aquifer. The Group accepts this advice, and endorses the Water Authority of Western Australia's advice that it will continue to monitor groundwater levels to determine if any detriment will result from its activities.

6. CONCLUSION

Based on the hydrological study carried out on Pink Lake, the Study Group has concluded that the Lake is not under threat of disruption from any of the current uses. As with any limited resource, there is the need for careful management to ensure an appropriate and equitable use of the Lake. The Group has made recommendations accordingly.

7. REFERENCES

1. MORGAN K H and PEERS R (1973). Esperance - Mondrain Island Geological Series - Explanatory Notes. Sheet SI/51-6, 10. International Index.