Groundwater at Lady Barron, Flinders Island.

W.L. Matthews

Abstract

Auger drilling about 1.5 km north of Lady Barron has located extensive coarse pebbly sand beds which probably contain enough water to supply the town. The quality of the water is comparable to, or better than that used at present at Whitemark and Lady Barron and simple treatment will improve the quality in some respects. The permeability of the aquifer and the size range of the aquifer sediments is such that slotted casing is suitable to instal for pump testing and probably for production bores. Drilling at a possible storage site indicates that if a dug earth storage is used, it is likely it would have to be lined to prevent adverse colouration from an organic cement in the near surface layers and also to prevent possible excessive loss through seepage.

The Rivers and Waters Supply Commission requested advice on the possibility of using an underground water supply to serve the town of Lady Barron. At present each household arranges its own water supply from rain catchment tanks, wells and springs on the side of Vinegar Hill. There are about fifty houses and two fish processing factories. The Commission estimate a yearly water requirement of about 23 000 m^3 (23 000 000 *l*) with a daily peak requirement of about 230 m^3 (230 000 *l*). The salt content of the water being used at present is fairly low but water from most of the wells and springs is dark brown in colour and acidic.

TOPOGRAPHY AND GEOLOGY

Apart from Vinegar Hill which rises to a height of about 100 m above sea level to the north-east of the centre of the town the landsurface forms an extensive flat area approximately 20 m above sea level for at least 6 km around the town. This flat area almost certainly represents a marine terrace cut at a time when sea level was higher than at present, probably during the Pleistocene.

Rock types in the Lady Barron area include Ordovician-Silurian quartzite and slate, Devonian granite, Tertiary basalt, and Quaternary sediments. Few exposures of the Ordovician-Silurian rocks occur in the vicinity of Lady Barron but one small exposure can be seen west of the homestead on the 'Sapphire' property, where it is an indurated, strongly quartz-veined quartzite. Granite exposures occur on Vinegar Hill, on the jetty point and to the east of the jetty along the foreshore. Tertiary basalt is exposed at intervals along the foreshore west of the jetty. It is generally weathered and vesicular where exposed but there are relatively unweathered boulders along the foreshore.

Basalt has been encountered in water holes and may underlie at depth a considerable area of the flat land between Vinegar Hill and the slopes of Strzelecki Peaks. North-east of Vinegar Hill is an area of limestone containing numerous freshwater gastropods, which Everard (1950) regards as a Recent lagoonal deposit. The area where this limestone is known to occur is enclosed in the zone marked on Figure 1. In a dam within this area marine pelecypod shells have been excavated and in one of the bore holes (20) similar material was obtained. Sand, gritty sand and clay underlie most of the flat land and are probably Quaternary in age. The sand and particularly the grit grains are largely rounded, indicating considerable working by water action. The upper section of the coarse sand in many of the holes drilled is cemented with a dark brown organic derived cement and forms a fairly

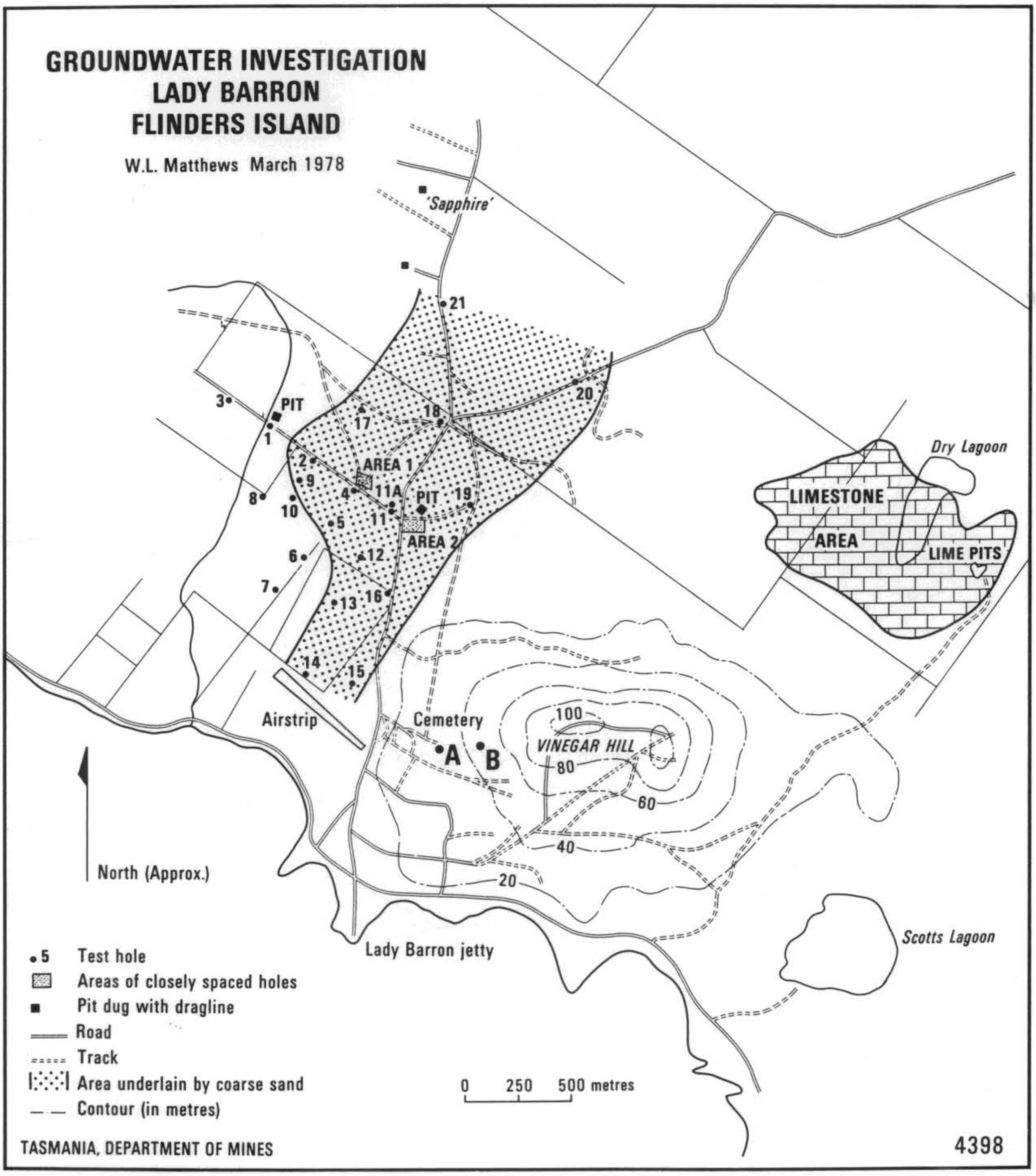

GROUNDWATER INVESTIGATION
LADY BARRON
FLINDERS ISLAND
W.L. Matthews March 1978
'Sapphire'
PIT
AREA 1
11A
PIT
AREA 2
Airstrip
Cemetery
A
B
VINEGAR HILL
100
80
60
40
20
North (Approx.)
Lady Barron jetty
Dry Lagoon
LIMESTONE
AREA
LIME PITS
Scotts Lagoon
5 Test hole
Areas of closely spaced holes
Pit dug with dragline
Road
Track
Area underlain by coarse sand
Contour (in metres)
0 250 500 metres
TASMANIA, DEPARTMENT OF MINES
4398

Figure 1.

compact material. This same material has been encountered in many of the wells and dams and can be seen exposed along the shoreline.

DRILLING

The Commission arranged for three holes to be dug with a dragline to a depth of about 3-4 m on an area of Crown land about 1.5 km north of Lady Barron. Two holes dug to the east of the Lady Barron-Whitemark road encountered good supplies of water but the colour was poor. Another hole dug about 400 m west of the road obtained clear uncoloured water but the salinity was fairly high.

A total of 21 holes were augered at locations around the dragline pits to examine the near-surface groundwater potential. The logs of these holes are given in Appendix 1. Details of other groundwater information are given in Appendix 3. From the drilling, an area underlain by pebbly coarse sand has been defined. The extent of this area is obviously wider than that drilled, but time did not allow a full investigation and in any case the area outlined is considered large enough if the locality is to be favourable for groundwater development.

A blue-grey to greenish clay was struck at the base of a large proportion of the holes and this is probably weathered *in situ* basalt. The clay was struck at depths ranging from 3.4 to 9.1 m below the surface. In some holes *e.g.* 12, 15, 18, 19, 20 and 21, the clay was not struck at the final depth. Although levelling has not been undertaken, these may all be in slightly more elevated positions than the other holes. Hole 3 has not been included in the prospective area although coarse sand was encountered to the depth drilled. It is an isolated hole separated from the area outlined and the water colour is not good. West of the area outlined on Figure 1, (except for Hole 3) the coarse sand is either absent or extremely thin. Most of these holes are in clay, which is probably derived from the weathering of basalt and the lower sections are probably *in situ* weathered basalt. The top of the weathered basalt appears to rise west of the potential groundwater source and may act as a barrier to the flow of water in this direction. There may be some flow to the south.

GROUNDWATER IN PROSPECTING HOLES

Slotted plastic 50 mm diameter pipe was installed in some of the holes and these were pumped for periods of up to 4 hours. The yields were high considering the type of installation (up to 70 *l*/min) as the number of slots cut in the pipe was limited. The standing water level in the holes was usually 1-2 m or less below the surface and a saturated thickness of coarse sand of up to 8.5 m occurred in some holes. Assuming an average thickness of 3 m of saturated sand over the whole area where appreciable thicknesses of coarse sand was found, it would be reasonable to assume that at least 0.3 m depth of free water could be extracted. Thus for an area of about 95 ha, the volume of extractable water would be about 285 000 m^3. These figures are regarded as being conservative.

To determine some of the aquifer characteristics, Hole 11 was pumped at 70 *l*/min for 5½ hours and water levels were measured in an observation hole drilled 6.3 m away from it. Recovery was measured for 85 minutes after pumping stopped. There were slight variations in the pumping rate and this may have resulted in the rather irregular plot of drawdown against time. The graph (fig. 2) flattens for a period up until the final half hour when it steepens sharply. It is not known whether this is due to the cone of depression extending to a less permeable zone within the aquifer or whether it is due to a pumping rate variation or a combination of both. It does indicate that a much longer pump test is necessary. The results of the pump test are plotted on Figure 2.

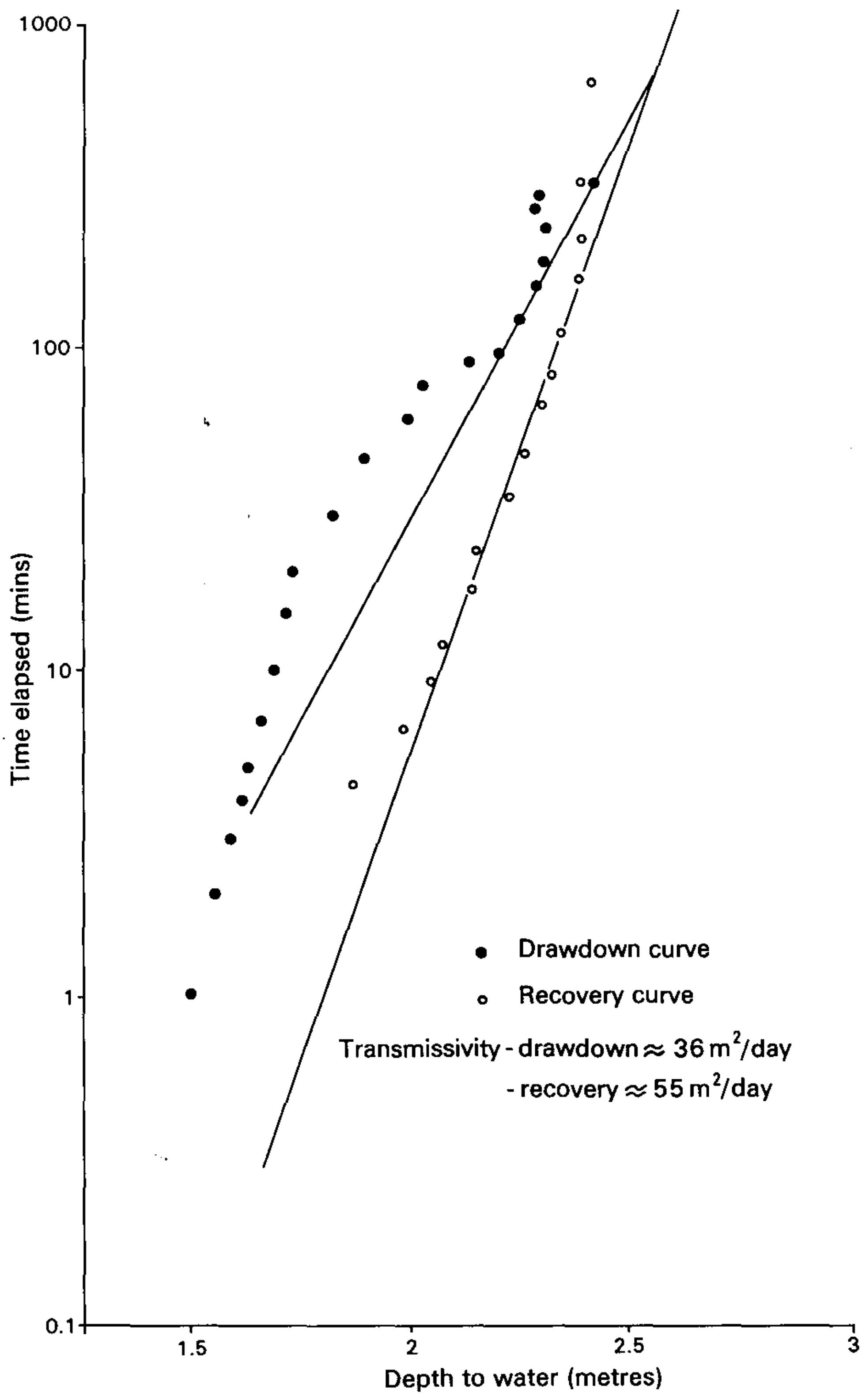
Table 1. ANALYSES OF WATER FROM BORES 1, 2, 4, 11, 11A AND 13, LADY BARRON

Item analysed	Bore 1	Bore 2	Bore 4	Bore 11	Bore 11A	Bore 13
pH	7.4	6.7	5.2	5.1	5.4	6.1
Conductivity (µS/cm)	1500	1650	500	570	600	610
	mg/l	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*
CO_3	nil	nil	nil	nil	nil	nil
HCO_3	440	210	14	13	17	24
Cl	410	510	160	190	200	210
SO_4	<5	53	7	<5	<5	12
SiO_2	34	27	12	12	20	13
Ca	180	44	5.0	2.1	2.1	12
Mg	34	36	13	12	13	14
Fe	0.4	0.5	1.0	0.7	0.4	1.0
Al	1.1	1.1	1.1	0.8	0.8	1.6
K	5.4	4.2	2.4	3.3	3.4	3.5
Na	200	330	96	120	110	130
H_2S	n.d.*	n.d.*	n.d.*	<1.0	n.d.*	<1.0
Total dissolved solids	1030	1130	430	410	440	570
Permanent hardness	240	85	62	49	50	78
Temporary hardness	360	180	12	11	14	20
Alkalinity	360	180	12	11	14	20
Total suspended solids	1320	30	150	<5	<5	30

*n.d. = not detected

Samples of water were collected from six bores and analysed by the Department of Mines Laboratory, Launceston (table 1). It can be seen that Bores 1 and 2 have a near neutral pH and a fairly high bicarbonate and total dissolved solids content. The other four holes have water that is fairly acidic, fairly low total dissolved solids content and a chloride content which is much higher than the bicarbonate content. The water in the first two holes is almost colourless while the water from the last group is brownish and contains abundant H_2S which appears to have escaped from the water before the chemical analysis was performed. The different chemistry of the two groups of holes indicates different materials through which the water has percolated. Hole 1 is near a drain which passes through areas (on the 'Sapphire' property) containing abundant calcium carbonate nodules in the soil and it is likely that contact with this material would account for the high pH and high bicarbonate content. The water in Hole 2 probably comes into contact with similar material. Holes 4, 11, 11A and 13 occur in areas where brown organic cemented coarse sand occurs near the surface and seepage through this material introduces humic acids to the water, thus lowering the pH.

None of the water is completely satisfactory for domestic use. The colourless nature and almost neutral pH of the waters from bores 1 and 2 are their most favourable aspects. The lower total dissolved solids and lower hardness of the other four holes are the factors which are most favourable. Water from all the bores has an iron content which is higher than that usually recommended for domestic use.



DRAWDOWN AND RECOVERY CURVES LADY BARRON

Figure 2.

5 cm

Table 2. SIZING ANALYSES OF SAMPLES FROM BORES 2, 4, 11, 13, 19 and 21, LADY BARRON.

	BORE 2			BORE 4			BORE 11		
mm	mass (g)	%	Cum.%	mass (g)	%	Cum.%	mass (g)	%	Cum.%
3.35	6.68	1.3	1.3	1.62	0.6	0.6	6.45	2.0	2.0
2.0	48.85	9.3	10.6	4.70	1.9	2.5	27.14	8.3	10.3
16	197.97	37.8	48.4	64.1	25.4	27.9	75.51	23.0	33.3
500	181.14	34.6	83.0	70.31	27.9	55.8	76.96	23.4	56.7
180	83.65	16.0	99.0	100.40	39.8	95.6	122.65	37.3	94.0
125	4.09	0.8	99.8	7.23	2.9	98.5	18.1	5.5	99.5
63	1.15	0.2	100.0	2.24	0.9	99.4	1.29	0.4	99.9
+45	0.18	0.03		0.78	0.3	99.7	0.17	0.05	
-45	0.39	0.07	100.1	0.98	0.4	100.1	0.16	0.05	100.0

BORE 13			BORE 19		
mass (g)	%	Cum.%	mass (g)	%	Cum.%
5.71	0.9	0.9	9.75	2.0	2.0
36.58	5.4	6.3	73.63	14.9	16.9
185.91	27.6	33.9	213.03	43.0	59.9
287.63	42.6	76.5	138.47	28.0	87.9
144.09	21.4	97.9	52.48	10.6	98.5
8.52	1.3	99.2	3.44	0.7	99.2
3.12	0.5	99.7	2.16	0.4	99.6
0.92	0.1	99.8	1.15	0.2	99.8
2.22	0.3	100.1	0.97	0.2	100.0

BORE 21			BORE 21		
mass (g)	%	Cum.%	mass (g)	%	Cum.%
1.06	0.3	0.3	1.24	0.2	0.2
41.36	10.8	11.1	97.01	16.9	17.1
103.62	26.9	38.0	252.21	43.9	61.0
91.03	23.7	61.7	159.41	27.8	88.8
132.48	34.4	96.1	56.0	9.8	98.6
9.68	2.5	98.6	5.76	1.0	99.6
3.04	0.8	99.4	1.71	0.3	99.9
1.17	0.3	99.7	0.54	0.1	100.0
1.29	0.3	100.0	0.45	0.1	100.1

GRAIN SIZE OF THE AQUIFER

Samples were collected from six of the drilled holes and sized (table 2). These samples were collected from auger samples below the water table and in the process of coming to the surface, some sorting may have taken place. They can only be regarded as being broadly representative of the aquifer material.

It was found in setting up the bores for pump tests that 50 mm diameter plastic pipe slotted with a hacksaw was effective in keeping the aquifer material out of the hole and allowed considerable flows of sand-free water to be pumped. The open area of the pipe was probably about 2%. If a metal screen was installed against the aquifer with an open area of 25-30% it would obviously produce a more efficient bore but because of the relatively high aquifer permeability, it may not be much more efficient than slotted pipe with 5-7% open area surrounded by a gravel pack. When pumping commenced some coarse sand was pumped with the water but the aquifer material stabilised after a few minutes and the water was then sediment free.

CLOSELY SPACED BORES

Because of the success in locating fairly extensive coarse sand areas containing appreciable quantities of water, it was decided to instal some closely spaced bores that could be pumped simultaneously with one pump. These could be used for more extensive pump tests and if the tests prove satisfactory there is a possibility that they could be used as production holes in the future. Two sets of holes, a western set of four holes and an eastern set of three holes (Bores 11 and 11A could be used as additional holes in this set) were installed in the positions shown on Figure 3. The results of drilling these holes are given in Appendix 2 and are summarised below. The western set of holes has a better average output per bore, although from short-term pumping from each hole both sets may produce the required amount of water. The colour of the water from the western set is better. All bores in each set delivered brown water initially but the colour became less noticeable as pumping proceeded. Water from Bores 2A and 2B remained the brownest at the end of the pumping period, the water from the other holes becoming almost colourless. The water from each bore is charged with H_2S gas.

Samples were collected from four of the bores for chemical analysis and for comparison, a sample was obtained from a household supply at Lady Barron, the same water being used for one of the fish processing factories. Another sample was obtained from the Whitemark water supply from a tap in the town. The results of these analyses are given in Appendix 3. In addition, some treatments of the water have been tried to improve the suitability of the water for a town supply. It can be seen that the quality of the raw water from the bores is similar to that of test holes 4, 11, 11A and 13. This is also similar to the water that Keid (1949) reported as supplying the fish factory from a well about one kilometre north of the town. The analysis of this water was then (ppm): T.D.S. 412, SiO_2 11, $Fe_2O_3 + Al_2O_3$ 4, Ca 4, Mg 12, Na 78, Cl 156, SO_4 9.9, CO_3 nil, permanent hardness 15.46, temporary hardness nil, pH 4.1. Similar analyses were obtained of water from test holes near the airstrip (Matthews, 1977).

It is apparent that the water from the bores is comparable with the Whitemark supply and better than the sample analysed from Lady Barron township. Treatment by percolation through a bed of the local limestone or by controlled addition of sodium carbonate will improve some aspects of the water quality to make it more acceptable. The presence of large amounts of H_2S when the water is delivered to the surface makes it essential that the water is properly aerated before reticulation to householders, as it would be unacceptable in its raw state.

The water in many of the wells and waterholes around Lady Barron has a dark brown colouration; this is derived from disturbance of the brown organic cemented sand and grit. In open holes, the wave action is probably sufficient to continually colour the water. In a bore, there is such a small area of the cemented material disturbed in the drilling that the water clears considerably after a few minutes of pumping. There seems to be some accumulation of colour in the water after pumping stops and restarts again.

Possible storage area

Two holes were drilled on the side of Vinegar Hill, an area which may

LOCATION OF CLOSELY SPACED BORES LADY BARRON

W.L. MATTHEWS

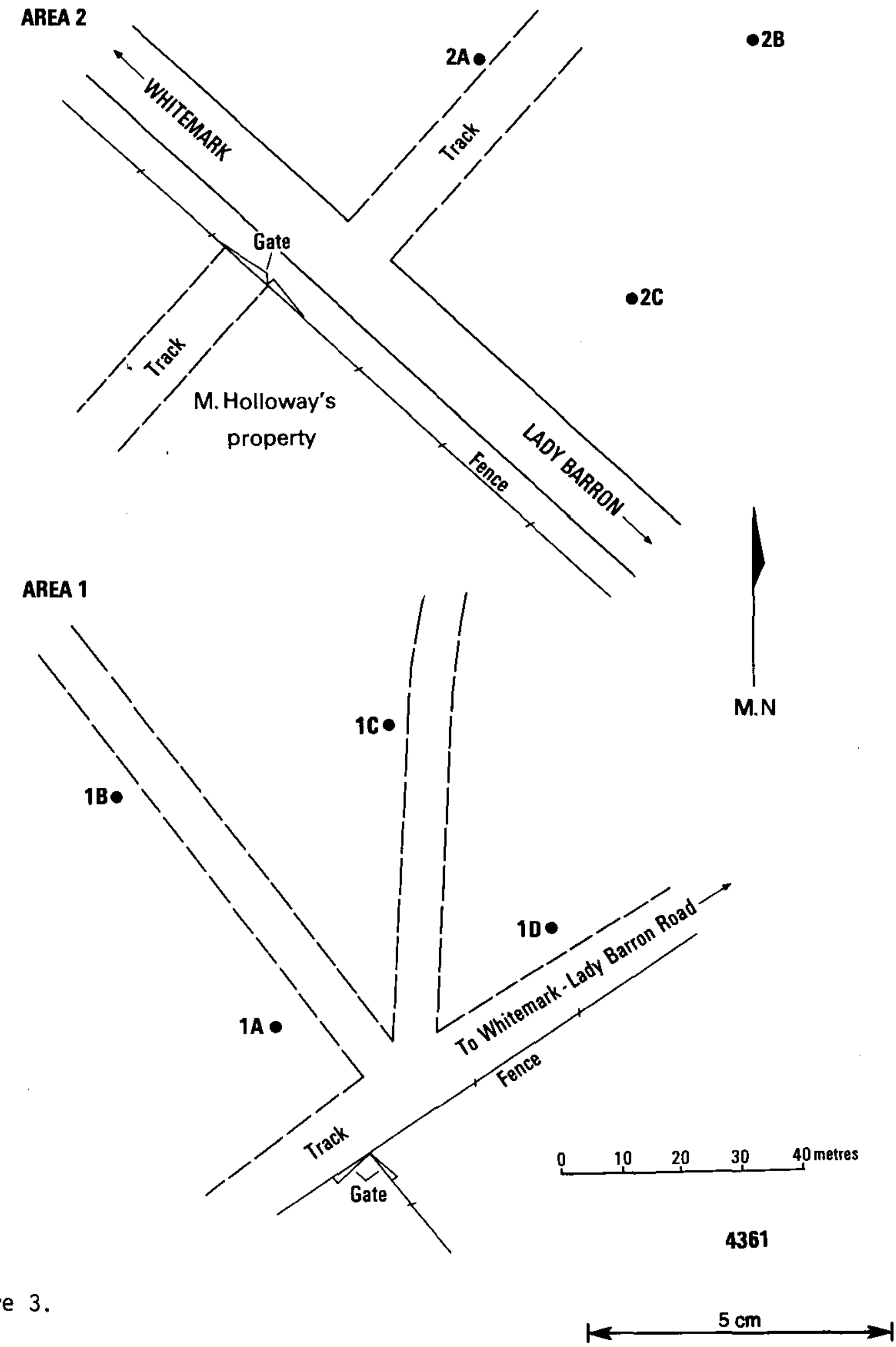


Figure 3.

be used as a site for a dug reservoir. The holes were drilled in the positions shown on Figure 1, east of the cemetery.

Hole A

Depth (m)	*Description*
0-0.9	Light brown gritty sand.
0.9-1.8	White and brown sand, fairly coarse and even-grained.
1.8-2.7	Dark brown organic cemented gritty sand.
2.7-4.9	Clayey gritty sand, fairly hard to drill.
4.9-5.5	Probable weathered granite.

Hole B

0-0.9	Peat and light grey sand.
0.9-1.8	White sand, even-grained.
1.8-2.7	Brownish sand, some grit.
2.7-4.6	Clayey brown gritty sand.
4.6-5.2	Damp grey clayey grit.
5.2-5.5	Weathered granite?

Some free water was present but the level was near the base of hole on completion of the drilling.

There is some brown organic cement in the upper layers of the sand in these two holes and storage of the water in an open hole, even if it were water-tight would probably result in serious deterioration of the colour. It may be possible to prevent this colour problem by lining the hole with plastic sheeting.

FURTHER WORK

Before a scheme can be seriously considered, a long continuous pump test to assess the performance of the aquifer should be conducted on one or both sets of holes, pumping two or three holes simultaneously and using the remainder as observation holes. The test should be conducted over a period of at least three days and preferably up to seven days, the water being discharged so that it does not re-enter the aquifer. A central pump would be able to draw from any number of the bores.

The water level in the bores should be measured occasionally to determine the natural depletion of the aquifer, particularly over dry periods. Levels of water were taken after the closely spaced bores were drilled and these are given in Table 3.

Table 3. WATER LEVELS

Hole No.	Depth to water 4/11/77	Depth to water 17/11/77	Total depth (m)	
1A		0.81	5.4	
1B		0.97	5.0	
1C		1.07	6.0	
1D		1.07	5.7	
2A		1.70	5.9	
2B		1.60	5.6	
2C		2.03	6.1	Had just stopped pumping.
2	0.91	1.02		
11	2.31			
11 pumped		1.58		
13	1.02	1.12		

CONCLUSIONS AND RECOMMENDATIONS

Drilling has indicated the presence of appreciable quantities of groundwater in coarse sand beds occurring at shallow depth to the north of Lady Barron. It is likely that enough water is stored in these beds to supply Lady Barron, but this should be proved by a long pump test (3-7 days) on either or both of the sets of closely spaced bores.

The installation of slotted plastic pipe into the bores has been an effective method of testing the holes and this is likely to be a suitable method for the production bores. The casing should not be disturbed unnecessarily as in some cases at least, groups of sand grains probably bridge across the slots and if they are disrupted they will enter the bore and pass through the pump, causing wear.

The quality of the water found in the bores compares favourably with the Whitemark water supply. It can be made more acceptable in some respects by treatment with sodium carbonate or by passing through a bed of the local limestone. The water should be aerated to remove hydrogen sulphide.

Water levels in the bores where casing has been left should be measured at intervals to examine the natural depletion over dry periods and the response to rain over the winter months.

Holes drilled near the cemetery struck coarse sand with a dark brown organic cement indicating that water in an open hole would become coloured. It is not certain that such a hole would be completely water-tight, although some clayey material was struck. A lining with plastic sheeting may be a solution to both problems.

ACKNOWLEDGMENTS

A large part of the field work was carried out by technical officers B. Cox, E. Johnson and C. Booth. Geologist C. Knights helped with the installation of the closely spaced bores.

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[20 March 1978]

APPENDIX 1

Logs of drill holes, Lady Barron

Hole 1

Depth (m)	*Description*
0-0.9	Brown gritty clay.
0.9-1.8	Blue-grey clay, a few grit fragments.
1.8-4.4	Fine gravel and grit, some clay intermixed.
4.4-4.9	Hard silty clay - probably weathered basalt. Became quite hard at end of hole.

A 1.8 m screen was placed in the hole and it was pumped at a rate of about 1.5 *l*/min (20 gal/hr).

Hole 2

0-0.9	Dark and light brown clay, some pieces of weathered basalt.
0.9-1.8	Light brown clay.
1.8-4.3	Light grey grit and coarse sand.
4.3-5.5	Dark blue-grey clay-weathered basalt?

This hole had a length of slotted P.V.C. pipe 50 mm in diameter inserted and pumped at 27 *l*/min (360 gal/hr).

Hole 3

0-0.9	Brown to grey fairly coarse even-grained sand.
0.9-1.8	As above but ending in gritty sand containing water.
1.8-6.4	Very little return apart from some brown gritty sand.
6.4-8.7	Clay and silty fine sand with quartz pebbles.

Slotted P.V.C. casing installed and pumped for about one hour. The water was very turbid at the start and was still slightly coloured at the end.

Hole 4

0-0.9	Brown sand and grit.
0.9-1.8	Coarse sand and grit with rounded grains cemented by brown humic rich material. Fairly hard to drill.
1.8-6.4	Mainly coarse sand and grit with rounded grains.
6.4-7.5	Blue clay-weathered basalt? (some grit grains may be from higher levels).

This hole was pumped for about one hour at about 70 *l*/min (900 gal/hr). It was turbid at the start but cleared at the end. The water has a very faint yellow colour and contains H_2S.

Hole 5

0-0.9	Brown sandy grit (coffee rock). Water at end.
0.9-1.8	Brownish gritty sand, rounded grains.
1.8-4.4	Gritty sand, rounded grains.
4.4-4.6	Blue-grey clay-weathered basalt?

Hole not pumped but grit indicated fairly good water supply.

Hole 6

0-0.9	Angular and gritty sand on surface, final few centimetres clayey sand.

Hole 6 (continued)

Depth (m)	*Description*
0.9-1.8	Clayey sandy grit with rounded grit fragments.
1.8-2.4	Sandy grit with some clay.
2.4-4.3	Clayey grit and fine gravel.
4.3-4.9	Blue clay-weathered basalt?
	Hole not developed as it is unlikely that much water would be obtained. There may be thin non-clayey sandy grit bands present.

Hole 7

0-0.9	Dark brown soil and plastic brown clay.
0.9-1.8	Blue clay.
1.8-2.7	Blue clay-weathered basalt?

Hole 8

0-0.9	Blue and brown fairly plastic clay.
0.9-1.8	Grey and bluish plastic clay.
1.8-2.7	Clay with some grit fragments.
2.7-3.7	Blue clay-weathered basalt?

Hole 9

0-0.9	Brown plastic silty clay.
0.9-2.0	Grey silty clay with a few grit fragments.
2.0-4.3	Gritty coarse sand, some milky quartz (vein), some clear. Fragments up to 6 mm across and coarser grains usually rounded.
4.3-5.2	Blue-green clay-weathered basalt?
	Slotted pipe installed and hole was pumped for about a half hour at 18 *l*/min (240 gal/hr) with the suction pipe only to 2.7 m below the surface. The water did not have a brown colour but was slightly turbid. H_2S was present.

Hole 10

0-0.9	0.15 m brown soil, then brown plastic silty clay, a few pebbles.
0.9-1.8	Grey blue plastic clay with quartz pebbles.
1.8-2.3	Gritty clay.
2.3-3.2	Sandy grit, rounded fragments, grey.
3.2-4.1	Blue-green clay-weathered basalt?

Hole 11

0-0.9	Grey grit, rounded fragments.
0.9-2.4	Brown rounded grit cemented with organic material - coffee rock.
2.4-9.1	Gritty sand, brownish with rounded grit fragments.
9.1-9.6	Blue clay-weathered basalt?
	Pumped for about four hours using slotted casing at 45 *l*/min (600 gal/hr). Water was turbid and brown when pumping started but cleared and was only faintly yellow on completion.

Hole 12

0-0.9	Coarse gritty sand, light grey brown.
0.9-2.7	As above but a little darker (some coffee rock).
2.7-9.8	Brownish gritty sand becoming grey brown at depth.

Hole 12 (continued)

Depth (m)	*Description*
	Water was struck at about one metre and water level on completion was about one metre below the surface. This hole was not pumped but is obviously potentially a very productive hole.

Hole 13

0-0.9	Gritty sand, rounded grains brown stained.
0.9-1.8	White gritty sand followed by dark brown gritty sand.
1.8-9.1	Gritty sand with rounded grains.
9.1-9.6	Blue clay-weathered basalt?
	This hole was pumped for about 2 hours at 45 *l*/min (600 gal/hr). The water was very pale yellow at the end of pumping and gaseous (H_2S).

Hole 14

0-1.4	White gritty sand.
1.4-3.4	Dark brown gritty sand - organic stained.
3.4-6.1	Blue clay-weathered basalt?
	Water level at 0.5 m from surface.

Hole 15

0-0.9	Light grey sand, some grit fragments.
0.9-2.7	Darker grey sand with occasional grit fragments.
2.7-4.3	A little harder to drill but similar to above, brownish coloured.
4.3-9.1	Mainly sand with a few grit fragments.
	Water level about 0.6 m below surface.

Hole 16

0-0.9	Light brown sand.
0.9-1.8	Dark brown sand.
1.8-6.4	Brownish gritty sand.
	Drilling stopped because augers stuck - edge of boulder? Water level about 0.6 m below surface.

Hole 17

0-0.9	Light grey-brown gritty sand.
0.9-2.7	Brown gritty sand - grit abundant and rounded.
2.7-5.8	Grey-brown gritty sand, grit abundant and rounded.
5.8-6.7	Fine even-grained sand.
6.7-7.0	Blue clay-weathered basalt?

Hole 18

0-0.9	Light grey to white coarse gritty sand, rounded grains.
0.9-3.4	Brown to dark brown gritty sand organic material.
3.4-9.1	Brownish gritty sand, grit grains very common.
9.1-9.6	Finer sand, bluish.
	Water level about 1.3 m from surface.

Hole 19

0-1.8	Gritty white sand, rounded grains.
1.8-2.7	Grey gritty sand.
2.7-4.0	Dark brown gritty sand, organic material.
4.0-9.1	Brownish gritty sand, rounded grit fragments.

Hole 19 (continued)

Depth (m)	*Description*
9.1-9.6	Finer grained sand with grit.
	Water level about 1.3 m below surface.

Hole 20

Depth (m)	*Description*
0-2.7	Coarse, cream coloured, fairly even-grained sand with occasional grit fragments.
2.7-6.4	Dark grey fairly even-grained sand, grit fragments becoming a little more abundant. May be slightly clayey on some levels.
6.4-9.6	Slightly lighter grey sand, as above but containing shell fragments and shells up to 3 cm across. Clayey or limey.
	Water level about 1.3 m below surface.

Hole 21

Depth (m)	*Description*
0-0.9	Light grey sandy grit, rounded grains.
0.9-4.6	Dark brown sandy grit.
4.6-9.6	Lighter brown sandy grit.
	Water level about one metre below surface.

APPENDIX 2

Summary of closely spaced holes.

Hole 1A

The hole was drilled to about 6.7 m through pebbly coarse sand. Blue-grey clay (weathered basalt?) was struck at the base of the hole. Slotted 50 mm diameter plastic pipe was installed and the hole was pumped for about one hour at the rate of about 83 *l*/min. The water had only a slight colouration at the completion of pumping.

Hole 1B

This hole was drilled to 6.4 m in material similar to hole 1A. Slotted plastic pipe was installed to 5.3 m and the hole was pumped for about 1½ hours at 53 *l*/min. The water was almost colourless at the completion of pumping and the drawdown at this rate was almost to the bottom of the hole.

Hole 1C

This hole was drilled to 7.8 m in pebbly coarse sand (weathered basalt not struck). Slotted casing was installed to 6.3 m and the hole was pumped at 90 *l*/min for about one hour with a drawdown of about 3 m from the surface. There was a faint yellow colour to the water at the completion of pumping.

Hole 1D

The hole was drilled to 7.3 m in pebbly coarse sand with no weathered basalt being struck. Slotted casing was installed to about 5.8 m. The hole was pumped for about 1½ hours at about 75 *l*/min with a small drawdown. The water was almost colourless at the completion of pumping.

Hole 2A

This hole was drilled to 7.3 m and 5.9 m of slotted casing was installed. Cemented brown coarse sand was drilled to about 2.6 m and then loose coarse pebbly sand was drilled to the final depth. The hole was pumped for about one hour at 60 *l*/min, the final drawdown being to about 4.7 m below the surface. The water at the completion of pumping was yellowish but clear.

Hole 2B

The hole was drilled to 7.3 m and 5.5 m of slotted casing was installed. It was pumped at 68 *l*/min for one hour with a drawdown of about 4.2 m from the surface. The water was yellow in colour but not as dark as the water in open holes nearby.

Hole 2C

This hole was drilled to 7.3 m and 5.9 m of casing was installed. It was pumped for about 1½ hours at about 55 *l*/min with near maximum drawdown. The water had much less colour than the previous two in this set.

APPENDIX 3

Analysis of Flinders Island water samples.

H.K. Wellington

Six water samples and a sample of limestone were received from W.L. Matthews in connection with a water supply for Flinders Island.

Reg. No.	*Description*
773122	Lady Barron Number 1A
773123	Lady Barron Number 1C
773124	Lady Barron Number 2A
773125	Lady Barron Number 2C
773126	Lady Barron Number 3 Supply to house
773127	Whitemark water supply Number 4

The analyses of these six samples are given in Table 4. In addition to the analyses in Table 4 it was requested that treatments be given to enhance these waters for use as a town supply. Percolation through a limestone bed and treatment with sodium carbonate were suggested. For the purpose a sample of local limestone (773128) was furnished. This was crushed and a gravel sizing -4 mm, +1 mm was produced. This sized limestone was packed into a percolation column through which the waters were passed, the residence time being about 2 minutes. For treatment with soda ash a solution of sodium carbonate was made and the equivalent of 1 g/*l* Na_2CO_3 was added to a sample of each water. After allowing the precipitate to settle the clear liquid was examined. The results of these tests are given in Table 5.

In addition to the above based on R548, the 'R1' ratio (chloride/alkalinity) has been calculated as a guide to corrosiveness. These values are given in Table 5.

RESULTS

Treatment with limestone has raised the pH to near 8 in most cases, it has in all but one case raised the Ca content and in all cases raised the hardness and alkalinity.

Treatment with soda ash caused a precipitate, hence if this were added provision for clarification must be made. As expected, the pH of all waters was raised to over 10, the Ca remained unchanged, Mg was either slightly reduced or unchanged, in most cases Fe and Al were removed and the hardness in most cases was reduced.

Based on recommendations in A.W.R.C. Technical Paper 7 the 'as received' waters are acceptable for domestic use except for:

Fe	all exceed 0.3 mg/*l*
pH	773122 and 773123 under 6.5
Colour	all exceed 15 colour units.
Turbidity	773127 exceeds 25 Jackson turbidity units

After limestone treatment, the pH is acceptable in all cases but the iron has not been corrected.

In all but 773126, the Fe has been corrected by soda ash but in all cases the pH exceeds 9 and hence is too high. A controlled addition of soda ash could probably maintain the pH under 9 while reducing the Fe.

From our work in R548 with respect to hot water, none of these waters is recommended because corrosion can be expected if the Cl exceeds 100 mg/*l* and the 'Rl' ratio exceeds 2. Chloride levels up to 250 g/*l* may be used but frequent replacements due to corrosion can be expected. I would not recommend the use of 773125 and 773126 at all.

However in all cases the 'Rl' ratio is too high to recommend any water even after limestone treatment. The use of soda ash would probably correct the ratio but probably result in excessive pH levels.

REFERENCE

HART, B.T. 1974. A compilation of Australian water quality criteria. *Tech. Pap.Aust.Wat.Res.Coun.* 7.

18/19

Table 4. ANALYSIS OF WATER SAMPLES

Reg. Nos.	1A 773122	1C 773123	2A 773124	2C 773125	Lady Barron 773126	Whitemark 773127
Item						
pH	6.0	5.5	6.6	6.4	7.0	6.4
Conductivity (µS/cm)	840	650	880	1150	1340	610
	(mg/l)	*(mg/l)*	*(mg/l)*	*(mg/l)*	*(mg/l)*	*(mg/l)*
CO_3	nil	nil	nil	nil	nil	nil
HCO_3	8.5	11.0	44	22	76	27
Cl	180	160	200	270	260	150
SO_4	14	13	15	52	53	14
SiO_2	16	14	13	19	27	10
Ca	4	3	12	9	30	8
Mg	13	11	13	19	13	10
Fe	0.7	1.0	0.8	0.8	1.2	0.9
Al	0.3	0.7	0.8	0.5	3.4	0.3
K	2.5	2.0	3.3	2.9	8.2	4.9
Na	100	86	110	155	150	100
Colour	20	300	230	40	1100	250
Total dissolved solids	380	330	470	600	750	390
Permanent hardness	59	50	53	87	87	41
Temporary hardness	7.0	8.6	36	18	62	23
Alkalinity	7.0	8.6	36	18	62	23
Turbidity TSS	<5	<5	<5	12	<5	76

Table 5. CHARACTERISTICS OF WATER SAMPLES

Sample Nos.		773122	773123	773124	773125	773126	773127
Item							
pH	AR	6.0	5.5	6.6	6.4	7.0	6.4
	L	8.1	7.3	7.8	8.1	7.7	7.9
	S	10.2	10.2	10.2	10.2	10.1	10.3
		(mg/l)	*(mg/l)*	*(mg/l)*	*(mg/l)*	*(mg/l)*	*(mg/l)*
Ca	AR	4	3	12	9	30	8
	L	21	12	21	22	29	14
	S	4	4	16	9	34	9
Mg	AR	13	11	13	19	13	10
	L	9	7	12	16	16	14
	S	9	7	13	15	12	8
Fe	AR	0.7	1.0	0.8	0.8	1.2	0.9
	L	0.4	0.6	0.4	0.4	2.2	0.2
	S	nil	nil	0.3	nil	1.5	0.2
Al	AR	0.3	0.7	0.8	0.5	3.4	0.3
	L	nil	nil	1	nil	6	nil
	S	nil	nil	nil	nil	0.5	nil
Hardness	AR	66	59	89	105	149	64
(as CaO_3)	L	89	61	107	122	175	68
	S	47	37	94	85	141	56
Cl	AR	180	160	200	270	260	150
	L	170	160	180	250	270	150
Alkalinity	AR	7	8.6	36	18	62	23
(as $CaCO_3$)	L	22	30	44	32	70	39
Rl Ratio	AR	26	19	6	15	4	7
	L	8	5	4	8	4	4

AR = Water 'as received' *i.e.* results from Table 4.
L = Water after percolation through limestone.
S = Water after treatment with soda ash and clarification.