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TITLE: REPORT ON G.S.W.A. MANDURAH NO.1
WATER BORE, MANDURAH, W.A.

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REPORT ON G.S.V.A. MANDURAH NO. 1 WATER BORE.

MANDURAH. V.A.

by

J. R. Pasmore

Record No. 1962/18

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ABSTRACT

The exploratory water bore, G.S.W.A. Mandurah No.1, drilled to 2,005 feet at Mandurah in the Perth Basin, provided new stratigraphic information and yielded poor quality artesian water.

Quaternary deposits were intersected from the surface to 84 feet 6 inches. Below this depth, down to 1,674 feet, the sediments are of Lower Cretaceous age and are correlated with the South Perth Formation. These are underlain by Upper Jurassic deposits, of similar age to the Claremont Sandstone.

Electrical logging indicated that water quality deteriorated with depth, and that the zone from 446 feet to 635 feet contained the freshest water.

This aquifer zone has a static head of 20 feet 4 inches above ground level, and produced a flow of 6,800 gallons per hour through 5 inch slotted casing. On pumping at 12,000 gallons per hour the static water level drew down 19 feet. The water contained 2,040 parts per million (143 grains per gallon) total dissolved solids and 1,598 parts per million (¹¹²143 grains per gallon) sodium chloride.

INTRODUCTION

The bore at Mandurah was designed to provide geological and hydrological information in an area where there had been no previous deep subsurface exploration.

Rotary drilling enabled the bore to be drilled open-hole so that the section could be electrically logged, and from the logs estimates were made of the quality and quantity of water in the aquifers before casing the hole. The logging will also provide correlation with other holes to be drilled in the area.

Any good quality water produced from the Mandurah bore was to contribute to a proposed town supply, for water is at present obtained mainly from private wells. The results of this bore will be used to plan others for the town supply.

The Geological Survey appreciates the assistance given by West Australian Petroleum Pty.Ltd. in lending the electric logging equipment and providing the services of two of their geologists, Messrs. M.H. Johnstone and J.W. Burdett to carry out the logging and preliminary interpretation.

BORE HISTORY

GENERAL DATA

Name: G.S.W.A. Mandurah No. 1 Water Bore.

Location: South-West Division.

W.A. Lands Dept.Lithe 380A/40, Crown Reserve 859.

Lat. $32^{\circ} 32' 8''$ S., Long. $115^{\circ} 42' 37''$ E.

Elevation: Ground level 6' above sea level.

Datum: Drill floor, 4'6" above ground level.

Commenced: 10th August, 1962.

Drilling Completed: 23rd September, 1962.

Testing Completed: 19th October, 1962.

Total Depth: 2005 ft.

Status: Fitted with valve, ready for use.

DRILLING DATA

Drilling Contractor: J.F. Grill

Drilling Plant: Failing #1 Rotary.

Hole Size: 9.7/8" from 4.1/2 ft. to 91.1/2 ft.

7.1/2" from 91.1/2 ft. to 430 ft.

6.3/4" from 430 ft. to 2005 ft.

Casing: 8" O.D. from 4.1/2 ft. to 92 ft.

6" O.D. from 1/2 ft. to 430 ft.

5" O.D. from +2 ft. to 635 ft.

(The 6" O.D. casing is cemented).

Perforation: 5" casing slotted from 446 ft. to 635 ft. -

Slots 12" x 3/32". 446 ft. to 580 ft. - 12" x 1/8".

580 ft. to 635 ft. - 108 slots per 20 ft.

Cement Plug: Set at 635 ft. to 690 ft.

LOGGING AND TESTING

Bore Site Geologists: J.R. Passmore, C. Emmenegger.

Ditch Samples: Taken from shale shaker every 5 ft. and examined;
10 ft. samples retained.Coring: 16 core runs with RK diamond bit, 9 ft. 6 ins. core
barrel. Core 2.1/2" diameter.

Table 1.

Core Depths and Recovery

Core No.	Depth		Recovery
1	142'-0"	to 151'-6"	9'-6"
2	286'-0"	to 295'-6"	6'-2"
3	372'-8"	to 382'-2"	9'-2"
4	493'-0"	to 502'-6"	3'-0"
5	575'-0"	to 584'-6"	7'-6"
6	651'-0"	to 660'-6"	9'-6"
7	771'-6"	to 781'-0"	3'-3"
8	925'-0"	to 934'-6"	4'-6"
9	1006'-0"	to 1016'-0"	0'-4"
10	1150'-0"	to 1158'-0"	2'-3"
11	1346'-0"	to 1361'-0"	1'-4"
12	1438'-0"	to 1451'-0"	nil
13	1461'-0"	to 1472'-0"	1'-7"
14	1588'-0"	to 1599'-0"	9'-6"
15	1756'-0"	to 1765'-6"	9'-0"
16	1901'-0"	to 1913'-0"	3'-4"
165'-6"			81'-3"
Recovery: 49%.			

Logs Run: Spontaneous Potential, Resistivity -- 16" Short Normal,
Resistivity -- 64" Long Normal, Point Resistivity,
Gamma Ray (Plates 3 and 4).

Drilling Time: Measured for each 2' drilled. For the composite
Log (Plate 2), averaged over 5 ft.

HYDROLOGICAL DATA

Developed Aquifer Zone: 446' - 635'.

Static Water Level: 20'4" above ground level.

Flow: 6,820 g.p.h.

Date of Pump Test: 17th to 19th October, 1962.

Yield: Pumped for 48 hours at 12,000 g.p.h.

Drawdown: 19'.

Quality of Water: Total Dissolved Solids: 2,040 p.p.m.

Sodium Chloride: 1,596 p.p.m.

GEOLOGY

GENERAL

Mandurah is in the southern part of the Perth Basin, about 20 miles west of the Darling Fault, which forms the eastern margin of the basin.

From gravity survey results (Thyer and Everingham, 1956), the thickness of sediments here is estimated to be of the order of 20,000 feet. The results of a seismic survey in the Rockingham--Mundijong area (Moss, 1962) suggest that beds are almost horizontal in the coastal area and inland have shallow easterly dips until near the Darling Fault.

Sediments of Jurassic and Cretaceous ages are known to occur to depths of at least 2,500 feet in several bores near Perth, and to at least 1,700 feet in the Busselton region. Lower Jurassic claystones have been intersected in two bores at Ryford, near the Darling Scarp, but all other known occurrences of Mesozoic deposits encountered in bore holes are of Upper Jurassic and Cretaceous ages. In the Perth area the formations of these ages are known as the Claremont Sandstone (Upper

Jurassic), The South Perth Formation (Uppermost Jurassic to Lower Cretaceous), and the Osborne Formation (Lower to Upper Cretaceous) from McPherson and others (1953).

The Kings Park Shale, of Lower Tertiary age, is known from bores in the Perth Metropolitan area, on Rottnest Island, and as far south as Rockingham (Pt. Perron bore). Its maximum known thickness is more than 1,000 feet.

The Mesozoic and Tertiary sediments are overlain by Quaternary deposits, Coastal Limestone in the coastal areas, (Fairbridge 1953), and various alluvial and estuarine deposits in other areas (Hearthur and Bettany, 1960). Near Mandurah the surface deposits are mainly limestone, with dark clays on the estuary flats.

LITHOLOGY AND STRATIGRAPHY

Sediments penetrated by the Mandurah No. 1 Bore are of Quaternary, Lower Cretaceous and Upper Jurassic ages. The Sample Log, Composite Log and Palynological Report by H.S. Edgell, are included in this report as Appendix 1, Plate 2, and Appendix 2, respectively. A Summary Log appears later in this report.

Quaternary

The Quaternary sediments, from 4 feet 6 inches to 81 feet 6 inches are estuarine silty calcareous sands and clays deposited under conditions probably similar to those in the estuary now. They contain abundant small gastropod shells, indicating a salt water environment, and fine carbonaceous material. At the base of this section the bore penetrated 3 feet of wood with several gum-nuts, and fragments of black coal. This marks the Lower Cretaceous--Quaternary unconformity.

Lower Cretaceous

The Lower Cretaceous sediments, from 81 feet 6 inches to 1,674 feet are an interbedded sequence of sandstones, siltstones, mudstones, and clays, containing coal, fine carbonaceous material

and pyrite nodules. From 81 feet 6 inches to 970 feet the sequence is finely interbedded, with the sandstones feldspathic, clayey, silty and poorly sorted. The clay and silt occur with the sandstones in places as distinct beds but more often as minor interbeds and matrix. White kaolin in the sandstones is derived from decomposed feldspar. Mudstones are mostly compact, in places greasy, and have a weak to moderate shaly cleavage. They contain fine carbonaceous material, pyrite, some fragments of coal and carbonised plant remains.

Some sandstones in this section contain pelecypod shells, and thin sections are cemented to hard calcareous sandstones and limestones, the calcium carbonate cement being derived from solution of shells. Cores of some limestone beds show solution cavities.

Except for the calcareous beds and some mudstones, the sediments are lightly consolidated. Good core recovery was obtained only in the consolidated beds and in sandstones containing a clay matrix.

Bedding is seen from the cores to be essentially flat, with occasional dips up to 10° , due to cross bedding. The mudstone from 642 feet to 670 feet has sections with wavy and contorted bedding.

From 970 feet to 1,674 feet the sequence is more distinctly bedded than that above. Sandstones are relatively clean, moderately well sorted, coarse grained, feldspathic, and contain pyrite and fragments of coal. Some contain kaolin from decomposed feldspar. Shell fragments and calcareous beds are extremely rare. Mudstones are mostly silty, compact, and greasy. Some have cleavage parallel to bedding and grade into shale. Micaceous siltstones, grading into fine grained sandstone, are frequently interbedded with the mudstones.

The better bedding in this section is seen in the grain size analyses (Composite Log, Plate 2), where the beds are more distinct; the sandstones are cleaner and better sorted, and

the mudstones contain less sand. The gamma ray log (Plate 4) shows more distinct bed boundaries and greater differentiation between mudstone and sandstone.

Bedding is thought to be approximately horizontal. Dips of up to 20° are frequent in the cores but are not persistent and appear to be due to cross bedding. Wavy bedding and small scale cross bedding occur in some siltstones and mudstones.

The sediments are in places well consolidated; the mudstones are compact and this resulted in slow drilling rates and good core recovery. Some sandstones are well cemented with clay matrix and pyrite cement, but the clean sandstones are only lightly consolidated and gave a poor core recovery. Calcareous cement is almost completely absent.

The assemblages of spores, pollen, microplankton, and foraminifera indicate marine nearshore conditions of deposition for nearly all the Lower Cretaceous sediments (Appendix 2), although only the upper section contains a significant number of pelecypod shells. The nearshore environment is supported by coal fragments and the carbonaceous material.

Upper Jurassic

Mudstones and sandstones of probable Upper Jurassic age occur between 1,674 feet and 2,005 feet, and these are probably disconformable with the overlying Cretaceous sediments (Appendix 2), although there is no evidence of this from the lithology.

The mudstones are generally very compact and grey to dark grey some, however, being light greenish-grey, greasy, slightly micaceous, and carbonaceous. They are silty in places and grade into siltstone. Cleavage along bedding is mostly weak, but a shale bed at 1,735 feet to 1,745 feet is laminated and shows distinct cleavage. In the core silty layers show the beds to be flat, wavy, weakly cross bedded, and in places exhibit small slump structures. In core no. 15, the mudstone from 1,756 feet to 1,760 feet 6 inches has shiny shearing surfaces,

some of which are approximately planar and have a dip of 45° , others are irregular and cause the core to be greatly fractured. The surfaces have lineations which, on the regular surfaces, are perpendicular to their strikes. It is possible that this shearing is due to faulting, in which case the fault would be at an angle to the bore.

The sandstones are moderately consolidated, medium to coarse grained, and mostly well-sorted. In places they contain kaolin from decomposed feldspar but are mostly clean. Fragments of coal are frequent in places, and minor thin beds contain concentrations of fine carbonaceous material, pyrite and garnet grains. In the core these thin beds show dips of 20° - 30° , probably due to cross bedding.

From the gamma ray log and the grain size analyses, it can be seen that bedding is distinct, similar to that in the lower section of the Cretaceous sediments.

The Jurassic sediments contain no marine microfossils and are believed to be of non-marine origin. Occasional small fragments and chips of calcareous sandstones found in the samples are probably due to contamination.

CORRELATION

As set out in Appendix 2, most of the section penetrated in the Mandurah No. 1 Bore may be correlated with formations observed in the Perth area. The Lower Cretaceous sediments are of similar age and facies to the South Perth Formation defined by McWhae and others (1958) and penetrated in bores recently drilled west of Byford by the Geological Survey (G.S.W.A. Byford Bores Nos. 3, 4 and 5). The "Leederville Sandstone" (Fairbridge, 1953) cannot be distinguished on lithological grounds in this bore.

The base of the Lower Cretaceous sediments, determined by palynology, is not marked by the fossiliferous basal sandstone

found in some bores in the Perth Metropolitan Area. At Wandurrah the lower 700 feet of these sediments contains few if any shells.

The Upper Jurassic sediments are non-marine, and similar in age to the Claremont Sandstone. Below the mudstone intersected from 1,674 feet to 1,851 feet, is coarse sandstone which, on lithology and facies, is correlated with the Claremont Sandstone.

SUMMARY LOG

From (feet)	To (feet)	Thick- ness (feet)	Water Potential	Age	Lithology
4'6"	81'6"	77	Minor aquifer 72'6" - 79'. Salty Water.	Quaternary	Sand and clay
81'6"	429	347'6"	Minor aquifers 200'-220', 270'-320'	Lower Cretaceous	Mudstone and sandstone with minor clay and siltstone
429	634	205	Aquifer with minor impermeable sec- tions. Salinity: 1,600 p.p.m. NaCl 2,040 p.p.m. T.D.S. (analysed)	Lower Cretaceous	Sandstone with minor Clay and Mudstone.
634	970	336	Aquifer 670'-735'	Lower Cretaceous	Sandstone, Mudstone, and Clay.
970	1502	532	Interbedded good aquifers and aquicludes. Salinity: 1060'-1105', 2,800 p.p.m. NaCl. 1235'-1280', 2,900 p.p.m. NaCl. 1450'-1500', 3,200 p.p.m. NaCl. (calculated)	Lower Cretaceous	Sandstone, Mudstone, and Clay, with minor Siltstones.
1502	1600	48	Aquiclude	Lower Cretaceous	Mudstone with minor Sand- stone and Siltstone.

SUMMARY LOG (Contd.)

From (feet)	To (feet)	Thick- ness (feet)	Water Potential	Age	Lithology
1600	1674	74	Aquifer. Salinity: 3,600 p.p.m. NaCl (calculated)	Lower Cretaceous	Sandstone with minor Mudstone
1674	1794	120	Aquiclude	Upper Jurassic	Mudstone
1794	1851	58	Poor aquifer 1794' - 1820'	Upper Jurassic	Mudstone with minor Sand- stone.
1851	2005	154	Aquifer Salinity: 1851' - 1824', 4,400 p.p.m. NaCl. (calculated)	Upper Jurassic	Sandstone.

HYDROLOGY

AQUIFERS.

Electric and Gamma-Ray logs were run in the bore by West Australian Petroleum Pty. Ltd. on the 3rd and 20th September, 1962. The first run, to 1,200 feet, is retained for reference by the Geological Survey, and the second logs, to 1,874 feet, are shown on Plates 3 and 4.

Valuable qualitative information was obtained from both the Electric and Gamma-Ray logs. Primarily the Electric logs were used to define the aquifer containing the best quality water and the zone from 425 feet to 640 feet was selected for testing. The records were not entirely satisfactory for quantitative estimates of water salinities but an attempt was made to calculate the salinities of the different aquifers. The original calculations were later modified using the measured salinity of the tested aquifer as a standard, and these results are tabulated below. The relative salinities of the aquifers remain unchanged.

Table 2.

Calculated Salinities of Water from Six Aquifer Zones.

Interval (feet)	425-470	1060-1105	1235-1280	1450-1500	1600-1675	1851-1874
Thickness (feet)	45	55	45	50	75	23
Calculated Salinity (p.p.m.)	1600	2800	2900	3200	3600	4400

The table shows that the salinities, estimated from the self-potential curve, increase with depth, and this is confirmed by the single point and short normal resistivity records.

From the logs, resistivity is seen to decrease markedly with depth below about 850 feet. The self potential variations, which depend on the relative salinities of the drilling mud and formation water, show increasingly negative values in the lower sands. Towards the top of the hole the curve is comparatively featureless and in part reversed, which indicates that the formation water has the same or slightly lower salinity than the drilling mud (2,000 p.p.m.).

The deeper aquifers are more porous than the zone tested, and would yield greater supplies of water, but were rejected because of their higher salinity.

The gamma-ray log shows excellent correlation with the grain size histogram and was used to accurately define bed boundaries and depths in the Composite Log (Plate 2).

YIELD

The bore was completed to produce through 5 inch diameter casing slotted from 446 feet to 635 feet. This interval produced a natural flow of 6,800 gallons per hour. It was pump-tested for 48 hours at 12,000 gallons per hour, the maximum rate possible by the testing method used (air lift inside 5 inch casing).

The drawdown at this pump rate was 19 feet below the static water level which is 20 feet 4 inches above ground level. As

the available drawdown is more than twice this -- another 25 feet for a centrifugal pump -- the bore has a potential yield much greater than 12,000 gallons per hour.

QUALITY

The water produced from the bore is of poor quality containing 2,040 parts per million (143 grains per gallon) total dissolved solids and 1,596 parts per million (112 grains per gallon) assumed sodium chloride (Appendix 3). Field salinity tests and several laboratory analyses of samples taken before, during, and after the pump test, showed no significant salinity change, but pump testing for a longer time is required to show whether the salinity will rise with continued use of the bore.

The salinity is twice as high as the maximum recommended for drinking water by the U.S. Public Health Service -- 1,000 p.p.m. total dissolved solids (Todd, 1959) -- although such water is used in exceptional circumstances. Domestic use of the water is not precluded (it has no objectionable taste), but effects such as corrosion, and the possibility of salinity rise with continuous use, should be determined before this is undertaken.

Its use for gardens or irrigation depends on the drainage of the soil. In poorly drained areas the salt content will tend to build up to concentrations toxic to plant life. In well drained areas this may not happen, but there may be a slight increase in the salinity of the unconfined ground water which has low salt content in many places, and is at present the main source of private domestic supplies.

RECOMMENDATIONS

To determine long term permissible output, and possible salinity variations, the bore should be pump tested for a long time (at least 200 hours) at a rate near its maximum yield.

The water would best be used to irrigate well drained areas for growing salt-tolerant plants such as couch, buffalo grass, or lucerne.

Further drilling for water of domestic quality at Mandurah should be to depths of 600 to 800 feet and preferably located to the east (inland) of G.S.W.A. Mandurah No. 1 Water Bore.

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APPENDIX 1

G.S.W.A. MANIDURAH NO.1 WATER BORE

SAMPLE LOG

Datum: Drill Floor - 4'-6" above ground level and approx. 10'6" above sea level.

From (feet)	To (feet)	Thickness (feet)	Description
0	4'6"	-	Drill Floor to ground level.
4'6"	7'6"	3	CLAY: black.
7'6"	31'6"	24	SAND: calcareous, grey, unconsolidated, medium grained, silty, composed mainly of shell fragments; contains fine carbonaceous material.
31'6"	43'6"	12	CLAY: silty, grey, unconsolidated, containing shell fragments.
43'6"	53'6"	10	SAND: calcareous, grey, unconsolidated, medium grained, silty, composed mainly of shell fragments; contains fine carbonaceous material.
53'6"	58'6"	5	CLAY: silty, grey, unconsolidated, containing shell fragments.
58'6"	60'6"	2	SAND: calcareous, grey, unconsolidated, medium grained, silty, composed mainly of shell fragments; contains fine carbonaceous material.
60'6"	62'6"	2	CLAY: silty, grey, unconsolidated, containing shell fragments.
62'6"	72'6"	10	SAND: calcareous, grey, unconsolidated, medium grained, silty, composed mainly of shell fragments.
72'6"	81'6"	9	SAND: quartz, unconsolidated, coarse grained, felspathic with fragments of wood (including gum-nuts) and hard black coal.
81'6"	87'0"	5'6"	CLAY: sandy, grey, containing coal and rare shell fragments.
87'0"	87'6"	6"	SILTSTONE: hard, compact, dark grey, containing quartz sand grains.
87'6"	95'6"	8	CLAY: slightly sandy, dark grey.
95'6"	102	6'6"	CLAY: sandy, dark grey, micaceous, containing shells, coal and pyrite.
102	107	5	CLAY: slightly sandy, dark grey.
107	117	10	CLAY: sandy, dark grey to black, micaceous, with fine carbonaceous material.
117	122	5	SANDSTONE: quartz, clayey, poorly consolidated, medium to coarse grained, with rare feldspar and mica.
122	137	15	MUDSTONE: slightly sandy, dark grey to black, with rare mica and fine carbonaceous material.
137	159	22	MUDSTONE: silty, black, micaceous, with fine carbonaceous material. Rare shell fragments.
142	151'6"	9'6"	Core 1, recovery 9'6". From top to bottom.
			5'0" MUDSTONE: silty, black, carbonaceous, containing fragments of coal and minor pyrite.

From (feet)	To (feet)	Thickness (feet)	Description
			4'6" MUDSTONE: slightly silty, compact, micaceous.
159	174	15	MUDSTONE: slightly sand, black, micaceous, pyritic.
174	192'6"	18'6"	SANDSTONE AND MUDSTONE: SANDSTONE: quartz, lightly consolidated, medium grained, poorly sorted, micaceous, containing coal and pyrite. MUDSTONE: dark grey.
192'6"	196	3'6"	MUDSTONE: sandy, black, carbonaceous, pyritic.
196	237	41	SANDSTONE AND MINOR MUDSTONE: SANDSTONE: quartz, lightly consolidated, fine to coarse grained, poorly sorted, feldspathic, with minor pyrite, carbonaceous material, and mica. MUDSTONE: dark grey to black.
237	274	37	MUDSTONE AND MINOR SANDSTONE: MUDSTONE: dark brown, carbonaceous, micaceous, pyritic. SANDSTONE: fine to medium grained.
274	349	75	SANDSTONE AND MINOR MUDSTONE: SANDSTONE: quartz, lightly consolidated, fine to coarse grained, poorly sorted, feldspathic, micaceous, with rare pyrite and fine carbonaceous material. MUDSTONE: silty, dark brown, micaceous.
286	295'6"	9'6"	Core 2; recovery 6'2". From top to bottom. 3'8" SANDSTONE: quartz, slightly clayey, unconsolidated to lightly consolidated, fine to coarse grained, poorly sorted, silty in part, feldspathic. 2'0" MUDSTONE AND SILTSTONE interbedded: MUDSTONE: dark brown, micaceous. SILTSTONE: micaceous. 6" SANDSTONE: silty, lightly consolidated, fine to coarse grained, poorly sorted, in part pyritic, with minor brown mudstone.
349	351	2	SANDSTONE: quartz, consolidated, calcareous cement, medium grained.
351	372'6"	21'6"	MUDSTONE AND MINOR SANDSTONE: MUDSTONE: dark brown, slightly micaceous and carbonaceous. SANDSTONE: quartz, fine to medium grained.
372'6"	375'6"	3	SANDSTONE: quartz, consolidated, calcareous cement, medium grained.
375'6"	389	13'6"	SANDSTONE AND MUDSTONE: SANDSTONE: quartz, lightly to moderately consolidated, fine to coarse grained, poorly sorted, feldspathic, with pyrite and

From (feet)	To (feet)	Thickness (feet)	Description
			fine carbonaceous material. MUDSTONE: silty, dark brown, carbonaceous.
372'8"	382'2"	9'6"	Core 3 ₁ recovery 9'2". From top to bottom. 2'9" SANDSTONE: quartz, consolidated, calcareous cement, medium grained. 6'5" MUDSTONE SILTSTONE AND SANDSTONE interbedded. MUDSTONE: dark brown, carbonaceous. SILTSTONE: light grey, lightly consolidated, carbonaceous and micaceous. SANDSTONE: quartz, silty, lightly consolidated, coarse to very coarse grained, poorly sorted. Rounded grains.
389	412	23	MUDSTONE AND SANDSTONE: MUDSTONE: black, carbonaceous. SANDSTONE: quartz, in part consolidated, fine to medium grained, feldspathic, micaceous, with pyrite and minor carbonaceous material.
412	431	19	MUDSTONE AND MINOR SANDSTONE: MUDSTONE: greenish black. SANDSTONE: quartz, some grains with green coating, fine grained.
431	446	15	SANDSTONE: quartz, lightly consolidated, fine to coarse grained, poorly sorted, with minor green clay.
446	451	5	SANDSTONE: quartz, consolidated, with calcareous fragments and veins of calcite.
451	461	10	SANDSTONE: quartz, clayey, lightly consolidated, fine to medium grained, feldspathic.
461	463'6"	2'6"	SANDSTONE: quartz, consolidated, with calcareous fragments and veins of calcite.
463'6"	466	2'6"	SANDSTONE: quartz, clayey, lightly consolidated, fine to medium grained, feldspathic.
466	469	3	SANDSTONE: quartz, consolidated, with calcareous cement and veins of calcite.
469	470	1	SANDSTONE: quartz, clayey, lightly consolidated, fine to medium grained, feldspathic.
470	473	3	SANDSTONE: quartz, consolidated, with calcareous fragments and veins of calcite.
473	482	9	SANDSTONE: quartz, clayey, lightly consolidated, fine to coarse grained, containing shells.
482	484	2	CLAY: sandy, green and white.
484	485	1	SANDSTONE: quartz, consolidated, calcareous cement, containing shells.
485	493	8	CLAY: sandy, green and white.
493	494	1	SANDSTONE: quartz, consolidated, calcareous cement, with fine carbonaceous material and shell fragments.

From (feet)	To (feet)	Thickness (feet)	Description
494	495	1	SANDSTONE: quartz, silty, lightly consolidated, fine to medium grained, poorly sorted. Pebble of grey chert.
495	495'6"	6"	LIMESTONE: sandy, shelly, consolidated, with cavities due to solution of shells.
495'6"	503	7'6"	SANDSTONE: quartz, silty, lightly consolidated, fine to medium grained, poorly sorted, with a few shells and calcareous fragments.
493	502'6"	9'6"	Core 4; recovery 5'2". From top to bottom. 10" SANDSTONE: quartz, consolidated, calcareous cement, with fine carbonaceous material and shell fragments. 6" SANDSTONE: quartz, silty, lightly consolidated, fine to medium grained, poorly sorted. Pebble of grey chert. 4" LIMESTONE: sandy, shelly, consolidated, with cavities due to solution of shells. 3'4" SANDSTONE: quartz, silty, lightly consolidated, fine to medium grained, poorly sorted, slightly carbonaceous, with few shells and calcareous fragments.
503	508	5	SANDSTONE: quartz, clay, consolidated, fine to coarse grained, poorly sorted, feldspathic, with feldspar partly decomposed. Shell fragments.
508	514	6	CLAY: sandy, grey.
514	519	5	MUDSTONE: black, silty, carbonaceous.
519	523	4	SANDSTONE: quartz, clayey, consolidated, with few shell fragments.
523	524	1	GRANITE BOULDER
524	527	3	SANDSTONE: quartz, consolidated, calcareous cement, with carbonaceous material and shell fragments.
527	560	33	SANDSTONE: quartz, clayey, grey and black, lightly consolidated, feldspathic, with minor ool and pyrite.
560	571	11	CLAY: sandy, brown with white kaolin from decomposed feldspar.
571	575	4	CLAY: brown.
575	577	2	SANDSTONE: quartz, clayey, in part consolidated, fine to coarse grained, poorly sorted, with kaolin from decomposed feldspar. Thin beds of light green sandy clay.
577	580	3	SANDSTONE: quartz, clayey, lightly consolidated, fine to coarse grained, poorly sorted, with thin beds of green and brown sandy clay.
580	581'6"	1'6"	SANDSTONE: quartz, consolidated, fine to coarse grained, with shells and carbonaceous material.
581'6"	586	4'6"	SANDSTONE: quartz, lightly consolidated, fine to coarse grained, poorly sorted, with kaolin from decomposed feldspar. Minor beds of green and brown clay.

From (feet)	To (feet)	Thickness (feet)	Description
575	584'6"	9'6"	Core 5; recovery 7'2". From top to bottom. 2'5" SANDSTONE: quartz, clayey, lightly consolidated with 4" section consolidated, fine to coarse grained, poorly sorted, with white kaolin from decomposed feldspar. Thin beds of light green sandy clay. 2'10" SANDSTONE: quartz, clayey, lightly consolidated, fine to coarse grained, poorly sorted, with interbeds of green and brown sandy clay. 1'4" SANDSTONE: quartz, consolidated, fine to coarse grained, with shells and carbonaceous material. 9" SANDSTONE: quartz, silty, light gray, lightly consolidated, poorly sorted, with kaolin from decomposed feldspar. Minor beds of green and brown clay. Few shell fragments.
586	601	15	SANDSTONE: quartz, lightly consolidated, coarse grained, moderately sorted, feldspathic, with rare mica and fine carbonaceous material, and containing shells.
601	602	1	SANDSTONE: quartz, consolidated, coarse grained, calcareous cement, containing shell fragments.
602	626	24	SANDSTONE: quartz, lightly consolidated, moderately sorted, feldspathic, containing shells and minor carbonaceous material. Slightly clayey in places.
626	627	1	SANDSTONE: quartz, consolidated, coarse grained, calcareous cement, containing shell fragments.
627	636	9	SANDSTONE: quartz, lightly consolidated, coarse to very coarse grained, moderately well sorted, feldspathic, containing minor coal and pyrite.
636	647	11	CLAY: sandy, dark gray, carbonaceous.
647	672	25	MUDSTONE: dark gray and blue-gray interbedded, compact, greasy texture, slightly silty and micaceous, with fine carbonaceous material disseminated and an occasional thin layers; fine grains of pyrites. Bedding flat, often wavy or contorted.
651	660'6"	9'6"	Core 6; recovery 9'6". 9'6" MUDSTONE: dark gray and blue-gray interbedded, compact, greasy texture, slightly silty and micaceous, with fine carbonaceous material disseminated and an occasional thin layers; fine grains of pyrite. Bedding flat, often wavy or contorted. Shaly when dry.
672	675	3	SANDSTONE: quartz, slightly clayey, lightly consolidated, coarse grained, well sorted, with shells and minor coal and pyrite.
675	681	6	MUDSTONE: gray and blue-gray. Gray mudstone brittle, flaky; blue-gray mudstone softer, very greasy texture.

From (feet)	To (feet)	Thickness (feet)	Description
684	690	9	SANDSTONE: quartz, clayey, dark brown, lightly consolidated, coarse grained, moderately sorted, feldspathic, containing shells.
690	691	1	SANDSTONE: quartz, consolidated, fine grained.
691	696	5	SANDSTONE: quartz, slightly clayey, coarse grained, moderately sorted, with minor coal and pyrite.
696	697	1	SANDSTONE: quartz, consolidated, fine grained.
697	704	7	SANDSTONE: quartz, silty, lightly consolidated medium to coarse grained, with minor coal.
704	770	66	SANDSTONE AND CLAY: SANDSTONE: quartz, clayey, grey, lightly consolidated, fine to coarse grained, feldspathic, with minor pyrite and carbonaceous material. Minor thin beds of grey mudstone. CLAY: sandy, silty, dark grey, micaceous.
770	772	2	SANDSTONE: quartz, consolidated, calcareous cement, fine to coarse grained, poorly sorted, feldspathic, with fine carbonaceous material.
772	848	76	SANDSTONE: quartz, clayey, green and grey-brown, lightly consolidated, fine to coarse grained, feldspathic, containing white kaolin from decomposed feldspar, minor pyrite and fine carbonaceous material. Few shell fragments. Consolidated beds at 799'-801', 816'-818', 822'-824', 826'-828', 836'-844'.
771'6"	781	9'6"	Core 7: recovery 3'2". From top to bottom. 8" SANDSTONE: quartz, consolidated, calcareous cement, fine to coarse grained, poorly sorted, feldspathic, with fine carbonaceous material. 2'4" SANDSTONE: quartz, clayey, green and grey-brown, lightly consolidated, fine to coarse grained, feldspathic containing white kaolin from decomposed feldspar and fine carbonaceous material. Thin interbeds of green sandy clay. Rare shells. 6" CLAY: sandy, dark brown, dense, micaceous.
848	860	12	CLAY: sandy, dark green-grey.
860	970	110	SANDSTONE AND CLAY: SANDSTONE: quartz, clayey and silty, lightly consolidated, fine to coarse grained, poorly sorted, feldspathic, in part micaceous, carbonaceous, with minor pyrite.
925	934'6"	9'6"	Core 8: recovery 4'2". From top to bottom. 8" SANDSTONE: quartz, slightly clayey, lightly to moderately consolidated, medium to coarse grained, moderately sorted, with small amount of kaolin from decomposed feldspar.

From (feet)	To (feet)	Thickness (feet)	Description
			<p>6" SANDSTONE: quartz, clayey and silty, lightly consolidated, fine to coarse grained, poorly sorted, micaceous, feldspathic, slightly carbonaceous.</p> <p>3'0" SILTSTONE AND CLAY</p> <p>SILTSTONE: sandy, gray, lightly consolidated, micaceous, and carbonaceous.</p> <p>CLAY: dark brown and gray, silty, micaceous.</p>
970	990	20	SANDSTONE: quartz, moderately consolidated, coarse to very coarse grained, well-sorted, with minor thin beds of clay.
990	1032	42	CLAY: sandy, gray-brown, carbonaceous, with minor pyrite. White kaolin from decomposed feldspar. Rare thin beds of brittle gray mudstone and sandstone in places consolidated.
1006	1016	10	Core 9; recovery 4".
			<p>4" SANDSTONE: quartz, poorly consolidated, coarse grained, well sorted, feldspathic, slightly clayey, porous.</p>
1032	1054	22	SANDSTONE: clayey, gray-brown, medium to coarse grained, with rare coal and pyrite.
1054	1112	58	CLAY: sandy, black and green-black, pyritic and carbonaceous.
1112	1118	6	MUDSTONE: slightly sandy, black, soft, carbonaceous, pyritic, and micaceous.
1118	1128	10	CLAY: sandy, black, slightly carbonaceous and pyritic.
1128	1150	22	MUDSTONE: slightly sand, black, soft, carbonaceous, pyritic and micaceous.
1150	1234	84	CLAY, SANDSTONE, MUDSTONE AND SILTSTONE: CLAY: dark gray and black. SANDSTONE: quartz, clayey, medium to coarse grained, in part consolidated, feldspathic, moderately to poorly sorted, carbonaceous. MUDSTONE: silty, black, micaceous, carbonaceous. SILTSTONE: sandy, gray, micaceous, in part consolidated.
1150	1158	8	Core 10; recovery 2'3". From top to bottom.
			<p>1'3" SANDSTONE: quartz, clayey, greenish colour, consolidated, poorly to moderately sorted, feldspathic, carbonaceous.</p> <p>6" MUDSTONE: black, silty, micaceous, with plant remains.</p> <p>6" SILTSTONE: sandy, gray, micaceous, and MUDSTONE gray and black, carbonaceous.</p>

From (feet)	To (feet)	Thickness (feet)	Description
1238	1240	6	SANDSTONE: quartz, clayey, dark gray, consolidated, medium to coarse grained, moderately to poorly sorted, feldspathic, with rare pyrite and carbonaceous material. Few shell fragments.
1240	1344	104	SANDSTONE: quartz, slightly clayey, lightly consolidated, with few consolidated beds, coarse to very coarse grained with some granules, moderately to well sorted, feldspathic with some feldspar partly or wholly decomposed to kaolin. Pyritic and carbonaceous beds. Minor gray clay.
1344	1351	7	MUDSTONE: soft and hard interbedded. Soft mudstone dark-brown; hard mudstone silty, gray-brown, micaceous, with fine carbonaceous material.
1351	1360	9	SANDSTONE: clayey, lightly consolidated, medium to coarse grained, minor pyrite and carbonaceous material.
1360	1361	11 ¹⁵	Core 11; recovery 1'4".
			1'4" MUDSTONE: soft and hard interbedded. Soft mudstone dark brown; hard mudstone silty, gray-brown, micaceous, with fine carbonaceous material.
1361	1375	14	MUDSTONE AND SANDSTONE: MUDSTONE: brown. SANDSTONE: quartz, clayey, medium to coarse grained, with rare pyrite and carbonaceous material.
1375	1435	60	SANDSTONE: quartz, slightly clayey to clayey, moderately consolidated, with a few hard thin beds, coarse to very coarse grained with rounded granules, moderately sorted, with rare feldspar and pyrite, and minor beds of coal.
1435	1504	69	SANDSTONE AND MUDSTONE: SANDSTONE: quartz, clayey, lightly to moderately consolidated, medium to coarse grained, with a few rounded granules, poorly to moderately sorted, slightly feldspathic, pyritic, and carbonaceous. Rare thin beds of hard, fine grained sandstone, some calcareous. MUDSTONE: gray and brown, mostly soft, some thin beds of brittle mudstone.
1438	1451	13	Core 12; recovery nil.
1461	1472	11	Core 13; recovery 1'7".
			1'7" SANDSTONE: quartz, slightly clayey, consolidated, coarse to very coarse grained with granules and few small pebbles up to 1 cm diameter, grains sub-rounded, poorly to moderately sorted, mostly porous with some sections more clayey and silty and less porous. Cementing material kaolin from decomposed feldspar.
1504	1540	36	MUDSTONE: slightly silty, gray, slightly micaceous and carbonaceous. Minor thin beds of light gray, fine grained sandstone.

From (feet)	To (feet)	Thickness (feet)	Description
1540	1544	4	SANDSTONE: quartz, moderately consolidated, coarse to very coarse grained, well sorted, feldspathic, containing fragments of coal.
1544	1572	28	MUDSTONE: light gray, compact, with minor thin beds of darker gray mudstone and hard, fine grained sandstone.
1572	1578	6	SILTSTONE AND SHALE: SILTSTONE: sandy, moderately consolidated. SHALE: dark gray.
1578	1580	2	MUDSTONE: light gray.
1580	1586	6	SANDSTONE: quartz, moderately consolidated, medium to coarse grained, with minor beds of hard fine grained calcareous sandstone and gray and greenish-gray mudstone.
1586	1590	4	MUDSTONE: light greenish-gray.
1590	1599	9	SILTSTONE, SANDSTONE, AND MUDSTONE:
1588	1592	11 1/2	Core log; recovery 9'6". From top to bottom. 1'11" MUDSTONE: very slightly silty, greenish-gray, compact, greasy texture, weak cleavage parallel to bedding. Some irregular vugs. One thin (1/8") bed of micaceous siltstone. Bedding dips 25°. 1'0" SILTSTONE: sandy, gray and greenish-gray, moderately compacted, micaceous (mostly biotite). Thin layers of silty mudstone (brown and greenish). Bedding flat to 20°, showing weak cross bedding. 6'7" SILTSTONE, SANDSTONE AND MUDSTONE: SILTSTONE: gray, compact, very micaceous. SANDSTONE: silty, greenish, consolidated, fine-grained, feldspathic, micaceous, with fine carbonaceous. MUDSTONE: silty, gray, compact, micaceous. Fragment of soft brown decomposed wood. Bedding flat to 20°.
1599	1674	75	SANDSTONE: silty in part, partially consolidated, fine to coarse grained, moderately sorted, with beds of mudstone (gray, greenish-gray, and dark brown).
1674	1735	41	MUDSTONE: slightly silty, light greenish-gray and dark gray. Minor thin beds of hard fine-grained sandstone.
1735	1745	10	SHALE: dark gray, finely laminated.
1745	1757	12	MUDSTONE: slightly micaceous, light greenish-gray.
1757	1800	43	MUDSTONE: slightly silty, gray with minor greenish-gray, compact. Minor beds of consolidated siltstone and fine gray sandstone.

From (foot)	To (foot)	Thickness (foot)	Description
1756	1756'6"	9'6"	Core 15; recovery 9'9". From top to bottom. 1'3" MUDSTONE: slightly micaceous, light greenish gray, compact, greasy texture, containing fine carbonaceous material. Shearing surfaces, shiny and with lineations perpendicular to strike - some irregular, some dip 45°. 3'3" MUDSTONE: similar to above mudstone, but gray to dark gray, and with irregular shearing surfaces. In places finely fractured. 10" MUDSTONE: slightly silty, dark gray, compact, slightly micaceous, with numerous particles of carbonaceous material. 2'8" MUDSTONE AND SILTSTONE finely interbedded. MUDSTONE: dark gray. SILTSTONE: light gray, micaceous, carbonaceous. The section is thinly laminated, with layers horizontal, wavy, or showing cross bedding; some small sections of intraformational microbreccias. 1" SILTSTONE: slightly sandy in places, light gray, compact, with fine laminations of mudstone and carbonaceous and micaceous material.
1800	1850	50	MUDSTONE AND MINOR SANDSTONE: MUDSTONE: gray and greenish-gray, slightly carbonaceous. SANDSTONE: quartz, consolidated, fine-grained, some calcareous. Rare feldspar and carbonaceous material, very rare pyrite and mica. Occasional shell fragments.
1850	1865	15	SANDSTONE: quartz, gray, very slightly clayey, consolidated, coarse to very coarse grained, with subangular to subrounded granules, well sorted with very rare feldspar, pyrite and carbonaceous material. Very rare fragments of shells.
1865	1920	55	SANDSTONE AND MINOR MUDSTONE: SANDSTONE: quartz, slightly clayey, moderately to well consolidated, medium to very coarse grained with some subrounded granules, mostly well sorted, slightly feldspathic, carbonaceous, and pyritic. Very rare grains of garnet in places. MUDSTONE gray and minor greenish-gray, silty in places.
1921	1913	12	Core 16; recovery 3'4". From top to bottom. 7" MUDSTONE AND SANDSTONE: MUDSTONE: dark gray with greenish-gray, compact, in places slightly silty and micaceous. Weak cleavage.

From (feet)	To (feet)	Thickness (feet)	Description
			<p><u>Care 16 continued:</u></p> <p>SANDSTONE: quartz, slightly clay, consolidated, medium to very coarse grained, poorly sorted, feldspathic, with feldspars partly decomposed, containing very rare grains of garnet. A few subrounded quartz granules.</p> <p>SANDSTONE: quartz, consolidated, fine to very coarse-grained, poorly sorted, pyritic, with frequent grains of garnet.</p> <p>1'2" SANDSTONE: quartz, slightly clayey, consolidated, fine to very coarse grained with a few rounded quartz pebbles, poorly sorted, slightly feldspathic with feldspars partly decomposed.</p> <p>1'7" SANDSTONE: quartz, consolidated fine to coarse grained, poorly sorted, slightly feldspathic with feldspars partly decomposed; micaceous. Frequent fragments of coal, irregular in shape. Some layers of carbonaceous and pyritic material showing dips 20-30°.</p> <p>SANDSTONE AND MINOR MUDSTONE:</p> <p>SANDSTONE: quartz, slightly clayey, moderately to well consolidated, medium to very coarse grained with some subrounded granules, mostly well sorted, feldspathic, slightly carbonaceous and pyritic, with very rare grains of garnet. Contains laminae from decomposed feldspar. Rare thin beds of hard fine-grained sandstone, some calcareous.</p> <p>MUDSTONE: gray and minor greenish-gray, in places silty and micaceous.</p> <p><u>TOTAL DEPTH: 2005 feet below datum.</u></p>
1920	2005	85	

APPENDIX 2.

PALYNOLOGICAL REPORT ON HANDURAH NO. 1 WATER BORE

by H.S. Edgell, Ph.D.

The detailed palynological examination of samples from Handurah No. 1 at intervals of approximately 30 feet has been completed. As a result the stratigraphic sequence has been dated in this bore and depositional facies have also been interpreted. The following time-rock units and formations were penetrated on descending sequence:-

System	Series	Stage	Formation	Depth	Facies
Quaternary	Pleistocene to Recent	indeterminate	superficial sands and muds	0'-81'6"	marine

unconformity

Cretaceous	Lower Cretaceous	Aptian to Neocomian	South Perth Formation	81'6"-1674'	predominantly marine
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probable disconformity

Jurassic	probably Upper Jurassic	indeterminate	unnamed mudstone	1674'-1851'	non-marine
Jurassic	probably Upper Jurassic	indeterminate	Claremont Sandstone	1851'-2005'	non-marine

Unusual features of the sequence in Handurah No. 1 are the excessive thickness of the South Perth Formation as compared with Perth Metropolitan bores, and the presence of a Jurassic mudstone unit above the Claremont Sandstone.

APPENDIX 3.

WATER ANALYSIS.

by Government Chemical Laboratories.

Bore: G.S.W.A. Mandurah No. 1 Water Bore.

Aquifer Interval: 446 feet to 635 feet.

Date Collected: 19/10/62.

Conditions: After 48 hour pump test.

Reaction: Neutral.

pH: 7.7.

<u>Mineral Matter</u>	parts per million
Calcium, Ca	58
Magnesium, Mg	25
Sodium, Na	671
Potassium, K.	25
Bicarbonate, HCO_3	305
Carbonate, CO_3	nil
Sulphate, SO_4	56
Chloride, cl	992
Nitrate, NO_3	less than 1.
Silica, SiO_2	22
Iron, Fe	0.5
Aluminium, Al	1
<u>Total (by summation)</u>	2185
<u>Total (by evaporation)</u>	2040

Assumed Combination on Evaporation at N.T.P.

Calcium carbonate, CaCO_3	145
Magnesium carbonate, MgCO_3	67
Sodium carbonate, Na_2CO_3	3
Calcium sulphate, CaSO_4	nil
Magnesium sulphate, MgSO_4	nil
Sodium sulphate, Na_2SO_4	127
Magnesium chloride, MgCl_2	nil
Potassium chloride, KCl	48

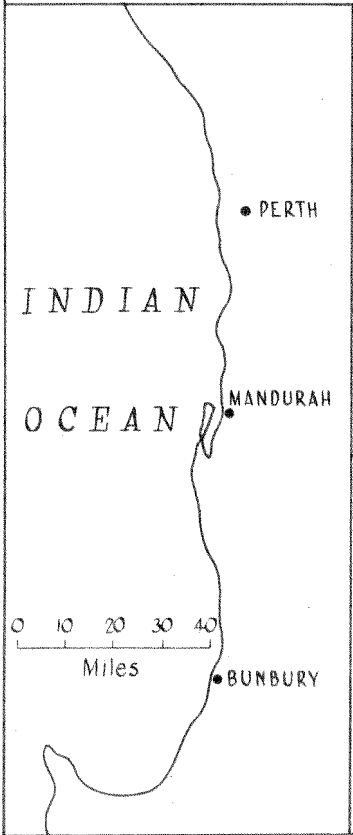
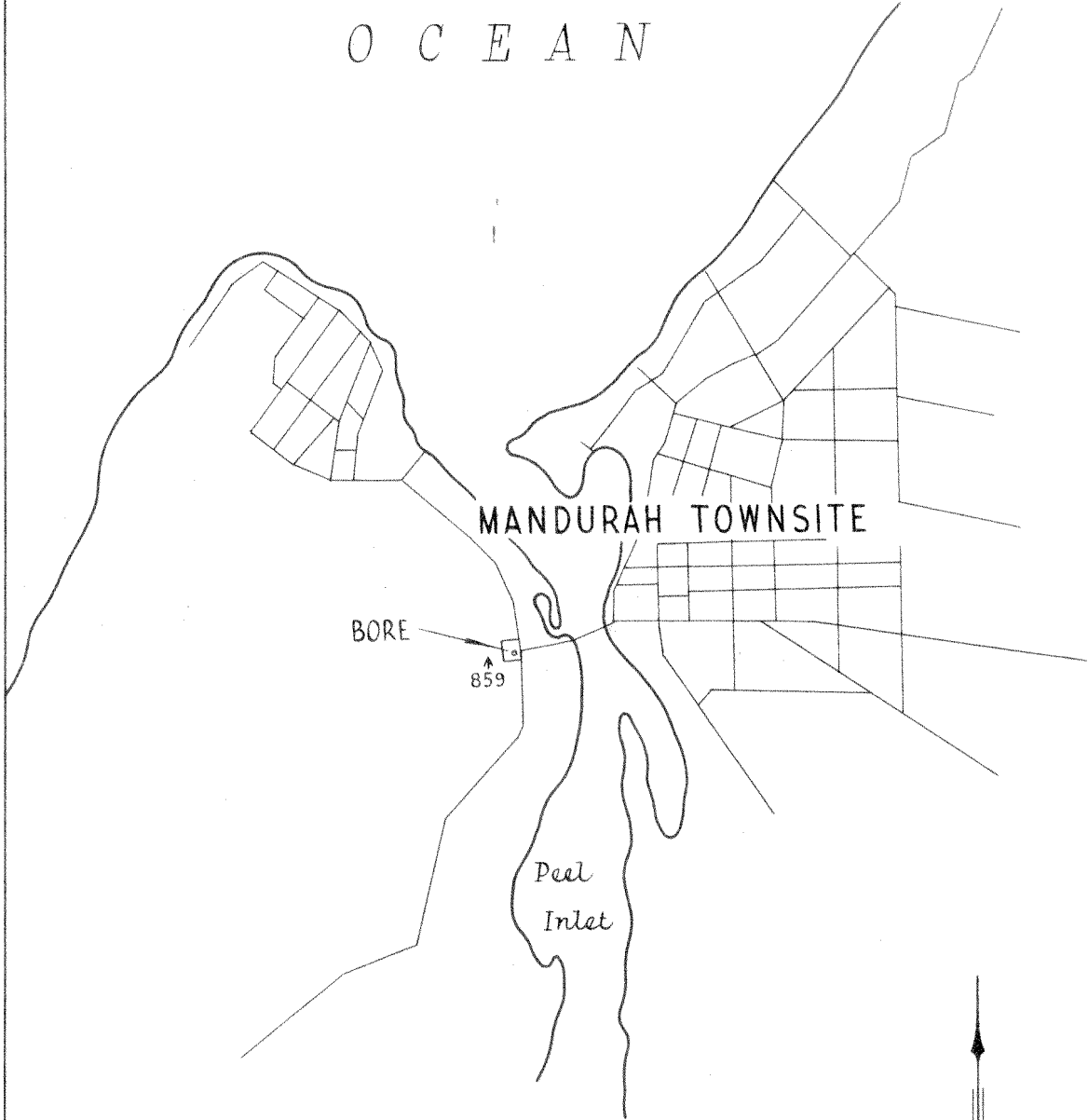
APPENDIX 3. (Contd.)

Sodium chloride, NaCl	1598
Sodium nitrate, NaNO ₃	nil

Hardness Calculated as Calcium Carbonate:

	parts per million
Total hardness	248
Bicarbonate (temporary) hardness	248
Non-carbonate (permanent) hardness	nil
Calcium hardness	145
Magnesium hardness	103

INDIAN
OCEAN



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA







LOCALITY PLAN

G.S.W.A. MANDURAH N^o.1 WATER BORE

Scale: $\frac{1}{2}$ mile to inch
CHAINS 0 10 20 30 40 CHAINS

C.S.W.A. MANDURAH N°1 WATER BORE

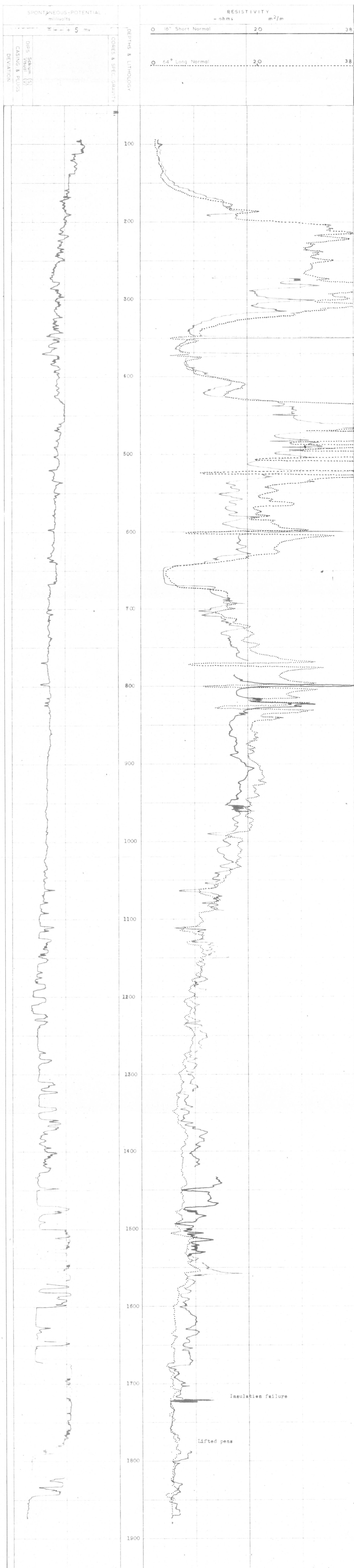
RIG : Failing M I Rotary
DRILLED FOR : Geological Survey of Western Australia
DRILLER : J. F. Grill
COMMENCED : 10th August 1962
COMPLETED : 19th October 1962
LOGGED BY : J. R. Passmore, C. Emmenegger
OTHER LOGS : Spontaneous Potential
Long and Short Normal Resistivity
Point Resistivity
Gamma Ray

	Pyrite		Casing shoe
	Mica		Slotted casing
	Shells		



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
SPONTANEOUS POTENTIAL AND RESISTIVITY LOGS
G.S.W.A. MANDURAH N°1 WATER BORE

ELECTRIC LOGS:	ELECTRICAL SURVEY		GAMMA RAY			
	1	2	1	2		
RUN NUMBER:						
DATE:	3 Sept. 62	20 Sept. 62	3 Sept. 62	20 Sept. 62		
INTERVAL RECORDED:	115-1200	55-1874	0 - 1200	20 - 1875		
MUD-NATURE:	High pH C.B.	High pH C.B.	High pH C.B.	High pH C.B.		
MUD-RESISTIVITY:	1.25 @ 70°	2.60 @ 77°	1.25 @ 70°	2.60 @ 77°		
MUD-RESISTIVITY B.H.T.	0.89 @ 100°	1.85 @ 105°	0.89 @ 100°	1.85 @ 105°		
MUD-WEIGHT:	--	--	--	--		
MUD-VISCOSITY:	43 @ 70°	46 @ 70°	43 @ 70°	46 @ 70°		
MUD-WATER LOSS:	--	--	--	--		
MUD-pH:	8	--	8	--		



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
GAMMA RAY AND POINT RESISTIVITY LOGS
G.S.W.A. MANDURAH N°1 WATER BORE

ELECTRIC LOGS :	ELECTRICAL SURVEY		GAMMA RAY			
	1	2	1	2		
RUN NUMBER:						
DATE	3 Sept. 62	20 Sept. 62	3 Sept. 62	20 Sept. 62		
INTERVAL RECORDED:	115-1200	55-1874	0 - 1200	20 - 1875		
MUD-NATURE:	High pH, C.B. High pH C.B. High pH C.B. High pH C.B.					
MUD-RESISTIVITY:	1.25 @ 70°	2.60 @ 77°	1.25 @ 70°	2.60 @ 77°		
MUD-RESISTIVITY B.H.T.	0.89 @ 100°	1.85 @ 108°	0.63 @ 100°	1.85 @ 108°		
MUD-WEIGHT:	--	--	--	--		
MUD-VISCOSITY:	43 @ 70°	46 @ 70°	43 @ 70°	46 @ 70°		
MUD-WATER LOSS:	--	--	--	--		
MUD-pH:	8	--	8	--		

REMARKS Resistivity curve base was moved 4 divisions (8 ohms) to the left at 598'.

