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Queensland's timber and iron lighthouses: 19th century colonial innovation.

Peter Marquis-Kyle, conservation architect, Brisbane

SUMMARY: *The geography, resources and economic circumstances of the colony of Queensland fostered the local design and construction of two related types of composite timber-framed, iron-clad lighthouse towers in Queensland from the 1870s – an early type clad with riveted wrought iron plating, and a later type clad with corrugated galvanised iron. This paper gives a short historical account of their design and construction, outlines the range of towers and how they have been changed. The paper concludes with an assessment of the success and influence of the type, and a table of major 19th century lighthouses.*

1. INTRODUCTION

From the establishment of the colony of Queensland in 1859 until the separate colonies federated to form the Commonwealth of Australia in 1901 engineers and architects designed an impressive set of lighthouses. The Queenslanders developed a type of timber framed, iron plated lighthouse tower which is a local Queensland invention. It turned out to be a technical and economic success, though the idea was not taken up elsewhere.

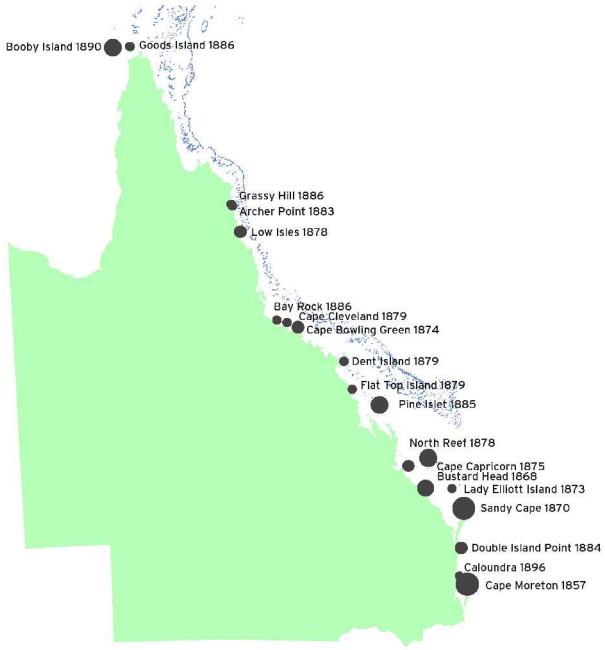

Figure 1. *Queensland coastal lighthouses before 1900*

I am an architect and I specialise in the conservation of historic buildings and places. I was commissioned in 2006 to work on a condition survey of 58 heritage listed lighthouses for the Australian Maritime Safety Authority (AMSA). My client was Australian Maritime Systems Ltd, AMSA's navigation aids maintenance contractor. I visited all but one of these lighthouses myself, a wonderful experience. The oldest of these structures was built in 1845, the youngest in 1984.[1] As a group they represented many aspects of the history of Australian lighthouse design, and the local variations that arose in response to the circumstances in each of the Australian colonies. This experience awoke my interest in the story of the composite timber and iron lighthouses that are the subject of this paper.

2. THE FIRST QUEENSLAND LIGHTHOUSES: LOCAL STONE AND IMPORTED CAST IRON

The new colony of Queensland, when it separated from New South Wales in 1859, started out with no railways and only a few poor tracks. It depended on coastal shipping, despite the difficulties of navigating a hazardous coast. It inherited a single lighthouse, at Cape Moreton, a stone tower built by convict stone masons and labourers in 1857 using sandstone quarried on the site.[2]

One of the first appointments made by the new colonial government was a marine surveyor, Captain George Poynter Heath. From his appointment in 1859 to his retirement in 1887 Heath was responsible for supervising the opening of 13 new ports, establishing 33 lighthouses, 6 lightships and 150 small lights and marking 724 km of the inner route through the Great Barrier Reef. Captain Heath advised a parliamentary select committee that set out the beginnings of the policy for developing lighthouses along the Queensland coast.[3]

Queensland's 7,000 km mainland coastline with its capes, shoals, shifting sand spits, tides and other navigation hazards, sits behind the 350,000 km^2 Great Barrier Reef – a complex of islands, cays and reefs. The coastline is not well provided with suitable stone for building traditional lighthouse towers.

In 1864 the select committee recommended erecting lighthouses at Sandy Cape and Bustard Head. Selection of these two sites reflected the importance at that time of the ports of Maryborough and Rockhampton. The government acted, and its agents in England procured two complete lighthouses in 'kit' form, with towers of cast iron segments made to be bolted together on their sites. The two towers were manufactured by different foundries in England, though their designs were similar. The Bustard Head tower was cast by Hennet & Spink of Bridgwater in Somerset, and the Sandy Cape tower by Kitson & Co of Leeds in West Yorkshire. Both were equipped with lantern houses and optical apparatus manufactured by Chance Brothers & Co of Smethwick near Birmingham, the major English lighthouse equipment maker. The Bustard Head lighthouse was first lit in 1868, and Sandy Cape in 1870. These fully-imported cast iron lighthouses were effective, though costly.[4]

The two cast iron lighthouses were erected by private building contractors under the supervision of officers of the Department of Public Works and with the advice of the Portmaster. The contractors also built timber houses for the light keepers. Erecting the iron lighthouses was quick, but getting the lighthouse components and other materials to the sites and preparing concrete bases beforehand took many months. The departmental staff and the contractors learned some useful lessons about the best ways to organise the works – lessons they would later apply to other lighthouse projects.

Figure 2. *The cast iron plates of the Bustard Head lighthouse tower*

3. THE EARLY TIMBER TOWERS

Even before the cast iron lighthouses were erected, the government had begun building small lighthouses to guide mariners at port entrances. These were timber framed and sheeted towers, generally square or hexagonal in plan. A lighthouse of this kind, built in 1866 at Cleveland Point, still survives.[5] On Woody Island there is a leading pair of lighthouses marking the line of a channel approaching the entrance to the Mary River, also dating from 1866.[6]

These timber towers – with their hardwood frames, truncated pyramidal forms, and horizontal weatherboard sheeting – were similar to New Zealand lighthouses designed by John Blackett through the 1870s and 1880s.[7] Blackett acknowledged North American precedents for such forms, and there may have been American influences on the Queensland designs too. While Blackett was refining the design of timber lighthouse towers to improve stiffness, wind resistance and durability, the Queensland designers were finding different ways to deal with these problems.

Figure 3. *Burnett Heads lighthouse (photo: Bundaberg Regional Council collection)*

4. THE PROTOTYPE TIMBER-FRAMED, IRON-PLATED TOWER: LADY ELLIOT ISLAND

Lady Elliot Island lighthouse, first lit in 1873, marked the beginning of a new system for building larger coastal or landfall lights with timber frames. The designer was Robert Ferguson (1840-1906), at that time a District Foreman of Works attached to the office of the architect F D G Stanley, Superintendent of Public Buildings.

Ferguson already had some lighthouse experience – he wrote the specifications and oversaw the erection of the iron lighthouses at Bustard Head and Sandy Cape, and was probably responsible for the 1866 timber towers on Woody Island. Ferguson was a skilled, innovative and practical architect who was later responsible for the

standardised design of a series of many timber school buildings.[8]

For Lady Elliot Island, Robert Ferguson developed a composite form of construction, which combined the economy of timber framing with the weather-tightness and durability of iron plating. This design brought together the established materials and techniques of timber-framing and boiler-making. The components of the tower were pre-fabricated on the mainland, shipped to the island, and assembled there.

The lighthouse tower was round in plan and tapered in profile, forming a truncated cone. The battered outer walls were framed with sawn hardwood posts and rails bolted together, with joints reinforced with wrought iron straps and brackets. The walls had light timber braces which would have served to stabilise the timber structure before the iron shell was fitted. There were three intermediate floors with hardwood joists and pine floor boards. In the centre of the tower was a vertical timber weight tube, which formed a central support for a winding timber stair that climbed up the bottom three levels of the tower. On the fourth level, where the conical tower was too small to fit a stair, there was a fixed ladder up to the level of the light room and balcony.

The frame was supported at the bottom by a segmented cast iron ring that formed a base, bolted down to a massive concrete footing and floor cast within a low stone wall. The timber posts were bolted to lugs made as part of the iron ring.

The tower was clad with a covering of galvanised wrought iron plates, about 2.5 mm thick, which were rolled to the conical shape. Joints between the plates were lapped and riveted, and the plating was screwed to the timber framework and to the iron ring at the base. A timber door was fitted at the bottom of the tower, and glazed windows at each floor level.

At the top of the tower was a timber framed structure which formed the floor of the lantern room and the projecting balcony surrounding the lantern. This balcony floor had a flooring of timber boards with a waterproof covering of lead sheet. On this floor was assembled a hexagonal lantern room with a domed roof, all constructed by the building contractor – this was probably done to save the cost of an expensive imported prefabricated lantern. Inside the lantern was a typical Chance Brothers 4th order (250 mm focal radius) rotating optical apparatus with kerosene (paraffin) wick burner and weight-driven clockwork.

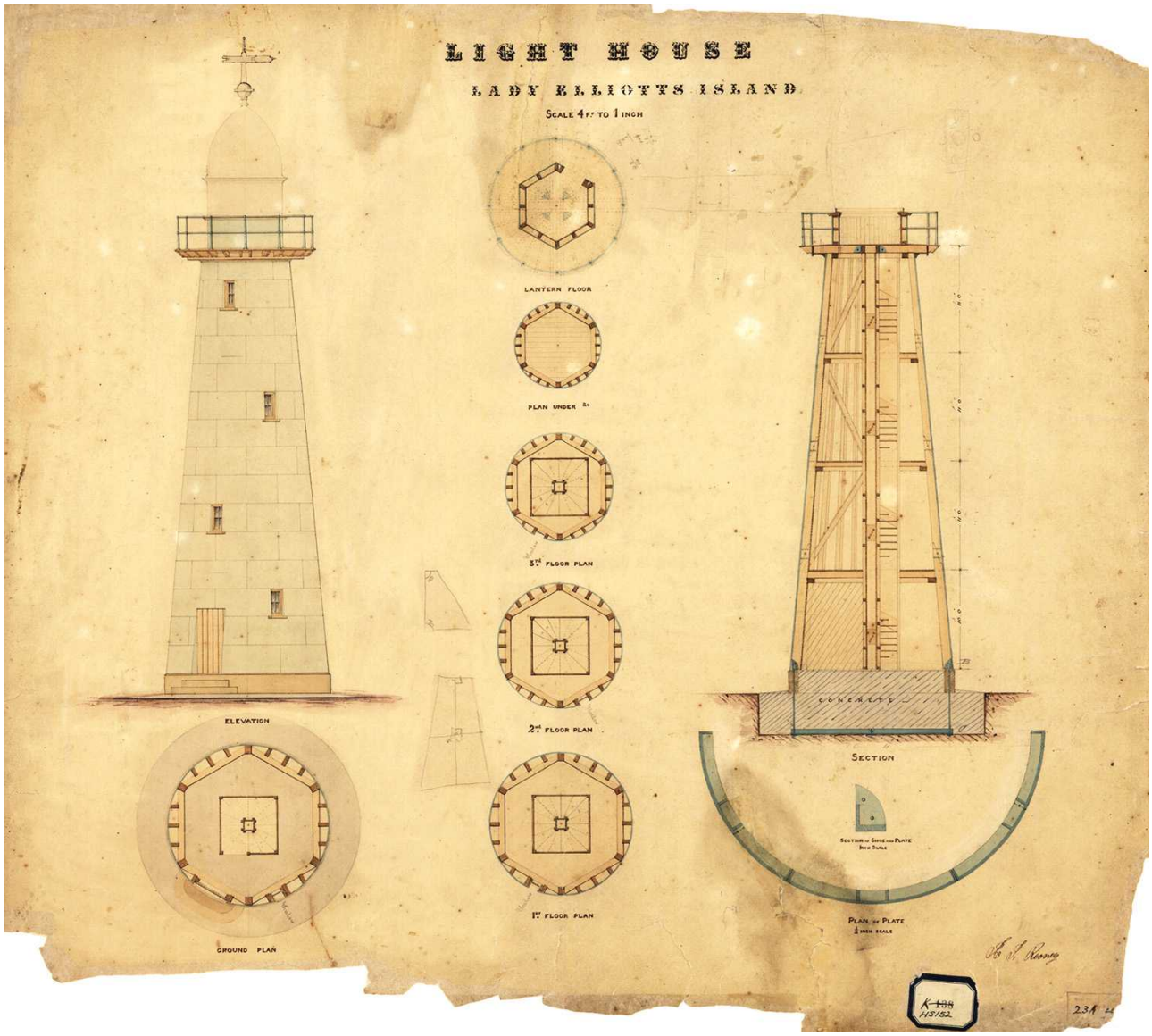

Figure 4. *One of the contract drawings for the construction of the Lady Elliot Island lighthouse*

Some of the main benefits of this design were nicely argued by F D G Stanley in a report to the government:

On connection with the Tower, as to construction and material, I would beg to remark that while the present design is more costly than the original, which was similar to those erected on Woody Island and entirely of timber, it is submitted that the increased strength and durability gained by using boiler plate casing, concrete foundation etc. will eventually more than compensate for the greater outlay in the first instance, the shrinkage and decay of timber sheeting in exposed situations such as the Lighthouse will occupy, being so great, as to render it almost impossible to keep the buildings weatherproof. Added to this the destruction caused by the white ant to all timbers placed below or upon the ground, is such as to render it most desirable, that every means should be used to place timber framing as far as possible beyond their reach.[9]

Stanley did not mention the structural benefits of the design, in particular the resistance to wind loads provided by the timber frame, the iron shell, the cast iron ring and the concrete base, all of which were strongly connected. In a region subject to regular cyclones this was important.

5. A SERIES OF TOWERS

After the Lady Elliot Island lighthouse was satisfactorily completed in 1873, eleven more of the same basic type were built – the last at Booby Island in the Torres Strait in 1890. The attributes of the sites were varied, but most were remote and difficult to access. Some of the sites were on coral cays or sand spits that required tall towers, and some were on rocky capes or islands where shorter towers would do. They were all equipped with Chance Brothers optical apparatus, ranging in scale from 2nd order (700 mm focal radius) to 4th order (250 mm focal radius).

The height of each tower was determined in response to the elevation of each site, and the range required. The shortest of the towers (Flat Top Island) was just 6 m from the ground to the lantern floor, and the tallest (North Reef) was 24 m. The details and materials were refined as the series evolved, but the basic structural system established at Lady Elliot Island was retained.

6. NORTH REEF

The most remarkable of the series was North Reef Lighthouse, and not only because it was the tallest. This lighthouse, completed in 1878, is an important aid to navigation along the Great Barrier Reef, built on a small migratory patch of sand inside a fringing coral reef. There was no stable ground available to build houses for the lighthouse keepers and their families, so minimal keepers' quarters were incorporated in the lighthouse tower. It operated as a 'bachelor' lightstation, staffed by keepers without families.

The tower sits on a cylindrical caisson of cast iron segments bolted together, sunk below low water onto a foundation of coral, and filled with concrete. This iron and concrete base is 13 m in diameter and 4.6 m high, with voids formed inside the mass of concrete for storage of fresh water. The tower was originally surrounded by the sand island, but the island later migrated away from the tower, leaving the lighthouse surrounded by water. It is now again surrounded by sand.

The 24 m high main tower was generally similar to that at Lady Elliot Island, but on a larger scale. There were four intermediate floor levels, and the optical apparatus was of the 2nd order. Apart from the iron and concrete base the most unusual aspect of the structure was the ring of rooms around the base of the tower. Here were the keepers' quarters, comprised of three bed rooms, two kitchens, two sitting rooms, and a store room – perhaps the head keeper had a private kitchen and sitting room, and the two assistant keepers had to share. The keepers quarters were framed and lined with timber, with a roof covering of galvanised iron with rolled seams, and external wall sheeting of corrugated galvanised iron.

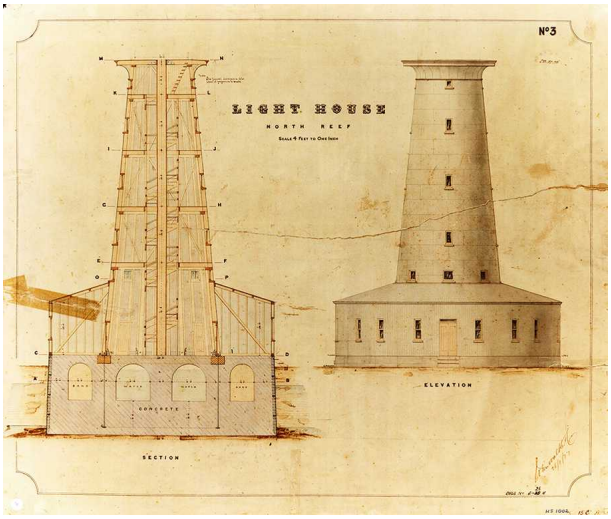

Figure 5. *North Reef lighthouse, 1878*

7. A LOWER COST VARIANT: CORRUGATED IRON CLADDING

In the 1880s a variant design was introduced for shorter towers, with corrugated galvanised iron sheeting instead of the thicker boiler plate. The first of this type was built at Goods Island in the Torres Strait. The timber framework had heavy timber cross bracing, but was otherwise similar to the iron plated type. The sheeting was specially formed with tapering corrugations to suit the conical shape of the tower.

Figure 6. *Interior of Goods Island lighthouse*

8. LOSING REGIONAL VARIATION: THE COMMONWEALTH LIGHTHOUSE SERVICE

Coastal navigation aids became a commonwealth responsibility after federation, but it took a few years to integrate the separate colonial lighthouse services into a new Commonwealth Lighthouse Service and to transfer the colonial assets to it. By 1912 the new arrangements were in place, and work began to upgrade lighthouses and build new ones. The new lighthouses were designed in a central office in Melbourne, and the distinctive character of the various colonial lighthouse services faded. The timber and iron towers in Queensland were kept in service, and their equipment upgraded, but no new towers of the distinctive Queensland type were built.

After 1912 new major Australian lighthouse towers, everywhere around the country, were built of reinforced concrete or steel lattice frame construction.

9. NEW TECHNOLOGY IN OLD TOWERS

Through the 19th and 20th centuries the lighthouse equipment was upgraded as improved equipment was developed. From about 1900 wick burners were replaced by pressurised incandescent burners, bringing substantial increases in brightness and efficiency, a process that gained momentum after the Commonwealth Lighthouse Service took over. Rotating lenses were mounted on mercury float bearings, more reliable and efficient than the previous generation of roller bearings. Some of the early lantern rooms were replaced by new Chance Brothers lanterns in the 1920s. From 1913 automatic acetylene apparatus – including the sun valves, flashers and rotating pedestals patented by Gustav Dalén's and produced by the AGA company – were introduced. More recently, electric lighting has taken over, generally using solar powered Vega VRB-25 apparatus made in New Zealand.

The most significant change to the lightstations has been their complete automation and de-manning. The last manned lighthouse in Queensland was automated, and the keepers withdrawn, in the 1990s.[10]

The nineteenth century towers have accommodated major changes to the optical and lighting equipment, without requiring substantial change to the towers.

10. A SUCCESSFUL DESIGN, BUT A DEAD END?

Of the twelve timber framed lighthouse towers with riveted iron plating built between 1873 and 1890, ten still survive. Six remain in service as major coastal or landfall navigation aids (Low Isles, North Reef, Cape Cleveland, Dent Island, Double Island Point, Booby Island). Two have been dismantled, moved and re-erected in museum settings (Cape Bowling Green and Pine Islet). Two more are no longer operating, but are conserved in situ (Lady Elliot Island and Flat Top Island).

The statistics for the corrugated iron towers are similar. Of the four examples listed in the table, two are in service (Goods Island and Grassy Hill) and the other two have been conserved – one in a museum (Bay Rock) and the other returned to its original site (Caloundra).

For most of their operating life these towers were well maintained by the resident keepers, and by itinerant tradesmen brought to the stations several times each year by the lighthouse steamers and tenders. Since de-manning, the towers have been maintained by periodic visits by Transport Department staff or, more recently, by the maintenance contracting company which commissioned my survey in 2006. The main task has been the maintenance of the paint which protects the iron plating.

North Reef lighthouse has been unmanned since 1978, and received periodic flying visits from technicians. It is due for major maintenance, which AMSA is planning to undertake. The other operating towers are all in good condition. They demonstrate the quality of their original design and construction, and more than a hundred years of timely care. Altogether the lighthouse towers have performed well, and have justified F D G Stanley's confidence in the durability and long-term value of the form of construction.

But, despite their innovative design, they appear to have had no influence outside of Queensland – they are, perhaps, an evolutionary dead end.

11. REFERENCES

See below

12. APPENDIX – TABLE OF MAJOR 19TH CENTURY QUEENSLAND LIGHTHOUSES

Lighthouse	*Year*	*Height*	*Order*	*Cost of buildings*	*Cost of optical apparatus*	*Structure*	*Extant*	*Moved to*	*In service*
Cape Moreton	1857	21 m	1st, catoptric	£15,232	included	stone	yes	-	yes
Bustard Head	1868	10 m	2nd	£4,835	£2,124	cast iron	yes		yes
Sandy Cape	1870	30 m	1st	£12,000	£3,000	cast iron	yes		yes
Lady Elliott Island	1873	17 m	4th	£1,820	£263	timber frame, iron plating	yes	-	no
Cape Bowling Green	1874	16 m	3rd	?	?	timber frame, iron plating	yes	Sydney	no
Cape Capricorn	1875	7 m	3rd	£3,938	£1,295	timber frame, iron plating	no	-	no
Low Isles	1878	18 m	3rd	£4,090	£1,389	timber frame, iron plating	yes	-	yes
North Reef	1878	24 m	2nd	£9,208	£2,359	timber frame, iron plating	yes	-	yes
Cape Cleveland	1879	11 m	4th	£2,635	£514	timber frame, iron plating	yes	-	yes
Dent Island	1879	10 m	4th	£2,558	£592	timber frame, iron plating	yes	-	yes
Flat Top Island	1879	6 m	4th	?	?	timber frame, iron plating	yes	-	no
Archer Point	1883	9 m	?	?	?	timber frame, iron plating	no	-	no
Double Island Point	1884	12 m	3rd	£3,556	£1,533	timber frame, iron plating	yes	-	yes
Pine Islet	1885	11 m	2nd	£4,540	£2,345	timber frame, iron plating	yes	Mackay	no
Goods Island	1886	5 m	4th, fixed	£2,406	£165	timber frame, corrugated iron sheeting	yes	-	yes
Grassy Hill	1886	6 m	4th, fixed	£842	£156	timber frame, corrugated iron sheeting	yes	-	yes
Bay Rock	1886	8 m	4th, fixed	?	?	timber frame, corrugated iron sheeting	yes	Towns-ville	no
Booby Island	1890	18 m	2nd	£4,244	£2,321	timber frame, iron plating	yes	-	yes
Caloundra	1896	9 m	?	?	?	timber frame, corrugated iron sheeting	yes	old site	no

[1] The best general published history of Australian lighthouses (now out of date and out of print) is Reid, Gordon 1988, *From dusk till dawn: a history of Australian lighthouses*, Macmillan, Adelaide.

For a recent impression of the range of Australian lighthouses see these two coffee table books: Ibbotson, John 2001, *Lighthouses of Australia: images from the end of an era*, and 2006, *Lighthouses of Australia: the offshore* lights, both published by Australian Lighthouse Traders, Surrey Hills.

See also, the *Lighthouses of Australia* website, http://www.lighthouse.net.au

[2] For an account of Queensland lighthouses before 1900 see Thorburn, J H 1967, 'Major lighthouses of Queensland, part 1', *Queensland Heritage*, vol 1, no 6, May 1967 & 'part 2', *Queensland heritage*, vol 1, no 7, November 1967.

See also, Davenport, Winifred 1986, *Harbours & marine: port and harbour development in Queensland from 1824 to 1985*, Department of Harbours & Marine, Brisbane.

[3] 'Heath, George Poynter (1830-1921)', *Australian dictionary of biography online edition*, http://adbonline.anu.edu.au/biogs/A040420b.htm

[4] Buchanan, Stuart 1999, *Lighthouse of tragedy: the story of Bustard Head Lighthouse: Queensland's first coast light*, Coral Coast Publications, Samford. See also Thorburn, 'Major lighthouses of Queensland, part 1.'

[5] Queensland Heritage Register Entry, http://www.epa.qld.gov.au/chims/placeDetail.html;?siteId=15547

[6] Queensland Heritage Register Entry, http://www.epa.qld.gov.au/chims/placeDetail.html;?siteId=16990

[7] Blackett, John 1879-80, 'New Zealand lighthouses', *Minutes of the proceedings of the Institution of Civil Engineers*, vol 60, pp 334-38;

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[8] Watson, Donald & McKay, Judith 1994, *Queensland architects of the 19th century: a biographical dictionary,* Queensland Museum, Brisbane.

[9] Quoted in Thorburn, 'Major lighthouses of Queensland, part 1', pp 22-23.

[10] For an account of the lightstation de-manning, see Buchanan, Stuart 1994, *The lighthouse keepers*, Coral Coast Publications, Samford.