HERITAGE COUNCIL OF WESTERN AUSTRALIA

REGISTER OF HERITAGE PLACES

DRAFT – *Register Entry*

1. DATA BASE No. P17171

2. NAME *Lake Clifton, Peel Region*

FORMER NAME (or OTHER NAMES) Thrombolites, Lake Clifton; Portland Cement Company (site of)

3. LOCATION Yalgorup National Park, Mandurah

4. DESCRIPTION OF PLACE INCLUDED IN THIS ENTRY

Portion of Reserve 117170, Portion of Lot 6138 on Deposited Plan 28841 contained in Crown Land Record 3145/281 as shown on HC Curtilage Map P17171

5. LOCAL GOVERNMENT AREA Town of Mandurah, Shire of Waroona

6. CURRENT OWNER

State of Western Australia - Department of Biodiversity, Conservation and Attractions.

7. HERITAGE LISTINGS

- Register of Heritage Places: ----------
- National Trust Classification: ----------
- Town Planning Scheme: ----------
- Municipal Inventory: ----------
- Register of the National Estate: 20/06/1999
- Aboriginal Sites Register 21/03/1978
- Ramsar Wetlands List 07/06/1990

8. ORDERS UNDER SECTION OF THE ACT

---

9. HERITAGE AGREEMENT

---

10. STATEMENT OF SIGNIFICANCE

Lake Clifton, Peel Region, comprising a 21km long hyposaline lake in the Peel region that features a number of thrombolites, small calcium carbonate structures produced by cyanobacteria and microalgae, and the physical remains of the WA Portland Cement Company operations (1919-1923), has cultural heritage significance for the following reasons:

the place is rare and has a high degree of international significance for the living thrombolite colony which is the lake's most distinctive feature;

the study of the living microbial colony of organisms producing the thrombolites at *Lake Clifton*, as well as the study of relict (abandoned and inactive) thrombolites, provides understanding on the beginnings of cellular life;

the place includes a rare early remnant of 21st century cement workings, the WA Portland Cement Company's attempt to harvest and process the lake bed lime, which became the model for the company's successful operations in Perth for several decades;

the place is associated with a transformative period in the State's building industry during the 21st century, when cement began to be produced in the state; and,

the vista of the lake itself, the natural bushland setting surrounding the lake, and the extensive thrombolite formations present a unique and evocative aesthetic landscape.

Recent development at the lake such as access tracks, vehicle tracks, interpretation and the timber thrombolite viewing platform is of little cultural heritage significance.

11. ASSESSMENT OF CULTURAL HERITAGE SIGNIFICANCE

Cultural heritage significance means aesthetic, historic, scientific, social or spiritual value for individuals or groups within Western Australia.

In determining cultural heritage significance, the Heritage Council has had regard to the factors in the *Heritage Act 2018* and the indicators adopted on 10 May 2019.

PRINCIPAL AUSTRALIAN HISTORIC THEME(S)

- 1.2 Tracing the emergence of Australian plants and animals
- 4.6 Remembering significant phases in the development of settlements, towns and cities

HERITAGE COUNCIL OF WESTERN AUSTRALIA THEME(S)

11(a) Importance in demonstrating the evolution or pattern of Western Australia's history

Lake Clifton, Peel Region demonstrates the growing interest and contribution by Western Australians to the international study of microbial life, which has the potential to provides understanding on the beginnings of cellular life.

The remains of the WA Portland Cement Factory within *Lake Clifton, Peel Region* demonstrate the early development of the State's historic cement industry as the site where the Company attempted to harvest and process lake bed lime.

11(b) Importance in demonstrating rare, uncommon or endangered aspects of Western Australia's heritage

Lake Clifton, Peel Region is rare both nationally and internationally as an example of a living microbialite community in hyposaline (brackish) environment.

11(c) Potential to yield information that will contribute to an understanding of Western Australia's history;

Lake Clifton, Peel Region is of value internationally for its ability to contribute to the wider understanding of the beginnings of cellular life by virtue of its use as a research and teaching site, and as a benchmark site for living microbialite community in hyposaline (brackish) environment.

Lake Clifton, Peel Region has potential to yield information contributing to a wider understanding of the development of lime and cement technology in the State during a time when Portland Cement was transforming Australia's building industry.

11(e)[1] Any strong or special meaning it may have for any group or community because of social, cultural or spiritual associations;

Lake Clifton, Peel Region is of value to the scientific and wider community for its unique and rare environmental features.

11(f)[2] Its importance in exhibiting particular aesthetic characteristics valued by any group or community;

The setting of *Lake Clifton, Peel Region,* including the open white lake bed, natural bushland setting and myriad low curved shapes of the thrombolite formations, comprises an aesthetically pleasing landscape.

12. DEGREE OF SIGNIFICANCE

12. 1 CONDITION

The condition of *Lake Clifton, Peel Region* is variable. The thrombolites themselves are thriving whilst the relict thrombolites are in good condition. The algae that had previously threatened the microbial communities appears to be absent.

The physical remains of the WA Portland Cement factory near the middle point of the lake is in a ruinous state, due to both the effects of salt attack, rust and vegetation regrowth. The place has a high level of archaeological potential to uncover further remains of the WA Portland Cement factory.

12. 4 INTEGRITY

This section explains the extent to which the fabric is in its original state.

The integrity of *Lake Clifton, Peel Region* is high. The Thrombolites are largely untouched, although a viewing platform has been constructed in the area.

The remnants of the WA Portland Cement Company are decayed and largely obscured by regrowth in the area, however they are unmodified from when the site was abandoned and demonstrate high integrity.

---

1 Please note that HERCON factors with no corresponding value are not listed in this document.

2 For consistency, all references to architectural style are taken from Apperly, R., Irving, R., Reynolds, P. *A Pictorial Guide to Identifying Australian Architecture. Styles and Terms from 1788 to the Present,* Angus and Robertson, North Ryde, 1989.
For consistency, all references to garden and landscape types and styles are taken from Ramsay, J. *Parks, Gardens and Special Trees: A Classification and Assessment Method for the Register of the National Estate,* Australian Government Publishing Service, Canberra, 1991, with additional reference to Richards, O. *Theoretical Framework for Designed Landscapes in WA*, unpublished report, 1997.

12. 5 AUTHENTICITY

This section explains the extent to which the original intention is evident, and the compatibility of current use.

The physical remnants of the WA Portland Cement Company are no longer intact, however the basic operation of the site can still be read in the landscape. The site has high authenticity.

13. SUPPORTING EVIDENCE

The documentation for this place is based on the heritage assessment completed by the Department of Planning, Lands and Heritage (Heritage and Property Services), in May 2019, with amendments and/or additions by the Heritage Council and the Department.

13. 1 DOCUMENTARY EVIDENCE

Lake Clifton, Peel Region comprises a 21km long saline lake in the Peel region of Western Australia, which features a number of thrombolites, small calcium carbonate structures produced by cyanobacteria and microalgae.[3] The place has been the subject of much scientific study at both the state and international level due to the information the colony may provide about the origins of early cellular life. Later use of the site saw the establishment of a cement factory to exploit lime resources within the lake by Portland Cement.

Thrombolites, products of the interaction between groups of microorganisms, are related to stromatolites and are part of a larger group of organically-produced sedimentary structures collectively known as microbialites. While stromatolites form layered sedimentary structures, Thrombolites are recognised by their 'clotted' internal structure – this difference relating to the varying communities of microorganisms that produce these structures.[4] These microorganisms are typically *cyanobacteria* and *microalgae*, both single celled colonial organisms capable of photosynthesis. While both of these microorganisms are forms of algae, microalgae cells have internal structures that are bounded by internal membranes (forming *organelles* such as the nucleus), while within cyanobacteria cells all structures are free-floating and there is little internal organisation.[5] The specific formation of the thrombolites occurs when the organic mass of microorganisms, known as the 'microbial mat', forms along the bottom of an underwater environment and begins to photosynthesise, with calcium carbonate molecules forming along the outer surface of these microorganisms as a by-product. These carbonates precipitate in the water, forming calcium carbonate clumps that over thousands of years grow into a thrombolite.[6] Fossilised stromatolites and thrombolites represent the earliest record of life on earth; stromatolites are believed to date back more than 3 billion years, and at 570 million years ago thrombolites became more

---

3 'Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)", *Species Profile and Threats Database*, Australian Government Department of Environment and Energy website, accessed 15 May 2019, http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=96

4 McNamara, K, 'Western Australia's Modern Stromotolites/Microbialites/Thrombolites', *Research and conservation: Western Australia's microbialites*, Department of Environment and Conservation symposium, 29-30 October 2012; *Approved Conservation Advice for Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)*, Australian Government Department of Environment and Energy website, accessed 15 May 2019, http://www.environment.gov.au/biodiversity/threatened/communities/pubs/96-conservation-advice.pdf

5 'Introduction to the Cyanobacteria: Architect of earth's atmosphere', University of California Museum of Paleontology website, accessed 15 May 2019, https://ucmp.berkeley.edu/bacteria/cyanointro.html; Deepak, V, Elena, F, Siddarth, J, Xiaolei, Z, '13.5.1 Microalgae versus macroalgae', *Biomass, Biopolymer-Based Materials, and Bioenergy*, Woodhead Publishing, 2019; Molnar, C, Gair, J, '3.2 Comparing Prokaryotic and Eukaryotic Cells', *Concepts of Biology*, BC Open Textbooks website, accessed 15 May 2019, https://opentextbc.ca/biology/chapter/3-2-comparing-prokaryotic-and-eukaryotic-cells/

6 Zhu, T, Dittrich, M, 'Carbonate Precipitation through Microbial Activities in Natural Environment, and Their Potential in Biotechnology: A Review', *Frontiers in Bioengineering and Biotechnology*, January 2016 vol 4(4), pp. 1-2; Varun, P, *Biomineralization of carbonates in modern microbial sediments and its implications for CO2 sequestration*, PhD Thesis, Missouri University of Science and Technology, 2014, pp. 3-11

dominant in the fossil record. While the cyanobacteria and microalgae of Lake Clifton are modern, evolved counterparts to the microorganisms represented in the fossil record, study of these microbial communities and the formation of thrombolites can provide information not just on early forms of cellular life but on the origins of organic energy production.[7]

Other living populations of microbialite communities are very rare, with only a small number of isolated communities found in river and lake systems around the world. Western Australia is the global exception, home to a surprising variety of living microbialite communities, including Hamelin Pool, Shark Bay, and Lake Richmond.[8]

Lake Clifton, Peel Region was formed in the Pleistocene era (2.8 million to 12 thousand years ago) when a coastal dune known as the Myalup Sand Ridge developed along the shoreline, leaving a shallow lagoon behind it. Geologically, *Lake Clifton* is significantly older than the other coastal lakes of the area, which formed approximately 7000 years ago, during the Holocene period.[9]

Noongar communities were living around these coastal lakes during the Holocene, whilst their ancestors are believed to have arrived from Southeast Asia more than 50,000 years ago. Archaeological sites such as Upper Swan and Devil's Lair indicate that Aboriginal people were hunting and gathering in the southwest of Western Australia at least 38,000 years before present.[10]

The nomadic lifestyle of the Aboriginal people in the southwest evolved with the environmental conditions, and archaeological evidence from Aboriginal coastal sites dated to within the last 6,000 years indicates the use of both coastal plains and marine resources. These foods included mammals, reptiles, fish and shellfish, as well as fruits, seeds and roots such as yams. However, marine resources appear to have been utilised less than terrestrial resources.[11]

In the region around Lake Clifton the Noongar groups were known as the *Binjareb* (also recorded as *Pinjarup*). Groups of families who may have totalled 100 people lived in the vicinity of Mandurah and knew the lake by its original name of *Yalgorup*. These groups utilised the natural resources of the area, coming together annually to take advantage of the cyclical abundance of various food sources. In the case of the Binjareb, the fish traps at Balgarrup were a series of communal structures that provided for such events.[12] At *Lake Clifton, Peel Region*, a fish trap is has been

---

7 *ibid*.; Portlock, C, Koch, A, Wood, S, Hanly, P, Dutton, S, *Yalgorup National Park Management Plan 1995-2005,* Department of Conservation and Land Management, National Parks and Nature Conservation Authority, 1995, pp. 22-23

8 *ibid*.; Assessment Documentation P18483 *Lake Richmond* (RHP)

9 V & C Semeniuk Research Group, *Quaternary geology, landforms and wetlands between Dawesville and Binningup – description, key features, and geoheritage significance*, Department of Environment and Conservation, 2009, pp. 13, 16-17, 29, 35

10 J Flood, *Archaeology of the Dreamtime*, Angus & Robertson, 1999, pp. 106-110; S Hallam, "The First Western Australians" in C T Stannage (ed.), *A New History of Western Australia*, UWA Press, 1981, p. 50

11 M Smith, "Southwest Australian coastal economics: A new review," in J Hall & J McNiven (eds.), *Australian Coastal Archaeology*, ANU, 1999, pp. 18-23; S Meagher & W D L Ride, "Use of Natural Resources by the Aborigines of South-Western Australia", ", in R Berndt & C Berndt (eds.), *Aboriginal of the West: Their Past and Present*, UWA Press, 1980, pp. 71-78

12 Gibbs, M, 'An Aboriginal fish trap on the Swan Coastal Plain: the Barragup mungah', *Records of the Western Australian Museum*, 2011, vol 79, pp. 5-12; Koch *et al*. *op cit.*, p. 26

recorded along the western edge of the lake, however its exact location is unknown.[13]

In 1826 a British settlement was established at King George Sound, followed by the formal declaration of the Swan River Colony in 1829. That same year Lieutenant Surgeon Collie and Lieutenant Preston explored the coastline between Bunbury and Mandurah, and named the large lake in the region *Lake Clifton* in honour of Marshall Clifton, one of the early financial backers of the colony and Commissioner of the West Australian Company.[14]

A small settlement developed around Peel in Mandurah in the early 1830s, but the settlement's population had declined by 1839 due to both mismanagement, and conflict between the British settlers and the local Bindjareb people.[15] Initial relations between the Binjareb and the British were cordial, and it is thought that the Noongar group considered the new settlers to be *djenga*, or returned spirits of the dead. However, hostilities arose over the colonist's lack of knowledge and respect for Noongar tradition, coupled with conflicts over crops burned during traditional firing, and the hunting of British stock. Skirmishes, some resulting in deaths, occurred between British and Noongar groups from the 1830s onwards, and in October 1834 a massacre, the accounts of which vary, is understood to have resulted in around 20-30 Binjareb deaths.[16]

While the massacre did not destroy the Binjareb people they were left weakened, and after 1839 the British settlement at Mandurah continued to expand.[17] Clifton's West Australian Company claimed a 640 acre lot along the southeast edge of Lake Clifton by 1843, and other lots in the area slowly followed.[18] By the 1880s roads had been built along both sides of Lake Clifton, and the number of farming lots along the banks had increased.[19]

In 1912 a local farmer, Newnham, noticed an unusual patch of clover along the bank of Lake Clifton, and discovered a deposit of pure carbonated lime, which was in demand for both the building industry and for farming. While limestone was readily available along the southwest coast, it needed to be burned in a kiln to produce the more useful lime. Consequently, the entire bed of Lake Clifton was identified as a high-quality lime deposit.[20] The following year, a report on the lime properties of the lake by geologist E Saint-Smith, noted:

---

13 Register of Aboriginal Heritage Places no 351 BOUNDARY LAKE; Fish Trap, Man-Made Structure.

14 Koch *et al*. *op cit.*, p. 27

15 R Richards, *op cit.*, pp. 6-11

16 Contos 1999, *op cit.*, pp. 20-37; Richards 1993, *op cit.*, pp. 6-8; Gill 1963, *op cit.*, pp. 164-165; Green 1981, *op cit.*, pp. 84-85; see also assessment documentation for P3957 *Pinjarra Massacre Site*. 'Massacre' is used here as per Prof Lyndall Ryan's definition: 'the unnecessary, indiscriminate killing of human beings, as in barbarous warfare or persecution, or for revenge or plunder,' involving at least six deaths. Ryan's definition was adapted from earlier historical researchers such as Ian Clark; see Ryan, L. 2010, 'Settler Massacres on the Port Phillip Frontier, 1836-1851', *Journal of Australian Studies*, vol.43, No.3, pp. 260, 263

17 Contos 1999, *op cit.*, pp. 46-50; Green 1981, *op cit.*, pp. 84-86

18 *Location 22, Lake Clifton, Peppermint Grove by M. Ommanney, Fieldbook 12 [scale: 5 inches to a mile, Tally No. 005729]*, State Records Office, AU WA S236- cons3869 Murray 037; *Lake Clifton, Lake Preston and adjacent coast by F.T. Gregory [scale: 50 chains to an inch]*, State Records Office, AU WA S236- cons3869 Wellington 038A; While subdivided, the original Location 52 is still apparent in the modern cadastre

19 *Various Locations vicinity of Clifton Lake and Harvey Estuary by G.R. Turner and others [scale: 20 chains to an inch]*, State Records Office, AU WA S236- cons3869 Wellington 057

20 'Reported discovery of pure lime', *The West Australian*, 6 December 1912, p. 8

along the eastern shore small circular patches of fairly compact lime are forming as the result of the growth of colonies of small organisms, but the deposit appears to be entirely superficial.[21]

By 1919, a railway was built and a settlement at Lake Clifton was proposed.[22] The WA Portland Cement Company began operations at Lake Clifton in 1921, which involved the extraction of lime from the lake bed and transporting the wet lime via pipes to evaporation ponds nearby. This lime was then transported by rail to the company's main factory at Burswood.[23]

The interwar period was transformative in Australia as the manufacture of Portland Cement (a key ingredient in concrete) had become economically viable and was made readily available to builders. Concrete promised a higher load strength and adaptability, and over the next few decades became a key component in Australian construction.

A simplified process of Portland cement manufacture (figure 1) involves the crushing and mixing of calcareous materials such as limestone, and argillaceous materials such as clay or shale, which are then heated in a rotary kiln to 1450 °C. This creates a sintering (bonding without melting) reaction, producing small, round clinkers of alite. These alite clinkers are then ground down again and mixed with small amounts of gypsum to regulate the reactivity of the material, and the resulting Portland cement is then stored for later use.[24]

21 'Lime Deposits: Report by Mr Saint Smith', *Western Mail*, 14 March 1913, p. 12

22 'Country', *The West Australian*, 7 October 1919, p. 8

23 Koch *et al*. *op cit.*, p. 27; 'WA Portland Cement Works: An Enterprise that Prospered', *The Daily News*, 1 October 1921, p. 16; the lime processing site, a child place of *Lake Clifton*, is recorded in the Historic Heritage database as P8637 Lime Works. The site of the main cement factory in Burswood was redeveloped into a residential area after 2002 (Landgate Historical Imagery).

24 'The Process for making Portland Cement', *Concrete Alberta*, website accessed 6 June 2019, http://www.concretealberta.ca/the-process-for-making-portland-cement

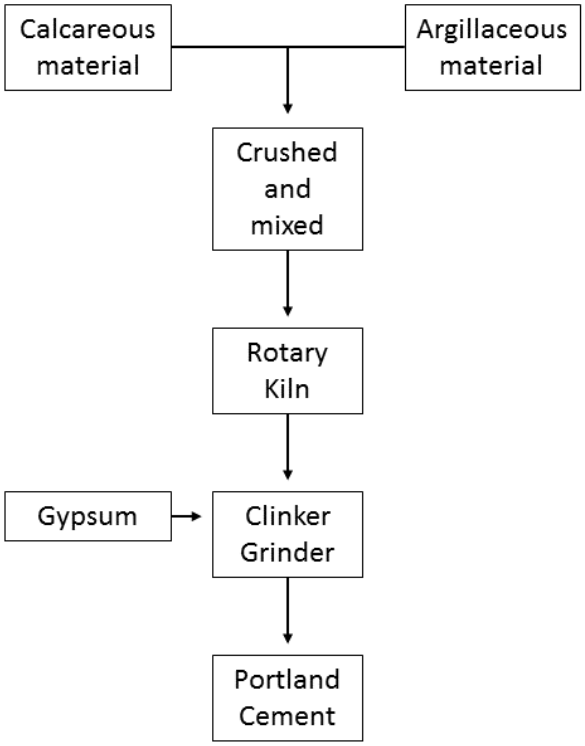

Figure 1. Simplified Portland cement manufacturing process.

The components needed for Western Australia to begin commercial production of Portland cement was already available in 1919. Clay was readily obtainable at Burswood, and *Lake Clifton, Peel Region* provided a source of fine-grained lime that bypassed the need to burn limestone. Ball mills for crushing and grinding were already in use by the 1890s for mining operations, and a rotary kilns were being used for brick production by the turn of the century.[25] Gypsum had already been discovered in Western Australia as early as 1837, and was being quarried or mined commercially by the 1870s.[26]

Another factor in the development of a local Portland cement industry was the drop in availability in imported cement after the First World War. As a result, Portland Cement companies were rapidly established across Australia, including the WA Portland Cement Company in 1919.[27]

While the Lake Clifton processing centre initially relied on dredging the lime lake bed along the shoreline, the company developed a method of dredging in the

25 'Mining', *The West Australian*, 11 July 1896, p. 20; 'Jandakot-Armadale Railway', *The West Australian*, 23 July 1907, p. 6

26 'Inland Sea', *The Perth Gazette an Western Australian Journal*', 18 February 1837, p. 853; 'News by the Colonial Mails', *The Herald*, 7 June 1873, p. 3

27 Lewis, M, *200 Years of Concrete in Australia*, Concrete Institute of Australia, 1988, pp. 6-9

deeper waters via a vacuum pipe, held in a frame leading from the shoreline, the end of which was suspended from a floating barge.[28]

Unfortunately the WA Portland Cement Company's operation at Lake Clifton proved too costly, and the company ceased operations at the lake in 1923, completely abandoning the site by 1925.[29] The proposed settlement, which had included a railway station, public hall, school and post office, was similarly abandoned.[30] The government of the day was forced to buy back the land for the Lake Clifton railway line, which became the subject of a Royal Commission.[31] The remains of pump lines into the water from the cement factory site were still extant in 1929.[32]

However, the method of lake bed lime harvesting using a floating barge was still carried out by the WA Portland Cement Company at Belmont, where over the new few decades the company, rebranded as 'Swan' Cement Company, dredged and processed more than two million tons of shell from the Swan River.[33]

Portland cement changed the landscape of Western Australian construction, becoming used in concrete construction for infrastructure such as bridges and pipes as well as in the production of asbestos cement sheeting, which allowed for the rapid expansion of residential building. As reinforced concrete became more common, larger and taller construction was enabled, permanently transforming Perth's CBD in the post-war era.[34]

In 1979, microbiologist Linda Moore initially identified the sedimentary structures at *Lake Clifton, Peel Region* as stromatolites. However, in 1993 she published a comprehensive study of the structures which identified them as thrombolites.[35] Moore noted the *Lake Clifton, Peel Region* thrombolites existed in the same environmental context (saline water with fresh water constantly seeping in through limestone base) as significant international fossil thrombolites, and was able to pose a number of research questions as to how prehistoric thrombolites flourished

---

28 'WA Portland Cement Works: An Enterprise that Prospered', *The Daily News*, 1 October 1921, p. 16; 'WA Portland Cement Works: An Enterprise that Prospered', *The Daily News*, 1 October 1921, p. 16; 'Abrolhos Island Guano and Lime', *Western Mail*, 1 December 1921, p. 5; 'The Now Famous Lake Clifton Lime Deposits', *Sunday Times*, 12 February 1922, p. 8; 'Cement Works', *Western Mail*, 9 October 1919, p. 30

29 'Where the Money Goes', *Westralian Worker*, 31 August 1923, p. 5; 'River Shell: A Neglected Asset', *The Daily News*, 25 March 1925, p. 3

30 *Lake Clifton, Peel Region [Tally No. 506884]*, State Records Office, AU WA S2168- cons5698 1014; the settlement is still apparent in the cadastre at the Lake Clifton Road intersection.

31 'Lake Clifton Agreement: Subject of Royal Commission', *Western Mail*, 5 January 1922, p. 29; 'Lake Clifton Railway Act', *Kalgoorlie Miner*, 10 July 1922, p. 3; 'Lake Clifton Railway', *The West Australian*, 23 March 1922, p. 7

32 Lake Clifton looking west, remains of pipeline to the suction pump of the old lime works, 8 January 1929, Battye Library Historic image Collection, 226858PD

33 'Who's for the West? An Industrial Parable', *Call*, 27 March 1925, p. 5; 'Perth City Works', *The West Australian*, 14 April 1930, p. 18; 'Shells used after 2 million years', *The Daily News*, 22 July 1950, p. 24; the remains of the Swan Portland No 1 Dredge (P8647) are located offshore from Cracknell Park, near the cement manufacturer's Burswood factory site.

34 Prentis, L, *The economic and geographical aspects of the manufacture of Portland Cement in Western Australia*, Geographical Laboratory, Dept of Economics, UWA, 1951, pp. 4-5; Edmonds, L, *The Vital Link: A History of Main Roads in Western Australia,* UWA Press, 1997, pp. 42, 66; Moore, B, *From the Ground Up: Bristile, Whittakers and Metro Brick in Western Australian History*, UWA Press, 1987, pp. 49-50;

35 Moore, L, *The modern microbialites of Lake Clifton, South-Western Australia*, PhD Thesis, UWA, 1993; Moore, L, *Classification and abundance of the littoral fauna of Lake Clifton, Peel Region and possible effects of seasonal changes on species diversity and distribution*, Graduate Diploma Thesis, Curtin University, 1979, referenced in Moore *op cit.*, p. *ix*

and were eventually overtaken by newer forms of life. Moore also identified a threat to the living microbial community of Lake Clifton from poor water management and incompatible farming, including the growth of algae around the thrombolites.[36]

In 1990 the Yalgorup lakes system was declared as a wetlands of international natural significance under the Ramsar Convention, as both a habitat for a number of bird species and as the site of internationally rare microbialite communities.[37] In 1995, the Yalgorup National Park was declared, which placed a number of protections on the ecology of the wetlands in the area, and had a particular focus on the thrombolites of Lake Clifton.[38] In 2004, a protection and recovery plan for the thrombolites was approved by the Western Australian State government.[39] In 2010, the thrombolites were listed as Critically Endangered under the *Environmental Protection, Biodiversity and Conservation Act 1999*. The supporting documents for this move noted that the significance of the microbial communities for researching the earliest forms of cellular life and their rarity on an international scale.[40]

In 2019, *Lake Clifton, Peel Region* continues to be visited and utilised for the purposes of tourism and scientific research.

13. 2 PHYSICAL EVIDENCE

Lake Clifton, Peel Region comprises a 21km long lake in the Peel region of Western Australia, which features a number of thrombolites, small calcium carbonate structures produced by cyanobacteria and microalgae.[41] The place also includes the archaeological remnants of the Portland Cement Company's workings, and an Aboriginal fish trap. However, the specific location of this latter element is currently unknown.

Lake Clifton, Peel Region is located in Western Australia's Peel region, part of the Yalgorup Lake system between Mandurah and Bunbury. *Lake Clifton* is oriented north-northwest to south-southeast, roughly parallel to the coast 2-5 km to the west. *Lake Clifton* is accompanied by Lake Pollard, Martins Tank Lake, Lake Yalgorup and Lake Preston to the southwest, Boundary Lake, Duck Pond and Swan Pond to the west and the Harvey Estuary to the northeast.

The waters of *Lake Clifton* are considered brackish or *hyposaline*, and are unique in that they are significantly less salty than the other water bodies of the Yalgorup Lake System. The waters are also considerably more alkaline than the surrounding lakes, due to the constant seepage of carbon-rich fresh groundwater into the lake

---

36 Moore *op cit.*, pp. 143-147

37 'Wetlands of national and international importance', Department of Biodiversity, Conservation and Attractions, accessed 16 may 2019, https://www.dpaw.wa.gov.au/management/wetlands/wetlands-of-national-and-international-importance

38 Koch *et al*. *op cit.*, pp. 12, 25,

39 Luu, R, Mitchell, D, Blyth, J, *Thrombolite (Stromatolite-like microbialite) community of a coastal brackish lake (Lake Clifton) Interim Recover Plan, 2004-2009,* Interim Recovery Plan no 153, Department of Conservation and Land Management, 2004

40 'Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)', *Species Profile and Threats Database*, Australian Government Department of the Environment and Energy, accessed 16 May 2019, http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=96

41 'Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)", *Species Profile and Threats Database*, Australian Government Department of Environment and Energy website, accessed 15 May 2019, http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=96

through the limestone geology of the eastern (inland) side.[42] *Lake Clifton* is prone to seasonal inundation, the water level dropping significantly in the summer, and because of this the chemical and ph balance of the water changes in an annual cycle.[43]

These conditions have allowed for the microbialite community of the lake to survive, and over time to develop the thrombolites. These thrombolites are mostly found along the eastern edge of *Lake Clifton*, stretching from the northern tip of the lake to the narrow neck of the lake near the southern end known as the Deep-water Channel. The thrombolite population is densest at the northeast corner of the lake, and a smaller group of thrombolites also exists along the northwest edge of the lake. The thrombolites themselves extend between 50 to 100m into the lake from the high watermark, and some structures are exposed or partially exposed during the summer months. The thrombolites range in size from 2cm to 2m, however most occur within the range of 2cm to 50cm. The height of the thrombolites is linked to the water level, and thrombolites in deeper waters are significantly taller. Most thrombolites have dome structures, although the largest have formed into discoid structure as the central microbial colony grew too large to be supported and migrated outwards. Groups of thrombolites have also joined as they have developed, forming 'reef-like' structures. These also include 'relict' thrombolites where there is no longer a living microbial community.[44] During a site visit in May 2019 it was noted that the thrombolites appeared to be very healthy, with no algae present on the thrombolite surfaces. A timber viewing platform has been erected to provide a safe alternate view of the thrombolites.

During the site visit the physical remains associated with the WA Portland Cement Company operations, towards the middle point of the lake, were also recorded. Photographs of the site from late 1921 and early 1922 indicate a complex of industrial structures, including an east-west pipe suspended in a wooden frame above the lake waters itself, connected to a pumping room and chimney stack along the shoreline. The pipe then appears to turn north along the shoreline, connected to a number of wooden boxes set into the shore. At the northern end of the site, another large timber structure is apparent, although the purpose is unclear in the photo. This image shows the barge connected to the outer end of the east-west pipe into the lake, which was constructed at the site in 1919. Behind the pump room, another view of the site shows the factory itself. The orientation of the image is unclear but it appears the bulk of the factory was oriented south along the shore line. A final image of the operation shows large drying paddocks where the dredged river bed was deposited to air-dry before being transported to the lime kiln.[45]

In May 2019 the remains of the east-west pipe frame were visible, but the east-west pipe was no longer extant. The frame was constructed of undressed bush timber, planted directly into the lake bed. Remnants of the north-south pipe were identified, which were heavily salt-encrusted and corroded. The pipe appears to have been laid in short sections that were bolted together. At the northern end of

---

42 Koch *et al*. *op cit.*, pp. 22-23; Moore *op cit.*, pp. 22-25, 57-64

43 *ibid.*, pp. 57-64; The curtilage of the place is based upon the high water mark.

44 Moore *op cit.*, pp. 40-45, 127-134

45 'WA Portland Cement Works: An Enterprise that Prospered', *The Daily News*, 1 October 1921, p. 16; 'Abrolhos Island Guano and Lime', *Western Mail*, 1 December 1921, p. 5; 'The Now Famous Lake Clifton Lime Deposits', *Sunday Times*, 12 February 1922, p. 8; 'Cement Works', *Western Mail*, 9 October 1919, p. 30

the pipe the remains of a timber frame supporting the pipe can be seen set directly into the beach.

A number of paired box frames reinforced with metal straps were noted along the water's edge adjacent to the north-south pipe, constructed of dressed timber planks. The corner structural members of the boxes indicate they would have originally stood proud of the water level, although they do not appear to be prominent features in the historic images of the site. Given what is known about pumping operations at the lake, these boxes are interpreted as settling beds, likely small-scale tests of the process before the larger drying paddocks were established.

More substantial wooden structural foundations were found in the vicinity of the unknown northern building and the pumping station, consisting of thick dressed timber planks over a timber frame reinforced with timber crosspieces and metal straps, atop what appears to be a timber log pile. The edge of a similar structure was seen in the vicinity of the pump room, however thick vegetation has now entirely obscured the structure. The factory itself, set back from the water's edge, was also unable to be located beneath the thick vegetation.

Remnants of a light tram rail were identified at the northern end of the beach, although little could be interpreted regarding how this feature fit specifically into the operations at the site. Numerous fragments of timber and metal were also noted along the shoreline.

An isolated block of concrete was noted in the bush behind the shoreline, as was a fragment of metal pipe. Unfortunately, the heavy vegetation made identification of specific cultural material impossible. A steep embankment was noted in the vicinity of the concrete block and pipe, less than 1m high, running approximately north-south. This has been interpreted as part of the drying paddock, now completely overgrown.

At the northern and southern edges of the cadastral block the remains of a timber stock fence are visible on the beach, with bush timber poles with double slots for holding cross pieces. These fences start in the lake itself and disappear into the vegetation.

Towards the eastern edge of the site lies the two remnants of the rotary lime kiln, which would have originally been approximately 20m long in an east-west orientation. The remnants of this kiln include the eastern (upper) end, consisting of a substantial brick furnace building, topped with concrete, with vents along the lower walls. A smaller brick room along the southern edge of this structure may have been the original access point to the furnace. The most prominent feature of the eastern end of the structure is a large circular hole that originally held the kiln barrel, lined with a triple ring of brick, corrugated iron and remnants of a timber frame. Behind the eastern brick remnant (at the eastern edge of the site) lies a small concrete vent that would have been connected to the furnace space. At the western end, a brick remnant that held the lower end of the barrel is extant, only showing a double line of curved brick. This remnant sits on a larger rectangular brick pad, which is largely obscured by vegetation. Between these two brick remnants lie two substantial concrete blocks, formed in seven layers with bolts still apparent in the upper surface. It is assumed these are footings for the machinery that held and rotated the kiln barrel.

13. 3 COMPARATIVE INFORMATION

Microbialites

A search of the Historic Heritage database for places with the place type 'Geological Monument' returns 113 entries, 1 of which is entered in the State Register (RHP). These places include gorges, hills, fossil sites and water bodies. By refining this group to places where stromatolites or thrombolites are directly mentioned, this number is reduced to three places, none of which are entered in the RHP. Another search of the database for any place with the keyword 'stromatolite' or 'thrombolite' returns 8 places, two of which are entered in the RHP. By combining these lists a total of 9 places can be identified as containing microbialites, two of which are entered in the RHP, of which only one place demonstrates a living microbialite community:

- P15743 *Armadale Brickworks Quarry (fmr)* (RHP): located in the City of Armadale, this quarry was attached to the Armadale Brickworks Factory, and includes the Cardup Series shale formation that includes some examples of stromatolite fossils.
- P18483 *Lake Richmond* (RHP): located in the City of Rockingham, this freshwater lake is home to a living thrombolite colony that is rare and scientifically significant at the international level.
- P4446 Strelley Pool: located in the East Pilbara, this site is considered to have the most extensive and best-preserved stromatolite fossils in the region. Part of this area is also entered in the database as P18735 Strelley West Geological Site.
- P3431 Meentheena Geological Site: located in the East Pilbara, this site contains a number of well-preserved stromatolite fossils.
- P3853 Knossos Geological Site – Stromatolites: located in the East Pilbara, this site contains a number of well-preserved stromatolite fossils.
- P3951 North Pole Geological Site – Stromatolites: located in the East Pilbara, this site contains a number of well-preserved stromatolite fossils.
- P4405 Duck Creek Gorge: located in the Ashburton, this geological formation includes outcrops of stromatolite fossils.
- P4435 Elimberrie Bioherms: located in Derby-East Kimberly, this bioherm (fossilised prehistoric reef) includes a number of stromatolite fossils.
- P5859 Lake Thetis and Stromatolites (MI): located in the Shire of Dandaragn, this hyper-saline lake contains a living colony of stromatolites that is considered to be of international rarity and scientific significance.

There is no complete and up to date list available of global microbialite sites, however one research paper has produced an unannotated map showing approximately 60 known modern microbialite communities around the world.[46]

---

46 Myrshrall, K, Dupraz, C, Visscher, P, 'Patterns in Microbialites Throughout Geologic Time: Is the Present Really the Key to the Past?', *Experimental Approaches to Understanding Fossil Organisms*, D Hembree (ed.),Topics in Geobiology, 2014, vol 41, p. 12, figure 6.7. Unfortunately the map is not annotated with names and specific locations.

Moore has produced a more comprehensive list in her 1993 PhD Thesis that identifies 36 living stromatolite communities and 11 thrombolite communities around the world. She identified 17 microbialite sites (both living and fossilised) in Western Australia.[47]

Cement Works

A search of the Historic Heritage database for places with the use 'INDUSTRIAL/MANUFACTURING' returns 525 entries, 77 of which are entered in the RHP. These places include mills, wineries, whaling stations, smelters, brickworks and kilns. Refining this search to any place with the keyword 'cement' returns 76 places, 17 of which is entered in the RHP. Of these 17, none represent places of cement or concrete manufacture. The only comparable place is P15829 *Armadale State Brickworks Dust Room & Machinery Shed (fmr)* (RHP), which after 1972 was owned by a Concrete production company.

A search was also carried out for places associated with the WA Portland Cement Company, which returns the following:

- P18338 Lime Kilns, Wanneroo (AP): located in the City of Wanneroo, this precinct of lime and charcoal kilns was constructed by various migrant families living and working at the kilns sites in the 1930s-1950s. The WA Portland Cement Company bought a number of these kilns to reduce competition in the 1950s.
- P8647 Swan Portland No. 1 Dredge (MI): Located in the City of Belmont, this wreck was the floating platform established by the WA Portland Cement Company in 1921 to collect river shell for lime production.
- P17909 One Tree Hill (MI): a quarry located in the Shire of Gingin, the WA Portland Cement Company is reputed to have operated at this site in 1921.

A search of the Historic Heritage database was also carried out to ascertain the early spread and impact of concrete (where Portland Cement is a key ingredient) as a building material in Western Australia. A search of places where concrete is the primary material returns 805 places, of which 131 are listed on the RHP. By refining this list to the inter-war period, this list is refined to 321 places, of which 76 are entered in the RHP. These places include government buildings, infrastructure such as bridges and dams, commercial buildings and industrial sites.

Conclusions

The comparative evidence for *Lake Clifton, Peel Region* indicates that while fossilised microbialites are relatively common in Western Australia, living microbialites colonies are very rare. Within a national and international context, living microbialite colonies are considered extremely rare.

Lake Clifton, Peel Region is also rare as a place associated with cement manufacture and for its association with the WA Portland Cement Company, which while short-lived was the first undertaking of its type in Western Australia during a transformative period in the state building industry.

47 Moore *op cit.*, pp. 32-40

13. 4 KEY REFERENCES

Moore, L, *The modern microbialites of Lake Clifton, South-Western Australia*, PhD Thesis, UWA, 1993.

13. 5 FURTHER RESEARCH
