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1985/06. Groundwater investigation for town supply Gladstone, north-eastern Tasmania, 1976-1978. Compilation report

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Abstract

The groundwater investigation for Gladstone covered all the suitable available aquifers. This included fractured rock and unconsolidated sediments. Exploration methods used were refraction seismic spreads, resistivity probes, nine shallow auger holes and four deep bores. Two bores were dry and two with low yields had acidic groundwater with a high iron content. A thick deposit of tin mining tailings deposited in the Ringarooma River bed was used as a filter horizon for the surface river water. Spear bores (50 mm) in the tailings and 150 mm bores into the underlying river gravels gave adequate supplies and improved water clarity but the acidity and iron content of the river water were unchanged. A simple spear bore array is recommended as a possible alternative to surface river water for Gladstone's town supply.

INTRODUCTION

In 1976, the Ringarooma Council requested the Department of Mines to undertake groundwater investigations for a water supply for the two small towns of Gladstone and Winnaleah. The existing town supply for both towns suffered from pollution. In the case of Gladstone, the existing town water supply is from Mount Cameron Water Race. The race water is primarily for sluicing for tin miners in the Gladstone region. The water is badly discoloured from a high iron content, both mineral and organic, and is often highly acidic.

During the period from 1976 to 1978, the Department had up to four drilling rigs working in north-eastern Tasmania on regional groundwater assessment in addition to geological mapping and geophysical exploration for the north-eastern groundwater project. The then Director approved both town water supply investigations with the provision that the investigations would be made within the framework of the regional groundwater programme and would not disrupt the planned drilling schedules. This arrangement of necessity resulted in both investigations being intermittent but provided a complete and comprehensive groundwater investigation with confirmatory drilling for both towns.

In the case of Gladstone, as there was a strong possibility of the Mount Cameron Water Race being closed in 1978 because of the lack of support from the tin mining industry, a further investigation outside the terms of reference of the regional groundwater programme was authorised by the Director. The scheme to be investigated was the use of tin mining tailings deposited in the Ringarooma River bed as a filter horizon for the river water. An intensive sampling programme of the existing water supply was also undertaken to determine whether the Department of Mines' Laboratory could suggest any method which would improve the quality of water from the existing supply (table 1; Wellington, 1984). These results were detailed in a series of reports, some verbal, given to the Council and to the then Chairman of the Water Supply Committee, Mr Jeff Cox, then postmaster at Gladstone (Appendices 1, 2).

This report does not cover the chemical investigation of the water quality associated with the high iron content and acidity of the existing or alternative water supplies.

GROUNDWATER INVESTIGATION PROGRAMME

As a result there were two phases in the groundwater investigation for Gladstone. In the first phase the regional groundwater programme resulted in the testing of the different aquifers around Gladstone. An aquifer is defined as a stratum or zone of rock below the surface of the earth capable of producing water from a well or a bore. In the second phase two different filter horizons in the Ringarooma River were tested.

Aquifers:

Fractured hard rock aquifers (Mathinna sediments and granite).
Unconsolidated sediment aquifers (Tertiary sediments, Quaternary river gravels and Recent tailings).

Filter horizons:

Tailings in the Ringarooma River.
River gravels of the original Ringarooma River bed.

AQUIFERS

Fractured hard-rock aquifers

MATHINNA BEDS

In the vicinity of Gladstone the major rock type is the contact metamorphosed alternating sequence of sandstone, poorly sorted siltstone and mudstone beds (fig. 1). These sediments are highly folded and fractured with numerous joints comprising several intersecting sets. It is in these joints and bedding discontinuities, when open, that the groundwater is stored.

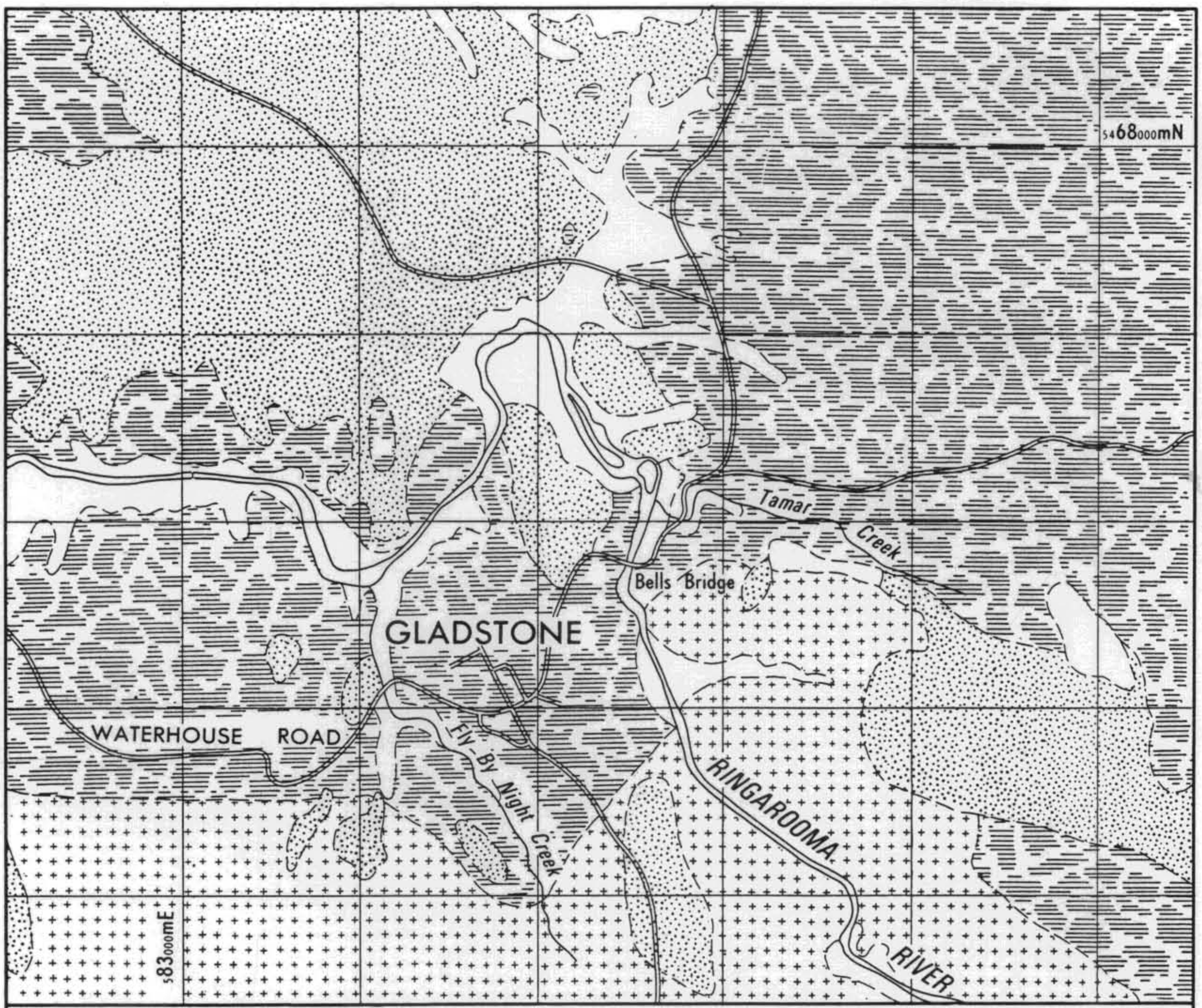
These sediments, locally termed slates, belong to the Mathinna Beds of Lower Ordovician to Devonian Age (McClenaghan *et al.*, 1982). They have been intruded by a suite of granitic rocks, which crop out 2 km south and east of the township of Gladstone (fig. 1).

Groundwater prospects

Bores drilled in these sediments in north-eastern Tasmania have a success rate of over 85%. The yield of the bores range from 0.25-3.8 *l*/s (200-3000 gal/h) with average yield of 0.6-1.25 *l*/s (500-1000 gal/h). The quality of the groundwater is generally good but the water from some bores is acidic and has a high iron content. Groundwater has been found to be too saline for stock in only one area in north-eastern Tasmania. In the majority of bores the groundwater is suitable for household use with some aerating and neutralisation of the acidity by the addition of soda ash, *etc.*

Exploration methods

Prior to the Gladstone town investigation, the unsuccessful bores in the Mathinna Beds to the east had been found to be close to the granite contacts, particularly where quartz veining and often mineralisation had taken place. In such areas, as Oxberry-Waterhouse, the old Lyndhurst gold field, and west of Scottsdale at the old Lisle and Lefroy tin and gold fields, investigatory bores were dry. Heat close to the granite contact is thought to have welded the joints together and this, combined with quartz veining, lowered the groundwater storage capacity of the Mathinna sediments.



GENERALIZED GEOLOGY GLADSTONE

W. R. MOORE, 1976–79

0 1 2 km

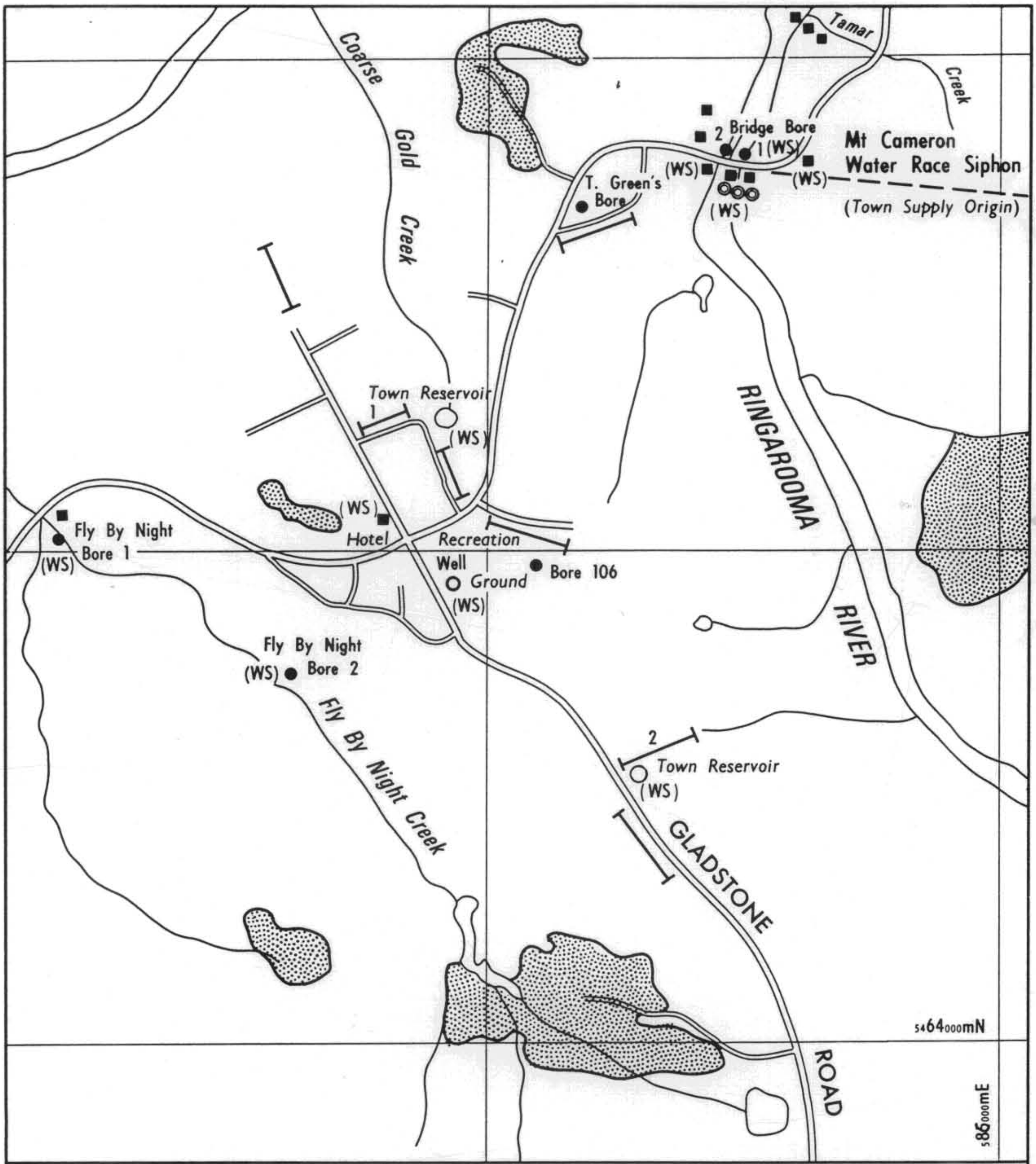
Tin mining tailings and Quaternary –Recent river gravels and sands.	Mathinna Beds: Alternating sequence of sandstone, siltstone and mudstone.
Tertiary: Unconsolidated fine gravels, sand and clay.	Devonian: Granitic rocks.

Geology adapted from 1:50 000 Geol. Atlas Series, Eddystone and Boobyalla Sheets.

Fig. 1

DEPT. OF MINES, TAS. 5075 B

5 cm



GROUNDWATER EXPLORATION PROGRAMME
GLADSTONE TOWN WATER SUPPLY

W.R.MOORE 1976—79

0 250 500 Metres

Seismic and resistivity probe

Auger drill hole

Investigation water bore

Shallow well

Spear bore

(WS) *Water sample location*

Old sluiced tin mining areas

Fig. 2

DEPT. OF MINES, TAS. 5075 A

5 cm

In these areas the non water-bearing Mathinna sediments were found to be very hard on drilling and to have high uniform seismic velocities. In contrast the water-bearing Mathinna sediments were found to have stepped seismic velocities within the range 1000-2500 m/s. Refractive seismic, combined with resistivity techniques, gave an effective exploration evaluation tool for differentiating between non water-bearing and water-bearing Mathinna sediments. The high drilling success rate achieved for bores in the Mathinna sediments at the end of the north-eastern investigation is the result of using the two geophysical methods in combination. Dry bores gave clouds of fine white quartz dust when hammer drilled, aptly described by the driller's term - a duster.

In Gladstone a dry bore had already been drilled in 1974 in the Mathinna sediments by the drilling section of the Department. This bore had been drilled to test the use of a down-the-hole air hammer on a cable tool plant. The hole was drilled to a depth of 39 m on T. Green's property north-east of the township and was completely dry (fig. 2). Using this bore as a control a seismic spread and resistivity spread were undertaken near T. Green's homestead. A further six seismic spreads and resistivity probes were then undertaken around Gladstone. All six seismic spreads showed, as did the control spread at Green's, the underlying Mathinna rock to be high velocity and hard very close to the surface. The resistivity probes also have high values confirming that no groundwater horizon exists in these sediments in the Gladstone town area.

To confirm these geophysical results it was decided to drill at one location in Gladstone. The decision to drill a site on the recreation ground was influenced by the groundwater quality of a nearby well. This shallow well is situated in the back yard of one adjoining residence and a water sample collected from this well was found to be of a better quality than the town supply (table 1). Even though most of the water in the well was considered to be surface seepage water it influenced the choice of the drilling site. Bore 106 was drilled in 1977 using a down-the-hole hammer to 50 m and was in hard Mathinna Beds sediments for its entire depth and was completely dry.

Seepages occur in the Mathinna sandstone near the abutments of Bells Bridge on the Ringarooma River. Two holes were augered to allow an increase in their flow in order to test the quality of groundwater (table 2). The samples when collected had excellent clarity but within an hour of exposure to the atmosphere the water became completely opaque and with an iron rust scum precipated on its surface. These results indicated that if any groundwater could be found in these sediments it would be unlikely to be suitable for town supply. Because of the negative drilling and geophysical results, it was decided that further investigation into the Mathinna sediments in the vicinity of Gladstone township is not warranted.

GRANITIC ROCKS

Granitic rocks crop out extensively 2 km south and east of Gladstone, (fig. 1). They were never seriously considered as a potential aquifer. By 1978 the north-eastern Groundwater Regional Investigation found that granitic rocks had the lowest drilling success rates of all rock types tested. Of all the known bores drilled in the granite only two have a high enough yield to warrant placing pumps in them and bringing them into production. This was true in 1979 and is still true in 1984 despite the extension of the north-eastern programme to St Helens and the East Coast and drilling of granitic rocks in Pyengana, Binalong Bay, St Helens and Bicheno. Therefore any suggestion of drilling south of Gladstone will mean drilling these granite rocks, which is considered by the writer unwarranted and too high a risk.

Unconsolidated sediment aquifers

During investigations made in the north-eastern regional groundwater programme, the unconsolidated sediment aquifers have produced large quantities of good quality groundwater, particularly the coarse sands, grits and fine gravels of Tertiary age of the Scottsdale Basin, Rushy Lagoon-Targetts Flat areas (McClenaghan *et al.*, 1982). Unfortunately these sediments are those in which tin occurs and mostly they have been sluiced for tin around Gladstone and their groundwater potential destroyed as a result.

Apart from a few remnant small areas of Tertiary sediments near the Ringarooma River the only unconsolidated aquifers remaining in the Gladstone township area with any groundwater potential are the tin tailings deposited in the nearby streams of Fly-by-Night and Tamar Creeks and the Ringarooma River and the original river bed gravels. Nine reconnaissance shallow auger holes were drilled using a Proline tractor-mounted auger drill (fig. 2).

In Tamar Creek the tailings were of little depth and no definite sediments of Tertiary age were identified. The auger holes in the Ringarooma River floodplain produced water, but those in the Tamar Creek were dry. The floodplain tailings were over 10 m thick. In the area on the west bank of Ringarooma River, north of Bell Bridge, some peaty sediments were present beneath the tailings and the groundwater was black and very brackish. Only in the Fly-by-Night Creek were thick tailings and gravels with groundwater encountered. This creek warranted further investigat drilling using a heavy drilling machine.

Fly-by-Night Creek: Cable tool rig (Bores 1 and 2, 1979)

Two 150 mm bores were drilled in Fly-by-Night Creek using 130 mm slotted steel water bore casing. Bore 1 was drilled by the ford crossing on the Gladstone-Bridport Road (fig. 2). The mine tailings were 6.5 m thick and were underlain by one metre of coarse river gravels. The bore then penetrated into 0.5 m of slate - a total depth of 8 m drilled. The bore was pump tested for eight hours at 3 *l*/s (2400 gal/h) and the water table drew down one metre during the test. The colour was good, the taste fair, but the water had a strong hydrogen sulphide odour apparent during pumping.

Samples collected at the beginning and end of the pump test showed, on chemical analysis, that the groundwater was highly acidic (pH 4.4) and had a high iron content (0.4 mg/*l*) (parts per million) which had increased to 1.7 mg/*l* at the end of the test (table 3).

Even though the total salt content of 170 mg/*l* was well within the range suitable for human consumption, the high iron content made the water unsuitable for town supply.

The drill rig was moved upstream in Fly-by-Night Creek as close as possible to the granite contact near a dam site, in the hope the quality of water may have improved (fig. 2). Bore 2 was drilled through 4.5 m of tailings; no gravels were encountered and it ended in slate at a depth of 5 m. A pump test yielded 1.1 *l*/s (900 gal/h). The water had a strong odour, was highly acidic but its iron content was considerably lower, and it was marginally better than the Tamar Creek surface water or Bore 1 groundwater (table 3).

It is possible that a horizontal spear bore at the location of Bore 2, placed in a trench at the base of the tailings, would produce adequate amounts of water for town supply. Such a scheme would require further investigation.

FILTER HORIZONS

The use of river sediments as a filtering horizon is a well established practice and had been used with some success at the Tonganah clay mine near Scottsdale. The Great Forester River water, because of the chemical pollution from the heavy fertilisation and irrigation of nearby hop fields, was unsuitable for the clay settling ponds. By using spear bores in the gravels near the edge of the flood plain, water of a suitable purity and clarity was obtained.

Spear bores in mine tailings, Ringarooma River, 1977

This scheme aimed at using the considerable thickness of tailings, thought to have been deposited in the Ringarooma River bed as a result of a century of tin mining operations, as a filter horizon for the muddy river water (table 4). In 1977 the river water was polluted by silt and mud caused by the sluicing from tin mines operating upstream of Bells Bridge (Wellington, 1984).

Three auger holes were drilled on the flood plain between the eastern abutment of the old Ringarooma bridge and to within 5 m of the water's edge. In two holes bedrock was encountered at 9-10 m. The remaining thickness comprised fine gravel tailings and coarse sand.

Three 50 mm spears were hand bailed down to a depth of 2-3 m; the first approximately 5 m from the river's edge. The middle spear was used as a pump bore, the others as observation bores. The middle spear was pump tested at approximately 42 *l*/min (550 gal/h) for two hours with no draw-down occurring in the observation bores. The water clarity was approximately equivalent to the existing town supply and certainly far better than the surface river water. The high iron content and acidity remained a major problem (table 5).

The results of the spear bore test (Moore, 1977) were encouraging but inconclusive for the following reasons:

(1) The depth reached from hand bailing (3 m) was not enough to give a thick enough filter horizon to clarify the surface waters. Depths of 10-15 m would probably have been needed with the high pollution levels of the river water in 1977.

(2) The pumps used were either pressure pumps or small volume pumps and so spears could not be jetted to the required depth (10-15 m). Large volumes of water rather than pressure are required even with pre-drilled holes.

(3) The only spears available in 1977 were 2 m in length and had a very fine screen. With this length of spear it was effectively drawing a filter horizon of one metre in thickness in a 3 m hole. A one metre spear with a coarser screen would have been preferable. A higher pumping rate and a higher level of clarity would probably have been achieved with this combination in a deeper hole.

(4) The total thickness of the tailings was not known in the middle section of the river and the seismic equipment then used could not effectively damp out the noise of the river, so even an estimate of this thickness was not possible.

A shallow spear bore array did not appear to be a viable alternative to the Mt Cameron water race supply in 1977 owing to the muddy river water from the tin sluicing operations upstream, however in 1985 the Mt Cameron water race was closed and tin sluicing operations have ceased so that this type of scheme would be more attractive. Water quality would also be unaffected in time of flood.

The next proposal for investigation was to drill from the bridge through the tailings into river gravels of the old river bed, to determine water quality at greater depths.

Double cased bore into original river bed gravels of the Ringarooma River, 1978

With the improvement in the clarity of the river water after passing through from 3 m of tailings, it appeared conceivable that complete clarity could be obtained if the total thickness of tailings and the original river bed gravels were penetrated.

It was proposed to drill a test bore using a cable tool plant from the decking of Bell Bridge. The river water would be kept out by using solid 150 mm drill casing with a 130 mm water bore casing inside it. The lowermost 3 m of the water bore casing was slotted. The outer drill casing would be withdrawn to the top of the gravels exposing the desired length of slotted casing. This was repeated three times, exposing the slotted casing at the different depths. This drilling technique had been successfully used with screens in the coastal sand dunes at Waterhouse and in river gravels in New River, Ringarooma, using a cable tool drill rig. If this was successful a high production bore could be obtained by placing a 130 mm screen with a seal replacing the slotted casing, placed at the optimum required depth (Moore, 1978).

After the Director of Mines approved this limited drilling programme the Council also approved the closing of half of the bridge while drilling proceeded. A bore was drilled near Pier 1 on the eastern side of the river, and passed through 13.5 m of tailings into the river gravel. Another bore near Pier 2 encountered 15.5 m of tailings and penetrated 2.5 m into the gravels. This bore was pump tested at three levels with slotted casing exposed at 4-7 m, 10-13 m and 15-18 m. Each test was four hours duration with a pumping rate of 314 *l*/s (2700 gal/h). The drawdown was 0.6, 0.9 and 1.5 metres respectively, with water level recovery almost instantaneous when the pump was stopped.

Water clarity was excellent during pumping but with exposure to air the water became cloudy. The chemical problem of a high iron content and acidity remained particularly at the 10-13 m and 15-18 m levels (table 6).

These tests prove there are ample supplies of groundwater available in the tailings and that the tailings at depth have filtered out the suspended solids. The chemical quality, particularly the iron content continues to be a problem, but may be within acceptable limits in the upper 4-7 m of the tailings (Appendix 2).

The chemical problem of acidity and more importantly the high iron content also affects the alternative schemes (Ringarooma River water (table 7) and Mount Cameron water race water (table 1)).

CONCLUSIONS

(1) The Mathinna Beds sediments which underlie Gladstone and occur in the immediate vicinity for a radius of approximately 2 km yielded no supplies of groundwater. Springs and seepages sampled in the area indicate that the quality of any groundwater in these sediments would not be suitable for a town supply. The groundwater is likely to be of high acidity and rich in iron.

(2) Granitic rocks are not considered an alternative aquifer in the Gladstone area. Bores drilled elsewhere in north-eastern Tasmania in granitic rocks are generally dry or have very low yields. There is no reason to expect that the Gladstone granites would be different. Piping groundwater a distance of 2 km from granite outcrops to the south and east of Gladstone is not considered economic.

(3) The unconsolidated sediments of tailings, river gravels, and sands and grits of Tertiary age around Gladstone are generally too thin to store adequate supplies of any groundwater. In the only area where there is an adequate thickness, lower Fly-by-Night Creek, the groundwater quality is not suitable, the water being acidic and iron rich.

(4) A 50 mm diameter spear bore tested in the tin tailings of Ringarooma River bed at a depth of 3 m indicated an adequate supply of groundwater. The water showed a considerable improvement in clarity compared with surface river water. This clarity could possibly be improved by drilling deeper towards the bottom of tailings. With no tin mines operating in 1984 compared with 1977 when these tests were conducted, this type of groundwater supply is possibly a viable alternative to using the river surface water if the high iron content and acidity can be corrected or are acceptable.

(5) Drilling deep into or below the tailings into the river gravels of the original Ringarooma River bed, sealing off the surface river water, gave more than adequate supplies for town supply from one bore. The high ferrous iron content of the water combined with the acidity would probably prevent its use for town supply. Only at depths of 4-7 m in the tailings did the groundwater approach acceptable chemical levels. The acidity can be corrected chemically but stopping the ferrous ion oxidising to ferric ion on encountering the air, forming rust, is a far more difficult problem.

(6) One of the most productive aquifers found in the north-eastern Groundwater Investigation is within the vicinity of Gladstone. Its distance of 8 km north-east of the town makes it an uneconomic project for such a small population. The cost of drilling a deep bore, pumping it, and piping it from Targetts Flat, north of Cinderella Hill, is considered too costly. The Tertiary sediment aquifer below Tertiary basalt has been pumped at 250 *l*/s (20,000 gal/h) and gave high quality groundwater.

(7) All three proposed Gladstone water supply schemes have acidic water with a high iron content and should be treated for town supply water. A treatment plant for a town of Gladstone's size is not economically feasible.

RECOMMENDATIONS

(1) No further groundwater bores should be drilled in hard rock by the Department of Mines for Gladstone town water supply because a comprehensive and full investigation has already been completed in 1978.

(2) The only possible alternative to the surface water scheme proposed by Rivers and Water Supply Commission is a simple two spear bore array, in the tailings of the Ringarooma River. This array would be required to reach a greater depth than achieved by the Department of Mines in 1977. It has the advantage over the surface scheme that, if the pumps were situated above flood level, the water quality would not be affected by the muddy waters of a flood.

(3) Such a proposal requires costing. Its installation could be undertaken by local residents, for example Messrs Green and Petrie of the Gladstone Water Committee, who have the necessary skill and knowledge, particularly with guidance from B. Cox, the Department of Mines' Senior Field Assistant.

(4) Before installation of a simple spear bore array is considered, a trial one-metre length 50 mm spear bore should be jetted to a depth of 7-8 m. Two observation bores should be drilled and the bore pump tested for 2-3 days. This operation may require the use of Council machinery to pull the Triefus trailer drill rig out on to the Ringarooma River flood plain. Water samples should be collected frequently for analysis when pump testing. The estimated time for this work with local help is one visit of three to four days for two members of the Department of Mines' staff. The pump test itself could be run by Mr T. Green who is familiar with this type of operation. The spears and connecting pipes should be buried below the surface of the flood plain and if successful the spear bores and pipe which the Department of Mines used could be replaced at cost by the Council or any appropriate authority.

(5) The groundwater produced from no. 2 bore in Fly-by-Night Creek has the best quality groundwater found to date in the vicinity of Gladstone, but the quantity was not considered to be sufficient for town supply. A horizontal bore placed at the base of the tailings would increase the amount produced. Such a scheme needs further investigation requiring the use of a backhoe, pump testing, and confirming water quality analysis.

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[28 February 1985]

Table 1. GLADSTONE WATER SUPPLY ANALYSES (Town supply samples collected 27 September 1978)

Locality	Gladstone Town Supply Water Race Sample 1	Gladstone Town Supply Resv. 1 Sample 2	Gladstone Town Town Supply Resv. 2 Sample 3	Gladstone Town Supply Hotel Tap Sample 4	Well Gladstone
pH	4.7	7.5	7.9	5.8	6.2
Cond. µS/cm	310	340	340	300	250
CO_3	Nil *(mg/l)*	Nil *(mg/l)*	Nil *(mg/l)*	Nil *(mg/l)*	Nil *(mg/l)*
HCO_3	0.67	52	43	4.7	Nil
Cl	95	88	91	91	54
SO_4	7	8	8	8	21
SiO_2					7.5
Ca	3.0	20	17	3.6	1.9
Mg	6.6	6.6	6.1	6.1	3.8
Fe	0.5	0.85	0.7	0.75	<0.1
Al	0.7	0.7	0.7	0.7	<0.2
K	1.7	2.1	2.1	2.1	1.7
Na	51	46	47	47	43
TDS	230	260	260	230	150
Alk. as $CaCO_3$	0.5	42	35	3.8	Nil

Table 1. (continued)

Locality	Gladstone Town Supply Reservoir 1 Sample 2	Gladstone Town Supply Top Reservoir 2 Sample 3	Gladstone Town Supply Mt Cameron Water Race Sample 1	Gladstone Town Supply Tap Water Gladstone Sample 4
pH	5.6	5.4	4.7	5.6
Conductivity	250 µS/cm	250 µS/cm	470 µS/cm	240 µS/cm
CO_3	Nil *(mg/l)*	Nil *(mg/l)*	Nil *(mg/l)*	Nil *(mg/l)*
HCO_3	7.5	<5	<5	7.5
Cl	57	75	130	60
SO_4	9.0	7.2	29	9.4
SiO_2	12	12	12	11
Ca	5.0	4.0	5.5	4.0
Mg	6.9	5.7	13	5.0
Fe	1.0	1.2	1.3	1.3
Al	0.6	1.2	1.5	1.2
K	3.5	2.9	2.5	2.7
Na	60	54	100	52
TDS	190	180	340	180
Hardness - (Perm.)	40	43	78	34
Hardness - (Temp.)	6.0	<5	<5	6.0
Alk. as $CaCO_3$	6.0	<5	<5	6.0

Table 2. CHEMICAL ANALYSES OF TWO SEEPAGES NEAR BELLS BRIDGE, IN MATHINNA SEDIMENTS, GLADSTONE

Locality	Seepage Gladstone I	Seepage Gladstone II
pH	6.1	6.5
Conductivity µS/cm	160	680
CO_3	Nil	Nil
HCO_3	13	370
Cl	46	Nil
SO_4	<5	<5
SiO_2	8	11
Ca	2.7	9.1
Mg	4.0	20
Fe	1.2	0.4
Al	1.3	<0.2
K	1.6	4.3
Na	23	63
Total Dissolved Solids	150	350
Hardness	34	110
Alkalinity	11	310

Table 3. FLY-BY-NIGHT CREEK WATER ANALYSES

Locality	Bore 1 Fly-by-Night Before Test	Bore 1 Fly-by-Night After Test	Bore 2 Fly-by-Night Before Test	Bore 2 Fly-by-Night After Test	Fly-by-Night Creek Water
pH	4.4	4.4	4.0	6.4	4.7
Cond. µS/cm	230	230	240	250	240
CO_3	Nil *(mg/l)*	Nil *(mg/l)*	Nil *(mg/l)*	Nil *(mg/l)*	Nil *(mg/l)*
HCO_3	Nil	Nil	Nil	51	8.6
Cl	68	68	57	57	71
SO_4	5	5	5	5	21
SiO_2	11	12	14	4.8	12
Ca	1.9	2.0	2.3	17	2.8
Mg	3.5	3.7	4.3	4.2	7.2
Fe	0.5	2.7	0.2	$<$0.1	1.5
Al	0.2	0.3	0.3	$<$0.2	2.1
K	2.7	2.5	2.6	2.7	3.3
Na	37	36	36	41	55
TDS	170	170	160	230	170
Hardness Permanent	20	27	23	18	44
Hardness Temporary	Nil	Nil	Nil	42	7.0
Alk. as $CaCO_3$	Nil	Nil	Nil	42	7.0

Table 4. TOTAL DISSOLVED SOLIDS (TDS) AND TOTAL SUSPENDED SOLIDS (TSS) IN WATER AT BELLS BRIDGE, RINGAROOMA RIVER, 1975-1978, (Wellington, 1984, table 2).

Date	Bells Bridge TDS	Bells Bridge TSS
10 February 1975	66	21
20 March 1975*	81	320
29 May 1975*	70	190
24 July 1975*	110	111
14 November 1975	70	16
5 February 1976	86	460
6 May 1976	70	74
5 August 1976	76	15
6 December 1976	80	26
28 February 1977*	77	35
1 November 1977	50	57
23 January 1978	72	260

* rain had increased river flow

Table 5. SPEAR BORE, BELLS BRIDGE FLOOD PLAIN, RINGAROOMA RIVER

	Sample A (before test)	Sample B (after test)
pH	5.8	5.5
Conductivity μS/cm	76	73
CO_3	Nil	Nil
HCO_3	8	7
Cl	18	18
SO_4	<5	5
SiO_2	8	9
Ca	1.4	1.4
Mg	1.8	1.8
Fe	2.5	1.6
Al	2.0	1.2
K	1.0	0.9
Na	17	17
Total Dissolved Solids	63	58
Hardness	27	21
Alkalinity	6	5

Table 6. ANALYSES OF WATER SAMPLES TAKEN AT VARIOUS DEPTHS IN RINGAROOMA RIVER SEDIMENTS AT BELLS BRIDGE (24 May 1978)

Depth	4-7 m	10-13 m	15-18 m
pH	5.4	5.3	5.3
Conductivity (µS/cm)	80	110	150
CO_3	Nil (*mg/l*)	Nil (*mg/l*)	Nil (*mg/l*)
HCO_3	13	30	26
Cl	21	25	28
SO_4	5	<5	<5
SiO_2	9	8	15
Ca	0.5	2	2
Mg	1	2.5	3
Fe	3	13	12
Al	0.3	0.3	0.6
K	1	1	1
Na	11	13	14
TDS	60	80	100
Hardness (Perm.)	1	16	20
Hardness (Temp.)	11	25	21
Alk. as $CaCO_3$	11	25	21
Reducing power as Fe++	8	29	

Table 7. ANALYSES OF RINGAROOMA RIVER WATER AT BELLS BRIDGE, 1975

pH	5.6	Alk	3.0
Ca	1.0 (*mg/l*)	HCO_3	4.0
Mg	1.6	SO_4	<5.0
Fe	0.5	TDS	61
Na	8.0	TSS (1)	21
Cl	23.0	(2)	8

TSS (1) Total Suspended Solid in sample when received

TSS (2) Total Suspended Solid in the liquid above after standing for 24 hours.

APPENDIX 1

Groundwater as an alternative town supply for Winnaleah and Gladstone

23rd June 1978

Council Clerk,
Municipality of Ringarooma,
DERBY, TAS.

Dear Sir,

Groundwater as an alternative town supply for Winnaleah and Gladstone

This letter is an interim progress report on the groundwater investigation of these two townships and to request some further information on the location of any municipal property in the Winnaleah township.

Winnaleah Investigation

The geophysical investigation followed by shallow auger drilling to locate and examine the basalt rock beneath the red soil have been completed. On the most attractive line of auger holes from the saleyards of Winnaleah in S.S.E. direction to Tuckers property opposite the football ground three holes have been drilled. The first situated between the railway line and saleyards was dry, passing through 7 metres of basalt rock into clay. The second hole situated in Stevens' paddock near the railway line penetrated 17 metres of basalt into a gravel bed 2.5 metres thick then into an organic clay with abundant charcoal fragments. The sediments below the basalt appeared to be an old river or lacustrine deposits possibly between two basalt flows as found in a bore on Steeles' property in our deep drilling programme of 1975.

To trace this sediment the next hole was stepped out to a paddock behind Crawford's garage and a third hole on a property west of the Winnaleah Derby Road. No sediments were found in this third hole.

Where the sediments were encountered at Stevens' and Crawford's the bores pumped 2,500 gallons per hour for four hours pump test with drawdowns of 13 metres and a fast recovery of the water level when the pumping stopped.

The water is very clear, soft and of good drinking quality with a total salt content of 150 - 160 parts per million and appears suitable for town supply. A biological test of the samples was not undertaken because the water has to be as fresh as is possible, and no older than 12 hours.

The yield from these two bores is well above the 4 - 5 million gallons per year estimated by the council for Winnaleah requirements. This estimate appears to be very low and could you inform us how this estimate was calculated. Also it must be stressed it is far too early in the investigation to state that this groundwater aquifer is a viable alternative for the town supply.

Further exploration drilling and possibly geophysics is needed to delimit the size and thickness of this aquifer. Also when this work is completed it will require some prolonged pump testing to try and define the aquifer properties and how much potential groundwater is available in the aquifer.

From the councils view point it would be simpler if this pumping area could be sited on municipal land rather than private property. Does the council own the football ground for example?

As this development work is likely to tie our rig and drilling crew down for some time and as a series of contract bores for the Tonganaah clay mine and farmers and home owners in Lebrina, Lilydale and Waterhouse have to be completed there will be a break in the investigation. Unfortunately all this work the department were committed to undertake before the Winnaleah drilling commenced and will take over two months to complete. This delay is unavoidable as this is the only rig that is able to drill the basalt economically.

<u>Gladstone Investigation</u>

Four holes were drilled into the Ringarooma river from the Ansons Bay - Gladstone road bridge, pier 1 and 2 from the eastern abutment. Great difficulty was encountered in penetrating the original River bed of gravel and boulders beneath 13.5 and 15.5 metres depth of tailings found to exist. The casing shoe became bent on these boulders of the old river bed and the bore could not be sealed from the surface water of the Ringarooma river. This was critical as the river was in flood for much of the time of drilling.

In Bore 4 on the western side of Pier 2, 2.5 metres of boulders and gravels were penetrated beneath 15.5 metres of tailings. This bore was pump tested at three levels with slotted casing exposed at 4 - 7 metres, 10 - 13 metres and 15 - 18 metres. Each test was four hours duration with a pumping rate of 2,700 gallons per hour. The drawdown was 0.9 and 1.5 metres and the water level recovery was almost instantaneous with the stopping of the pump.

These tests prove there are ample supplies of groundwater available in the tailings and enough in the top 3 metres below the summer water table level for Gladstone's requirements. Also the test showed that slotted casing which is far cheaper than bore screens would be adequate.

Water quality particularly the iron content continues to be a problem.

On pumping all the water samples collected at the end of testing were very clear. The turbidness of the water experienced with the spears at 1 - 2 metres depth, in the preliminary investigation, did not occur even at the 4 - 7 metre level. After three to four days the samples became rusty but the 4 - 7 metres only slightly. This is shown in the iron content of the water sample analyses and this iron occurs in the form of a ferrous ion. In the spear bore investigation the iron content from 1 - 3 metres depth was 2.5 as pumping commenced, and 1.6 on completion of testing. In the water sample collected at 4 - 7 metres depth the iron content had increased to 3.0 milligram of iron per litre, to 12 - 13 milligram per litre in samples collected from 10 - 13 metres and 15 - 18 metres.

These analyses make this water unacceptable for town supply unless the ferrous ion can be stopped from oxidizing and turning the water rusty. Mr. Wellington, Chief Metallurgist and Chemist of the Mines Department Laboratory Launceston, is examing this problem. Water samples have been collected from the various locations in the Gladstone supply scheme from the source the tin race to the individual householder's tap for analyses in connection with this study. If the ferrous ion can be kept in solution particularly when in the hot water systems of the householders ~~systems~~ the water in the top 3 - 4 metres of tailings could be made suitable as its total salt content is 60 parts per million and its present acidity would be reduced. A technique is apparently used in the clearing of iron contaminated murky water for swimming pools but if it is possible for town supply is not known.

Yours faithfully,

(J. G. Symons)
DIRECTOR OF MINES

APPENDIX 2

Preliminary report on an alternative groundwater scheme for the town water supply at Gladstone.

W. R. Moore

A preliminary investigation of the proposed scheme for obtaining a higher quality water for the town of Gladstone [EQ850650] has been completed. The existing town supply is taken from the Mount Cameron water race. The scheme under investigation proposes to collect the groundwater by either a screened bore or horizontal screen collector placed in the sluice mine tailings on the aggraded floodplain of the Ringarooma River. The mine tailings would act as a natural filter to the normally turbid water of the Ringarooma River as it infiltrates through the tailings.

PRELIMINARY INVESTIGATIONS

A preliminary investigation was required to attempt to answer the following questions before feasibility testing using a trial bore with a screen could be undertaken.

(a) Do the type of coarse quartz sand and fine gravel mine tailings seen on the surface of the Ringarooma River floodplain extend to the original level of the river bed before tin sluicing commenced in the Gladstone area?

(b) Do these tailings extend laterally over the present river floodplain to its banks?

(c) Do the tailings allow an adequate supply to be pumped for the towns requirements?

(d) Do these tailings act as an adequate filter to clarify the underground water, compared with the normally turbid Ringarooma River water, its original source?

(e) Is the quality and clarity of the groundwater from the tailings better than the existing town supply?

Three auger holes approximately 5 m apart were drilled from the waters edge to the eastern bank on the floodplain of the Ringarooma River, near the junction of the river and Tamar Creek. Coarse sand and tailings extended to depths in excess of 10 m in all holes. Two further holes were drilled on the western bank, immediately north of the bridge on the Cape Portland road. These holes encountered black organic mud with strong smelling poor quality groundwater. Two further holes were drilled south of the bridge where sand overlies yellow clay and weathered slate of the Mathinna sediments. Clear water was obtained from both holes. The ferrous ion content of the water was so high that the water rapidly became discoloured on exposure to air and a rusty iron slick covered the surface of the water within thirty minutes.

Three further holes were drilled between the eastern abutment of the old Ringarooma bridge and to within 5 m of the waters edge. The holes were drilled along the line of the piles of the old bridge. These holes encountered bedrock at 9-10 m, with one metre of organic mud occurring in the hole closest to the bank. The remaining thickness comprised fine gravel tailings and coarse sand.

Three spears were bailed down to 2-3 m depth along this line, with the first spear approximately 5 m from the waters edge. The water clarity for all spears was noticeably better than the river water and the town supply.

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Some persistant cloudiness was present in the water from all three spears. No difference in the water clarity existed between the spears, nor did it change with pumping. The slight turbid discolouration did not settle in the samples taken for chemical analysis. The water was soft, with 63 and 58 p.p.m. salt. The iron content is high for a town supply with 2.5 and 1.6 p.p.m. The chemical analyses of the water (Table 1) are from a spear located near the pier of the old bridge, with samples taken at the beginning and end of a two hour pump test. The hole yielded 42 *l*/min (550 gal/hr).

No measurement of the drawdown was possible at the spear being pumped, but no change in level was observed in the other two spears during pumping. The recovery in the pumped bore was very rapid, with the original water level being reached in the time it took for the short suction hose to be withdrawn and the level to be measured.

These spear tests indicate that an adequate amount of water is available. With a 125 mm (5 inch) screen, either placed vertically or horizontally, the tailings would supply ample water for the requirements of Gladstone. The water clarity was better than that of the Ringarooma River, even while tin sluicing was being carried out upstream.

The groundwater from the tailings lacked the brown colouration evident in the town supply, despite its high iron content. The groundwater remained turbid even after centrifuging and it is considered doubtful whether completely clear water could be obtained, even at depth, while sluice mines are operating in the area.

CONCLUSIONS

Although complete water clarity remains a problem, the next stage of the investigation appears to be warranted. This will require the drilling of a bore, either from a stage built on the existing bridge or from a stage or temporary embankment built from the eastern abutment to the first pier of the old bridge. This hole should be drilled to bedrock and cased using the 150 mm (6 inch) casing. A 125 mm (5 inch) screen should be set at the 6-9 m level and the casing back jarred to expose the screen. The bottom of the screen should be capped with a one metre length of casing at its base. This level should be pump tested for a minimum of four hours, with 50 mm (2 inch) spears set as observation bases in a circle of 3 m radius. Grain size samples should be collected at every metre, if possible, when drilling. Water samples should be collected at the beginning and end of each test and any changes in the clarity of the water noted.

The test should be repeated with the screen set at the 3-6 m and 1-4 m levels. This drilling should be undertaken in summer, when the flow of the Ringarooma River is at its lowest. It is estimated that the time for the whole study will be about one week, using a cable tool plant.

From these tests, it should be possible to decide which of the two alternative methods, a production screen bore or a horizontal screen set in a gravel packed trench cut by drag line or back hoe, is the best. It should also be possible to accurately cost the alternative schemes for comparison with the existing water supply and with the knowledge of what quantity and quality water can be anticipated from each alternative.

[28 October, 1977]

Table 1. ANALYSIS OF WATER SAMPLES, GLADSTONE

Registered No.	*771358 (before test)*	*771359 (after test)*
pH	5.8	5.5
Conductivity	78 S	73 S
	ppm	*ppm*
CO_3	nil	nil
HCO_3	8	7
Cl	18	18
SO_4	<5	<5
SiO_2	8	9
Ca	1.4	1.4
Mg	1.8	1.8
Fe	2.5	1.6
Al	2.0	1.2
K	1.0	0.9
Na	17	17
TDS	63	58
Hardness (as $CaCO_3$)	27	21
Alkalinity (as $CaCO_3$)	6	5

Analysis by Department of Mines Laboratory, Launceston.