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DUCK REACH – THE FIRST SIGNIFICANT HYDRO-ELECTRIC DEVELOPMENT IN AUSTRALASIA

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1. THE DEMAND FOR POWER.

In the United Kingdom the industrial revolution provided the demand for and the means to supply energy in increasing quantities with the great surge of power beginning in the late 1700's. Bolton advised his partner James Watt to develop his stationary engines since "All England is crying out for steam". However in Tasmania water power was extensively developed for mechanically driven flour, timber and other mills. "From 1850 to 1860 there were some 80 flour mills of which 55 were water driven(1)". In his comprehensive world-wide studies, Dallas (2, 3) has shown that because of its lower costs and smooth, constant running, water-power has been the preferred motive force, where practicable, and a major influence on the profitable development of industries, particularly for remote works such as mining and underdeveloped areas. The water wheel was dominant until the 1880s, the mechanical direct turbine until c.1910 and hydro-electric power was well established by the early 1900s. Messrs Gilbert Gilkes and Gordon of Kendal, England, the turbine suppliers to Duck Reach, state "We manufactured our first water turbine in 1856" (private communication p.c.) and Siemens Bros. of London, the generator suppliers, produced the world-first practical dynamo (1865), (devised by M. Faraday c.1831).

In 1877/78 Lester Allen Pelton (1829-1908) Comptonville, California produced the "first successful impulse water wheel…The high efficiency was due to the use of the first splitter type bucket…" (4). By 1904 the Pelton Water Wheel Co. claimed 11,000 installations (9,000 in USA) totalling more than 1x 10^6 h.p. with their highest head more than 2,000ft and their largest installation 30,000 h.p. at Puget Sound (3).

Work by F.de Moleyns (1841), Starr & Wing (1845) and others culminated in Sir Joseph W. Swan's practical carbon filament incandescent lamp (1878), followed by T.A.Edison's (1879). Swan forced cotton wool dissolved in zinc chloride through a die into alcohol, the resulting thread being wound on to formers and baked; Edison chose bamboo and his patents led to a long law suit which was settled in favour of the Swan Electric Light Co. (of 1881). They joined forces in the U.K. (1887) adopting the USA 100 V. and by 1898 cheap British made 200/250 V. lamps were available (5,6).Sir Charles Parson's UK patents for his Steam Turbine and Electric generator were dated 28th April, 1884, the year the public supply of electricity began in both UK and USA. Electric lighting (carbon arc and direct current-d.c.) was in use earlier, for example, the British Houses of Parliament were lit by the equivalent of 3066 standard sperm candles from a steam driven Gramme dynamo (1875) and the New Zealand Parliament buildings were partly lit experimentally for £2254.10.11, using 300 Swan lamps at 5/- ea. and a 16 h.p gas engine and dynamo (1883) (6). The first recorded death from electrocution was in France (1879).

2. TRANSFORMATION AND TRANSMISSION.

Prior to W. Stanley's development of a commercial transformer (1886) d.c. was used, but its high transmission losses and costs, electrolytic corrosion and limited range were major disadvantages. George Westinghouse had purchased (1885) the English patents of Gaulard and Gibbs for a "series alternating current of distribution" (1881) and N. Tesla's patents for his polyphase A.C. System. Stanley worked with Westinghouse and its first alternating current (a.c.) was demonstrated at Chicago (1893) (7). Previously a.c. had been used elsewhere, Lowell (1889) transmitted 20 miles, a Frankfurt exhibition was lit by a.c. transmitted from Lauffen, Sweden, 100 miles away (1891) and from Hallsjon, near Ludvika, a.c. was transmitted eight miles to a mine (3).

The facility to transmit electricity over long distances cheaply and reliably gave access to the enormous potential of hydro-electric generation. However the technical and economic parameters were still developing as indicated by Read, “ development of Great Lake hydro-electric power for use in Hobart would have been impossible before 1895, risky before 1903 and uneconomic before 1907” (7). The first stage of Great Lake (1916) transmitted 65 miles on 589 steel towers at 88kV and distributed at 6.6kV.

The pace of development in UK was severely hindered by public and government opposition to granting “monopoly” rights to developers and a long public enquiry resulted in the Electric Lighting Act (1882). This brought about the complete paralysis of the electrical industry in England. The “Electrician” claimed (Mar. 1884) “the fanatical dread of a monopoly has resulted in there being no business to monopolise”. By contrast, the rapid response of private and largely uncontrolled developers in USA to electrical innovation is indicated by the application of electric traction to tramways with overhead trolley systems (street cars). After several years of trial and modification the first was successfully operated at Richmond, Virginia (1888) and 789 street railway companies were formed in American cities (by 1890) (8). Built by Siemens Bros. the Hobart tramways were the first successful system in Australia (21 Sept. 1893).

3. EARLY HISTORICAL HYDRO-ELECTRIC DEVELOPMENTS.

The following items are a few examples of historically significant developments which formed the genesis of the hydro-electric contribution to the relentless surge of power. Commencing in the late 1800’s they and subsequent developments maintained its momentum until the present time. They have been selected to provide a comparative base for early Tasmanian power developments.

By 1897 the total hydro-electric power development was (x 1,000 h.p) USA 72, Switzerland 32, France 18, Norway & Sweden 20 & UK 4. The then assessed potential of Great Lake was 100 (Tasmanian Parliamentary Paper No. 59 of 1897) (9).The installed capacities of the five Tasmanian hydro-electric power stations on completion of Great Lake-Stage 2 (1923) was 63,000kW compared with Victoria’s 94,000 (1924.5), the populations being 219,000 and 1,625,000 respectively.

3.1 U.S.A

The first hydro-electric plant in North America to supply both private and commercial customers was Edison’s at Vulcan Street, Appleton, Wisconsin (Sept.1882, designated 1977) (4). His thermal Pearl Street Station, New York, was contemporaneous and is said to be the world’s first central generating station (8). The Cataract Co. of Niagara awarded a contract (27 Oct. 1893) for the hydro-electric development of the fall and 100,000 h.p was installed with 5000 h.p units (1894/95). Also to G.E.C. for a 22 mile transmission line to Buffalo to supply 10,000 h.p- later 40,000 h.p (23 Jul.1894) (3).”The first system to provide long distance H.V-3 phase transmission for significant municipal and industrial multi-purpose power use” was Fulsom hydro-electric power system in California (1895) (4).The Snoqualmie Falls cavity generating station, Washington is “ the first underground hydro-electric power station" (1899) and is still producing power (designated 1977) (4). The Sault-Ste-Marie, Michigan hydro-electric complex (1902) “was and remains the largest low head facility in the USA…canal capacity 30,000 cfs...” (4).

3.2 England

Up to 1894 there were eight known hydro-electric stations distributing electricity of which the City of Worcester's station on the R.Teme at Powick was the only one owned, built and operated by a municipal authority. It was opened on 11th October, 1894 when the load, which was mainly domestic and street lighting was 200kW a.c. Of its 4 x 125kW alternators one was driven by a water turbine, one by steam and the other two either by water or steam or both…"With an output of 400kW..(hydro-electric) it was the largest…built in the 19th century for public supply and for two years…the largest hydro-electric station of any kind in the country." It was sold in 1925, but its waterpower was used until 1945 (10).

3.3 New Zealand

The early application of hydro-electric engineering in New Zealand (N.Z) paralleled that of Tasmania, the common influences being suitably located water resources, remote mining activities and the pioneering demand for power. Their subsequent developments have made New Zealand a world leader with installed and potential hydro-electric power larger than that of Japan. N.Z legislative controls were more advanced than those in Tasmania when (1917/18) John H Butters (later Sir John) Chief Engineer and General Manager of the Hydro-Electric Department, (Commission 1930-HEC) was introducing the licensing of electrical contractors and recommending standards for electrical machinery and equipment. There were interchanges of information and experience and, for example, the Auckland Electric Power Board sought Butter's advice and the New Zealand Government requested a report from him on the Hydro-Electric Department's organisation and developments (1922)(11). Although N.Z proceeded under enacted controls there was strong regional independence and "Apart from minor involvement at Rotorua the Public works Department was not involved until their first station at Lake Coleridge was commissioned…" (1915)(12). The Electric Lines Act (1884) and the Counties and Municipal Corporation Acts (1886) gave public bodies special authority to promote the use of electricity, but the Water-Power Act (1903) reserved to the Crown the sole rights to use water power in lakes, falls, rivers and streams for the purpose of generating or storing electricity or other power. Never-the-less the Minister for Public Works (Hon.R.Mackenzie) stated (1910) that, "the Government considers that the time has now arrived to take up with vigour, the question of developing our abundant water power…until all our centres of population have been supplied with hydro-electric energy and until our principal sources of power have been turned to commercial advantage" (6). Much of the N.Z. data which follows relies on references 6, 8 and 12 with some of the sources giving different values and in several cases duplicated information.

The Phoenix Quartz Mining company's Skipper's Creek hydro-electric development is claimed to be the first in N.Z (early 1886). It is described in detail by H.A.Gordon F.G.S, Inspecting Engineer in his reports to the Minister of Mines which are appendices to the journals of the House of Representatives (1186 et. seq.). Since the mine only had secondary rights to the water, "Mr. Prince of Fletcher & Co. electrical engineers, Dunedin,…undertook to erect electrical machinery…now erected on the left branch of Skipper's Creek, about a mile and three quarters from the crushing battery…to generate the electricity. As this is the first time in the history of electricity that it has been employed…to drive extensive crushing machinery, a full description…will not be out of place". Water was diverted from Skipper's Creek via a cutting to the forebay and then to twin wrought iron penstocks each 22 inches in dia; decreasing to 6 then 2.5 inches at the nozzles, to two 6ft dia. Pelton hurdy-gurdy water wheels (manufactured in N.Z. under licence) under 165ft. head, situated at the foot of a near vertical cliff. From the Brush pattern dynamos of the "largest size yet manufactured" d.c. power was transmitted by a No.8 B.W.G.(1/8 inch) copper wire 1 3/4 miles across a 800ft. mountain ridge to the mine battery of 30 revolving stamps.(10x800+20x650 pounds) plus a rockbreaker and two compressors. The output of turbines was about 75 h.p delivering c.50 to the mine. Since the hydro-electric installation and the mine equipment was installed and varied over a period of several years, the operating date of early 1886 could have (effectively) extended into 1887, whilst the outputs are approximations by the Inspecting Engineer. It is not known how long the station operated, but in 1888 he reported the company "has worked out…now merely prospecting".

At Reefton, West Coast-South Island the Reefton Electrical Transmission of Power and Lighting Co.Ltd. "harnessed…the Inangahua River and installed and operated the first hydro-electric plant to be worked by a public body in the colony, supply being given to the town. Indeed it is claimed that it was the first such supply in the Southern hemisphere." (4 Aug.1888)(6). Its initial installation was a 200kW Crompton bipolar dynamo 30/110V, belt driven by a water turbine made by Scott Bros. of Christchurch. The water race was 1.5 miles long and provided 27ft. head at the station. A 110 h.p Boving turbine was installed (1908) and the station was burnt down (1911). A steam prime mover (1901) and replacement generators kept it operating until November 1946, but it is not clear how much of its output was hydro-electricity. It was listed as in operation under the Electric-power Boards Act (1918), but as a steam supply (31st Mar.1919). It was not a supply authority as at 31st Mar.1948, having been taken over by the Grey Electric-power Board (Nov.1946). Its first supply of filament lamps was carried to the works packed in a butcher's basket, but they were all burnt out by 11.00 o'clock.

With the Wellington City Council's agreement an English syndicate, the Gulcher Electric Light & Power Co. installed 4 "Vortex" turbines of 22h.p each, driven by water from the Council's supply, in two stations and lit 500x22 c.p. street lamps (June1889). They subsequently erected a steam station with four horizontal engines each of 75kW (1892) and extended the supply for private use. Their plant and rights were purchased by the Council (1907) and listed as steam (31st Mar.1919) with bulk supply from the Hydro-electric Department.(He-D). The Electrical Supply Co. installed a hydro-electric station to supply the town of Stratford (1898). In March,1919 the station is listed with 800 consumers, water and oil power of 90 and 145kW, a.c. respectively. The Council purchased the company's assets, including a diesel generating plant (1916).

A 1948 return lists it as a Supply Authority with mixed generation as above, however, after its distribution system was changed to 3 phase supply (1926) the Council purchased power in bulk from the Taranaki Electric-power Board. At Outram, Otago a small generator driven by a Pelton turbine supplied the township (1899), it was not listed as operating in 1918 and no further details have been sighted. Hydro-electric plants were installed at Patea and Okere Falls, Rotorua by the He-D (1901) with 50kW a.c. and 70ft. static head and 200kW a.c. and 14ft. respectively. They were still operating as supply authorities at 31st Mar.1948 with 120 and 714 consumers respectively. Power was developed from the Waingorogoro stream by the Hawera County Electric Supply Co. (1903) with an installation of 145kW a.c. from a static head of 55ft. An oil fired unit of 154kW was also installed. The company was not a supply authority by 1948, but was operating as such in 1918.

Waipore Electric-power Co. Ltd, Dunedin constructed the first large hydro-electric station in the South Island (1907) to harness the Waipore Falls by a timber crib dam, 1¾ mile timber flume (replaced by a 4,700ft tunnel, 1909/1911), a 3ft dia. steel penstock under 665 ft.head and 2 Pelton turbines each driving 1000kW a.c. generators. It transmitted 28 miles to Dunedin. It was taken over by the Dunedin City Corporation (1907) before completion and the installation was increased to 4x1000 (1910) and 6x1000 (1913). The earlier machines were subsequently replaced and its capacity increased to 21,400kW (later than 1920). The first large hydro-electric project in the North Island was built and operated by the Waihi Gold-mining Co. Ltd (1913) at Hora Hora on the Waikato River. Capacity was 6,300 kW and transmission 45 miles to Waikato at 50 kV and 5 miles at 11kV to Waihi. It was purchased (1919) by the government and was the "pioneer of the large Government plants". It was submerged after 33 years by the filling of Lake Karapiro. Lake Coleridge, Christchurch &

Canterbury Province was the first hydro-electric development designed, constructed and operated by the Public works department. It initially had an installed capacity of 4,500kW a.c. (Mar.1915), but was subsequently increased to 6,000 (4x1500 in 1920) plus 2x3000 (1923) and 3x750 (1930), then to 34,500kW (by 1950). Static head is 490ft.

3.4 Mainland Australia

The early development of electricity in the mainland States was almost entirely thermal based. Since the main population centres were coastal, they had ready access to technology, equipment and coal. The tyranny of distance caused some of the inland towns to be late in achieving electrification. For example, Corin (see later) is credited with designing and installing electrical stations in “many…country towns. Amongst these…were Albury, Wagga Wagga, Wollongong, Orange, Cowra, Dorrigo and Mullumbinby,” that is after c.1910 (17) whilst their topography and hydrology was, in most cases, unsuitable for hydro-electric schemes. These factors, together with the advent of the railways resulted in thermal generation. Some early mining, flour and timber mills were operated by water wheels such as at Tumut, NSW and in the Australian Alps, also the 22ft dia. Garfield wheel near Castlemaine (15).The Moe-Walhalla railway line (1895) is photographed showing a large wooden water wheel supplied by a long elevated timber flume, (16, pp 54/5) and some such sites may have converted to hydro-electric power. However in his “notes on the electricity supply for Launceston” of May, 1958 (pc) the Director of the Queen Victoria Museum and Art Gallery, Launceston, F.Ellis, states that “Its claim as the first commercial hydro-electric generating station to be built in Australia has remained unchallenged and appears justified”. A counter claim from the township Thargomindah (Qld) for a small water turbine mounted on the outlet pipe of an artesian bore to operate (24 Jan.1893) two dynamos with d.c. supply to 200 street lights and total capacity 16kW, fails to upset the above statement (pc SEC Qld, Oct/Nov 1974).

The first use of electric lighting in Victoria was in Melbourne to celebrate the marriage of the Prince of Wales (1863) when Parliament House, the General Post and the Telegraph Offices were each lit by a carbon arc lamp supplied by adjacent chemical batteries. Using d.c. and overseas technology a number of small electric plants were built. The Victorian Electric Lighting Co. was formed (1881), later the Australian Electric Co.Ltd.(1883), by R.E.Joseph with Professor W.C.Kernot, Chairman and during the 1880s several similar small companies built and operated stations to provide street lights using reciprocating steam or (occasionally) gas engines driving by belt or rope arc lighting d.c. generators. Such companies were also manufacturing, selling or agents for arc and incandescent lighting. The above named company supplied the first electric lighting to Mt.Bishoff Mine (1883) q.v. Their distribution area was small and local, but the Melbourne City Council’s power station (1894) although of “formidable size and supply range… (also)…operated solely on public lighting”. The first significant hydro-electric installations in Victoria were the Sugar loaf-Rubicon System of five power stations (completed 1928) of which Rubicon contains 2x6,000h.p turbines under 1450ft. head (14).

Electricity from the tramway’s Piermont steam power station was used to light Sydney streets (from July,1904); however the influence of one of Australia’s outstanding pioneering engineers, William Corin (1867-1929) on the mainland’s hydro-electric developments occurred later. He was appointed Electrical Engineer to the Launceston Corporation (26th.Nov.1895-May, 1907) and was responsible for management, modifications and additions to the newly completed (December, 1895) Duck Reach hydro-electric power station and its rapidly growing distribution system. His design and supervision of the conversion of the wiring to a 3 phase-4 wire system was one of the “first in the British empire”. He was given leave (1906) to advise the Queensland Government on its Barron Falls hydro-electric scheme and his proposals were eventually adopted (1923/24). He travelled to Fiji for similar consultations (1906), New Caledonia (1920) and advised the New Zealand Government on its Lake Coleridge projects. He was consulted on the North Coast, Clarence et alia hydro-electric proposals (1919). Corin joined the NSW Public Works department (1908) and was appointed Chief Electrical Engineer (1913) and consultant to the Department of Mines. His paper to the Inst.C.E. (UK) "Efficiency Tests of a Hydro-electric Plant with observations upon the Water Power of Tasmania" Vol. CLXXXIII (1911) was awarded the Telford Premium. The Government sent him abroad for 12 months (late 1913/14) to study contemporary power engineering developments in UK, the Continent and USA, following which his paper, "Power Requirements and Resources of NSW" (1915) was the beginning of many important works which he carried out, notably the Burrinjuck, Dorrigo and Nymboida hydro-electric projects. Although his chief responsibility was for thermal installations, his hydro-electric knowledge was applied to these other developments. The three hydro-electric stations serving public supply had installed capacities of Nymboida 4,800kW, Wyangala 7,500 and Burrinjuck 2,000 (1950). He proposed and estimated the cost of a Snowy Mountain hydro-electric scheme (1920). He resigned (Dec.1923) and entered private practice as a Consulting Engineer, served on the Federal Capital Commission and his name was honoured by the Corin Dam on the Cotter River, Canberra (1966) (17). It is evident from the above that its timing, size, standards and pioneering hydro-electric development gave Duck Reach primacy and status in the mainland states and elsewhere, which together with Corin's professional capacity was reflected in his post Tasmanian career.

3.5 Tasmania

Mt.Bishoff Tin Mining Co. Waratah installed a Swan Electric Light d.c. System in their offices, workshop, and the Manager's house (19^{th}June1883 et seq.) The dynamo was operated from one of their five water wheels. The company subsequently installed a dedicated Pelton turbine, two more dynamos and extended electricity to other equipment and plant, including d.c. from a rotary transformer to their locomotives, and 400 incandescent lamps at Waratah (1886) which is claimed to be the first town permanently lit electrically in Australia. The hydro-electric lighting of their works is considered to be the first in an Australian industry. The company also built and operated a significant hydro-electric power development (before Dec.1907) with two Escher-Wyss Pelton turbines under 500 foot head and Westinghouse alternators each 150kW. Two additional sets of Voith turbines and AEG 375kVA alternators were added (19^{th}.Sep.1909 and 1912 resp.). The now neglected station and m/c's are extant, but have been stripped of copper and other salvage items. The mine was effectively closed (1945) and the power station (c.1950) (19).

Waverly Woollen Mills, (1872) near Launceston used a 36ft. undershot water wheel and later three Gunther Garrad turbines, 35 and 50 h.p (1890) and 100 h.p (1922). Electric lighting was installed (5^{th} July 1889) using an Anglo-American Brush Co. dynamo and a Leffels water turbine. The 120 year old mill is open daily and some of the plant is extant (p.c.). Pioneer Tin Mine, near Derby built and operated (Apr.1909) its Moorina hydro-electric power development including the large rockfill Frome Dam 720ft. long, 60ft. high which is the earliest in Australia (18) and one of the first in the world to be built with an upstream waterproof concrete membrane. The three Voith (of Heidenheim) turbines at 423 ft. static head and AEG 375kVA alternators are operating in original condition as also are the dam, canal, penstock and power house (19).

Mt.Lyell Mining and Railway Co.Ltd. built and operated the Lake Margaret hydro-electric power development (Nov.1914) initially with 4x1750b.h.p Pelton turbines directly coupled with leather flexible linked belting, to 4x1200kW (at 0.8 power factor) GE alternators. Two additional sets of Boving and Gordon turbines were added (1918) and a seventh (1930) to 8,400kW station capacity. A lower head downstream hydro-electric station was built (1928-32) with a Boving (Francis) turbine and 1,600kW alternator. Both stations are operating in substantially original condition, except that the penstocks to both have been replaced together with the control board, main buspipes and valves to the main station (19).

Great Lake- first stage hydro-electric development was commenced (Aug.1911) by the Hydro-Electric Power and Metallurgical Co., but due to the Great War and the resulting financial problems, the Government took over the Company's assets and the Hydro-Electric Department, now Hydro-Electric Commission, completed the first stage when power was formally switched on first at Waddamanna and then in Hobart by the Governor-General, Sir Ronald Crauford Munro-Ferguson (6th.May, 1916). Two Boving (Pelton) turbines under 1123 foot static head, coupled with 3,500kW Westinghouse alternators gave an output of 7,000kW. Power was transmitted 65 miles to Hobart at 88kV and distributed at 6.6kV. Great Lake-second stage included the construction of the 40 foot high concrete multiple (27) arch No.2 dam. It was the world's leading dam for its type and size at this time. Great Lake capacity was thereby considerably increased and the headwaters of the Ouse River were diverted into it by the Liawenee Canal. Waddamana canal and associated hydraulic works were similarly increased with additional penstocks plus 7x6000kW m/c sets of Boving Pelton turbines and Westinghouse alternators at Waddamana A power station, total output being 49,000kW with 9 m/c sets (Nov.1919 to Apr.1923). Transmission was increased with a second line to Hobart, extended to Electrona, and one to Launceston (1921/22). The development was made obsolete by the diversion of Great Lake northwards via Poatina and the power station withdrawn from service in its 50th year (30 June, 1965). It is conserved as an HEC museum in original condition. The Great Lake hydro-electric power development was justly described as the "first major works of this type in Australia". It was a product of the continuing search for power and was authorised by the Complex Ores Act of 1909. The electrolytic purification of such ores from the mainland and the West Coast of Tasmania required large electrical capacity at low prices. Indicative power costs at the time were £75 per h.p year, the major contracts with the HED in the 1920s were £2, and £2/10/- and New Zealand hydro-electric power costs were subsequently similar. (1)(19)(20).

The Duck Reach hydro-electric power development (10th Dec.1895) was built and operated by the Launceston City Corporation (LCC) on the South Esk River about 2 miles from Launceston. The South Esk is one of Tasmania's major river systems, with a catchment of 3400 square miles, yielding an average flow of 2450 cubic feet per second and in the late 1880's several proposals were made to develop its potential both for public water supply and energy. In the lower reaches of the deep turbulent Cataract Gorge, a timber aqueduct was built against the dolerite cliffs to supply the Cataract Mill (1834) later Richies (building extant). A syndicate sought to buy these water rights for the "Launceston Light and Motive Power Co." (May, 1887), but the LCC's rights to the lower 3 miles of the South Esk were enacted (51 Vict. 43 of Dec. 1887). After considering other private proposals and engineer's reports the Council decided to invite tenders for an hydro-electric supply from the South Esk and the lighting of the city (Jul. 1888). Their consultants were Messrs. G. Gordon, MInstCE, C.W.James, CE and W.C.Kernot, MA, Professor of Engineering, Melbourne. Mr. K.L.Murray, MIEE, was engaged to define and supervise the programme (July, 1891) and Mr. C. St. John David MSE was appointed Surveyor and Engineer (Mar. 1892). Following further consideration a firm scheme was adopted and as required by their Act, a poll of citizens was held, which despite a strong campaign by opponents resulted in 2173 in favour and 690 against. Although the main competitor to the proposal was the Gas Co. which supplied street lighting (5 Apr. 1860) plus the domestic and industrial demand, strong views were also expressed from those who doubted the adoption of the new electrical technology.

The layout consisted of a low masonry weir at the downstream end of "Duck Reach", a 5 foot 6 inch diameter tunnel 2763ft. long with the invert half-circumference concrete lined to 5 foot internal diameter, a concrete forebay delivering to a 5 foot decreasing to 4 foot, wrought iron penstock (¼ inch plate), a "receiver" or bus-pipe at the power house on the north (left) bank of the South Esk River. The machines (m/c's) were 3x158 h.p at 111 foot head, plus 5x21 h.p Thompson-Vortex type turbines by Gilbert, Gilkes and Co. Ltd, Kendall; coupled to Siemens Bros London, alternators 3x100kW a.c. and 5xd.c. dynamos (7 amp at 1750V) to light 125 carbon arc lights of 1250 candle power each. The power house was a substantial masonry structure, 105 x24 feet on concrete foundations with the front and end walls built of dolerite spalls excavated from the benching and pits (up to 35ft. deep). It was designed by David who was also responsible for the tunnel and other hydraulic works, the suspension bridge (1896) and cottages inter alia. A successful trial arc lighting of the city took place from 8.00-10.00pm on 10th December, 1895 and continuously from the 17th. Within five months 5000 incandescent lamps were installed.

William Corin, MInstCE (q.v) was appointed City Electrical Engineer (Nov.1895-Mar.1907) and designed and supervised the expansion of the power development resulting from the rapid increase in demand. Two additional 100 kW m/c's were installed (1899) and a contract awarded to Kolben and Co. Prague (1903) for 4x445 h.p at 100ft net head Francis turbines coupled with 4x300 kW, Siemens alternators. Their installation and related works were completed (1906) by the conversion to a 3 phase 4 wire systems, except to arc lights. The power station alterations raised the machine hall roof to two storeys throughout and the control panels and switch boards were refitted. A large substation was built in the city. A second penstock was constructed and the bus-pipe divided by a 4ft diameter isolating valve. The new Kolben exciters were coupled to the old 21 h.p turbines. The intake weir was raised (1910) and "horizontal gratings" (trash racks) installed. Since the smaller units were replaced the net increase was c.1000 e.h.p. to 1600 e.h.p.

Headworks storages were increased at Arthur's (each approximately 6 square miles) Woods (3.5-4.5) and Tooms Lakes. At Arthur's Upper Lake the stop boards controlled a spillway of about one foot six inches by 67 foot six inches. The lower lake had seven steel sluice gates, each three foot by three foot three inches, set in a long low rock-armoured bank, with puddle clay core and about six feet of the lake's surface was controlled. Woods Lake rockfill dam was about 190 feet long by 6 foot above the sill sluice gates (7 off) set in two outlets. These works which, were built to augment the low summer flows at Duck Reach were done in two stages. HED were contracted by the LCC to build a 27 foot high dam at Arthur's Lower Lake, but this work ceased when Council accepted the proposed bulk power supplied subsequently by Waddamanna to Launceston by 88kV transmission (on-line Sep.1921).

Launceston was connected to the State Grid (1 Jan.1923) and its supply upgraded, 240 volts from 110 (1 Apr.1924). Schemes were put to the LCC by David (City Engineer) and R.J.Strike, City Electrical engineer to more fully develop the potential of the Gorge. Three proposals (1909) included one with an intake about 2 miles further up-stream and later a layout with tailwater the Tamar River tidal high water (1919), but they were not proceeded with. However a flume was built (1919-1921) consisting of 11 chain of masonry aqueduct from the intake weir plus 84 chain of six foot by four foot deep timber fluming set on timber trestles to the forebay. To develop the extra flow a new generator set was installed (1921) of 1180 h.p-800kW. Other than the damage caused by the 1929 flood the machinery operated without significant change until the station was closed down (Dec.1955) after 60 years of service, when the HEC's Trevallyn Power Development was commissioned. It had been compulsory acquired by HEC (1 Jul.1944) together with the LCC's supply system for £244,000. There were five m/c's under 113 foot static head and its rated capacity was 2000 kW.

Historic flood maxima occurred across the northern half of Tasmania in April 1929 when on the 5th. And 6th the South Esk River was said to be 10 foot deep in the station, i.e. at SL 280, the "usual" level being SL 240 and their design flood level SL 265. Station floor is SL 271.32 ft. The front and end walls collapsed and a major part of the roof was carried away. The machines were not seriously damaged and rebuilding in reinforced concrete, drying out and rewiring continued until recommissioning (mid 1930). The cable suspension foot bridge including pylons was rebuilt, but again washed away in a lesser flood (1969). The pylons are extant, but the decking and cables were not replaced (1, 7, 19, 21). The HEC offered (1957) the then obsolete development to the LCC without cost, but it was not accepted. Inaccessible and neglected it now consists of the bare powerhouse with several large diameter truncated pipes and damaged roof cladding, the winder house including gears and steelwork, large masonry pylons (2 off) and the original Corin Street staff houses built of dolerite spalls from the powerhouse foundations (1896/97). Several of the early turbines, alternators, exciters and valves were placed in safe keeping including at the Queen Victoria Museum, Launceston and others are displayed at Trevallyn power development. In the early 1980's strong public support was given to proposals to partly restore or reactivate the station, but since costs of ten million dollars were indicated for a site of very difficult access, the movement failed.

4. CONCLUSIONS.

The hydro-electric power developments at Appleton (1882), Niagara (1894/95) and Fulsom (1895) USA, were earlier than Duck Reach as was the (UK) City of Worchester's mixed thermal and hydro-electric station at Powick (1894) and New Zealand's Skippers Creek (1886), Reefton and Wellington (1889). Never-the-less the Launceston City Corporation's enabling Act (Dec.1887) and electrification (Dec.1895) place Duck Reach amongst the world's leaders of hydro-electric development, both in time and technology. The New Zealand projects were much smaller than it, but also lacked its potential for growth, both in demand and supply.

No significant early hydro-electric developments have been located on the Australian mainland, but in Tasmania both Mount Bischoff (1883 lighting of works, 1886 lighting of Waratah) and Waverly Woollen Mills (1889) precede Duck Reach. These electrical installations, however are comparable with New Zealand's first two projects, but for similar reasons, not to Duck Reach.

Launceston's Municipal Electric project provided a large increase in its commercial and industrial development when its advertisements for cheap electricity attracted overseas manufacturers, including Patons and Baldwins, Kelsall and Kemp, Rapson Tyre Works, plus municipal tramways, pumped water and wastewater services. Corin (q.v) was photographed with his 43 staff, also with 12 power station staff (1907) whilst the construction and fabrication activities, employing many more, helped the recovery from the severe 1890's depression. From a small population base (23,370-1895) LCC's bold initiative and foresight led Tasmania firmly into major hydro-electric developments, with their low unit prices, low maintenance costs and long economic "lives". Moorina (83 years) and Lake Margaret (78 years) are still operating with original machines, Duck Reach and Great Lake –Stages 1 & 2 (each 50 years) were bypassed by larger hydro-electric projects, whilst Bischoff (43 years) was made obsolete when the mine was worked out. Although the Great Lake hydro-electric power development (1916-Stage 1 - 7MW and 1923-Stage 2 - 49MW) was much larger and ultimately made a much greater contribution to the Tasmanian economy, Duck Reach (1895, 5 m/c's and 2MW) fully deserves the claims made by the Launceston City Corporation and by the available evidence now cited herein that it was "The First Significant Hydro-Electric Power Development in Australasia".

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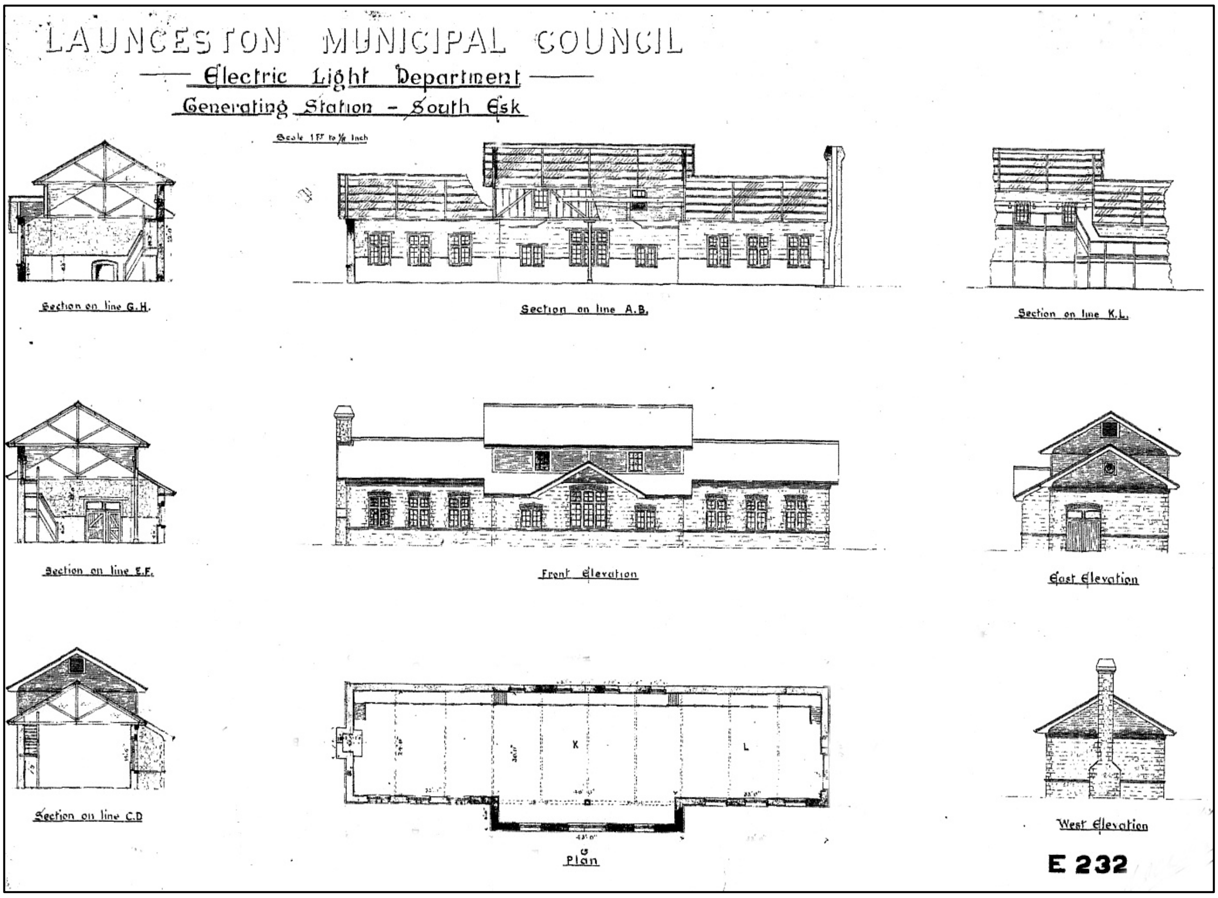
SUMMARY

When the street arc lights were activated by the Duck Reach Power Development at 8.00 pm. on 10th December, 1895, Launceston saw the beginning of an era of hydro-electric power in Tasmania, which has continued for nearly 100 years. Built on the South Esk River two miles from Launceston the development consisted of a diversion weir, tunnel, penstock and power station situated in a steep dolerite gorge. The capacity of the station was increased (1899/1906/1921) and it operated until 5th December, 1955 when the Trevallyn Power Development (80,000 kW) was completed. The latter used the full head of the gorge to the upper tidal reach of the Tamar river estuary and in so doing, bypassed the old 2,000 kW station. The paper examines the significance of Duck Reach in the history of hydro-electric engineering, particularly in Australasia.

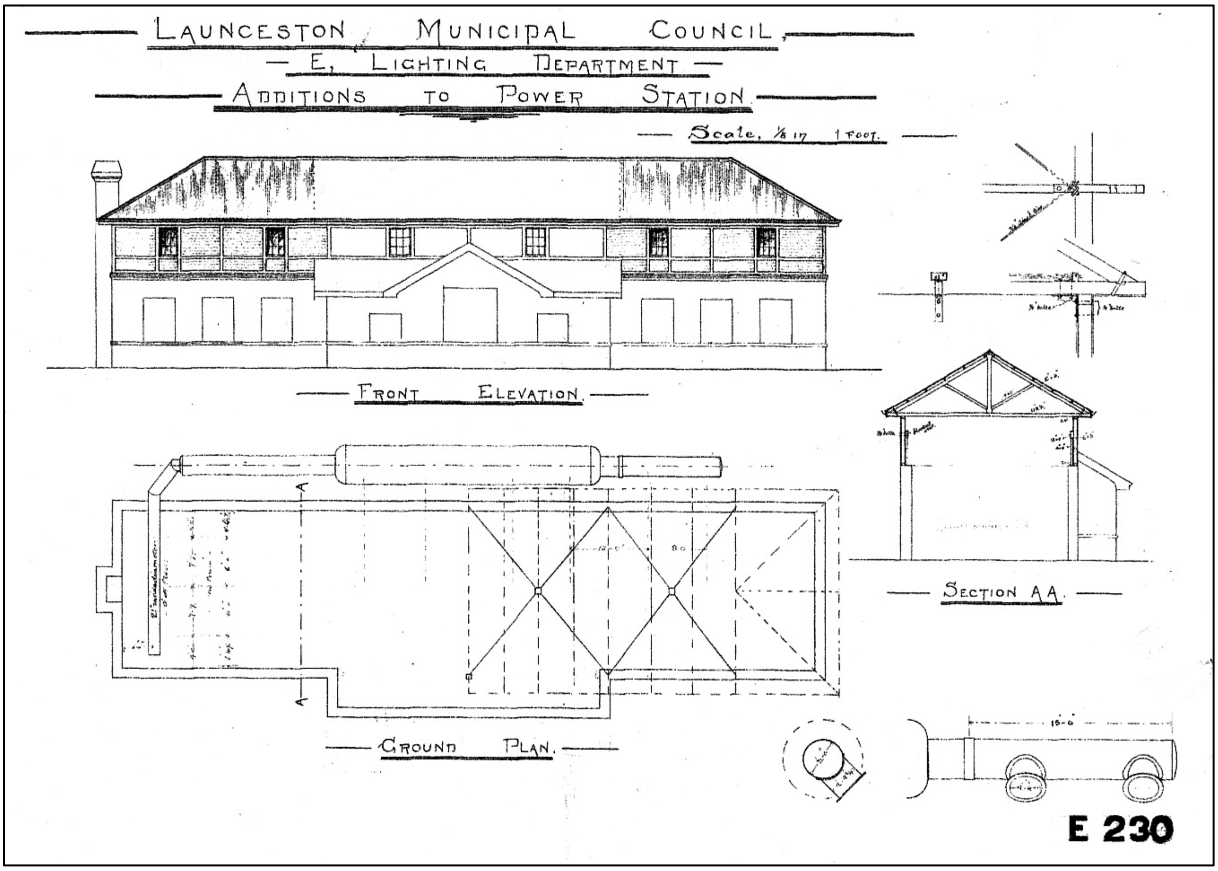
Dimensions have been given their historical values, mainly Imperial Units, including the customary use of Watts for electrical outputs.

Transcriber's note: Some abbreviations in the original have been reproduced in full for greater clarity and the two illustrations, Figures 1 & 2, have been omitted. The symbols for the electrical units have been retained as written in the original.

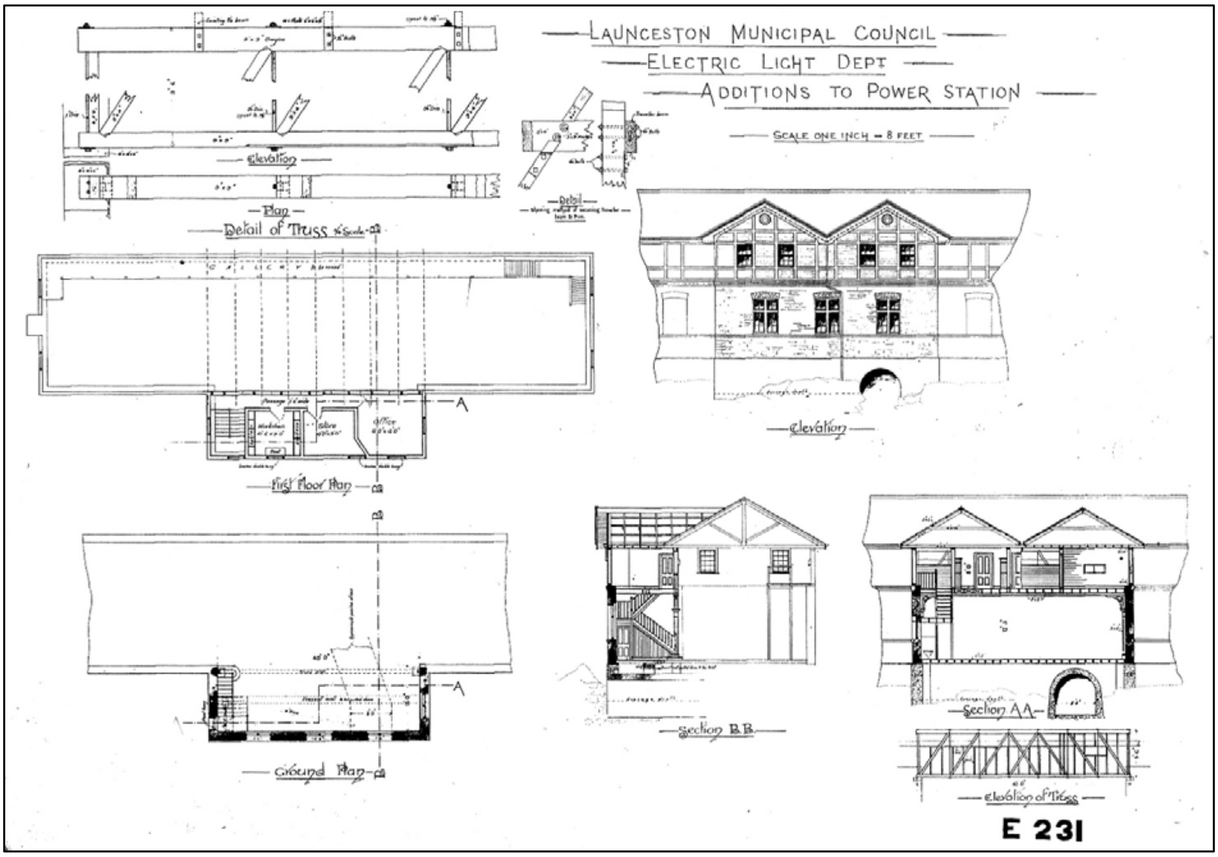
DRAWINGS



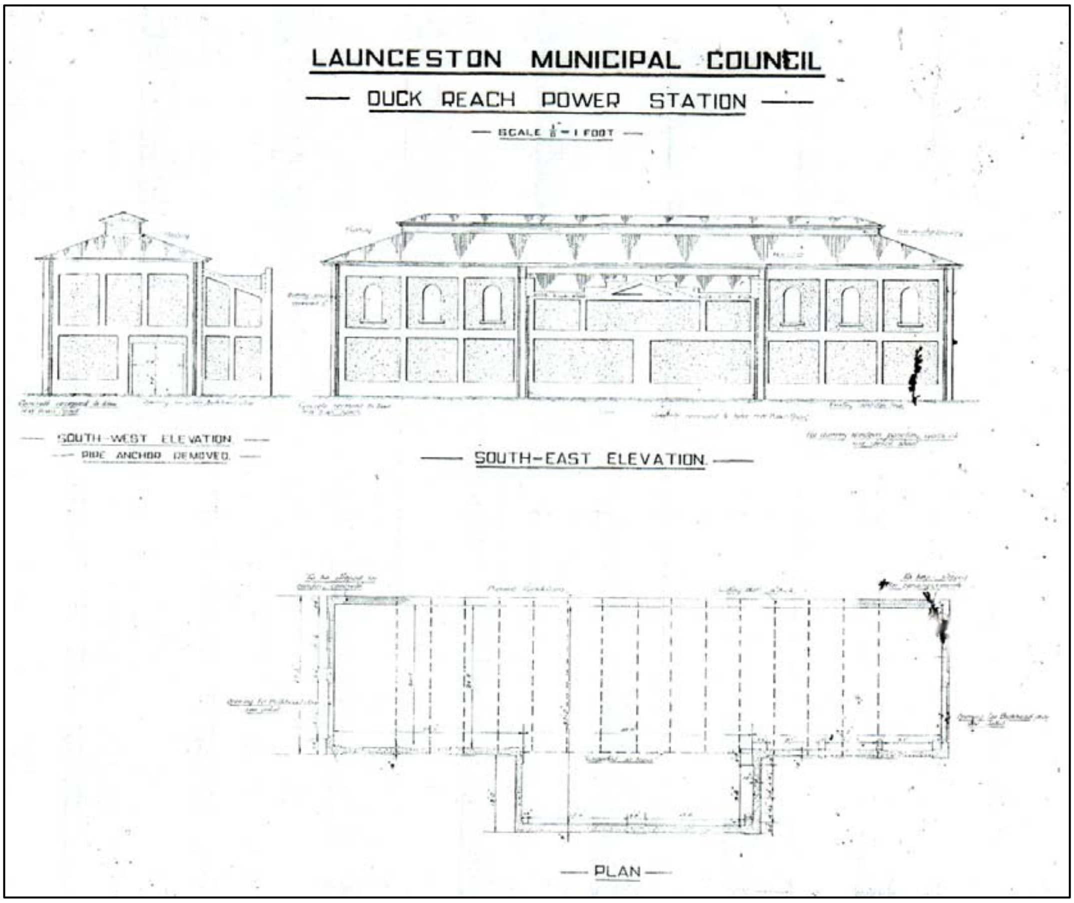
Original Power Station 1895



Additions to Power Station 1905
(roof ends raised)



Additions to Power Station 1907
(two gables over enlarged switch room)



Power Station after reconstruction in 1929.