Anchor Tin Mine, Tasmania: a century of struggle for profitability

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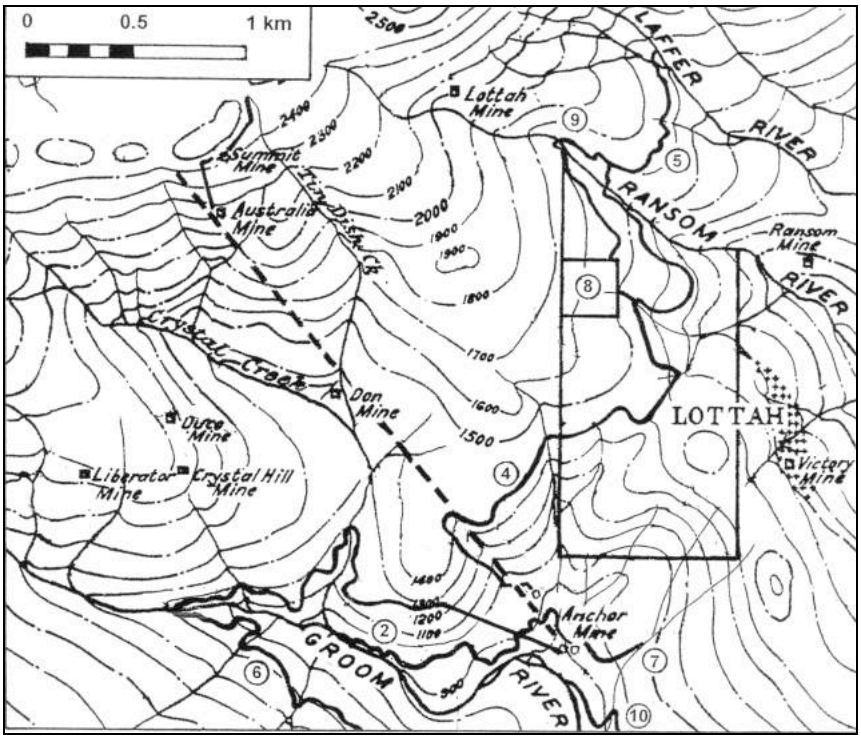
The Anchor mine was located on the southern footslopes of the Blue Tier, a broad dome rising to a height of 750-850m in north-eastern Tasmania (Fig. 1). Deeply incised and steeply graded country made access for mining purposes difficult but south-easterly flowing rivers that drained the Tier, including the Groom and its tributaries, the Crystal and Tin Dish Creeks, as well as the Ransom and Laffer Creeks, were utilised by the Anchor and nearby mines to generate power for mineral processing. Access to the Anchor mine's battery site adjacent to the Groom River at an elevation of 260m was gained from a ridge that separated the Groom and Ransom valleys. The Lottah township was established on a flat-lying section of this ridge at an elevation of 440m.

Figure 1: *Mines located on the southern slopes of the Blue Tier, water races supplying the Anchor Mine and aerial ropeway to Australian Mine. (See Appendix 2 for reference numbers, contour levels in feet).*



Source: Mineral Resources Tasmania, Plan 834-32, March 1943 with additions from Mineral Charts Weld2 & 4, July 1934.

Geologically complex, both in terms of overall structure and the associated mineralisation, a detailed understanding of the granite batholith complex of northeast Tasmania was not established until post-WW11. This led to much confusion and conflicting opinions by successive Mines Department geologists. At the Anchor mine

the tin mineralisation is now attributed to pneumatolytic alteration and greisenisation of the upper batholith contact that is marked by a discontinuous pegmatite band up to 0.3m in thickness. Greisenisation extending to a depth of about 40m below the contact is described as variable and also affects many of the associated dykes, all of which added to the early confusion.[1]

This paper outlines the chequered history of the Anchor Tin Mine, the largest open cut mine on the Blue Tier, where low ore grades determined that the adoption of water power and a high mill throughput were essential for profitable operation. Inadequate and inconsistent rainfall, rugged topography, difficult site access, a complex orebody and demanding ore processing requirements challenged a succession of experienced mine managers. Although substantial finance became available following floatation in England, poor management retarded development and a reliance on Cornish mining practices hindered the implementation of efficient tin dressing techniques. Failure to undertake a comprehensive prospecting programme ultimately led to an early termination of operations in 1914, higher grade deposits later being worked periodically through the 20th century by both open cut and underground mining methods.

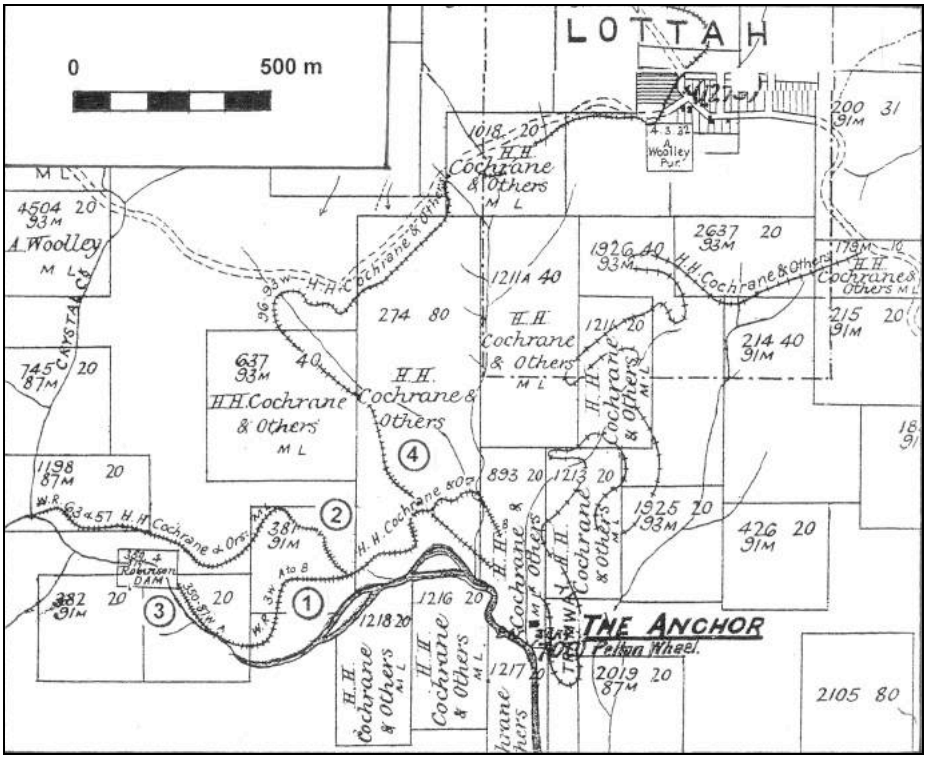
Initial site development 1882 - 1883

Prospecting of the Anchor tin mine was pursued through 1881 by a retired master mariner, Captain James William Robinson with the assistance of his sons, Alfred Bingley and William Arthur. The family held a 32-hectare lease (Section 274 on Fig. 2) and three 8-hectare leases (Sections 893, 1211 & 1213) that surrounded a disputed 16-hectare lease (Section 1211A), the ownership of which was decided by a Court of Mines hearing on 15th March 1881. The hearing ruled in favour of Joseph Harbottle but the ruling was overturned in the Supreme Court on 5th July due to an error on the plan produced by the Lands & Works Office. This finding enabled the family to consolidate the mineral leases and promote development of the mine.[2] Captain Robinson received a cash offer of £22,500 from a representative of an English syndicate while the Supreme Court hearing was underway but this was refused, a decision that he later described as 'the mistake of my life'.[3] A prospectus was issued at the end of the month seeking to raise £41,400 in 30 shilling shares, and was fully subscribed at the time an application to register the Anchor TM Co. [Tin Mine Company] was made in September. The initial capital raising of £27,600 included payment of £17,000 and 5,000 shares to the Robinson family, with £5,000 being allocated to working capital. The principle shareholders included Capt. Robinson (2,500), C.A. & C.W. Chapman (3,700) and Alexander McGregor (1,500), accounting for almost 28 per cent of the stock.[4]

Planning proceeded rapidly following the appointment in October 1882 of John Symonds as mine manager and a Melbourne mining engineer, John Lewis, who was contracted to prepare development recommendations, produce tender documents and liaises with machinery suppliers. In November, Thompson & Co. of Castlemaine was awarded a contract to supply a 20 Head Battery [HB] and iron components for a waterwheel and dressing equipment at a cost of £2,990. At this juncture 50 men were engaged preparing the machinery site and clearing the alignment for a highly sinuous

3.8km tramway extending from the Lottah road (Fig. 2). By the end of the year, 600m of timber rails for the tramway had been cut and Lewis had returned to establish the plant layout and water supply requirements. Tenders for excavating a water race from the Groom River were called in February 1883, and by the end of the month a wheel pit for a powerful 18.3m diameter pitchback waterwheel (Fig. 3) had been excavated, and the tramway completed. By this time almost £3,000 of the working capital that included a down payment of £1,000 to Thompson & Co. had been spent, and the first call to shareholders was about to be made.[5]

Figure 2: *Anchor mine lease holdings, water races pre-1900 and access tramway to the northeast.*



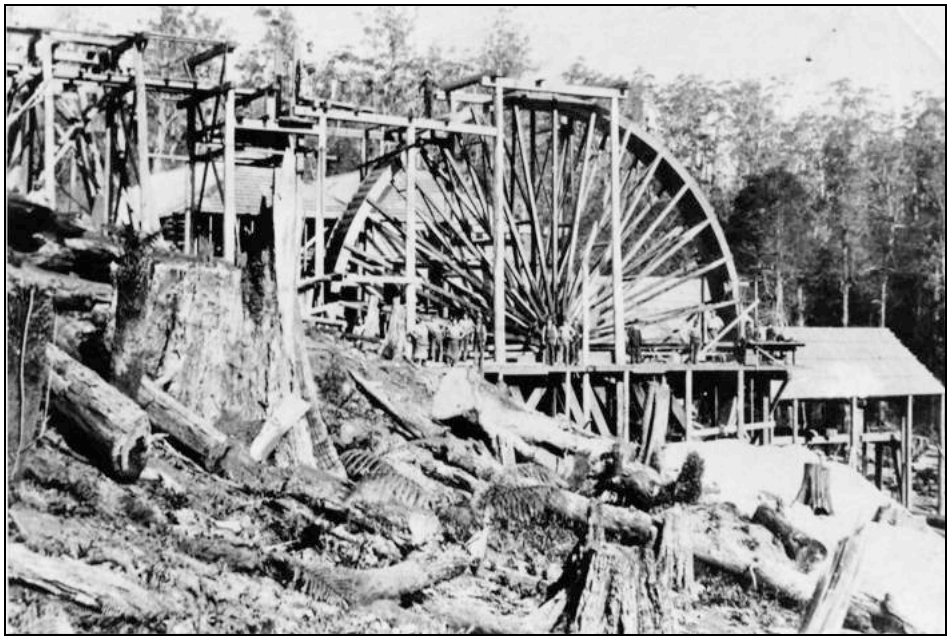
Source: Journals of the House of Representatives, Tasmania, vol. 45, no. 55, September 1901.

A Victorian engineer, Dr. Joseph Dawe, was appointed to supervise the erection of the battery and waterwheel in March, and three weeks later the first machinery consignments that included the 4.5 tonne [t] waterwheel centres were being hauled to site from Georges Bay (St. Helens). Applications for the rights to 24 sluice-heads from the Groom River were registered in July, approval being delayed by a requirement to survey the locations of four proposed storage dams.[6] To avoid further delays the directors decided to proceed without dam construction, a decision that was to restrict operations during the summer months. Three weeks later, even before the deposits had been thoroughly tested, the directors rashly committed to further expenditure when tenders were called for an additional 20 HB. Thompson & Co.'s tardy performance with the supply of machinery also delayed progress, as the final consignment was not delivered to site until October, some two months after the scheduled delivery date. Progress on site was further slowed by a shortage of carpenters to construct the

waterwheel, battery shed and 400m of fluming to connect the waterwheel and headrace.[7]

Meanwhile, construction of Lewis's tin dressing plant proceeded, incorporating four separating tubs (classifiers), eight buddles to his own design, and two slime tables.[8] At the end of October the last of the 160 iron buckets was fitted to the 1.37m wide timber-framed waterwheel that became the largest erected in Tasmania, having an operating weight of about 100 tonnes.[9] Completion of the fluming the following month enabled the battery to commence operation on 12th December 1883, after a 13-month construction period. Expenditure to the end of June that included £2,000 for machinery, £1,600 for the tramway and water race construction, and £1,550 for wages,[10] had amounted to £7,400, a sum that exceeded the initial working capital by almost 50 per cent.

Figure 3: *Pitchback waterwheel and 40 HB (1883 - 96).*



Source: St. Helens History Room.

Failure and closure 1884 - 1885

The first crushing of 500t at 1.0 per cent was encouraging but by mid-May when the first period of battery operation ended, the grade of gold in the ore had fallen to 0.77 per cent. At the shareholders meeting in March it was resolved to undertake a review of the processing plant and William White of the West Bischoff TM Co. was engaged.[11] Finding that the classifiers were 'unable to separate sand and slime', leading to poor recovery, White recommended the adoption of Borlase buddles (a Cornish design introduced to Tasmania by Richard Mitchell at the East Bischoff mine) to improve recovery and reduce dressing costs.[12] When the battery resumed operation in July, recovery rates had not improved, and six weeks later the company urgently sought the opinion of H.W.F. ('Ferd') Kayser, manager of the Mount Bischoff TM Co. Kayser, who had been ridiculed by a contingent of Cornish tin dressers about the effectiveness

of the Mount Bischoff plant, did not hold back when declaring that the 'dressing plant was costly, complicated and almost useless'.[13] Up to the end of 1884, development costs to the order of £17,000, were funded by the original working capital (£5,000), income from ore sales (£4,700) and calls on shareholders of 9 shillings per share, not all of which were honoured (maximum of £12,420).[14]

Development work during 1884 included construction of the lower water race (Ref. No. 3W) that was underway by January in response to a shortage of water for battery operation; fabrication of the second set of stamps by the Launceston ironworks of W.H. Knight for £685; and ironwork for buddles recommended by White for installation in the second 20 HB.[15] Following dissatisfaction expressed at the August shareholders meeting, Alex McGregor instigated the appointment of Richard Mitchell from the Waratah Alluvial Co. at Mt. Bischoff to try to revive operations. Mitchell, an experienced Cornish miner, had previously erected a battery at the Cadia (NSW) mine before working for nine years at Mt Bischoff. To reduce costs at the Anchor, he introduced self-feeding chutes for the stamp batteries and modified the buddles to improve recovery, however, the results were disappointing for grades remained unchanged at 0.77 per cent.[16] The additional expenditure of £1,655 was sourced from ore sales (£607) and calls to shareholders of 9 pence per share (£1,035). Operations continued until the end of November when shareholders declined further revenue raising, a total production of 157t tin oxide realising only £6,700.[17] The following month a prophetic summary appeared in the Hobart Mercury:

> So the Anchor stampers are again hung up in peace and the majestic water-wheel will again receive its usual Xmas exercise – four turns round night and morning, with a cold shower-bath ... this mine is like Mount Nicholas, too big for Tasmanian investors.[18]

Failure of the first venture has been attributed to an inadequate water supply, poor ore handling methods and inefficient dressing equipment, to which should be added excessive expenditure on an over-engineered waterwheel and duplication of the plant capacity before the ore deposits were adequately tested.[19] The mining engineer responsible for the plant design, John Lewis, had worked for 20 years on the Central Victorian gold field, particularly at the New North Clunes GM [Gold Mine] where he introduced the Lewis-Munday buddle, before establishing a consultancy in Melbourne in 1876.[20] In November 1881, the New Providence GM Co. at Beaconsfield engaged him before he became heavily involved in numerous mining projects on the northeast and west coast tin fields of Tasmania. Lewis adapted his buddle design for use in a number of tin mines, with the Anchor being the largest application.[21] The failure of the Anchor venture was widely associated with Lewis's lack of tin dressing expertise and his reputation dissipated practically overnight. Any involvement at the Anchor mine appears to have ceased by mid-1884 and he retreated to the mainland to manage a number of silver mines in the Barrier Ranges of NSW between 1887-1888 (Pinnacles, Treasure & Dora mines) and the Enmore gold mine in NSW in 1890.[22] Lewis shared his inability to establish efficient tin dressing practices for the fine grained Tasmania

deposits with a number of experienced engineers at Mt. Bischoff, who were proficient in both Cornish (Wesley, Mitchell & White) and German (Kayser) practices.[23]

Long stagnation 1886 - 1895

In February 1886, the property was purchased at auction for £630 by Capt. Robinson, who took a 25 per cent stake in a partnership with Hobart bookmaker, Francis Pike (25 per cent), and Alexander McGregor (50 per cent). Any activity undertaken in the following two years went unreported but by May 1888 Capt. Robinson's son Arthur had ten stamps operating, Lewis's ineffective separating tubs and slime tables were removed and the buddles modified. Extension of the water race to the lower mine workings enabled weathered 'lodes' to be ground sluiced, with the tin recovered in sluice boxes constructed to the design of Capt. Hancock at the Moonta (South Australia) mine. The income generated enabled 16 Alves concentrators to be installed in the battery shed.[24] At the time of the first visit by Mines Department geologist Alexander Montgomery in November 1889, only ground sluicing was being undertaken, the battery dressing plant having 'been altered by successive managers and allowed to fall into bad repair till now it is in a deplorable condition'. Montgomery considered the waterwheel to be 'a fine piece of work but it is a great pity a cheaper and more modern type of motor was not erected in its place'. He also commented on the potential for water storage on the top of the Blue Tier where a dam could impound some 900ML at Wheal Tasman Flat.[25]

Relative to their holdings, £2,400 was raised in September 1888 by the syndicate members to enable new equipment to be purchased. A stonebreaker was acquired to reduce the size of the battery feed, this being driven off the waterwheel shaft. In addition, in August 1890, the buddles were stripped out of the battery in preparation for installation of seven Frue vanners driven by a 1.22m diameter pelton wheel using a pressure head of only 15m.[26] After the battery re-commenced operation and up to Montgomery's second visit in January 1893, production amounted to 137 tonnes at an average grade of 1.1 per cent (see Appendix 1). Using no more than 30 stamps that crushed less than one ton per stamp in 24 hours, some £6,320 was raised. While production costs (mining and milling) averaged 6s 9d per ton, a sum comparable with the performance at Mt. Bischoff, Montgomery believed this could be reduced if a typical throughput of three tons per stamp in 24 hours could be achieved. In concluding his report, Montgomery emphasized the need to establish the size and grade of the ore deposits, considering that anything over 0.5 per cent of black tin would allow them 'to confidently look forward to the Blue Tier district becoming quite as famous as Mount Bischoff'.[27]

William Dickinson was appointed mine manager when Arthur Robinson left the Anchor to be appointed manager of the Full Moon Extended mine in September 1892. Although tribute working commenced in September 1893 with R.J. Johnston employed as the battery manager, Capt. Robinson appears to have retained an active involvement at the mine until at least late 1894. No production figures are available for this period but a profit of £3,000 during the final two years of operation can be attributed to Robinson's sustained persistence. However, the intention was for this profit to be re-invested in the mine in preparation for sale, rather than to benefit the syndicate.[28]

English ownership: a 'tin swindle'?

Negotiations for the sale of the mine proceeded in England early in 1894 and were completed by May when Alex McGregor accepted an offer of £20,000. Details of the sale process were revealed in later court actions that were not completed until August 1897. Capt. Robinson was one of the litigants claiming that McGregor had deceived him into relinquishing his share of the mine for £1,500. He considered that the sale process was fraudulent, describing the affair as the 'Anchor swindle' in his reminiscences penned in 1904 when aged 80.[29]

The Anchor TM Ltd was floated in London with a nominal capital of £150,000 of which only a third was available as working capital. A substantial proportion of the available funding (between 30-50 per cent) appears to have been misappropriated during the sale process, and this limited future expenditure and constrained mine development for the following 20 years. The new board of directors included chairman Alfred Deedes (a banker) and Henry H. Cochrane (a Durham colliery owner) who had financed the purchase of the mine. In November 1895, William Wesley was appointed mine manager on a three-year contract, to oversee the re-development that was to take over two years.[30]

Re-development 1896 - July 1898

Initially, an unprecedented 200 HB to be driven by four 52kW steam engines supplied by twelve 22kW boilers at an estimated cost of £7,500 was proposed as it was realised that a large mill throughput was required to make the low grade deposits profitable. Processing of 1,000t of 0.5 per cent ore per day was considered the base level to break even, an annual profit of £15,600 calculated for each incremental 0.125 per cent increase in ore grade. Inevitably, this had been scaled back to a 100 HB towards the end of the year, but even so it was the largest proposed to that time in Tasmania. Water rather than steam power was substituted at the instigation of mine manager Wesley. Even for a 100 HB, the proposed throughput would have required a highly efficient plant for each stamp to crush five tons per day of high strength rock. The company was now committed without detailed prospecting, but could the required quantity of ore exceeding 0.5 per cent grade be found, and were adequate water supplies available to achieve a low cost operation?[31]

Progress initially was far from ideal, for just a few days after the sale had been concluded the previous May, the battery shed was burnt to the ground during bush fires. The remaining Frue vanners were destroyed in another fire on 9th January 1896, thereby effectively clearing the machinery site. But this also ensured that income would be limited to proceeds from alluvial working by tributors during the protracted construction period.[32] A priority was water supply, and applications for eight sluice-heads from the Ransom and Laffer Rivers in addition to the existing entitlement of 24 sluice-heads from the Groom River, were submitted (see Fig. 1 & Appendix 2). This, however, amounted to an increase of only 33 per cent, an obvious shortfall when considering the previous water supply had been inadequate for a 40 HB during the summer months, and this at a time when a 250 per cent increase in throughput was being proposed.

During the first half of 1896, Adam Lee, who subsequently became a director, was engaged to undertake a technical audit of the project, this contributing to the slow progress at the mine site. The first consignment of machinery that included two Gates stonebreakers and components for a 50 HB from the Sandycroft Foundry (Chester, England) did not reach Launceston until July. Meanwhile, work on upgrading the 0.75m gauge tramway with 13.6kg iron rails proceeded ,a project that was not completed until the end of the year. The tramway descended 180m at an overall grade of about 1 in 19, being worked by gravity, while horses were used to return the empty trucks. A visitor in April 1897 described it as

> … quite serpentine in its windings, doubling back in places till the passenger can see it lying almost beneath him ... by no means the mode of progression a nervous person would adopt by choice.[33]

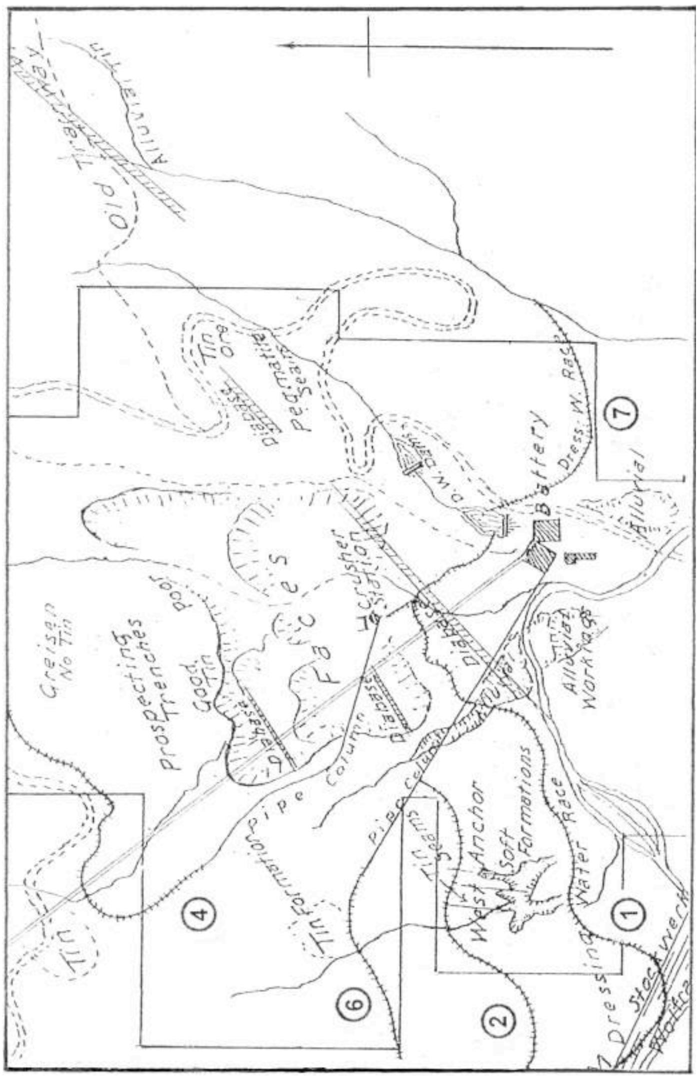
Deliberations over the mode of power supply appear to have taken until August 1896 to resolve, for tenders for water race construction, first called in January, were re-advertised in October when the 'majestic' waterwheel was being dismantled after working well below its design limits over an eleven year period. The chairman, Alfred Deedes, was pursuing the purchase of the Liberator mine (see Fig. 1) for £4,000 at this time, which is likely to have influenced developmental decisions affecting the Anchor mine, as applications for water rights (168-93W and 281-93W) to the headwaters of the Groom River were made in 1897 to enable the Liberator development to proceed.[34]

Two water supply schemes were now to be constructed for the Anchor; a southern scheme from the Groom River at a higher elevation than the earlier one (for which an application has not been found) in order to increase the pressure head for the adoption of pelton wheels, and the northern water race from the Ransom & Laffer Rivers. Both involved considerable sections of timber fluming, 10 per cent (480m) of the northern scheme being elevated where it was conveyed across the saddle used for siting the Lottah township (see Fig. 1), and almost half (917m) of the southern scheme where it crossed tributaries and the Groom valley. Both required pipe columns supplied by Mephan Ferguson in Melbourne; the northern race 660m of 355mm diameter piping to supply a crusher station at a pressure head of 146.4m; and 610m of 406mm piping for the southern scheme supplying the two battery sheds at a pressure head of 79.3m (see Fig. 4). The output from the crusher station was conveyed across a creek bed to the batteries along a 240m long double line tramway at a downward grade of 1:100**,** with horses being used to haul up the empty trucks.[35]

Tenders and subsequent negotiations with the American Pelton Wheel Co. in February 1897 did not proceed until after a visit by Alfred Deedes in December, seven pelton wheels being shipped from San Francisco arriving via Sydney in September (see Table 3 for details).[36] Approval for the second 50 HB also followed Deedes visit, when tenders for a local supplier were called in February to reduce transport costs, W.H. Knight's foundry in Launceston again being awarded the contract for a total of £4,690. Expenditure for the twelve months up to 30th June amounted to some £28,320, including £14,380 for machinery, £2,290 for expenditure in England and £11,645 for Tasmanian expenditure. As total expenditure was now almost £37,000 (74 per cent of working

capital), plans to raise £15,000 from debentures were put in place. A breakdown of expenditure reveals the high price of importing machinery (£430 for shipping & £905 for State import duties), water race construction (£835 contract labour, £765 for timber and £350 pipes) and stamp batteries (approximately £12,000).[37]

Figure 4: W*ater supply races 1905 - 14 showing pipe columns to the crusher station and No.1 battery shed to the east of the No. 2.* (*See Appendix 2 for reference numbers).*



Source: J.B. Lewis, 'The Blue Tier Tin Field of North-East Tasmania', *Chemical Engineering & Mining Review*, vol. 16, December 1923, p. 90.

Adam Lee had already departed for his second visit to Tasmania when a cable from Wesley advised of a delay in completing the plant. A number of reasons were given including late delivery of machinery (pelton wheels and steel piping), missing components from the 50 HB supplied by the Sandycroft Foundry, and the ramifications of poor construction planning. The latter involved the layout of the battery sheds relative to the tailrace that was located within a tunnel beneath the floor of the No. 1 battery (Sandycroft 50 HB). This could not commence operation until the No. 2 battery was largely completed and tailrace was functioning. Lee was finally able to commission the No. 1 battery in February 1898 when 520t was crushed at a grade of 0.78 per cent,

this being in the target range. After Lee's departure, three months passed before crushing resumed on a six day a week basis over a six week period, 12,773t being processed, although details of the yield were not released. *The Mercury* reported that 'the yield of tin ore has not been payable since the first 2,100 tons'. As Wesley was instructed to shut down operations on 9th July, a grade of less than 0.5 per cent would seem to have been a likely outcome.[38]

Increased production but no profits 1899 - 1903

The directors were now under considerable pressure leading to several measures being implemented. Lee was sent back to Tasmania to re-engage Richard Mitchell (then the manager of the S&M tungsten and bismuth mine at Moina) to undertake a review of both the Anchor and Liberator mines, as Wesley's contract had ended in August. Trials of the processing plant supervised by both Lee and Mitchell led to adjustments being made before Lee returned to England in March 1899 after a six-month spell in Tasmania. Rather belatedly, negotiations were completed with the Mines Department for a diamond drill rig to be hired for a nine-hole prospecting programme.[39] An increase in water supply also needed to be resolved, the George River to the southwest of the mine being identified as a suitable source, and an application was made in February 1898 for the rights to 35 sluice-heads. The survey requirements for this must have been daunting, considerable time elapsing before an alignment for a prodigious 48km long race (220-93W) to the North George River for 10 sluice-heads, and a further 19km (223-93W) to the South George River for 25 sluice-heads had been finalised. A measure of the circuitous alignment of the North George section was provided by a later manager, James Lewis, who commented the 'race was well graded ... its intake was only six miles [9.6km] in a straight line from its terminus'. Approval for construction of the section to the North George River appears to have been given during Deedes's second visit to Tasmania in June 1899. After inspecting the property in August 1901, when construction was well underway, Mines Department geologist William H. Twelvetrees commented that 'experience with long partly-flumed races has invariably shown that great loss of water takes place', an opinion that should have been sought at an earlier date.[40] Tenders were let for the race construction in January 1900. By May about 50 men were employed but barely a month later this was reduced to only eight when some 5km had been partly constructed from the George River.

Work on the project had been suspended by July due to funds being diverted to undertake construction of a short-lived smelter at St Helens. Tenders for the smelter closed in February, and by May, brickwork, including the chimneystack, was completed by Hobart contractor Stabb Bros. Commissioning followed in October after an expenditure of £3,400. Supervision of the smelter construction was entrusted to E.W. Woodgate, a metallurgist recruited from NSW.

Work had resumed on the race by March 1901 when labour became available due to mining activities being limited because of a shortage of water. By October some 21.6km had been cut by the company's labour, augmented by the work of five contractors. It was finally completed in June 1902 at a cost of £14,335.[41] As the new

race delivered water 37.5m higher than the 1897 race, additional power could be generated, thereby raising the water consumption to 1.22ML per hour for both power and ore dressing (equivalent to 30 sluice-heads). This amounted to approximately 40 per cent of the Mt. Bischoff usage for a similar mill throughput of up to 140,000t per year, thus supporting the claim that economical dressing methods had been introduced. A journal report of 1923 noted the race as providing adequate water in winter but in dry weather the flow

> was not sufficient to overcome the loss [from evaporation and seepage] due to the great length of the race ... had it been constructed 100 ft. higher up, it would have been less than half the length, would have carried more water and at 100 ft. greater pressure.[42]

A review of operations undertaken by a Cornish engineer, Capt. James Harvey, towards the end of 1902, emphasized a requirement for the batteries to run at maximum capacity to reduce operating costs, even if steam power was used in the summer months. He was highly critical of the smelter design and accused Woodgate of incompetence, noting that a major structural defect had resulted in the furnace floor collapsing when first charged, Closure of the smelter was recommended until sufficient tin oxide was available to ensure that it operated at full capacity (40t per month), and this at a time when the entire Blue Tier production amounted to only 45t per quarter.[43]

Following lobbying of MHA members, Danish civil engineer Karl L. Rahbek was engaged on 1st May 1901 to investigate water and power supply issues affecting the Blue Tier mines. The fieldwork was completed by 19th June and a preliminary report prepared by 23rd September. Available hydrological data for the Blue Tier was limited to rainfall on the top of the dome for a 12-month period to August (rainfall in 1901 was below average) of 1,300mm. Gauging below the confluence of the Ransom and Laffer Rivers indicated that these combined catchments had a winter flow of 14 sluice-heads when Rahbek estimated that the Anchor mine required 13 sluice-heads of 'dressing water' for an annual mill throughput of 40,000t (that is, about 32 sluice-heads required for 100,000t throughput). Rahbek confirmed the Wheal Tasman Flat as the prime site for a 760ML storage dam capable of supplying 20 sluice-heads continuously for 38 days. This may have been adequate to ensure the Anchor mine operated at full capacity through the summer months if supplemented by the George River race then under construction. However, the storage dam was also required to meet the demands of the other operating mines that included the Moon, Puzzle, New Crystal Hill and Liberator, all of which used pelton wheels for power generation. The costs of the storage dam and supply races were estimated to be £94,000 (excluding land acquisition and access road construction), which effectively terminated any further detailed consideration of the scheme.[44]

Prior to the George River race being completed, annual throughput during Mitchell's period of management averaged 39,000t at a gradually falling grade from 0.39 per cent to 0.35 per cent (see Appendix 1). An operating loss of £1,190 was reported for the year ending June 1899 increasing to £5,800 in 1901. The financial situation up to 1902 was summarised in the 1906 annual report that showed total

income of £107,195 as against accumulated losses of £23,700. Consequently, re-financing, including calls at 5s per share, expected to raise £28,500 was adopted following appointment of a new chairman, C. Williamson Milne in June. Milne revealed that all of the overburden was now being processed, indicating a lack of confidence in the previous prospecting. Inevitably this led in the following year to a diminution in grade (to 0.23 per cent) that was compensated for by increased water availability from the George River race, resulting in a 250 per cent increase in throughput (see Appendix 1). This was achieved by doubling the number of operating stamps to 76 for the year ending June 1903, thereby demonstrating to the shareholders that the considerable expenditure on the race had been justified (see Appendix 4).

Mitchell was to be the last of the Cornish tin dressers. In October 1902, Lindsay C. Clark, a civil engineering graduate from Melbourne University, who had been recruited from Mt Lyell, replaced him.[45] Clark's tenure although brief, coincided with a visit by Donald Clark who was collecting information for his book on Australian mining. He monitored operations over a fortnight and came to the conclusion that it was 'the cheapest mining, milling and concentration in Australia ... yet this wonderfully low return [0.21 per cent] ... showed a profit of more than £100 per fortnight'.[46]

Profitability at last, then closure 1903-17

In May 1903, Lindsay C. Clark was replaced by another Melbourne University civil engineering graduate, James Bannatyne Lewis (no relationship established with engineer John Lewis), formerly manager of the North Brothers Home No. 1 mine, an alluvial tin mine venture on the Ringarooma River. He was born into a mining community at Whroo in northern Victoria, where his father accumulated considerable wealth from claims while working the Balaclava Reef.[47] Lewis implemented a number of measures that culminated in a long overdue period of profitability.

The first significant development commenced in March 1904 with an application for a dam site on the Marie Louise Creek and feed race that was implemented (see Fig. 1 & Appx. 2), to finally correct a 20-year deficiency. Construction began in June and was completed early in 1905 when the northern water supply was re-directed to a crusher station located within the open pit workings (Fig. 4). A Hadfield & Jack (Heclon) gyratory crusher of 60 tonnes per hour capacity was installed to handle blocks of ore up to 100kg passing to two Gates stonebreakers before being conveyed to the stamp batteries. The Heclon crusher was operational by June 1905 driven by an Australian-designed and manufactured pelton wheel supplied by A.G.M. Michell of Melbourne.[48] Lewis also re-modelled the dressing plant after January 1905, dispensing with 40 double-plunger jigs (due to the high power and water requirements) and 34 vanners (low capacity and high maintenance cost) and six buddles. These were replaced by 26 tables to the design of the battery manager, Mitchell claiming these to be twice as efficient as the vanners.[49]

These measures had a dramatic impact on the mill throughput and operating costs (see Appendix 4), the latter being described at the 1905 annual general meeting as 'an almost phenomenal figure', the production cost (that of mining and milling) having fallen to 2s 6d per ton. This impressive result was approximately 40-50 per cent of that

achieved at Mt. Bischoff before Kayser was replaced as mine manager.[50] Above average rainfall of 1,995mm in 1903-04 enabled the batteries to operate at near capacity (91 per cent) for the first time, achieving a throughput of 138,034t.[51] At this time the Mt Lyell Mining & Railway Co. Ltd. commenced prospecting on the Blue Tier and their consultant-mining engineer, Luke Williams, produced a preliminary report in November 1904, which revealed that the record production produced a profit of only 1.3d. per ton. Despite funding an extensive prospecting programme on the Blue Tier in 1906-07 at a cost of £10,000, no large payable deposits were discovered and the Mt Lyell Co undertook no further work.[52]

Increased annual revenue of between £16,000 and £20,000 was obtained during 1903-1906 on the back of the increased production and a rising tin price that reached a high of £173-£181 per ton the following year. A record production of 156,198t for 225t of tin oxide in 1906-07 produced revenue of £29,450 and the first operating profit of £5,040 after debenture interest of £1,875 had been distributed. Favourable rainfall had coincided with the record tin price to reduce working costs to 2s. 4d. per ton, the lowest figure attained over a prolonged period. Alluvial working along the Groom River floodplain had contributed to the bottom line, as 25,540m^3 had been treated for a profit of £525. However, the income was used to offset previous deficits and no dividend was paid. Deteriorating conditions now followed, with lower rainfall leading to reduced output and consequently, declining revenue.[53]

The final strategy for sustained profitability revolved around an application for a State Government loan of £5,000 in August 1908 to finance working of the Australian and Puzzle deposits, located towards the top of the Blue Tier dome, some 400-450m higher in elevation. Construction of an aerial ropeway linking them with the Anchor battery was proposed to overcome the topographical constraints (see Fig. 1). This appears to have been a political ploy to draw attention to the lack of government support, as eight months later, liquidation of the 1902 company was announced and another re-structure completed. Controlled by the same board of directors (Milne, Deedes, Cochrane & Lee) the Company had a nominal capital of £70,000.[54] Conditions deteriorated further in 1908-10 when drought conditions prevailed and bush fires destroyed the Australian battery shed and other infrastructure in January 1910, including timber stockpiled for construction of the aerial ropeway trestles and flumed sections of the Anchor race. The opening ceremony of the aerial ropeway was finally held in March 1911, enabling higher grade ore deposits to be accessed. This was to be a short-lived respite, however, as the next high in the tin price in 1912-13 (to £192-£210 per ton) coincided with a resumption of drought conditions, reducing mill throughput to only 86,240t in 1913. A slump in the tin price in 1914 (to £151 per ton) led to closure in June, with the miners accepting tribute working in lieu of unpaid wages. The Government, as the principle secured creditor, instigated a fire sale in 1917 and disposed of the remaining infrastructure to Hobart foundry owners, Kennedy & Sons for a scrap value of only £2,000.[55] The 1909 re-structure had raised a further £31,700 from shareholders, bringing the total expenditure over a 31 year period to almost £200,000, a noteworthy figure when considered that no dividends had been paid.[56]

Higher grades not sustainable 1923 - 96

Intermittent working in the first half the 20th century (Appendix 1) involved smaller scale operations requiring modest investment capital that could be raised locally. Tasman Tin Mines was formed in 1922 by a syndicate headed by Jack A. Hodgman, a small pelton wheel-powered, second-hand 10 HB being installed in the open cut workings supplied by the northern race from the Marie Louise dam. Production data is limited but Mines Department Geologist Alexander M. Reid reported that 1,144t of the 'richest ore' was sorted and treated at a grade of 0.4 per cent in the first quarter of 1928.[57] Hodgman formed a new syndicate in 1934 raising £3,000 to finance re-location of the 10 HB closer to the 'West Anchor' workings (Fig. 4), where the overburden thickness was reduced, water for the battery supplied by a newly constructed race (2292W) from the Groom River. Prospecting was supervised by Lindsay Clark and the income generated from crushing 300t per week used to add an additional 10 HB the following year and to pay £3-10s per share in dividends, the first in 50 years of production.[58] In 1936, Tasman Tin NL was formed with a nominal capital of £50,000 to acquire the mine, 20,000 shares (£5,000) allocated to the Hodgman syndicate, while Metals Investigation P/L took up 120,000 shares (£30,000). The increased funding enabled additional tabling and vanning units to be installed together with a new pelton wheel, the work force being increased to 34, and production raised. A temporary drop in the tin price in 1938 (to £189 per ton) soon halted progress, leading to tribute working being re-introduced due to the low grade deposits being exploited (0.19 per cent), which continued until the end of 1942.[59] This marked the end of large-scale open cut working and milling performed by stamp batteries, the remaining 20 HB being a rare survival of 19th and early 20th century technology from Tasmanian and Victorian foundries.[60] The postmistress was the final resident of Lottah, leaving in 1950, to allow the vegetation to reclaim the township site.[61]

A period of underground mining between 1989-1996 targeted higher ore grades of 0.4-0.6 per cent (Appendix 1) but even with modern technology and prospecting methods, operation was terminated by 'grade problems, an under-performing mill and the weak tin price', the same issues that confronted a succession of mining engineers and mine managers almost a century earlier.[62]

Conclusions

Low tin grades limited the ouput from the Anchor mine during a century of intermittent operation to about 4,600t of tin oxide, making it the third largest Tasmanian *lode* deposit to be worked after the Renison Bell mine at Rosebery and Mt. Bischoff. The Anchor output is, however, dwarfed by the last two mentioned mines, forming about 6 per cent of Bischoff's total output to 1940 and approximately six months production from Renison Bell in recent years. Development costs were high due to the rugged terrain and extended supply route, factors shared with many Tasmanian mine sites. Although favourably located for the adoption of waterpower, rainfall was inconsistent leading to regular shortages in the summer months and increased operating costs. While the initial development funded by local investors was under-capitalised, the second

venture after 1895 was well funded by English capitalists yet failed to deliver a sustained period of profitability due to:

- a bungled sale in England resulting in the misappropriation of some 30-50 per cent of the investment income,
- management being slow to grasp the water supply and storage requirements to ensure that the processing plant operated at near maximum capacity,
- systematic prospecting not being assigned a suitable priority and when eventually undertaken proving to be ineffective, leading to tin grades being diminished by processing the entire overburden profile,
- prolonged reliance on expensive Cornish tin dressing practices associated with a high water consumption, and
- wasteful expenditure on an overly long water supply race and an aborted smelter project.

With the benefit of systematic prospecting, later ventures during the 20th century demonstrated that deposits with grades of 0.4-0.6 per cent remained unworked. Although these were targeted for underground mining between 1989-96, the final ventures on the Anchor lease also failed to produce sustainable profits.

Acknowledgements

The assistance of AMHA member Greg Dickens with drawing searches and the supply of plan copies by Mineral Resources Tasmania is gratefully acknowledged.

Endnotes

[1] D.I. Groves, *et al*, 'The Blue Tier Batholith', *Geological Survey Bulletin no. 55,* Mineral Resources Tasmania [hereafter *MRT*], 1977, p. 89.

[2] *The Mercury*, 16 March 1882, p. 3, 26 April 1882, p. 2, 3 May 1882, p. 3; *Launceston Examiner*, 10 May 1882, p. 3, 6 July 1882, p. 3; Capt. Robinson published a detailed account of the dispute in J.W. Robinson, 'A statement of the facts involved in the late mining case of Harbottle versus Robinson', nd,, Mitchell Library collection, DSM/042/P325.

[3] *Australian Town & Country Journal*, 15 July 1882, p. 23; M. Nash (ed.), *Captain Robinson: the reminiscences of a Tasmanian Master Mariner*, Blubber Head Press, Hobart, 2009, p. 133; M. Nash, 'The reminiscences of Captain James William Robinson, 1824-1906', *Papers & Proceedings of Tasmanian Historical Research Association*, vol. 55, no. 1, March 2008, pp. 42-43.

[4] *Tasmanian Archives & Heritage Office* [hereafter *TAHO*], MIN66/1/262, September 1882; *The Mercury,* 28 July 1882, p. 1.

[5] *TAHO,* MIN66/1/262, September 1882; *ibid.,* 18 October 1882, p. 3; *ibid.,* 30 November 1882, p. 3; *ibid.,* 20 December 1882, p. 2; *ibid.,* 28 December 1882, p. 3; *ibid.,* 14 February 1883, p. 3; *ibid.,* 24 February 1883, p. 3; *ibid.,* 27 February 1883, p. 3.

[6] William Pretyman (WP) to John Lewis, 15 March 1883, WP to John Symons, 5 April 1883, 'Anchor TM Co. letterbook', NS1012/1/4, *TAHO*; *Tasmanian Mail,* 5 May 1883, p. 11; 'Mineral Lands Act 1877', *Journals of the House of Representatives, Tasmania* [hereafter *TPP*], vol. 35, no. 54, 1877, p. 5, defines a sluice-head as 'a quantity of water as shall pass through an aperture 16 inches wide and one inch deep with a pressure not exceeding six inches'.

[7] WP to John Symons, 27 April 1883, WP to John Lewis, 1 May 1883, WP to Thompson & Co, 17 August 1883, 'Anchor TM Co. letterbook', NS1012/1/4, *TAHO*; *Tasmanian Mail*, 6 April 1883, p. 3; *The Mercury,* 29 June 1883, p. 3; *Tasmanian Mail,* 28 July 1883, p. 22.

[8] G. Thureau, 'Report on the Blue Tier Mining District and its Tin Deposits', *MRT,* OS066, February 1886, p. 3.

[9] *Launceston Examiner,* 19 October 1883, p. 3; *Daily Telegraph,* 12 January 1889, p. 2; the Anchor waterwheel diameter was variously reported to be 60ft, 64ft and 66ft, scaling of the people in Fig. 3 suggests that the lower dimension is representative.
[10] *Ibid.*, 21 December 1883, p. 3; *The Mercury*, 22 August 1883, p. 3; 30 November 1883, p. 3.
[11] *Tasmanian Mail,* 26 January 1884, p. 20; 'Anchor TM Co. - reports of mine yield', NS1012/1/9, *TAHO*; WP to William White, 6 March 1884, 'Anchor TM Co. letterbook', NS1012/1/5, *TAHO*.
[12] *The Mercury*, 25 March 1884, p. 3; for the adoption of the Borlase buddle by the East Bischoff TM Co., see *ibid.,* 8 April 1884, p. 1, and by Waratah Alluvial TM Co., see *ibid.*, 23 May 1883, p. 3, 24 May 1884, p. 1.
[13] *The Mercury*, 28 August 1884, p. 3; *ibid.,* 3 February 1885. p. 3; WP to Ferd Kayser, 21/8/1884, NS1012/1/5, *TAHO*; for the animosity between the Cornish tin dressers and Kayser see Nic Haygarth, 'Tasmania's Mount Bischoff tin mine: Dolcoath of the Antipodes?' in *Proceedings of the 8th International Mining History Congress*, Cornwall, 2009, pp. 148-49.
[14] *The Mercury*, 27 March 1884, p. 3; *ibid*., 3 February 1885, p. 3; NS1012/1/9, *TAHO*.
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[16] *The Mercury*, 28 August 1884, p. 3, 12 March 1885 p. 3; *Tasmanian Cyclopedia*, vol. 2, Maitland & Krone, Hobart, 1900, p. 540.
[17] *Ibid.,* 3 February 1885, p. 3, 27 November 1885, p. 3; NS1012/1/9, *TAHO*.
[18] *Ibid.,* 16 December 1885, p. 4.
[19] G. Jackman, 'An archaeological survey of the Blue Tier tin-field', vol. 2, *Forestry Tasmania*, 1997, pp. 126, 135.
[20] *The Argus*, 31 December 1874, p. 6, 18 October 1876, p. 7, 30 December 1876, p. 5.
[21] *Ibid*., 3 November 1881, p. 10; for involvement at Tasmanian tin mines see for example, *Launceston Examiner*, 23 December 1881 p. 10 (Mt. Cameron), 31 January 1883 p. 4 (Mt Bischoff), 15 September 1883, p. 3 (Ben Lomond); *The Mercury*, 11 February 1882, p. 3 (Mt Heemskirk), 10 July 1882, p. 3 (Ringarooma River), 19 August 1882, p. 3 (Blue Tier).
[22] *Sydney Morning Herald*, 29 June 1887, p. 11; *The Argus*, 30 January 1888, p. 9, 6 January 1890, p. 3.
[23] For William H. Wesley's practices for dressing alluvial tin at the Great Britain TM (NSW) using his 'tin extractor', see Michael Pearson & Barry McGowan, 'Mining Sites in NSW: History & Heritage', *NSW Department of Industry & Investment*, 2008, p. 194; for similar equipment at Mt. Bischoff see *The Mercury*, 24 May 1879, p. 3, 18 October 1879, p. 2, 11 March 1884, p. 2; for Richard Mitchell see endnote 12 above; for William White, manager of West Bischoff TM Co. see *The Mercury*, 30 August 1881, p. 3, 20 December 1881 p. 3; for Ferd Kayser manager of Mt. Bischoff TM Co. and a comprehensive account of the milling methods see D.I. Groves, et al, 'A Century of Tin Mining at Mount Bischoff 1871 - 1971', *Geological Survey Bulletin, no. 54*, 1972, pp. 53-92, *MRT*.
[24] *Launceston Examiner*, 27 February 1886, p. 4, 3 March 1886, p. 2; *The Mercury*, 25 June 1888 p. 4, 2 November 1888, p. 3, 19 August 1897, p. 4; *Daily Telegraph*, 12 January 1889, p. 2.
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[27] A. Montgomery, 'A Report on the Tin Mines at the Blue Tier, County of Dorset', OS101, January 1893, *MRT*.
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[29] *Daily Telegraph*, 24 March 1896, p. 3; for details of Capt. Robinson's Supreme Court hearing see *The Mercury*, 17 July 1897, p. 1, 19 July 1897, p. 4, 20 July 1897, p. 4, 21 July 1897, p. 4, 19 August 1897, p. 4; Nash, Nash, *Captain Robinson: the reminiscences of …*, 2009, pp. 1, 4 & 135.
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[31] *Ibid*., 7 November 1895, p. 3, 10 October 1896, p. 4, 20 April 1897, p. 4; *Launceston Examiner*, 17 June 1896, p. 5; *Daily Telegraph*, 9 July 1896, p. 4.
[32] *Ibid*., Supplement, 11 January 1896, p. 1, 17 June 1896, p. 4, 5 January 1897, p. 4, 20 July 1897, p. 4.
[33] *Ibid*., 14 July 1896, p. 4, 16 December 1896, p. 4, 20 April 1897, p. 4; *Daily Telegraph*, 8 July 1896, p. 4.
[34] *Ibid*., 30 December 1897, p. 4, 24 February 1898, p. 4; 'Registers of applications for water rights', MIN90/1/2, *TAHO*; *TPP*, vol. 37, no. 44, July 1897, p. 12.

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[37] *Launceston Examiner*, 18 February 1897, p. 3; *The Mercury*, 30 December 1897 p. 4; *North West Post*, 3 July 1897, p. 4.
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[42] *Launceston Examiner*, 2 January 1903, p. 2; H. Herman, 'Australian Tin Lodes and Tin Mills', *Proc. Australasian Institute Mining Engineers*, no. 14, 1914, p. 361; *CEMR*, vol. 16, September 1924, pp. 463-67.
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to the Tasmania TM Co. at Ben Lomond in 1882 and 5 HBs installed in the Mercury battery at Alberton for the Mercury GM Co. in 1883 and Caxton GM Co. in 1884; Keith Preston, 'Mount Victoria Goldfield', *Journal of Australasian Mining History*, vol. 9, 2011, pp. 185, 187; *Launceston Examiner*, 11 April 1883 p. 2; *Daily Telegraph*, 8 May 1884 p. 3.

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Appendix 1: *Summary of Tin Production at the Anchor Mine*

Mine Manager	Period	Ore Treated (tonnes)	Tin Oxide (tonnes)	Grade (%)
John Symonds(1)	12/1883-12/1885	18,722	157	0.84
William Robinson	1888-12/1892	> 12,504	> 137	1.09
Tribute working	1/1893-2/1898	?	?	?
William Wesley	2/1898-7/1898	13,500	< 68	?
Richard Mitchell(2)	1/1899 – 6/1901	112,946	441	0.39
	7/1901-6/1902	42,632	170	0.35
	7/1902-6/1903	109,608	254	0.23
	1/1899-6/1903	265,186	865	0.32
James B. Lewis	7/1903-6/1904	138,034	246	0.18
	7/1904-6/1905	120,532	193	0.16
	7/1903-5/1914	1,111,488	1,745	0.16
Tribute working	6/1914-1917	22,549	43	0.19
Blue Tier Tin Mines	1923-28	?	159	?
	1934-35	20,398	113	0.55
Tasman Tin	1936-42	132,986	250	0.19
Spectrum Resources(3)	1989-91	124,000	756	0.61
Mancala(3)	1995-96	91,000	364	0.40
Total		> 1,812,000	c4,650	c0.25

Notes: (1) Plant design produced by John Lewis.
(2) Replaced by Lindsay Clark October 1902.
(3) Underground mining adopted, all previous workings by open cut.

Appendix 2: *Summary of Water Races*

Original Ref. No.[1]	Fig 1&2 Ref. No.[2]	Source	Application Date	No. SH[3]	Length	Construction Date
Southern Supply						
3W	1	Groom R	?	24	1410m	6 - 9/1883
57 + 63W	2		1/6/1883		1160m	
350-87W	3		6/11/1890		140m	c1891
2292W	–		1933	?	1910m	8/1933-3/1934
George River Scheme						
220-93W	6	N.George R	11/2/1898	10	43km	5/1900-5/1902
223-93W	–	S. George R	4/3/1898	25	19km	Not constructed
'Dressing Race' (102W) & Alluvial Workings (337W)						
102W	7	Groom R	20/11/1902	1	500m	c1903
337W	10	Groom R	19/5/1905	–	c1600m	?
Northern Supply						
96-93W	4	Ransom R	14/12/1895	3	3700m	12/1896-1/1898
103-93W	5	Laffer R	8/2/1896	5	1005m	
216W	8	Marie Louise Dam	7/3/1904	–	–	6/1904-3/1905
263W	9	Ransom R	31/10/1904	1	1055m	

Notes: (1) Mines Department registers of water race applications (TAHO MIN90).
(2) Numbered in order of application date.
(3) SH = Sluice-head, equal to 0.68 cubic metres per minute or 41.1 kilolitres per hour.

Appendix 3: *Anchor Mine: Summary of Batteries*

Operating Period	Number Stamps	Manufacturer	Power Source
12/1883 - 12/1885 1888 - 5/1895	20	Thompson & Co, Castlemaine	18.3m diameter pitchback waterwheel. 1.2m pelton wheel added 6/1890 to drive Frue vanners.
	20	W.H. Knight, Launceston	
1/1898 - 1917	50	Sandycroft Foundry, England	2 x 1.5m pelton wheels for 50 HB's. 2 x 460mm pelton wheels for concentrating plant. 2 x pelton wheels for rock breakers. Small pelton wheel for sawmill + fitters shop. 610mm pelton wheel added 1905 to drive Heclon gyratory crusher.
	50	W.H. Knight, Launceston	
1923 - 28	10	?	Erected at the crusher station.
1934 - 50	10	Thompson & Co, Castlemaine	Pelton wheel, details unknown.
	10	Salisbury Foundry, Launceston	

Appendix 4: *Anchor Mine output and production costs 1901 - 1912*

Year Ending/Mine Manager	Ore Treated (tonnes)	Grade (%)	Average No. Stamps Operating	Output (t/stamp/day)	Production Cost/t [(1)]
Richard Mitchell + Lindsay Clark					
6/1901	40,850	0.38	35	4.2	4s 3.25d
6/1902	42,632	0.35	42	4.3	4s 4.5d
6/1903	109,608	0.23	76	4.0	3s 6d
James Lewis					
6/1904	138,034	0.18	91	4.9	2s 6.5d
6/1905	120,532	0.16	74	5.1	?
6/1906	124,322	0.15	73	5.4	2s 5.2d
6/1907	156,198	0.15	87	6.0	2s 3.7d
6/1910	102,283	0.16	66	5.6	2s 8.75d
6/1911	102,944	0.16	68	5.7	2s 7.5d
6/1912 - Anchor	77,416	0.15	63	5.5	3s 6d
- Australian	28,992	0.22		6.2	3s 6.25d

Notes: (1) Includes the costs (in shillings & pence) of mining, ore transport to the battery and ore treatment.