# APPENDICES

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## Appendix A: *Cocks Eldorado Dredge,* by Fletcher and O'Malley

Paper in Chemical Engineering and Mining Review, 8 July 1936

## Appendix B: *Treatment Plant of Cock's Eldorado Dredge*, Watson

Paper by J.C. Watson, in Mining and Geological Journal, January 1938

## Appendix C: *The Story of Eldorado*, by D.G. Swift

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## Appendix E: Annual Production Statistics for the Eldorado Dredge

Production of gold and tin per year, from Victorian Dept. of Mines reports

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# Appendix A

# Cocks Eldorado Dredge

by D.P. Fletcher and G.B. O'Malley

from

*Chemical Engineering and Mining Review*

8th July 1936

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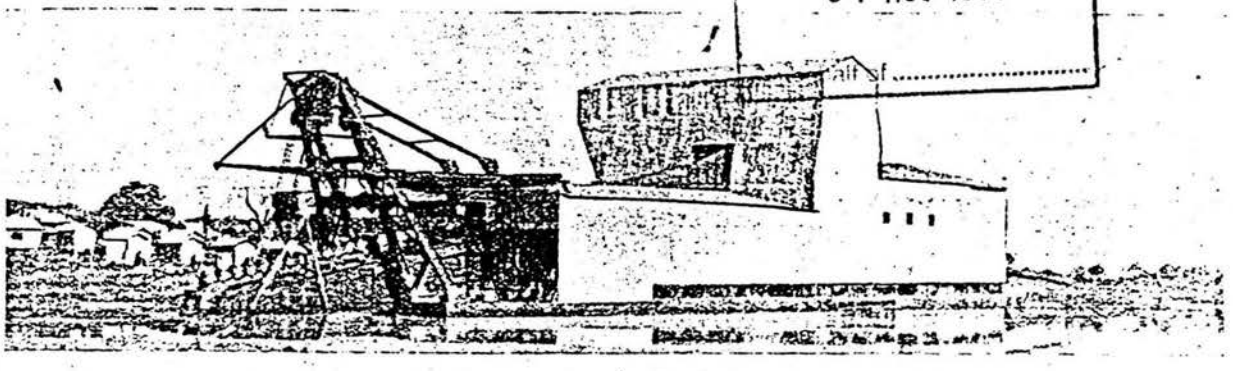

A General View of the Dredge

# Cocks Eldorado Dredge

## Capacity 200,000 *c.* yd. Monthly from 90 ft.

*By D. P. Fletcher[1] and G. B. O'Malley[2]*

RECOVERY of alluvial gold by bucket dredging, once a thriving industry in Australia, suffered the setback experienced by all forms of gold mining in this country as a result of the post-war increase in costs. Interest was reawakened with the discovery of the rich alluvials of New Guinea in 1928, and it was further stimulated by the appreciation in the value of gold from 1930 onwards. The first signs of recovery in Australia were the re-erection of the Adelong dredge at Bright, Vic. (November, 1933) and of an old dredge at New Campbell's Creek, Vic. (March, 1935). These dredges are digging to depths of only 20 to 25 ft., are of small capacity, and lack many of the outstanding features of the large modern dredges developed in Malaya and elsewhere. The first local representative of the new era in dredging is the Cocks Eldorado dredge which has now commenced work at Eldorado, 14 miles from Wangaratta, Vic. It is equipped for digging to 90 ft. and has a capacity of 200,000 c. yd. per month, and deserves particular attention because of its almost complete construction from Australian materials.

### Cocks Eldorado Alluvial Deposits

The leases of the Cocks Eldorado Gold Dredging N.L. are situated in the old bed of Reedy Creek, which has been worked for gold and tin from 1860. The general history of the district has been covered by one of the authors in a recent article* describing the operations of Cock's Pioneer Gold and Tin Mines (1934) N.L. The relationship of the several leases is shown in Fig. 1. Reedy Creek occupies a well defined valley between granite ridges running roughly east and west; near Eldorado township the valley is 2,000 ft. wide and contains up to 240 ft. depth of alluvium. The creek bed was originally on the southern side of the valley; it was diverted by the Cock's Pioneer Co. in 1927 to the northern side in order to make the original bed available for hydraulicking. The gold and tin values occur in fine wash on five distinct floors at depths of 30, 50, 70, 90 and 220 ft.; the deepest wash is on the granite bedrock, whilst the others are on false bottoms of pug. In some sections of the field the 50, 70 and 220 ft. floors have been mined as deep leads, and sluicing has in more recent times taken the ground to the 70 and 90-ft. levels. Dredging thus represents the third method of alluvial mining to be applied to these deposits.

### Quantity of Wash and Values

The estimate of the values in the main dredging lease is based upon past boring records, present-day borings and the sluicing yields of Cock's Pioneer in the neighboring lease. The pontoon of the dredge was built on stocks in a section of the old creek bed and was floated out into a pond about 70 ft. deep which had been an old sluicing paddock, thus taking advantage of unusually favorable circumstances which made it possible to avoid the difficulties inseparable from launching from a slipway. The lease is thus divided into an upper or eastern and a lower section. The original intention of Cocks Eldorado Gold Dredg-

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*"Sluicing for Gold and Tin," by G. B. O'Malley, C.E. and M.R., June, 1936.

ing N.L. when formed in 1934 was to dig to 70 ft., but the plans were subsequently modified to take in the 90 ft. floor, and the dredge was designed for a correspondingly increased output. The estimated quantity in the upper area, which measures 2,000 ft. long by 1,000 ft. wide by 90 ft. deep, is about 7,000,000 c. yd. containing values averaging 1/- per c. yd. with gold at £8 per fine oz. and tin at £175 Australian currency per ton. The lower area is 3,200 ft. long by 700 ft. wide by 100 ft. deep, and contains 8,000,000 c. yd., averaging 8d. per c. yd. This virgin ground is covered with tailings from sluicing activities to depths up to 35 ft., aggregating 3,000,000 c. yd., the values in which are now being investigated by boring. The dredging yardage available thus totals 18,000,000 c. yd. at a value somewhat in excess of 8d. per c. yd. The estimated working cost of dredging is 2½d. to 3d. per c. yd.

In addition to the areas thus developed, there exist on the northern section of the lease terraced lands which may prove to contain some millions of c. yd. of profitable material. This is new ground except for some underground workings on the 70-ft. floor. On the western end there are many acres of excellent dredging ground in which recent borings by an associated company, Gold and Tin Development N.L., has indicated values of the order of 6d. per c. yd. These areas are to be tested by systematic boring. Examination of the records shows that boring was done fairly extensively but sporadically in the past, and the results will be checked as far as possible in the present campaign. On the main dredging lease a line of 13 bores at intervals of 1 to 2 chains across the lead about 10 chains ahead of the building site shows values averaging 12.6d. per c. yd., a figure which agrees closely with the older records in this vicinity.

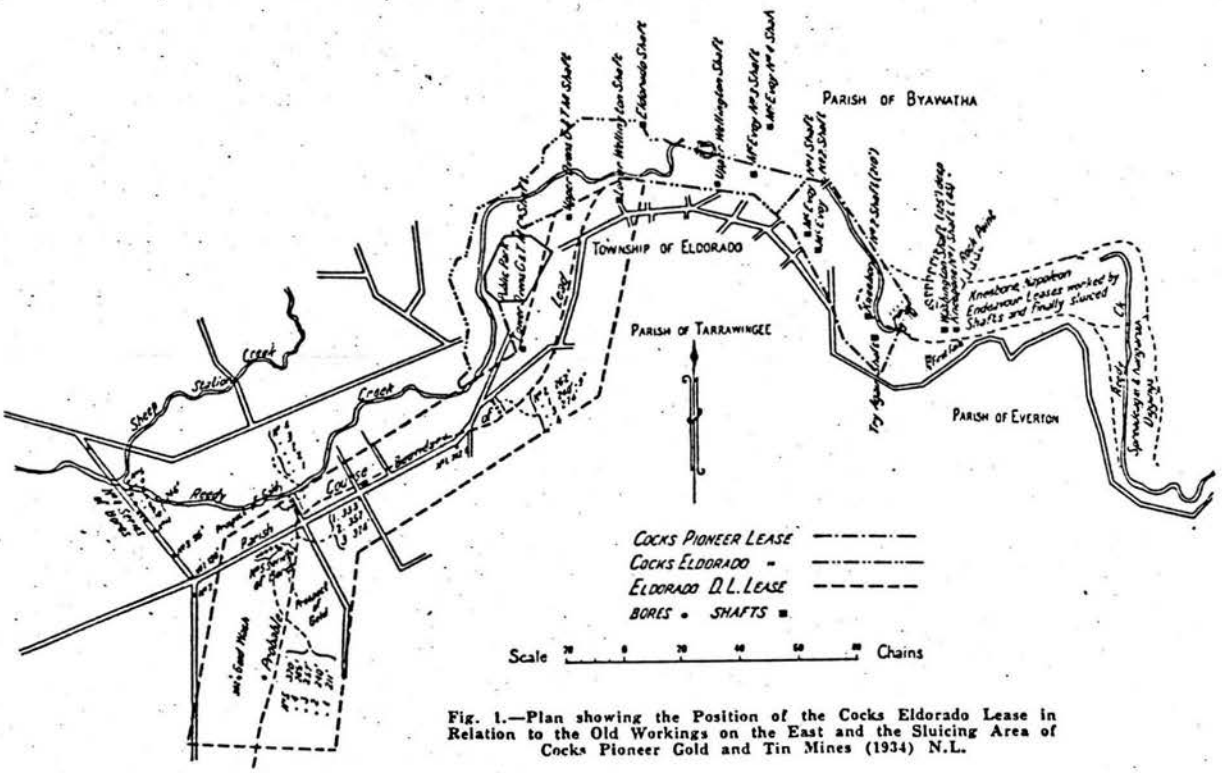


Fig. 1.—Plan showing the Position of the Cocks Eldorado Lease in Relation to the Old Workings on the East and the Sluicing Area of Cocks Pioneer Gold and Tin Mines (1934) N.L.

In order to define the lead and to obtain some indication of mineral recoveries on the dredge it is proposed to bore the ground ahead in lines about 8 chains apart with intervals of 2 to 4 chains between the bores according to the course of the lead. In the event of values being located within a reasonable depth below the 90 ft. floor, as may be expected on the northern boundary where the granite bedrock has been struck at 113 ft., it is possible to increase the depth of digging by stacking the tailings and lowering the level of the pond.

The ground in these areas is considered to be ideal for dredging because of the occurrence of the values in relatively fine wash on soft false bottoms, the largest pebbles encountered being 5 in. diameter. The friability of the ground and the absence of timber are other favorable features. In the initial stages of operation it has been necessary to cope with a good deal of slum and drift sand from the overburden of sluice tailings, and some trouble has been caused by

partly burnt mining rubble which blocks the pump screens and jig spigots, but these difficulties should be diminished when the regular digging programme is attained.

The company also holds the leases over a further 170 acres on Reedy Creek on the east of the Cock's Pioneer lease. The width varies here from 150 to 600 ft., and the depth averages about 25 ft. with granite bottom and much buried timber. This is not dredging ground, and if the preliminary indications of values are borne out by systematic boring it will probably be treated by dragline excavators with sluicing monitors to clean up the bottom. The values already indicated are as high as 2/9 per c. yd. The proving of these areas which may supplement the dredging activities will require a long campaign of boring. At the present time the company is using a percussion drilling outfit putting down 4-in. bores, driven by a 3-h.p. gasoline engine. Boring to the average depth encountered costs somewhat less than 2/- per foot.

### General Design of the Dredge

The dredge is of all-steel construction and is electrically operated, and with its 12 c. ft. buckets, digging depth of 90 ft. and capacity of over 2,000,000 c. yd. per annum, is the largest yet built in Australasia. The details of the dredge were arranged by the company's consulting engineer, and the construction under his supervision was carried out by the Thompsons Engineering and Pipe Co. Ltd., Castlemaine and Williamstown, Vic. With the exception of the motors, the top tumbler casting, the Frenier pump for the save all, and certain of the largest structural members, the dredge is built from Australian materials throughout, marking a very definite advance in local engineering production.

The general layout of the pontoon, superstructure and equipment is shown in the plan and elevation in Fig. 2. The plan shows from front to rear along the centre-line the fore gantry and bucket-ladder suspension gear; the ladder-well, ladder and top tumbler; the drop-chute, screen and jig distributing box; the stone chute and the gravel pump for emergency stacking of the tailings. The primary jigs and the sand chutes are symmetrically placed aft; on the port side forward are the slewing crane for handling the buckets, the electrical sub-station and the ballast pump. On the starboard side the ladder-winch and mooring-winches are grouped below a central control platform. The high and low pressure pumps are housed amidships below water-level in a compartment of the pontoon, and the secondary jigs are also below deck in a well directly beneath the primary jigs.

Several features in the design are new to this country, and certain of these are actually being applied for the first time in dredging. In the first place, the total weight of the ladder and bucket-band for 90 ft. depth digging, amounting to 360 tons, which is carried by the top tumbler frame and the fore gantry, is reduced by approximately 60 tons, when the ladder is submerged, by the provision in the lower end of a watertight compartment in which a pressure equivalent to 90-ft. head of water is automatically maintained by a motor-driven air compressor, in conjunction with a release valve in the bottom of the ladder.

A second novel feature is the use in the save-all of a large Frenier pump to elevate to the screen the spill from the buckets. It has been asserted that this type of pump is not satisfactory under conditions of varying suction, but it is the experience of the dredge designers that the Frenier pump is actually more efficient under such conditions than the gravel pump used for the same purpose on Malayan dredges. It is customary to station a man at the speed control of the gravel pump, but this will be unnecessary with the Frenier pump, an important consideration under Australian labor conditions.

Thirdly, jigs are employed as the sole mineral saving device, being chosen in preference to sluice-boxes for their compactness, continuity of operation and minimum of attendant labor, and because of their proved capacity for recovery of alluvial gold and tin. Further, the secondary jigs are fed by gravity from the primary units, instead of the usual practice of pumping the primary concentrate to the clean-up jigs on the same level. The new arrangement has the advantage that the amount of final concentrate to be elevated is very much reduced, and it is proposed to install a hydraulic elevator, dispensing with the gravel pumps usually employed. It is important to note that the gravity flow is achieved without an increase in the height of the top tumbler, which is determined as usual by the required height of delivery of the sand chutes to the pond.

The dredge design includes a further novel arrangement in the provision of by-passes from the sand chutes to a gravel pump, which is capable of stacking the tailings to a height of 40 ft. and a distance of 75 ft. behind the pontoon. This not only gives a greater measure of flexibility in manoeuvring the dredge, but also makes it possible to increase the effective digging depth by lowering the pond level below the banks, should values in the ground warrant this modification. A still further increase in depth may be obtained by the addition of an extension to the ladder, the pontoon having been generously designed with this prospect in view. The dredge is of the re-soiling type, the stones being delivered 25 ft. and the sand tailings 50 ft. behind the pontoon. Pollution of the stream is prevented by the isolation of the dredge pond from the creek and the use of several settling dams for the tailings.

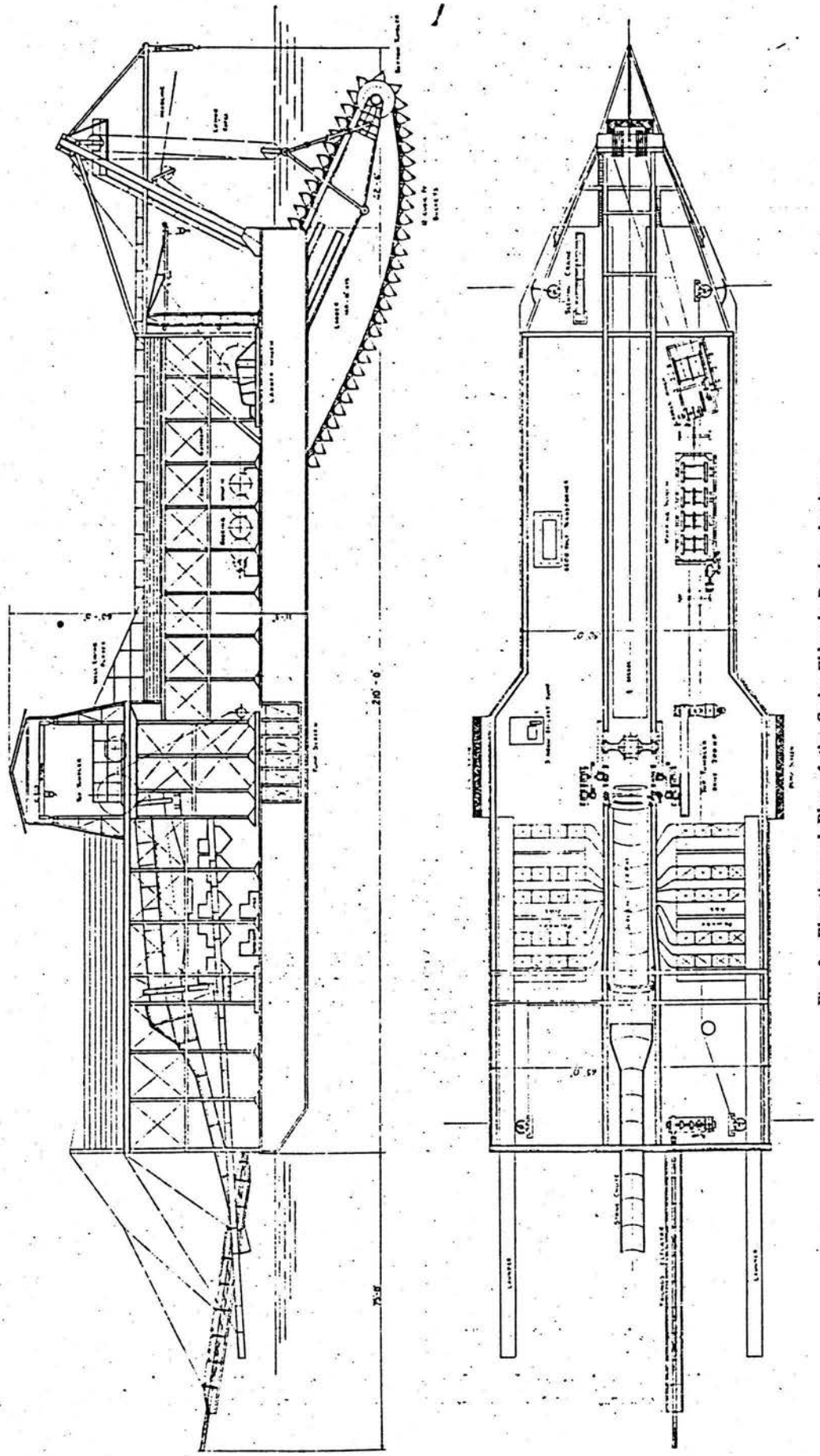

Fig. 2.—Elevation and Plan of the Cocks Eldorado Dredge showing the layout of the Various Components and the Electrical Equipment

one piece with the shaft, measuring 3 ft. 6 in. wide over the flanges, 2 ft. 8 in. between the flanges and 17 ft. 2 in. over the shaft. The faces are machined and fitted with manganese steel wearing plates 2¼ in. thick, attached by nickel-chrome steel bolts; the flanges are fitted with 1¾ in. manganese steel plates rivetted on. The shaft is double-ended, 19 in. diameter, machined and fitted with splash ring and keys. The tumbler, the total weight of which is 15 tons, was supplied by Messrs. Hadfield's Ltd. (Sheffield). The sole plates and bearing caps are also of cast steel; the lower section of the bearing is lined with phosphor bronze. The tumbler is driven by a 200-h.p. slip-ring motor with speed range from 420 to 280 r.p.m. through a 24-in. flat belt over 35-ft. centres and two-stage gearing on both sides of the tumbler, giving a normal tumbler speed of 3.5 r.p.m. and dumping the buckets at the rate of 20 per min. The gears are of cast steel with machine moulded teeth.

The bottom tumbler assembly weighs 15 tons and consists of a circular casting 8 ft. diam., shrunk on to a 13-in. forged shaft, with a high carbon steel sleeve running in grease-tight grit-proof bearings. Provision is made for two-point attachment of the lifting gear by forged steel suspension links, the front links being articulated. The fore gantry lifting gear is of the double type, each section consisting of five cast steel sheaves 4 ft. 6 in. diameter with cast iron bushes. Special attention has been paid to the lubrication of the sheaves, the device adopted consisting of a five-sided greasing head with five separate grease passages, the head being turned into a new position between successive applications of the grease-gun. The hoisting rope of 4¾ in. circumference is wound on the 5-ft. diam. grooved drum of the ladder winch, which is driven by a 160-h.p. motor and provided with both solenoid and hand brakes.

On the top chord the ladder is fitted with 20 18-in. diam. chrome steel rollers carrying the bucket band; these are shrunk on to 4½-in. diam. mild steel shafts in self-adjusting cast steel bearings 12 in. long. The weight of the ladder itself is 150 tons; complete with tumblers and rollers the total weight is 200 tons.

The bucket band consists of 118 close-connected 12-c. ft. buckets of free delivering design made in double annealed chrome steel with 8 in. by 1⅜-in. manganese steel lips rivetted on. The buckets have three eyes with 1½ in. manganese steel bushes; the pins are L-headed, 5½ in. diam., forged nickel-chrome-molybdenum steel. The weight of each bucket with the lip is 25 cwt., and the complete band weighs about 160 tons. The buckets are handled for repairs and for adjustment of the band by a slewing crane operated by three motors for lifting, slewing and racking of 6, 3 and 3 h.p. respectively. The forward gear includes also a jib with 15-ton tackle for lifting out the bottom tumbler, and the jib serves also to carry the head-line from the mooring winch.

### The Screen

The buckets discharge over the top tumbler into the drop-chute and are cleaned out by two 2-in. nozzles supplied with water at 80-ft. head from the high pressure pump. The spill and drippings are collected in a sump below the save-all grizzly and elevated to the screen by a 96-in. by 18-in. Frenier pump which is capable of 40-ft. head. The screen framing is constructed in broad-flanged beams and rolled steel joists rigidly braced; the screen itself is 8 ft. diam. by 49 ft. long with 35 ft. of perforations. It is set on a slope of 1 in 12 and driven at 7 r.p.m. by a 65-h.p. motor through a cast steel driving wheel 10 ft. 6 in. diam. by 15-in. face. The screen is built up of seven belts of 5-ft. plates with an outer shell with ⅝-in. perforations and an inner shell with ⅜-in. perforations, each shell being ½ in. thick. It is supported and driven from the bottom end by means of a chrome steel friction roller 4 ft. 6 in. diam. by 15-in. face cast in one piece with its 12-in. diam. driving shaft. Further support is given by two cast steel thrust rollers 18 in. diam. by 6-in. face on the after side of the bottom end path, and by two cast steel guide rollers 18 in. diam. by 15-in. face. The top end is carried on two rollers 39-in. diam. by 15-in. face set at 45 deg. off centre with adjustable phosphor-bronze lined bearings.

The material passing through the screen is washed by a number of 1½-in. high pressure jets from the sparge pipe; the undersize passes through into the distributing box and the oversize is delivered into the semi-circular stone chute which tapers from 10 ft. diam. to 5 ft. diam. and projects 25 ft. behind the pontoon on a slope of 1 in 4. A stream of low-pressure water assists the flow of the stones and pug; about 20 per cent. of the total feed to the screen goes out in this way.

### The Jigs

The distributing box has ten individually controlled outlets feeding the ten primary jigs, which are four-compartment Harz type units. Each compartment is 4 ft. by 3 ft. with $^1/_{16}$ in. square aperture screens and 1½-in. beds of hematite ragging sized between ⅜ in. and $^1/_{16}$ in. The stroke is ¼ in. and the speed 140 strokes per minute, and each jig is capable of handling 35 c. yd. of solids per hour. The spigot products from each bank of five jigs gravitate in steel launders to a secondary (clean up) jig of the same dimensions operating on ⅛ in. stroke and 200 strokes per minute. The products from the first spigots of the clean-up jigs are collected in tubs, brought up on deck and taken ashore, but it is proposed

to install a hydraulic elevator and re-treat the concentrate either on the pontoon or ashore by further jigging or tabling as may be indicated by test work, followed by magnetic separation and barrel amalgamation. The products from the remaining three spigots are at present being returned to the head of the clean-up jig, but their disposal will be determined later according to their mineral content and sizing.

The tailings from the primary jigs are carried off by sand chutes 3 ft. wide by 18 in. deep to a point 50 ft. behind the pontoon. As has been stated earlier, the chutes are provided with by-passes to a stacking pump, which is an 8-in. Thompson gravel pump direct coupled to a 40-h.p. motor. This unit is capable of delivering the tailings to a height of 40 ft. and a distance of 75 ft. behind the pontoon. The several chutes are suspended by adjustable steel ropes from the stern framing. The clean-up jig tailings are discharged directly into the pond through a 12-in. pipe. The installed horse-power at the jigs comprises a 35-h.p. motor for each bank of five primary jigs, and a 17-h.p. motor for the two secondary jigs.

### Water Supply

Water is required on the dredge for the high-pressure jets at the drop chute and screen, for a supply to the jigs, tailing chutes and save-all, and for ballast and odd purposes such as washing down the decks. In order to comply with the government regulations regarding pollution of streams, the dredge pond is isolated from the creek and a small supply of fresh water is brought down in a race from a point about 5 miles upstream, where a concrete dam of length 200 ft. and maximum height 4 ft. has been built on a granite bar. The race delivers to the pond and the water supply for the dredge is pumped from the tunnel in the pontoon by means of a 14-in. centrifugal pump delivering 3,500 gal. per min. at 80-ft. head and a 16-in. unit delivering 6,000 gal. per min. at 40-ft. head. Each pump is direct coupled to a 150-h.p. motor, and their position below water-level in the pontoon ensures that they are always primed.

A general purpose supply is pumped by a ballast pump on deck, which serves also as a bilge pump; this is a three-throw 5-in. plunger, 8-in. stroke unit driven by a 15-h.p. motor. The intake water is screened through plates with 1-in. perforations over the tunnel, and a baffle ensures that the supply is drawn from the upper 12-in. of the pond. In the initial stages of dredging one of the most serious problems has been the necessity for repeated cleaning of the screens through the presence of a large amount of timber debris and pulp in the sluice tailings. This material causes trouble at the screens and spigots of the jigs, whilst the slum content affects the specific gravity of the water to an extent which interferes with jigging more or less seriously. Several schemes for coping with this trouble are being evolved.

Under the original arrangement with the parent company, Cocks Pioneer, the Cocks Eldorado Co. has been required to provide settling for the tailings. The water as received contains about 25% solids by volume, a proportion of which is extremely difficult to settle, and six dams totalling 65 acres have been constructed to hold back this material. The dams are simply constructed by close-spaced timbers or corrugated galvanised iron on a rough timber framework.

### General Operation of the Dredge

The progress of the dredge is controlled by means of a head line carried on the fore gantry and four side lines leaving the pontoon normally at the corners through fairleads and swivelling 32-in. diam. pulleys on 4½-in. pins attached to the deck. The head line is 4½-in. circumference steel rope and keeps the buckets against the face; the 3½-in. side lines control the lateral movement. The lines are wound on five drums of the mooring winch, which has also two spare drums for odd jobs such as hauling timber from the pond, and for interchange during repairs. The winch is driven through a Richardson reduction gear by a 35-h.p. motor; the brakes are lined with Ferodo and the special friction-type clutches are faced with the same material. The lines are attached at the shore end to 12-in. round timbers sunk 3 to 5 ft. in the ground.

The upper area now being attacked is 1,000 ft. wide and is to be taken in an upstream advance over a 500-ft. face, followed by a return downstream over a similar width, the programme being varied according to the boring results ahead of the dredge. The usual arrangement is to take a series of cuts about 6 ft. deep across the face until the 90-ft. floor is reached, the several floors providing a more or less steady supply of values. In this way a minimum of working time will be lost and operation over 90 per cent. of full time is expected. The dredge is running six days of 24 hours per week; the crew comprises ten men per shift and the total labor including the shore gang amounts to 40 men.

### Mineral Recoveries

A great deal of interest centres around the use of jigs as the sole method of recovering gold and tin values. This is familiar practice in Malaya and New Zealand, but is new to Australian dredging. The advantages claimed for jigs over sluice-boxes include greater capacity per sq. ft. of area, and continuity of operation. Malayan experience has shown that recoveries of 90 to 95 per cent. of cassiterite are commonly obtained on jig-equipped dredges; the values in these deposits range be-

tween 10 mesh and 150 mesh (Peele—Mining Engineer's Handbook.) There can be little doubt, therefore, of the ability of jigs to recover gold values of somewhat smaller sizes, and in this connection it is interesting to study the sizing-assay of a concentrate from the first spigot of the clean-up jig obtained during a preliminary run.

The figures in Table 1 show that approximately 5 per cent. of the values recovered is present in the minus 100 mesh product, in which many of the gold particles are actually minus 200 mesh (74 microns); unfortunately the amount of such material is so small that no reliable assay figure can as yet be given. The capability of the jigs to retain very fine particles is thus demonstrated, and complete recovery of all such values is a matter of providing sufficient jigging area and arranging the most efficient retreatment of the lower grade products from the later compartments. It is proposed to initiate at an early date a testing campaign to determine the size distributon of the values in the jig feed and the spigot products; the conditions which give the most efficient combination of tonnage, recovery and grade can then be established.

Table 1.—Sizing Assay of Final Concentrate from Secondary Jigs.

| Screen (Tyler) | Weight per cent. | Assay Au. oz./ton | Values Sn. per cent. | Distribution of Values Au. per cent. | Sn. per cent. |
|---|---|---|---|---|---|
| + 28 | Trace | — | — | — | — |
| + 48 | 14.9 | 10.0 | 34.0 | 3.0 | 10.0 |
| + 65 | 30.2 | 24.0 | 47.5 | 14.6 | 27.7 |
| +100 | 48.6 | 79.3 | 61.5 | 77.6 | 58.0 |
| —100 | 6.3 | 37.8 | 34.5 | 4.8 | 4.3 |
| | 100.0 | 49.7 | 51.5 | 100.0 | 100.0 |

Classification of the feed and division between several groups of separately adjusted jigs has given rather variable results on some Malayan dredges, and this matter will be investigated with a view to its application to the Eldorado deposits. A check on the work of the jigs will be afforded by the use in the sand chutes of cocoanut matting or corduroy under a cover of expanded metal, or by means of a pilot table over which the flow of tailings may be temporarily diverted.

With regard to grades of final products, the experience at Cock's Pioneer in producing gold bullion assaying 993 fine, and concentrates assaying 73 per cent. metallic tin, gives an indication of the results which may be expected from the dredge.

A point which lends added interest to the initiation of dredging at Eldorado is that a comparison will be possible of the results of dredging at 3d. with sluicing at 9d. per c. yd. For this reason and many others the mining community eagerly awaits the establishment of regular operating conditions on the dredge. The regular digging programme will shortly be attained, for the dredge is now entering upon virgin ground, but a good deal of experiment will be necessary before the optimum jigging conditions can be determined.

# Treatment of Cupriferous Gold Ore

## With Recovery of Copper Precipitate and Zinc Sulphate

CYANIDATION of a gold ore containing a small amount of copper is successfully carried out by the Transvaal Gold Mining Estates Ltd.'* and the method adopted is of particular interest to Australian metallurgists. The plant treats the ore from eight mines, the average composite assay of which is gold 5 dwt. per ton, and copper 0.09 per cent. The sands and slimes are treated separately. The sands after a 10 days' treatment give a residue of 0.8 dwt. gold and 0.04 copper and the slimes after 22 hr. agitation with 0.045 per cent. NaCN, a residue of 0.34 dwt. gold and 0.06 per cent. copper.

### Precipitation

Interest principally attaches to the method of precipitation with recovery of the zinc. The solution strength in the cyanide plant is maintained at .045 per cent. NaCN and .01 per cent. CaO. The maintenance of a high free cyanide strength throughout the treatment is beneficial as the tendency to increased cyanide consumption is more than compensated by the increased gold extraction.

The gold bearing solution from sand and slime plant is collected in a common tank before passing through the Crowe vacuum plant and thence to the filiform zinc precipitating boxes. These boxes are dressed half-monthly and fresh zinc is then added. At the clean-up the contents of the lower halves of the first compartments from each box, plus the fines below the screens are removed to the acid vat. These fines are as a rule densely coated with copper and resemble cement copper more than gold slime. At this stage the gold-zinc fines contain 23 per cent. copper.

* See Journ. Chem., Met. and Mining Soc. of S.A., Feb., 1936, article by C. G. Brink.

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# Appendix B

# The Treatment Plant of Cocks Eldorado Dredge

by J.C. Watson

from

*Mining and Geological Journal*

January 1938

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an acute angle. At the intersection of this fault with the reef a bulge of stone yielded several ounces of fine and coarse gold in pieces up to 4 dwt.

The quartz is milky-white, with pieces of ironstone attached, many of the gold-quartz specimens being very fine samples and the gold being of excellent quality and mostly coarse. A well-defined anticline crosses the gully about 150 feet to the west of this reef channel; this anticline is seen again near the Vaughan Mineral Springs half a mile to the north, where it crosses the Loddon River, diagonally under the concrete weir. The reef channel from which the recent find has been made is no doubt the southerly continuation of what was known as Middleton's reef when worked, many years ago, to shallow depths in workings immediately to the east of the Mineral Springs.

The recent find is a promising one and, although no work has yet been done to determine its magnitude and value, it will probably be the means of this area receiving much attention from the quartz prospector, and it is also a practical illustration of what the sluicer might disclose whilst treating alluvial debris.

(*Date of report*, 9.12.1937.)

# *The Treatment Plant of Cock's Eldorado Dredge*

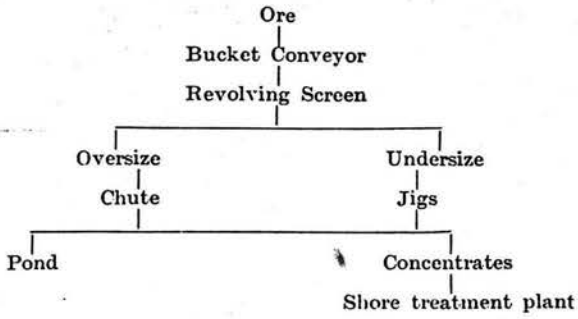
*By J. C. Watson, Chemist and Assayer.*

The Eldorado dredge was designed to treat 200,000 cubic yards of gold and tin-bearing gravel and overburden per month, and to work to a depth of 90 feet below water level. The bucket band is fitted with 120 buckets, each of 12 cubic feet capacity and tumbling at the rate of 21 buckets per minute. The buckets, of tough manganese steel with nickel chrome alloy steel connecting pins, are drawn in an endless band over the hexagonal top tumbler by a 200 horse-power electric motor. The raising and lowering of the 160-ton digging ladder is performed by an electric winch at the rate of 6 feet per minute.

Portion of the ground available for treatment has previously been worked to a shallow depth so that the present company has to remove and re-treat approximately 20 feet of practically worthless overburden.

The gold and tin-bearing "slurry" raised by the buckets is discharged into an inclined revolving screen punched with ¾-in. holes. This screen, 40 feet long and 9 feet in diameter, rotates at nine revolutions per minute. The coarse gravels and lumps of clayey material pass through the lower outlet into a chute which discharges into the pond, and the finer sands, &c., pass through the screen to be conveyed to a series of Harz type jigs for rough concentration. Water at 35 lb. pressure is supplied to the screen for washing mullock, &c., through the holes, the volume of water required being about 4,500 gallons per minute. The undersize material is conveyed by distribution launders to a series of pulsating jigs which produce valueless tailings—discharged to pond by sand chutes, and impure concentrate—carrying free gold, sand, cassiterite, ilmenite, &c.

DREDGE FLOW SHEET.




*Treatment of the Impure Concentrate on Shore.*

Approximately 40 buckets containing 2 tons of low-grade concentrate from the primary jigs on the dredge are brought ashore every 24 hours by punt. The gold in the sand is clean, bright, scaly metal which can be amalgamated with mercury without difficulty. An amalgamating barrel consisting of a cylindrical steel drum, 5 feet in length and 3 feet in diameter, and fitted with clean-out doors is used. After charging with 32 cwt. of concentrate to which water and mercury have been added, the barrel is slowly rotated for three hours, after which the material is passed through a streaming-down box, where the amalgam is caught in wells and on copper plates. Steel balls are not used during amalgamation. The amalgam is squeezed through cloth and retorted for gold. The gold-free concentrate contains quartz, sand, cassiterite, titaniferous iron, and a small percentage of common, coloured gem stones as zircons, garnets, &c.

From the amalgamation tables the material flows by gravitation into a concrete pit whence it is conveyed to two concentrating jigs of the Harz type, which are now fed by hand but arrangements are in progress for belt conveyor handling. The jigs consist of double compartment concentrators fitted with 16-mesh sieve openings and coarse lead shot for bedding.

The ore bed in the screen is 3 inches thick and the vibrating and pulsating action, produced by the stroke of an eccentric causes the material in the machine to be continually raised and lowered at each stroke. This repeated lifting action, in conjunction with the regulated flow of water causes the minerals of higher specific gravity, such as cassiterite, to work downwards and pass through the shot bedding and screen, while the lighter minerals and sand are carried away horizontally.

From the first hutch in the jig an exceptionally high-grade tin concentrate assaying between 74 and 75 per cent. metallic tin is recovered. The tin value of the concentrate from No. 2 hutch is approximately 50 per cent. tin. This is re-treated and the jig residues are further concentrated by a Wilfley table.

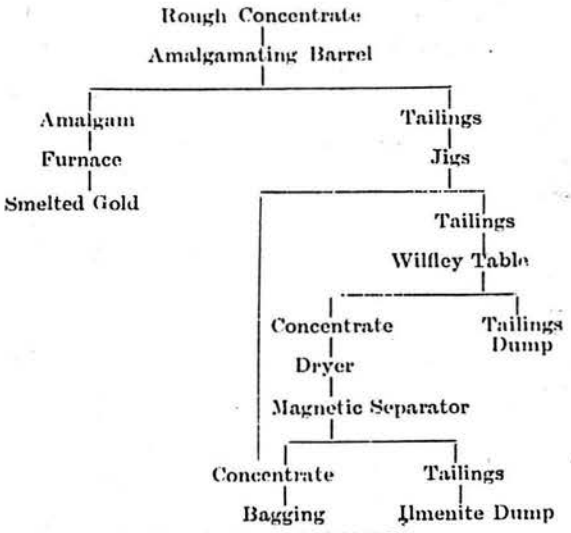
Following drying operations the black sand is finally relieved of most of the titanium impurities by an automatically fed "Rapid" Electric Magnetic Separator which contains two independent 6-in. belts and a 30-in. revolving disc and can treat 2½ tons of concentrates in eight hours. Power for the Separator is supplied by a five kilowatt D.C. motor-generator set.

Electric power is obtained from the State Electricity Commission at 6,600 volts and conveyed to the dredge by means of a trailing cable carried on floats. Transformers on the dredge supply current to the motors at the required voltages, the power output being distributed as follows:—

| | | | |
|---|---|---|---|
| Bucket band | ... | ... | 200 horse-power. |
| Pumps | ... | ... | 350 horse-power. |
| Jigs | ... | ... | 100 horse-power. |
| Winches | ... | ... | 200 horse-power. |

Acknowledgment is made to Mr. W. Lane, Field Superintendent, and other members of the staff for their assistance during inspection of the plant.

FLOW SHEET—SHORE TREATMENT.




[Date of report, 2.12.1937.]

# *The Great Western Mine, Tarnagulla*

*By J. J. Caldwell.*

Gold was discovered on the Great Western line of reef in 1858 or earlier, when, according to extracts taken from the *Maryborough and Dunolly Advertiser* (30th April, 1858), 1¾ tons yielded 124 oz. and 3 tons gave 44 oz. of gold. Old workings, extending over a length of half a mile along the line, bear evidence of former activity sustained mainly by individual and co-operative effort. Details of many of these early deeper operations cannot now be obtained, except at a locality about 30 chains south-west from the Tarnagulla Post Office, where a syndicate is entering on what appears to be a well-conceived prospecting venture. Through its efforts, opportunity of making a survey of a section of the old stopes to a depth of 170 feet has been afforded.

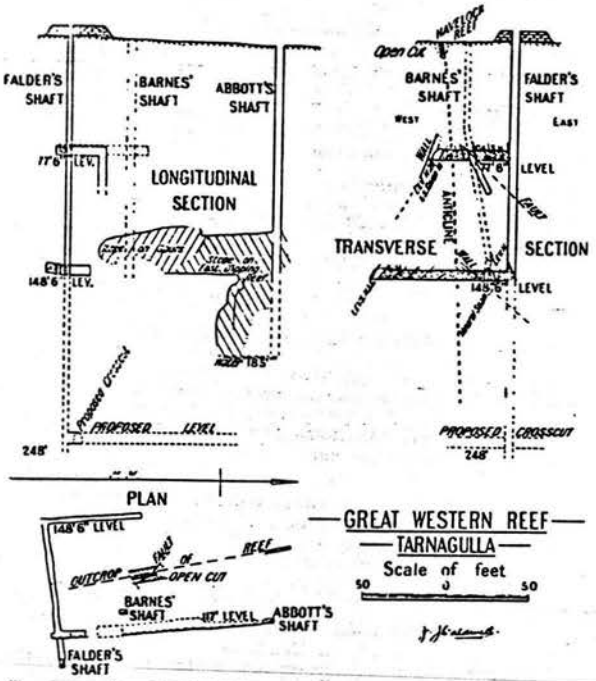
The examination of these and of the surface workings reveals that the Great Western formation occurs along the fractured beds of the anticline. Much of the quartz is of a spurry character, while, to a lesser extent, some of it is "bedded." Though associated with "centre country," the lode does not appear to be a saddle reef of the recurring type. There is reason, however, for assuming that the formation will persist in depth.

Some 50 years ago a shaft was sunk by Abbott and party to a depth of 170 feet, where, it is stated, the shoot of gold (the reef was small and said to be worth 1½ oz. to the ton) pitched south underfoot. Abbott's shaft, shown on the accompanying section, has been sunk vertically to 117 feet, where it entered the gold-bearing quartz on its easterly dip. Below this point the wall of the reef dips steeply to the west for a further 20 feet, beyond which the shaft follows the east-dipping wall. In this lower section the reef, where it has been stoped north and south from the shaft, conforms to the dip of the beds. At a depth of 170 feet the end of the south stope is 35 feet distant from Abbott's shaft.

Distinct from the east-dipping reef and under it, at about 117 feet in depth, is a spurry formation set in sandstone several feet wide which has been stoped out south to 100 feet from Abbott's shaft. The inclination of this stope, too, is in a southerly direction. Barnes's shaft is 85 feet from Abbott's. It is vertical for the first 60 feet or so, and then it goes down on an easterly underlay, reaching the top of the stope at a depth of 115 feet.

Falder's shaft, the site of present operations, is located 127 feet south from Abbott's and about 40 feet east from "centre." It was sunk by Mr. C. Falder and party to a depth of 150 feet about 30 years ago. At 77 feet a west crosscut was put out to 53 feet, and 25 feet from the shaft a short north level traverses an east-dipping fault. "Centre" was passed through at about 27 feet, and at the end of the crosscut a well-defined wall, with 2 inches of quartz on it, dips 70° east. This has the semblance of a west "back." A north level on it to 55 feet entered older workings.

The lower crosscut (148 ft. 6 in. below sill) has been extended west to 83 feet. A pyritic seam 2 inches wide is revealed at 10 feet from the shaft. It is stated that a sample taken from this seam, and sent to the Mines Department about 27 years ago, assayed 7½ oz. of gold and 2 oz. of silver




to the ton. At 15 feet a wall, which dips 82° west, appears to be identical with that noted in Abbott's workings. Another wall, probably a fault, dips east at 20 feet. Between these walls 2 feet or more of quartz spurs occur in sandstone. A level north to 15 feet, just above the intersection of these two walls, appears to reach within a few feet of the old stopes. "Centre country" was passed through at 35 feet from the shaft. A south level from the west end of the crosscut has been extended 57 feet, disclosing very little quartz. It seems likely that the west-dipping wall or "back" seen at the end of the upper crosscut has not yet been disclosed at the 148-ft. 6-in. level. It is probably a few feet west from the end of the crosscut.

The opinion gained from this examination is that the search for the extension of Abbott's shoot of gold and for other auriferous "makes" of quartz is warranted. It is therefore recommended, as a preliminary to such investigation, that Falder's shaft be sunk a further 80 or 100 feet, and that a crosscut be driven to locate the east-dipping reef worked further north from Abbott's shaft. When this reef is intersected, it should be driven on as indicated on the longitudinal section. [Date of report, 25.10.1937.]

# Appendix C

# The Story of Eldorado

by D.G. Swift

from

*Mining and Geological Journal*

January1938

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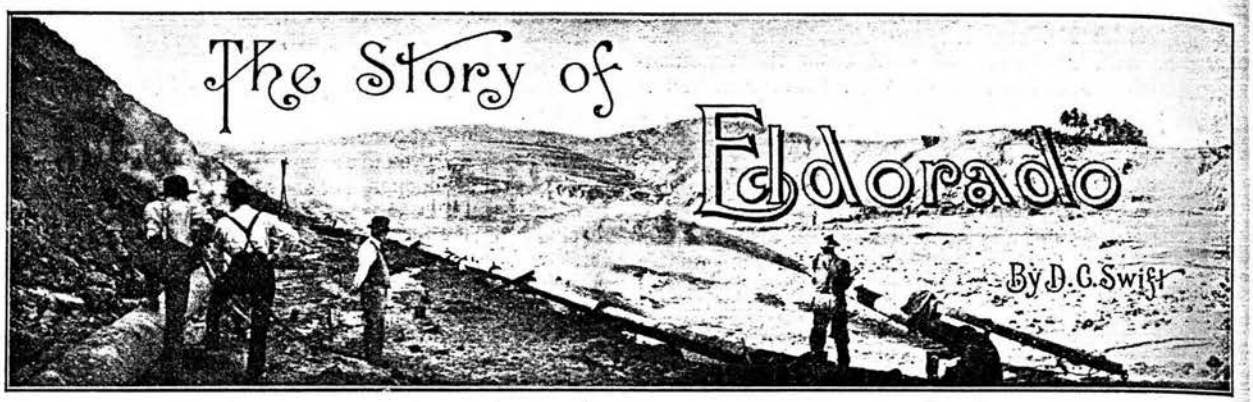



THE success of gold-winning operations at Eldorado during the past three years has attracted a great deal of attention, and it is therefore interesting to look back into the history of this small town and trace its rise to fame. The fact that Eldorado was so named leads one to suppose that the story will not be lacking in romance.

To the miners who first discovered it, however, this field proved a bitter disappointment, and, abandoned as a failure, was actually deserted for nearly a year. Surface gold was scarce because Reedy Creek, on which the "find" was situated, widens out at this place from the narrow Woolshed Gorge, and has spread its alluvium over a great area, distributing the gold far and wide. It was at the upper end of the gorge that fortunes were made almost overnight, and there, that a group of miners are said to have shod their leader's horse with gold and sent him to Beechworth to contest a seat in Parliament and so defend their rights.

At all events, the disappointed prospectors of the lower reaches of the stream, little knowing what wealth they were leaving behind, moved off to try their luck elsewhere. The end of the next year saw attention again focussed on the locality, and the following article appeared in the *Argus* on 19th October, 1855:—

> "In the new rush some 8 miles below Woolshed most of the large claim-holders have secured shares in large sluices. This new rush, called El Dorado, was tried about sixteen months ago, and was a complete failure. Races of a mile or a mile and a half are being constructed here, and under the new system it is expected to pay handsomely."

It seems that this prediction was over-optimistic, for very little work was done on the claims in succeeding years, and it was not until 1859 that organized efforts were made to sink shafts on the flat near Eldorado township. The great influx of water and the swelling ground proved almost insuperable difficulties and prevented many parties from bottoming their shafts, but finally Kneebone and Company succeeded in so doing. Soon afterwards McEvoy and Company also completed their shaft after many difficulties due to the wet, sandy ground. The mine was in good working order and paying well when the wash dirt drives put out on a false bottom collapsed. The Wellington party was also unfortunate, and instead of reaching washdirt, its shaft entered hard rock and was abandoned.

The already famous Kneebone and McEvoy mines, however, were giving high returns and amply rewarded those resolute men who defied the treacherous ground. Yet all the time the water remained a great menace. Workings would be put in order during the summer months, only to suffer severely from heavy winter floods. Perseverance was the keynote of the campaigns waged by these two companies—perseverance coupled with the heartening fact that they were getting gold and in large quantities. Apart from splendid returns of gold, the claims at Eldorado yielded large quantities of tin oxide. An amazing variety of gemstones was also found, including topaz, garnets, sapphires, rubies, zircons, amethysts, agates, and, it is stated, diamonds. Small diamonds were certainly found above the township, near Woolshed, so it is not unreasonable to believe that this statement is true.

In the first seven years the two above-mentioned mines, working one shift only, and employing in all 60 men, yielded approximately a quarter of a million pounds worth of gold and tin, and at the end of 1867 the McEvoy mine was taken over by the United Eldorado Company. In the meantime, the Wellington claim-holders had weathered their lean and difficult days and were also extracting rich washdirt. The Mining Registrar for Beechworth stated, in his report to 31st December, 1866, that some of the richest washdirt obtained at Eldorado had been taken out of the Wellington claim, and that some of it had yielded as much as 5 oz. per bucket.

Such companies as the Ovens Gold and Tin Mining, Eldorado Extended, Perseverance, and Great Extended Gold and Tin Mining, however, failed, and the reputation of the field was upheld only by the steady output of the three pioneer mines. After some years of extremely rich yields mining slackened off considerably. The workings proved the ground to be 180 feet deep, with clay false bottoms at 30 feet, 60 feet, and 90 feet, each carrying its layer of washdirt in addition to that on the bedrock at 180 feet.

The Wellington Company abandoned its bottom floor of washdirt and put in prospecting drives at the first and second floors, pending the construction of a new

shaft. To crown the troubles of the hard-pressed companies a great flood swept down the creek on 9th March, 1870. Mr. William Dunstan, an old resident, recently wrote to the *Age*—

> "That was the greatest flow of water I ever saw down the creek in my day. The flood cleaned up all the claims from here to Beechworth . . . a number of water wheels, scores of wheelbarrows, and hundreds of planks came down the creek. After that the miners did not know where their mines were."

It was a blow to the district when in 1872 the Knee-bone Company's machinery was sold off and the ground abandoned. This left only the Wellington and McEvoy mines as producers since the other companies, including the United Ovens Gold and Tin and the Warrior, were engaged principally in prospecting work. Before the mines commenced to close down the population was 4,500. The school had an attendance of 450 scholars and a staff of nine teachers, but when the depression came as many as 500 people are said to have left in a week.

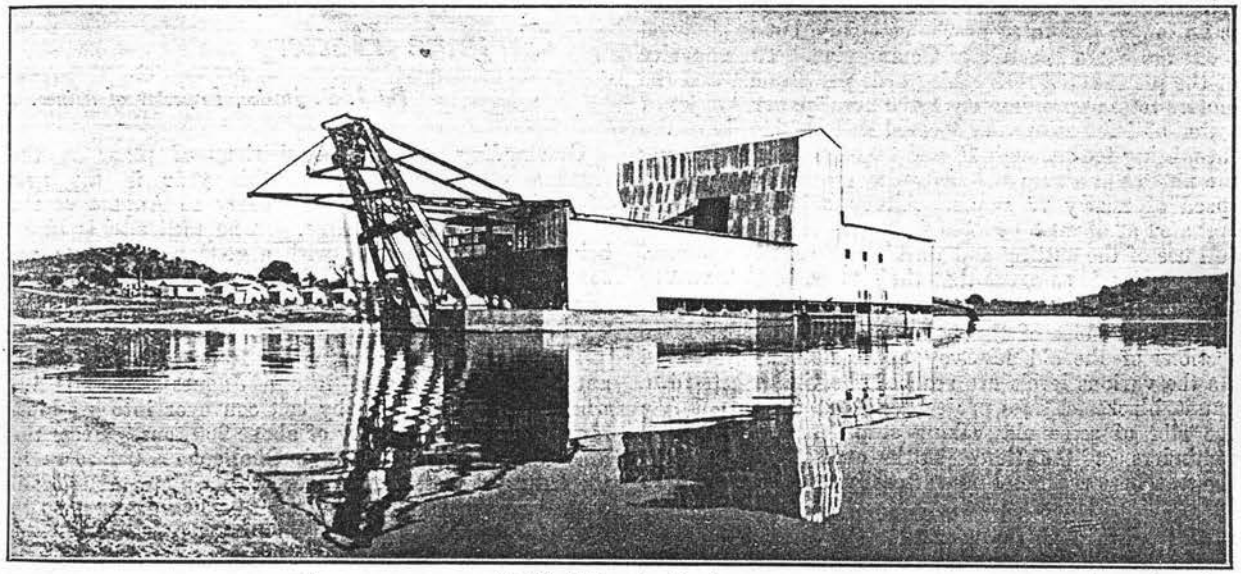
The Wellington Company closed down in 1878, and the McEvoy mine carried on alone with its yield decreasing, and was soon afterwards sold up by mortgagees. The Try Again Company was formed in 1882 to re-awaken interest in Eldorado, but after some fair yields had been obtained the mine was let to tributers, who worked it for a few months and then ceased operations when an accident, caused by a fire-damp explosion, injured two men.

In 1888 the Mining Registrar stated:—

> "It is contemplated to work the ground again by means of a new system of mining, known as dredging. . . ."

and this statement marked the beginning of a new era in the history of Eldorado. This branch of mining, too, had a sluggish beginning. Nothing was done for a long period as the interested parties were closely watching the results of sluicing methods at Yackandandah.

Towards the end of 1890 a new company commenced operations at the McEvoy mine, and opened out on the wash at the 200-ft. floor. The old mine was again producing steadily when, in 1895, the terrible McEvoy disaster occurred. An inrush of water and sand filled the lower workings of the mine, entombing six miners. Their bodies were not recovered until ten days later. When work was recommenced it was on a false bottom, 70 feet from the surface, where a lead 300 feet in width and yielding 1 oz. to the fathom was met with. The mine was again flooded in 1897, and a new shaft was sunk, but by 1901 the values had fallen to 8 dwt. per fathom. A reduction in contract rates was followed by a strike, and the famous old mine closed down for the last time.



Cock's Eldorado Dredge.

Meanwhile gravel pumps had come into use, and in 1899 the original Cock's Pioneer Electric Gold and Tin Sluicing Company was formed, with the late Mr. H. Falconer, father of the present manager, in charge of operations. A large 340 kilowatt steam-powered generator supplied electric current to the 500 horse-power plant on the company's barge. The ground was worked to depths of from 50 to 85 feet, and by 1909 gold and tin to the value of £120,000 had been recovered. The barge was floated a mile downstream in 1912, but the greater depth of the ground put an end to the company's successful operations. Two years later the Cock's Pioneer Gold and Tin Mines N.L. Company was formed, with a paid-up capital of £120,000,

and commenced sluicing on a large scale. Two sets of high speed triple expansion engines coupled to three-phase alternators provided about 1,000 horse-power at the plant, the transmission line from the generators to the barges being a little over 3 miles in length. A creek diversion was made and 14-in. gravel pumps were installed. This elaborate plant, costing between £25,000 and £30,000 worked continuously until 1929, when the yields dropped to an unpayable level. From 1899 to 1929 these two companies had proved conclusively that Eldorado, properly worked, could justify its legendary reputation. In all, approximately 100,000 oz. of gold were obtained, together with tin valued at over £175,500.

The area was re-opened in 1934 by the Cock's Pioneer Gold and Tin Mines (1934) Company N.L., which, by the end of the following year, had become the second company on the Victorian dividend list, distributing £15,000 to shareholders. The electric power is no longer generated by the company, but is obtained from the State Electricity Commission. The capacity of the plant is 800,000 cubic yards per annum, and the motors total approximately 1,400 horse-power. A jet of water of immense power is used in breaking down the face, being fed through 16 and 18-in. pipes and leaving the nozzles at a rate of 5,000 gallons per minute with a speed of nearly 75 m.p.h. Although the nozzles are operated at about 80 to 100 feet from the face to make full use of the cutting and washing power of the water, the pressure is so great that the jet can be thrown 250 to 300 feet.

The operations of this company have revealed large sections of the old McEvoy and Kneebone workings. As the various levels are reached the timber sets form gaunt, blackened lines projecting above the ground like the ribs of some old Viking ship. They are mute reminders of the fierce battle once waged against the treacherous ground now so easily worked by modern hydraulic sluicing.

Midway through the year 1935 the construction of a mammoth gold dredge was commenced for Cock's Eldorado Gold Dredging N.L. It is the largest of its kind in Australasia, and was officially opened by the Minister of Mines on 1st May, 1936. Capable of treating about 12,000 tons of material each day, its power is brought in, as in the case of the Pioneer Company, from the State Electricity Commission's mains at 6,600 volts, and drives no less than fourteen electric motors, the largest of which, developing 200 horse-power, is used on the bucket band. With a length of 328 feet the dredge weighs 2,100 tons, and cost nearly £90,000. The buckets, which number 120, each deliver 12 cubic feet of material, and work to a depth of 90 feet.

The year 1937 saw the Cock's Eldorado plant working steadily, and up to the beginning of October the gold yield had already reached 6,298 oz., with each week adding over £1,000 to the profits of the company. The Cock's Pioneer, in the meantime, had paid £10,000 in dividends during 1936, and up to the end of July, 1937, had recovered 4,108 oz. of gold. Extensive boring operations were then commenced, 74 bores being put down, and as a result the existence has been disclosed of a hitherto undiscovered lead channel which is said to be the original course of the stream. It is estimated by Mr. Falconer, the mine manager, that the new ground will provide at least 12,000,000 cubic yards of payable ground for treatment.

The Cock's Pioneer and the Cock's Eldorado Companies have succeeded in restoring to this locality some of its former importance, and in place of what appeared to be an exhausted field we now find a revived and busy mining centre. An old resident tells us that in the seventies "there were sixteen public houses and two shanties . . . ", and although it may never again make that claim to greatness Eldorado continues to be a vital mainstay of the mining industry of Victoria.

# *The New Central Nell Gwynne Battery*

*By J. B. Justice, Inspector of Mines.*

Outstanding amongst acquisitions of plant by the Bendigo Mining Companies this year is the new 20-head mill put into service early in August at the Central Nell Gwynne Mine. The mill site is ideal, being situated on a hill, with a good natural getaway for tailings through a series of settling dams quite adequate to hold all slum produced, and on to the creek.

The ore leaves the mine in 15-cwt. trucks, which automatically discharge into a Jaques stone-breaker, whence it is distributed by belt conveyor into ore bins, having a storage capacity of about 200 tons. From the bins the stone goes through Challenge self-feeders to the battery boxes, thence over copper-plate tables, concentrating tables and blanket strakes, by gravitation to the sand dumps.

**Battery.**—The battery consists of 20 heads of stamps, each of 1,250 lb. and operating at 105 drops per minute. The frames are constructed of Kauri timber, which tends to reduce vibration. The battery boxes are of the Homestake pattern, the discs three-keyed, the guides cast-iron, and the driving wheels wooden. The battery is driven by leather belts from a counter shaft, and is arranged so that each five heads can be operated separately by jockey pulleys. Four Phoenix-Weir type tables are used for concentrating.

**Power Plant.**—The main units are two 10 H.R.C. Ruston double cylinder horizontal crude oil engines, developing 156 horse-power at 260 r.p.m., and actually running at 235 r.p.m., at which speed each develops 141 horse-power. One-piece bed plates are used. Mechanical lubricators driven from a side shaft function automatically at the stopping and starting of the engines, which are started with compressed air supplied by a Ruston Mark B.C.D. double-cylinder compressor driven by a 3 horse-power Ruston P.B. petrol-kero engine.

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# Appendix D

# Gold Dredging in Victoria

by D.R. Dickinson, B.Sc.

from

*Mining and Geological Journal*

January1939

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***Editorial Article—***

# *Gold Dredging in Victoria*

*By D. R. Dickinson, B.Sc.*

*Gold Dredging—A source of national wealth? A field for profitable investment? A legalized method of despoiling land?*

The economic worth of an industry is the justification for its existence and in gold dredging operations economic conditions may affect differently the nation, the land owner and the investor. From a national standpoint the despoiling of good land must be avoided wherever practicable, and it is chiefly in this respect that criticism has in the past been levelled at our dredging companies. It may thus be well at the outset to emphasize the fact that the practicability of the complete rehabilitation of dredged land varies with local conditions. The principle of the individual consideration of each case is therefore vital, and no generalized ruling could be applied with equity.

There is no need to stress the tremendous influence of gold in the developmental history of Victoria, which despite the smaller yields of more recent years, has been Australia's greatest gold producer. Nor is there any purpose in denying the scars on some of our landscapes accumulated during the winning of this vast wealth, save perhaps, to remark that very few of these disfigurements can be attributed to the operation of bucket dredges, even under the less regulated conditions prevailing before 1906.

In the past much has been written in newspapers, journals, and official reports concerning the value, or more often lack of value, of dredged land. A critical survey of many of the instances quoted indicates that time has had an apparently unexpectedly beneficial effect on the areas in question. Inadequately reconditioned land is certainly to be found in some districts, but the amount of good land seriously damaged is very small; small indeed compared with that lost through erosion hastened by deforestation and overstocking. Moreover, as will be mentioned in more detail later, much land has been treated with negligible detriment and a not inconsiderable amount to its ultimate benefit. There is justification, therefore, for the assertion that under normal conditions land definitely can be restored after dredging to a condition satisfactory for pastoral or agricultural purposes, while in many cases it can be materially improved.

It may be enlightening to refer briefly to the type of criticism responsible for the extreme views possessed by some people on the subject of dredging. Let us consider, for example, a few extracts from the report of a Board appointed some years ago to investigate complaints against dredging companies. Among their findings appears the statement that the Board does not

> "attach much importance to the inclusion of resoiling conditions in the leases for the reason that the members are unanimous in the belief that neither these nor any other forms of restoration work so far devised, ordered, and applied are of practical and permanent avail in returning these lands to their pristine productiveness."

The report further condemns advance stripping of overburden because—

> "the soil becomes completely disintegrated; the position of the constituents are altered in relation to one another, the bottom becomes the top; and it is idle, in the opinion of the Board, to contend that land so treated is not seriously injured permanently."

These conclusions can be refuted by examples drawn from practically every dredged district of Victoria; they are also not invulnerable to arguments based on the established principles of soil formation. The very origin of our valley soils, which are essentially composed of transported materials, and are not resultant from rock weathering and decomposition *in situ*, indicates that further handling of a well conceived nature need produce no permanent ill effects. In fact, some of the richest deltaic soils of the world are subjected to annual inundation and siltation which adds to, rather than detracts from, their productiveness. It seems strange that this aspect did not commend itself to the Board, for in another part of the report, referring to land carrying several feet of alluvium deposited as a result of mining operations upstream, the statement is made that "the new surface appears to be good cattle grazing country, said to be worth £25 an acre, &c."

Many areas in Victoria left by alluvial miners in a useless condition, with numerous shallow shafts and intervening heaps of gravel, have been transformed by dredging into good grazing land. Frequently these sections had been covered by noxious growths and were a harbor for vermin.

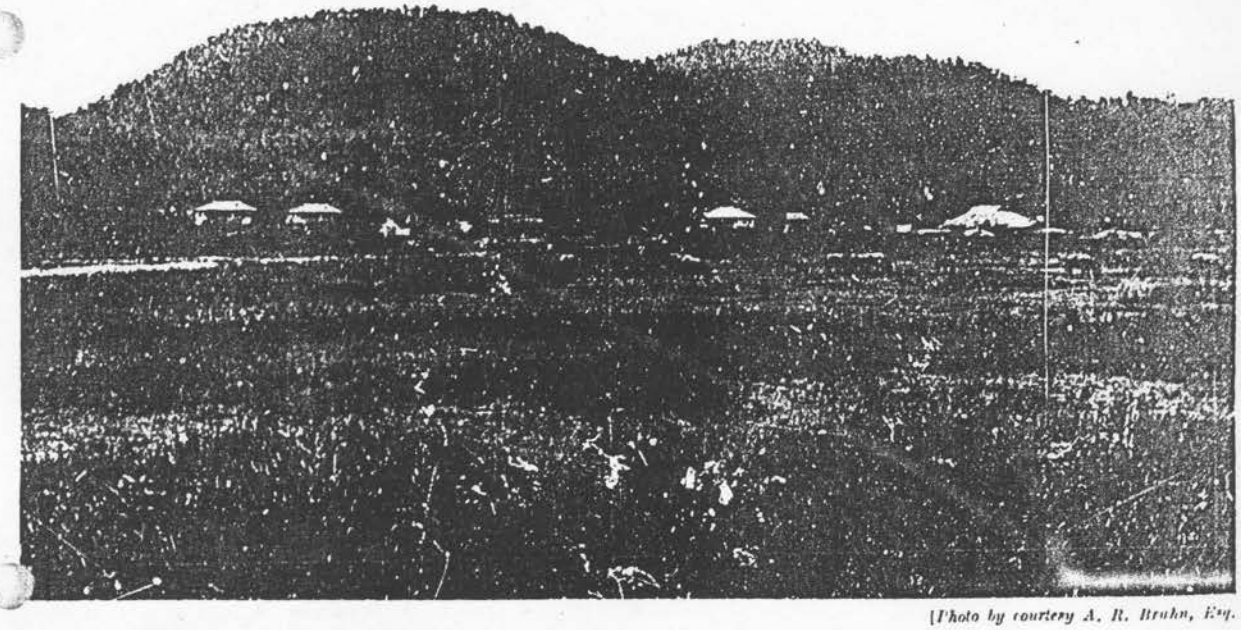
Stream pollution is another aspect concerning which much has been written, and this also has been largely of a critical nature. The importance of this matter can scarcely be over-estimated and, like resoiling, it is one which requires individual consideration in each case. It will suffice to mention at this stage that certain of our leading companies have been able to arrange their scheme of operations so that there is no discharge at all into natural water-courses. Coupled with the levelling and planting of the dredged areas this eliminates all possibility of pollution either directly,

or indirectly as a result of excessive erosion. The absolute avoidance of the discharge of surplus water is not practicable throughout the year in all cases, but if a generalization be permitted, one may say of stream pollution, as of resoiling, that where the land carries good values in gold a satisfactory method of dealing with these problems can usually be found.

Another conclusion of the above-mentioned committee which seems rather illogical is that "The Board considers it nothing to the purposes that the owners of the lands are being compensated possibly richly; &c." Dredging operations are frequently carried out on almost unproductive land, and the owners, many of whom have been struggling for a livelihood, invariably secure most favorable terms of settlement. It has, indeed, become the practice to base assessments of this nature on the full agricultural value of the land, plus liberal compensation for inconvenience, and frequently with the further proviso that the treated land be handed back in workable condition, either gratis, or at a nominal valuation. The genesis of the matter lies in the fact that a company able to finance the erection and setting in operation of bucket dredging equipment can usually afford to pay more than top market price for land required. To such a company it is good policy to satisfy the land-owner rather than to leave him with a real or fancied grievance.

Returning to the economic aspect of dredging, one can point to the striking fact that at Newstead a profit in the vicinity of £2,000 is won per acre of land dredged, while in deeper ground at Eldorado the figure is nearer £5,000 per acre. In the former case the capital value of the land for agricultural purposes may be £25 per acre, while in the latter it is probably as low as £5 per acre. Such sums as those earned by dredging, if invested in productive industries, or even in Commonwealth bonds, would provide in perpetuity an annual return from the land many times greater than its capital value. Assuming then, as is undoubtedly the case, that good land can usually be satisfactorily re-soiled, and that poor land can frequently be improved by dredging, there can normally be no question of economic waste in permitting richly auriferous areas to be dredged under proper control. In fact, the most contentious point is the determination of how much of the profits won by dredging can with economic soundness be devoted to the rehabilitation of land which never was, and under present conditions is never likely to be worth the amount sometimes spent on these works.

A further point that is perhaps not generally realized is that bucket dredging operations have only been carried on during the present century. Most of the land despoilation due to mining dates back much further than this into the more or less uncontrolled "rush" days.

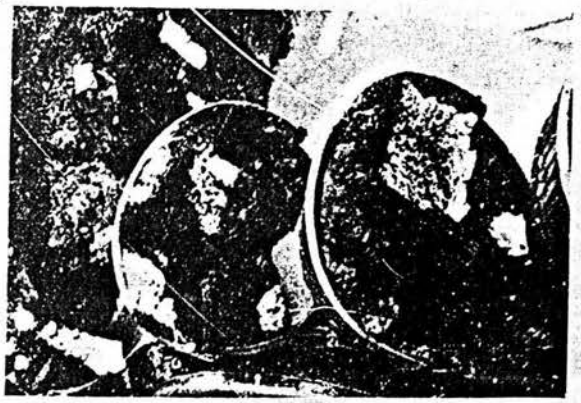


[Photo by courtesy A. R. Bruhn, Esq.

Dredging in Malaya. Buffalo grazing on land used as a silt repository after dredging by Katu Tin. The bungalows in the background were erected by the company.

It is also interesting to note that in swamp and other waste areas dredging equipment, similar to that employed for mining purposes, is used to remake land for residential or industrial purposes. Useful portions of West Melbourne, Lakes Entrance, and several suburbs of Sydney have been formed in this way.

Before 1906 the regulations governing dredging were somewhat inadequate. During that period and a few years immediately following there were numerous easily operable dredging areas available, and these were frequently worked by small companies or syndicates with limited capital and sometimes, no doubt, in an irresponsible fashion. At the present time dredging properties are more difficult to find and more expensive to develop. Dredging itself is governed by strict regulations, and we have entered an era in which the industry is controlled by soundly financed companies, conscious of and able to meet their obligations. It will thus be instructive to review the way in which the various problems presented by the different areas in Victoria are being dealt with to-day.



Newstead Dredge.—The dredge buckets are stripping overburden which is tipped on to the resoiling stacker in this almost dry state.

The Victoria Gold Dredging Company is developing an area in the Loddon Valley near Newstead which would be classed as fairly good agricultural or grazing country. Further, the discharge of effluent water into the Loddon River is considered undesirable, so that the company has been required to provide and maintain rather elaborate resoiling and water retention works.

The sludge problem has been met by the construction of a large slum dam above flood level to which used water from the working paddock is elevated by an electric pumping system. After settling, the water, less losses due to evaporation and seepage, is returned to the dredge pond. Make-up water, amounting to perhaps 20 per cent. of the total intake, is normally supplied by pumping from the Loddon. Owing to the dry season this source has temporarily failed and a bore, at present delivering about 5,000 gallons per hour, has been sunk downstream from the dredge. Mine water from the Guildford Plateau mine, a few miles upstream, is also being utilized. A substantial levee bank along the river boundary serves as protection against possible flooding and all danger of stream pollution is virtually eliminated.

The property is well adapted to resoiling in that it carries some 10 feet of sandy soil or loam. It is interesting to note that part at least of this overburden is considered to have accumulated during the last hundred years, probably in consequence of sluicing and mining operations upstream and as a result of erosion accelerated by the deforestation and cultivation of the watershed. The fact that the soil mantle of this fertile area is largely drift material lends strong support to the contention that the redistribution of soils involved in resoiling processes is not necessarily harmful.

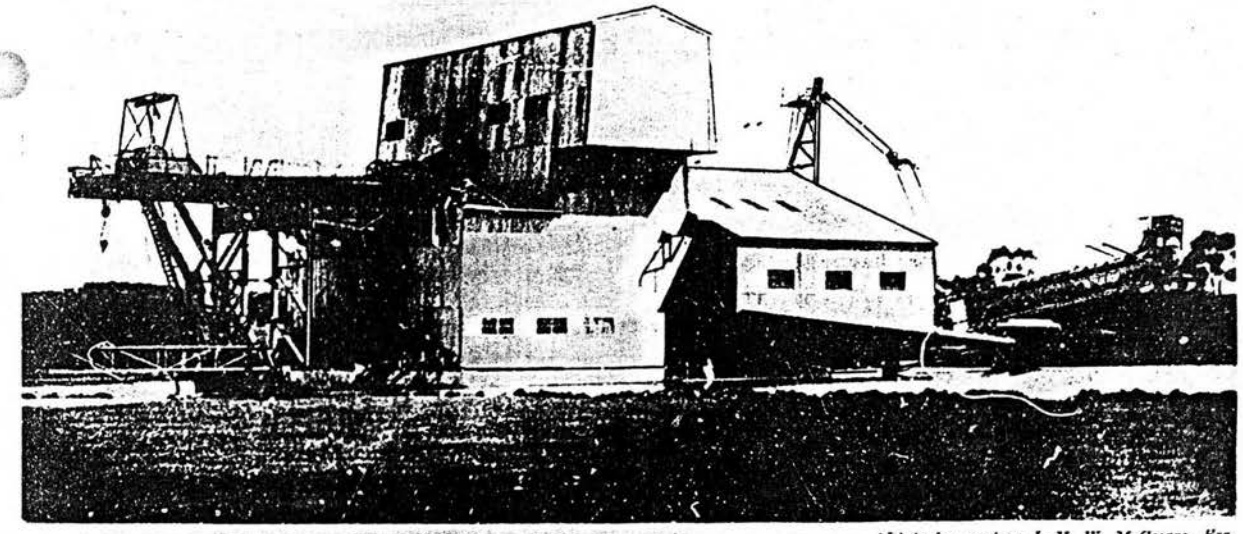
Newstead Dredge.—Soil overburden travelling out behind the dredge on the stacker conveyor belt. The semi-dry condition of the material is evident.

The auriferous gravels dredged up after the removal of the overburden are washed in a rotating screen equipped with nozzles at each end, the gold being collected by mercury traps and by riffles on inclined tables.

The gravel-free overburden, to a depth of about 9 feet, is dug in a semi-dry condition by the dredge buckets, and is discharged by belt conveyor more than 100 feet behind the dredge. The screen-oversize pebbles and boulders are dropped from chutes about 15 feet astern, and the sands about 25 feet astern, so that the re-made land is built up with boulders and coarse gravel

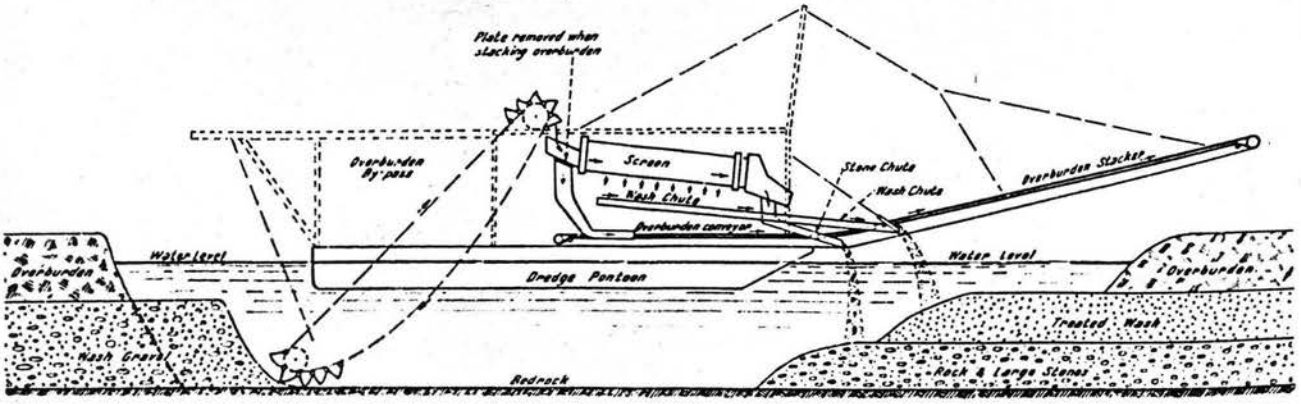
at the bottom, passing up into a surface soil similar to that at present on the undredged areas. The broad details of the process may be gleaned from the accompanying diagram. After the lapse of sufficient time for the consolidation and draining of the treated areas the land will be levelled by bulldozer tractors and sown with grass. Thus the only change undergone by the soil is that it will have been re-sorted. It is not being broken down or robbed of any of its essential constituents as it does not enter the washing system of the dredge at all. Bearing in mind the fluviatile origin of this material it is reasonable to assume that a period of not more than five years will be sufficient to restore the area to its full productivity.

This system has not yet been in operation at Newstead long enough for the results to be accurately gauged. A similar if less elaborate scheme was, however, used by the Briseis No. 3 dredge when operating in the Staghorn Flat area, near Yackandandah, some 25 years ago. These flats are low-lying, and prior to dredging were covered with river-sorted mining drift from old alluvial workings upstream; the land nevertheless was both fertile and valuable. Re-soiling of dredged areas was effected by advance stripping the overburden with the dredge buckets and discharging it astern by belt conveyor. The paddocks were then graded, ploughed and planted. Good crops were obtained from the outset, and to-day the land carries



[Photo by courtesy J. H. W. McGeorge, Esq.

Victoria Gold Dredge, Newstead.—The dredge is digging auriferous gravels and the discharge from the chutes is to screen-oversize and screen-undersize, with the resoiling stacker (extreme right) out of commission. The position of the bucket band is similar to that shown in the accompanying diagram.




Victoria Gold Dredge, Newstead.—Diagram showing the digging and discharge layout. The overburden covering of the strip being worked has been removed, and the buckets are digging gravel which is being washed and graded. The nature of the re-made land is also indicated.

valuable dairy herds and is ranked amongst the best in the district. The treatment of similar land at Newstead by more modern equipment should likewise produce most satisfactory results.

From a financial standpoint the success of the Victoria Gold Dredging Company has been spectacular. Less than three months after the commencement of dredging the company's shares were valued at about three times the amount to which they were paid. In the first five months of operation gold to the value of over £60,000 had been won, and dividends totalling £37,500 were paid. It would be difficult to find a more profitable way of working the 20 acres of farm land from which these results were obtained.

The company's dredge, costing over £70,000, is, with the exception of one motor, entirely Australian. It draws from the State Electricity Commission's mains power to the value of about £500 per month, and directly provides continuous employment for 25 men. Owners of land required by the company have also fared very well as regards purchase considerations.

Staghorn Flat.—Hereford cattle grazing on resoiled land dredged by the Briseis No. 3 plant in 1913. The return in gold was over 300 oz. per acre and the area is now regarded as first class pasture land.

The largest and most powerful gold dredge yet built in Victoria is that now being operated by the Cock's Eldorado Company at Eldorado, in the valley of Reedy Creek. This dredge, which will probably head the State's gold production list for 1938, is working in land almost valueless for agricultural purposes. The return per acre in gold and tin is, however, up to £10,000, of which more than half is profit.

The portion of the lease dredged to date carried at the surface from 2 to 40 feet of old tailings, so that re-soiling works have not as yet been necessary. The gravels, which are dug from depths of up to 90 feet, are washed in a rotating screen fitted with a central "sparge" pipe for supplying water at pressure. Gold recovery is by concentration in primary jigs on the dredge and subsequent barrel amalgamation at the shore treatment plant, where a high grade tin concentrate is also produced.

The screen oversize materials, including the hard clays of the false bottoms, are deposited from chutes directly behind the dredge pontoon. The undersize residues are distributed over the surface by means of a sand pipe and produce a fairly level sandy surface with a small proportion of finer silts.

Eldorado.—One of the six settling dams constructed by the Cock's Eldorado Company. Office buildings and employees' residences are in the background.

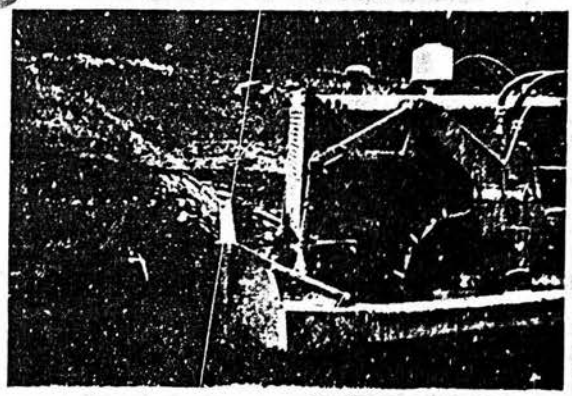
The terrain thus formed cannot be said to be ideal for any particular purpose, except perhaps for pine or wattle plantations which have been very successfully grown under less favorable conditions. It is, however, at least in no worse condition than when taken over by the company and, bearing in mind the almost

Pine plantation between Bright and Freeburgh. The trees were planted between 1924 and 1926 on old dredge tailings. The rate of growth has been above average and the plantations are providing good milling timber.

negligible initial value of the land, it cannot be considered to merit the very considerable expenditure that would be involved in procuring and spreading a useful amount of top dressing. While there is little scope or need for re-soiling at Eldorado the water question at times presents serious difficulties. At present there is no flow at all in the creek and the problem is to procure water rather than to dispose of it. In wet seasons, however, there is the danger of stream pollution to be guarded against, and the company has constructed six large slum dams, covering more than 70 acres, for settlement purposes. These may be used wholly or partially

in series, or individually, as requirements demand. The dredge needs for efficient operation about 500,000 gallons of clean water per day. Of this amount some 80 per cent. is normally returned from the dams while make-up water is either pumped from wells or from the creek. The matrix of the gravels is clayey, and the suspended material produced by the washing is difficult to settle. Filter alum, used as a precipitating agent, costs about £15 per day, and a gang of 26 men is continuously engaged on water settlement and conservation works.

The dredge will shortly turn and commence a downstream run during which it will probably be desirable to treat small areas of land carrying soil. In this eventuality it is proposed that the soil will be dry-stripped by tractors and scoops, and replaced by the same means after dredging. The slum dams are also converting considerable areas to what will become useful land. Portions of the valley down stream, where the surface has been covered by slum from earlier workings of the Cock's Pioneer Company, are now highly valued for pastoral purposes.



Bulldozer tractor stripping overburden on the property of Adelong Gold Estates, Freeburgh.

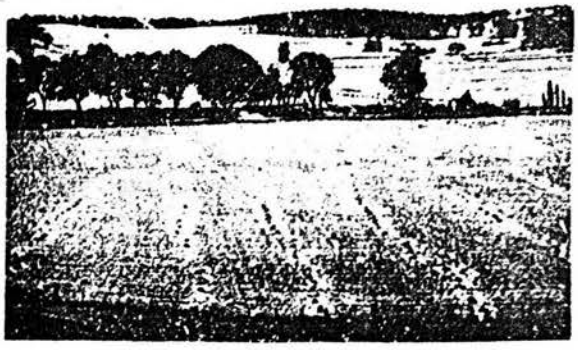
Eldorado is situated in a small valley flanked by productive granite hills and its prosperity, in fact almost its very existence, has always been largely dependent on mining activities. For so small an area the return in alluvial gold and tin has been amazingly good, and the two companies operating at present have most satisfactory prospects. The Cock's Eldorado Company is splendidly equipped, maintains a reserve fund of £20,000 and pays regular dividends on 275,000 shares. It employs 78 men and pays from £750 to £800 per month to the State Electricity Commission for power.

The dredging at Eldorado is the deepest ever carried out in Victoria, and it is taking place under conditions which have no close parallel in this State. Conditions at Bright were, however, somewhat similar in that there was little or no soil to be replaced. The accompanying photograph shows land in this locality some 25 years after treatment by dredges, which left a hummocky surface with a large proportion of coarse shingles. Eldorado land, by virtue of its depth and grading, should respond very much better to whatever subsequent use is made of it.

The valley of the Ovens River between Eurobin and Freeburgh has in the past been more extensively dredged than has any other area in Victoria. The treated land, particularly that in the higher reaches, was largely of poor quality and not well adapted to re-soiling. It has, however, been utilized with conspicuous success for large pine plantations. The two bucket dredges at present

Freeburgh.—Area recently treated by Adelong dredge. The land has been levelled and graded, and top-soil is being distributed where available.

working are the Bright Valley, upstream from Bright, and the Adelong, near Freeburgh. In both cases the discharged material is graded to oversize and under-size, and subsequently levelled where necessary.



Strangways.—Old slum dam of Guildford and Campbell's Creek dredges. The land was used this season for an oat crop and has in the past grown excellent lucerne.

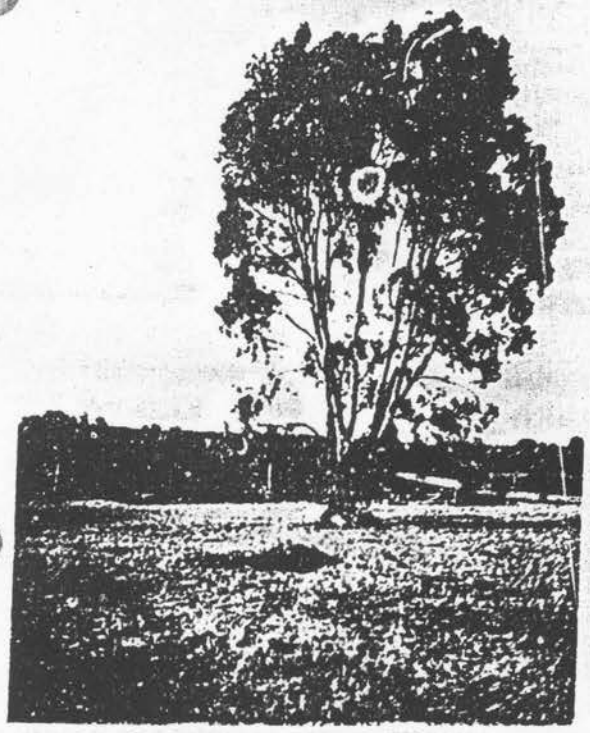
The Adelong dredge is now running into an area carrying surface soil which is being dry-stripped by a bulldozer tractor. Operating from the centre outwards the tractor piles the soil up on each side of the paddock ahead of the dredge. After dredging, the soil can be pushed back over the top sands which are spread by the dredge chutes on the coarse gravels and boulders. The ground water level in this valley is only a few feet below the surface so that the treated land would be excellent for tree culture. The portions carrying redistributed soil will form useful grazing land, and may also be suitable for certain kinds of crops.

Both dredges have adequate water supplies, and under normal conditions experience no settling difficulties, because the whole depth of ground is largely sands, gravels and shingles. The majority of the discharge water from the dredges seeps back into the working paddocks. Part, however, reaches drainage channels which lead it to the river. During its sub-surface journey the water is more or less completely filtered and enters the river carrying little or no sediment.

The Bright Valley Company has a new all-steel dredge, but the Adelong is one of the older type, and was built in New South Wales more than twenty years ago. It differs from other Victorian dredges in that the buckets discharge into a shaker instead of a rotating screen. The gravels are washed by jets from lateral pipes situated above the shaker at both ends. Gold recovery is by mercury traps and sluice boxes fitted with riffles.

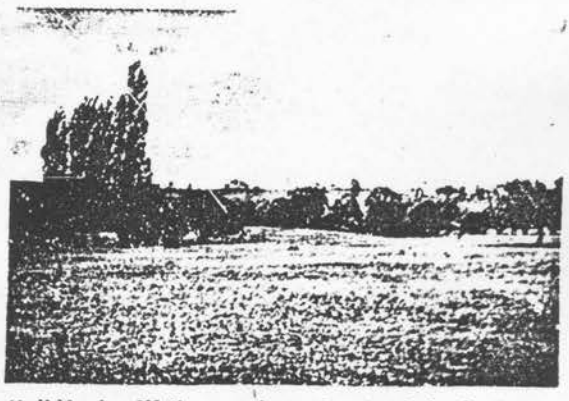
The New Campbell's Creek dredge, near Castlemaine, has achieved considerable resoiling success by settling slum over the dredged paddocks. Some of the land treated had been blocked out by early miners and left in bad condition. Other parts carried 2 or 3 feet of gravelly hill wash and were of little agricultural value. The slum dams, however, as is shown in the accompanying photographs, produce good crops and represent a definite improvement on pre-dredged conditions.

Much of the Loddon Valley, and also that of Campbell's Creek near the junction of the two streams, was dredged in pre-war days. Resoiling was carried out largely by advance stripping with distribution by loam chutes and by slum settling. Results obtained in most cases were satisfactory and the area is, in general, well grassed, productive, and quite resistant to erosion.



Campbell's Creek.—The fruit trees in the backgr und and the eucalypt in the foreground are growing on land dredged and resoiled by the Campbell's Creek No. 1 dredge. These trees are exceptionally well grown.

Campbell's Creek.—A year ago this paddock was a slum dam of the New Campbell's Creek dredge. A similar paddock last year produced a record oat crop.



Guildford.—Well-grassed grazing land dredged and resoiled by Campbell's Creek No. 1 dredge.

As an example of the complete success that these methods were capable of producing may be quoted the case of portion of an orchard at Campbell's Creek owned by Mr N. O. Robinson. Dredged and resoiled some 30 years ago, this area now produces better fruit than any other part of the property, and has also grown prolific lucerne crops. Mr. Robinson attributes its added fertility to the fact that dredging has broken up the hard clay sub-soil, so allowing a freer circulation of water and permitting the tree roots to spread to greater depths. There was no noticeable diminution in the ability of the soil to nourish plants, and its greater permeability to water resulted in an accelerated growth rate.

Redbank Valley.—This useless and unsightly area awaiting dredging forms a striking contrast to the fertile and productive strips of resoiled land in the Loddon and other dredged valleys.

At Redbank, near Avoca, Redbank Dredging N. L. completing the construction of an electric dredge with a capacity of 25,000 cubic yards per week. The property to be worked is scarred by innumerable shallow shafts left by early diggers, and is at present practically valueless for agricultural or grazing purposes.

The dredging company proposes to spread the sands and fine gravels over the screen-oversize material, after which the paddocks will be levelled as necessary by bulldozer tractors and, where available, slum will be settled on the surface by the construction of numerous small dams. Whatever method were to be employed, it could hardly be detrimental to land in such condition. The above programme may be expected to transform it into a useful area.

The work being carried on by the various dredging companies in Victoria will result in the transformation of much otherwise useless land into profitable grazing or agricultural areas. No appreciable areas of land are being materially damaged. No natural watercourse is being polluted. Considerable employment under good conditions is being provided, and the nation's resources are benefiting by the increased production of the world's most sought and saleable commodity—gold.

Loddon Valley.—Dairy cattle grazing on land dredged and resoiled by the Guildford dredge some twenty-five years ago. The poplar trees protect the river boundary from erosion.

# *Mining Personalities—*

**Mr. W. J. Parr** became Chief Clerk of the Victorian Mines Department in 1934. Prior to this he had held various positions in the Education Department, the Treasury, and the Forests Commission, before being transferred to the Mines Department in 1932.

During recent years, Mr. Parr has been a keen student of mining law, and his office has become a reference bureau to which innumerable problems and technicalities are submitted by both staff and public. Possessed of an analytical mind he has proved a valued adviser to mining companies through his experienced interpretations of the Mines Act.

Mr. Parr was attracted to the study of palaeontology in his early youth and has become a recognized authority on the foraminifera, a great fossil group now utilized in all parts of the world for purposes of correlation in the search for and development of oil fields.

Either alone, or in collaboration with others, including Mr. F. Chapman, the former Commonwealth Palaeontologist, Mr. Parr has published 22 papers on this subject. At present he is engaged, with Mr. Chapman, in the examination of the dredgings made by the last expedition to the Antarctic under the leadership of Sir Douglas Mawson.

Mr. W. J. Parr.

# Appendix E

# Annual Production Statistics for Eldorado Dredge

derived from

*Victorian Department of Mines - Annual Reports*

1936 - 1955

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## SUMMARY OF ANNUAL PRODUCTION STATISTICS FOR COCK'S ELDORADO DREDGE

| YEAR | ALLUVIUM | GOLD OUTPUT from DREDGE | | | STATE | TIN OUTPUT from DREDGE | | DIVIDEND |
|---|---|---|---|---|---|---|---|---|
| | Millions of Tons | Ounces year | Ounces total | State rank | Ounces gold | Tons of Tin Concentrate | Pounds Value | Pounds money |
| | (a) | | (b) | (c) | (d) | (e) | | |
| 1936 | * | 396 | 396 | | 132,462 | * | * | - |
| 1937 | * | 9585 | 9,981 | 2 | 160,571 ? | 169 | 33,283 | 41,250 |
| 1938 | * | 8542 | 18,523 | 2 | 161,114 | 149 | 25,140 | 55,000 |
| 1939 | 1.8 | 5328 ? | 24,015 | 9 | 172,105 | 134 | 25,924 | 13,750 |
| 1940 | 2.1 | 6630 | 30,645 | 7 | 197,587 | 109 | 22,467 | 41,250 |
| 1941 | 2.4 | 3476 | 33,576 | 11 ? | 165,081 | 71 | 15,690 | 6,875 |
| 1942 | 2.3 | 4859 | 38,435 | 6 | 114,326 | 83 | 18,954 | 20,625 |
| 1943 | 2.3 | 3431 | 41,866 | 7 | 56,511 | 60 | 14,162 | 6,875 |
| 1944 | 1.9 | 3254 | 45,121 | 2 | 54,086 | 55 | 12,835 | 6,875 |
| 1945 | 1.8 | 2042 | 47,163 | - | 61,639 | 42 | 9,969 ? | - |
| 1946 | 1.8 | 2786 | 49,949 | - | 98,357 | 64 | 14,917 | - |
| 1947 | 1.9 | 3017 ? | 52,996 | - | 95,307 | 87 | 25,397 | 10,312 |
| 1948 | 1.9 | 2993 ? | 55,929 | 7 | 68,580 | 54 | 20,695 | - |
| 1949 | 1.6 | 2512 | 58,441 | - | 68,426 | 49 | 20,109 | 6,875 |
| 1950 | 1.8 | 1720 ? | 60,162 | - | 67,826 | 40 | 21,327 | - |
| 1951 | 1.8 | 2357 ? | 62,519 | 9 | 66,063 | 50 | 33,232 | - |
| 1952 | 1.9 | 3091 | 65,610 | 8 | 66,777 | 52 | 42,218 | - |
| 1953 | 2.0 | 2389 | 67,999 | - | 63,917 | 44 | 22,756 | 10,313 |
| 1954 | 1.7 | 2032 | 70,031 | - | 59,515 | 34 | 22,846 | - |
| 1955 | 0 (f) | 92 | 70,123 | - | | 2 | 1,268 ? | - |
| Total | 31.0 | 70,532 | 70,123 | | | 1348 | £403,189 | £220,000 |

NOTES: These statistics are derived from Department of Mines Annual Reports. Figures marked "?" were unclear or doubtful. Figures marked "*" were not found for that year.

(a): Millions of tons of alluvium dug up and treated by the dredge, then discharged back.
(b): Cumulative total gold output, but with discrepancies from reported annual production.
(c): Department of Mines Annual Reports usually ranked the top ten gold producers in Victoria.
(d): Total annual gold production for the State of Victoria.
(e): Tons of tin ore recovered, after further concentration on shore to about 75% tin content.
(f): In 1955 the dredge was shut down, but some gold and tin was recovered in cleaning-up.

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# Appendix F

# Interpretation Panel & Mounting Frame Drawings

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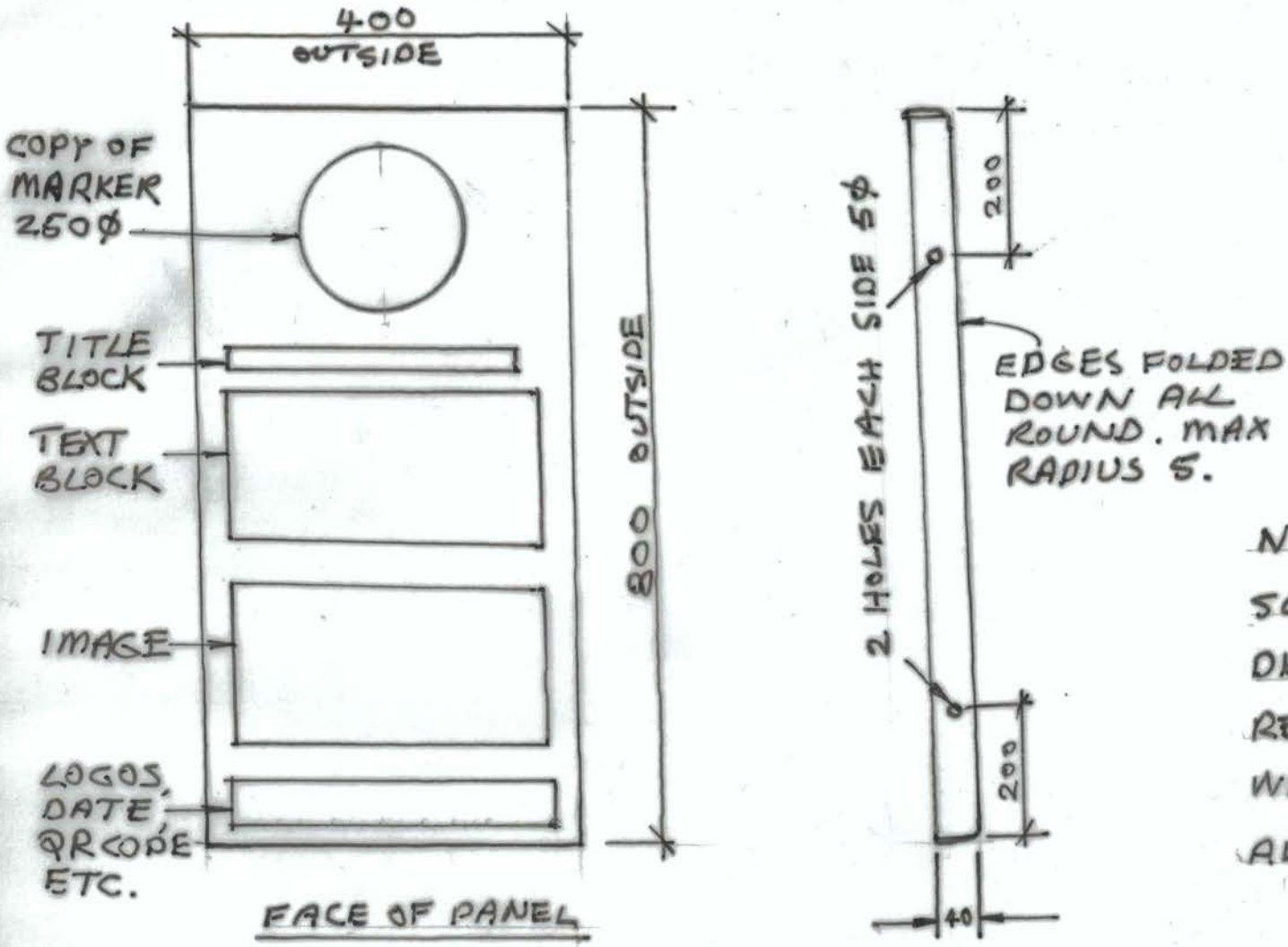


NOTE:
SURFACE MATERIAL DIGITALLY PRINTED REFLECTIVE VINYL FILM WITH UV LAMINATE ON ALUMINIUM SHEET 1.6T

# INTERPRETATION PANEL

## MINI - PANEL
## VINYL - ON - ALUMINIUM

DIMENSIONS IN mm
NOT TO SCALE

DRAWN:
OWEN PEAKE
7/7/2015

DRAWING No: EHA 2015/1