POWER AND WATER AUTHORITY

MINJILANG GROUNDWATER RESOURCE EVALUATION 1986-1987

REPORT 11/1989

P Jolly
Water Resources Division
Darwin
May 1989
SYNOPSIS

A groundwater investigation was undertaken at Minjilang to assess available groundwater resources and develop a strategy to meet the community's water requirements.

An aquifer system developed in a slightly indurated laterised sublabile sandstone of the Cretaceous Aged Moonkinu Member of the Bathurst Island Formation was identified. This system has a sustainable annual yield of at least 1.5 million cubic metres.

Three new production bores - 24475, 24477, 24478 - were constructed using fibreglass casing and stainless steel screens. These bores have a combined sustainable yield of 1120 cubic metres per day.

The three existing production bores - 7836, 7839, 9455 - were lined with PVC casing to prevent the possible future ingress of sand due to the corrosion of the existing steel casing by the extremely aggressive groundwater. These bores have a combined yield of 700 cubic metres per day. However, bore 7839 with a recommended yield of 220 cubic metres has an immovable obstruction adjacent to the screens which could render it inoperable.

A monitoring programme has been recommended to enable assessment of the long term performance of both the resource and the borefield.
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July 1986

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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>m</td>
<td>Metre</td>
</tr>
<tr>
<td>km</td>
<td>Kilometre</td>
</tr>
<tr>
<td>L/s</td>
<td>Litre per second</td>
</tr>
<tr>
<td>us/cm</td>
<td>Micro siemens per centimetre</td>
</tr>
<tr>
<td>mg/L</td>
<td>Milligrams per litre</td>
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<tr>
<td>RN</td>
<td>Registered Number</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
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<td>MSL</td>
<td>Mean sea level</td>
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<tr>
<td>m²/d</td>
<td>Square metres per day</td>
</tr>
<tr>
<td>SWL</td>
<td>Standing water level</td>
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<td>Drawdown</td>
</tr>
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<td>Pump discharge rate</td>
</tr>
<tr>
<td>OBS Bore</td>
<td>Observation bore</td>
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<tr>
<td>S</td>
<td>Specific Yield</td>
</tr>
<tr>
<td>m³/d</td>
<td>Cubic metres per day</td>
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<tr>
<td>m³</td>
<td>Cubic metres</td>
</tr>
<tr>
<td>GL</td>
<td>Ground Level</td>
</tr>
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<td>Internal diameter</td>
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1. INTRODUCTION

Minjilang is located on the north western side of Mission Bay, midway along the eastern coast of Croker Island. (Refer Figure 1(a)).

Prior to the early 1970's the community was run by the Methodist Overseas Mission. During this period the community obtained its water supply primarily from a spring sourced swamp known as Black Jungle Swamp. Small additional supplies were also obtained from three wells. The location of these supplies are given in Reference 1. The Black Jungle Swamp source is still equipped.

In 1962 the Water Resources Branch of the Northern Territory Administration carried out the first groundwater investigation on the Island. Four holes were jetted down to depths ranging from 6 to 12 metres. The location of these holes are given in Reference 2. Only small yields (less than 0.1 L/s) were obtained.

In 1966 the Water Resources Branch undertook a second groundwater investigation during which four bores were drilled. Three bores were constructed, two of which (5538 and 5540) are currently equipped with windmills which are not operational. Of these bores, one was drilled to supply the community and the other 3 were drilled for stock watering points. The community water supply bore 5513, was tested at 2.5 L/s but was never equipped.

In 1970 the Methodist Church engaged a drilling contractor who drilled ten holes (7263 to 7272), eight of which were constructed (refer Figure 1(b) for
locations of cased bores). Two bores 7263 and 7265 were constructed as community water supply bores and tested at 3.5 L/s. However, they were never equipped. Of the remaining six bores, five are currently equipped with windmills which are not operational, and one - 7270 - is equipped with a draw plunger pump and diesel motor.

In 1974 the Water Resources Branch drilled two bores, 7836 and 7839, to provide the community with an alternate water supply source to that from Black Jungle Swamp. These bores are currently equipped and referred to as Production Bores 1 and 3 (refer Figure 1(c)).

In 1979 the Water Resources Division of the Department of Transport and Works drilled twenty holes on Croker Island, eight of which were drilled to identify a potable water source for Alamira outstation, ten to do similar for Third Bay outstation (9601 to 9610), and two to improve Minjilang's water supply. Of the two holes drilled to improve Minjilang's water supply, one was constructed - 9455 - and is currently equipped. It is referred to as Production Bore 2.

In 1984 Kinhill Stearns produced a report (Reference 4) on Minjilang's water supply in which it concluded that "Without a reduction in the present rate of consumption per capita these proven yields (11 L/s) would be sufficient to satisfy predicted demand in the year 2000." It was also recommended that "a desk study of the aquifer potential be conducted to ascertain if it will continue to supply Minjilang's needs." This work was then programmed to be undertaken by the Water Resources Division in 1986/87.
However, in early 1986 problems were noted with all production bores by the operator of the water supply, the Water Division of the Department of Transport and Works. These problems were attributed to sand intrusion into the bores. Subsequently Production Bore 3 - 7839 - 'failed' and the Water Resources Division of the Department of Mines and Energy (currently the Water Resources Group of the Power and Water Authority) was requested to bring forward to the commencement of the 1986/87 financial year a project which had the following objectives

- construction of three new production bores capable of yielding 11 L/s. These bores were to be constructed utilising inert material where feasible;

- an estimation of water resources in the area to assist in the formulation of a planning and management strategy; and

- where feasible the rehabilitation of existing production bores
2. HYDROGEOLOGY

The following is a summary of the interpretation of results obtained from drilling and field work in and around the borefield. Bores will be referred to by their registered numbers (RN). Bores with registered numbers 24475 to 24479 and 24670 were drilled during this investigation.

2.1 Geology

The geology of Croker Island is outlined on Figure 2.1(a). The major stratigraphic units outcropping on the Island belong to the Cretaceous Aged Bathurst Island Formation.

The Wangarlu Mudstone was deposited in open marine conditions. It is predominantly composed of micaceous mudstone. It underlies the Moonkinu Member which was deposited in a deltaic environment and is composed of fine to very fine sublабile sandstone interbedded with dark grey to light grey siltstone and mudstone.

During the Tertiary period chemical weathering of these sediments produced an extensive cover of laterite.

Subsequent sea level fluctuations during the Quaternary have produced the extensive plain on the western side of the island. This plain covers an area of more than 20 square kilometres and consists of a series of beach ridges and back lagoons (approximately ten) that have infilled a bay that probably existed prior to the Quaternary period.
The major aquifer on Croker Island has been developed in the slightly indurated sublabile sandstone of the Moonkinu Member. The contact between this sandstone and the underlying impermeable mudstones and siltstones of both the Moonkinu Member and Wangarlu Mudstone occurs at a reduced level of approximately 0 to 3 metres above mean sea level in the borefield area (refer Figure 2.1(b)). This contact has a dip in a northerly direction of approximately 0.01 degrees. The contact is exposed in the cliffs on the east coast to the north of Mission Bay. The sandstone is extremely porous and where weathered by wind action has formed pale orange coloured sandy ridges that are not dissimilar to sand dunes. The underlying mudstones and siltstones have been indurated and form erosion resistant 'ledges' adjacent to the shore line.

Relief of up to 10 m in the position of the contact has been observed along the cliffs. This variation in relief is expressed as gentle undulations. No faulting is evident.

To the east of the borefield, immediately beneath the Minjilang Community, the contact is elevated and occurs at approximately 10 m above mean sea level. To the west of the borefield the level of the contact fluctuates between 0 and 5 m above mean sea level (Figure 2.1(b)).

2.2 Aquifer Parameters

Six bores were tested during this investigation. Details of the type of tests and plots of the data obtained from them are given in Appendix A. A summary of the results is given in Table 2.2.
MINJILANG CROSS SECTION A-B

Fig. 2.1(b)
### TABLE 2.2 AQUIFER PARAMETERS

<table>
<thead>
<tr>
<th>PUMPED BORE</th>
<th>Q (L/s)</th>
<th>TEST TYPE</th>
<th>OBS. BORE</th>
<th>r (m)</th>
<th>T (m²/d)</th>
<th>S</th>
<th>COMMENTS</th>
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<tr>
<td>9455</td>
<td>1, 2, and 3 Step test</td>
<td>-</td>
<td>-</td>
<td>310</td>
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<td>Step test conducted on 13.8.86, SWL of 12.44 m</td>
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<td>24475</td>
<td>6.03</td>
<td>Constant Rate</td>
<td>-</td>
<td>-</td>
<td>270</td>
<td></td>
<td>430 minutes Constant Rate test 23 to 25.8.86. SWL of 7.89 m</td>
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<td></td>
<td></td>
<td></td>
<td>24476</td>
<td>10.2</td>
<td>320</td>
<td></td>
<td>DD vs log time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7839</td>
<td>61.2</td>
<td>400</td>
<td>0.05</td>
<td>DD vs log time</td>
</tr>
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<td></td>
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<td></td>
<td>24477</td>
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<td>400</td>
<td>0.03</td>
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<td>6.05</td>
<td>Constant Rate</td>
<td>-</td>
<td>-</td>
<td>200</td>
<td></td>
<td>DD vs log time</td>
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<td></td>
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<td>230</td>
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<td></td>
<td>24477</td>
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<tr>
<td></td>
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<td>-</td>
<td>-</td>
<td>430</td>
<td>0.02</td>
<td>DD vs log distance</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Composite plot of drawdowns in observation bores for tests on 24475, 24477 and 24478.</td>
</tr>
</tbody>
</table>
The longest duration constant rate test was a three day test on bore 24475. A comparison of the drawdowns in bores 24476 - constructed as an observation bore to monitor drawdowns in the producing zone - and bore 24479 - constructed to monitor drawdowns at the water table - is given in Figure A3(1). Both bores are similar distances from the production bore and results indicate that the aquifer is acting in a semi-confined manner.

This would then tend to indicate that values for the specific yield of the aquifer obtained from analysing the results of tests undertaken during this investigation would be lower than the aquifer's true value. The data given in Table 2.2 shows a range of between 0.01 and 0.05 for the specific yield. The aquifer system has been developed in a laterised clayey sandstone. From other work undertaken in this sort of strata specific yields in the order of 0.10 have been obtained. For subsequent calculations in this report a value of 0.10 for specific yield has been utilised.

Transmissivities ranging between 200 and 430 m²/d have been calculated from tests undertaken during this investigation. Values of 300 m²/d or less have been obtained from data from bores located less than 100 metres from the pumped bore. These bores show partial penetration effects. The production bores have been screened to maximise available drawdown and hence the producing zones in each bore produce from only a portion (usually less than 50 per cent) of the aquifer thickness. A value of 400 m²/d is considered to be indicative of the transmissivity of the full thickness of the aquifer.
Thus the aquifer intersected by the production bores can be considered as a semi-unconfined aquifer, developed in a laterised clayey sandstone, having a transmissivity of 400 m²/d and a specific yield estimated at 0.10.

2.3 Groundwater Movement and Recharge

The groundwater flow regime in the vicinity of the borefield is shown on Figure 2.3. The system is typical of the majority of the Northern Territory's coastal aquifer systems where groundwater flows from topographical highs to lows.

Groundwater discharge from the vicinity of the borefield manifests itself primarily as discharges to either Black Jungle Swamp to the east or the eastern edge of the extensive plains drained by Ajamuji Creek to the west.

The sustainable annual yield of the aquifer system intersected by the borefield has been estimated in Appendix B to be at least 1.5 million cubic metres.

Saline intrusion into the aquifer system is unlikely to occur for the following reasons:

(a) The base of the aquifer system (refer Section 2.1 and Figure 2.1(b)) is above mean sea level.

(b) Current demand and likely future demand is at least an order of magnitude below the aquifer system's sustainable yield (refer Section 3).
POSTULATED 15m POTENTIOMETRIC CONTOUR
JULY 1986

Fig. 2.3
**TABLE 2.4  WATER QUALITY DATA**

<table>
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<tr>
<th>RN</th>
<th>COND (us/cm)</th>
<th>TDS (mg/l)</th>
<th>pH</th>
<th>Na</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Total Hardness</th>
<th>Total Alkalinity</th>
<th>Fe</th>
<th>SiO₂</th>
<th>Cl</th>
<th>SO₄</th>
<th>NO₃</th>
<th>HCO₃</th>
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<td>45</td>
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<td>0.1</td>
<td>12</td>
<td>12</td>
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<td>3.0 L/s after rehabilitated</td>
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<td>1</td>
<td>7</td>
<td>2</td>
<td>0.1</td>
<td>0.1</td>
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<td>1.9</td>
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<td>-1</td>
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<td>4</td>
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<td>13</td>
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2.4 Water Quality

All available chemical water quality data is summarised in Table 2.4. These waters show a characteristic of being of low total dissolved solids content (less than 50 mg/L), low pH (approximately 5) and low alkalinity. The only significant chemical concentrations are of Sodium, Chloride and Silica and these are all less than 20 mg/L. Apart from its inherent acidic nature, the water is within the guidelines adopted by the Australian Water Resources Council and National Health and Medical Research Council (Reference 5).

The water is extremely aggressive and material resistant to corrosion should be utilised throughout the water supply system (Reference 3).
3. WATER SUPPLY DEMAND

Available population data for Minjilang indicates a population in the order of 175. Data contained in a report written by Kinhill Stearns in 1985 (Reference 4) gave current and predicted demands at:

Current:
- average wet season consumption: 130 m³/d
- average dry season consumption: 545 m³/d
- peak daily consumption: 635 m³/d
- total annual consumption: 136,000 m³

Predicted demand for the year 2000:
- average wet season consumption: 170 m³/d
- average dry season consumption: 630 m³/d
- peak daily consumption: 740 m³/d
- total annual consumption: 160,000 m³

Based on observations by the author during July and August 1986 these consumption figures appear to be too high. Accurate metering of not only the discharge from the production bores but outflow from the storage tanks should produce more reliable consumption figures. A current average dry season consumption in the order of 200 m³/d appears to be a more reasonable figure on which to base future planning decisions.

Table 3 summarises recommended production rates for various extraction regimes for bores currently constructed to production bore standards and the recommended order in which they should be utilised in the case of either an existing production bore becoming inoperable or increasing demand.
### TABLE 3 - RECOMMENDED PRODUCTION BORE PUMPING RATES

<table>
<thead>
<tr>
<th>BORE (RN)</th>
<th>REGIME 1 (m³/d)</th>
<th>REGIME 2 (m³/d)</th>
<th>REGIME 3 (m³/d)</th>
<th>REGIME 4 (m³/d)</th>
<th>REGIME 5 (m³/d)</th>
<th>RECOMMEND PUMP SETTING (m BELOW GL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7836</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>31.0</td>
</tr>
<tr>
<td>24477</td>
<td>260</td>
<td>260</td>
<td>260</td>
<td>260</td>
<td>260</td>
<td>24.0</td>
</tr>
<tr>
<td>9455-1</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>24.0</td>
</tr>
<tr>
<td>24478</td>
<td></td>
<td>430</td>
<td>430</td>
<td>25.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7839</td>
<td></td>
<td></td>
<td>220</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24475</td>
<td></td>
<td></td>
<td>430</td>
<td>20.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sustainable Yield

| (m³/d) | 220 | 480 | 700 | 910 | 1780 |

28a: GDWT2
4. SUMMARY AND CONCLUSIONS

The Minjilang Groundwater Resource Investigation was undertaken primarily in the vicinity of the existing borefield.

The aquifer system has been developed in a slightly indurated laterised sublabile sandstone of the Moonkinu Member of the Bathurst Island Formation. It is underlain by impermeable mudstones and siltstones of both the Moonkinu Member and the Wangarlu Mudstone at a reduced level of approximately 0 to 3 m above MSL in the borefield area. This contact dips in a northerly direction at approximately 0.01 degrees.

The aquifer has Transmissivity and Specific Yield values in the order of 400 m²/d and 0.10 respectively. It has an estimated annual sustainable yield of at least 1.5 million cubic metres (which equates to approximately 4000 m³/d) in the vicinity of the borefield. Recharge is directly through the surface in the vicinity of the production bores and hence activities which could lead to pollution of the aquifer should not take place in this area. Discharge is primarily to Black Jungle Swamp to the east and Ajamuji Creek to the west.

Mean dry season water requirements for the year 2000 have been estimated at 740 m³/d (Reference 3). Three new production bores have been constructed of fibreglass casing and stainless steel screens. These bores have a sustainable yield of 1120 m³/d. The three existing production bores were lined with PVC casing. These bores have a sustainable yield of 700 m³/d. However bore 7839 has an obstruction adjacent to the screens which could not be removed. It is probable that this bore will fail in the near future.
Various production bore regimes have been modelled for water supply requirements ranging between 480 and 1780 m³/d. These are given in Table 3.

Water quality is characterised by low pH, low alkalinity and consequent high corrosivity. Measures need to be taken to use materials resistant to the highly aggressive nature of the groundwater.
5. RECOMMENDATIONS

It is recommended that:

1. Maximum sustainable yields not exceed those given in Table 3.

2. Production bores be equipped as recommended in Table 3 and Appendix C. The pumping rates and pump settings are not to be exceeded due to the problems likely to arise from the erosion of the poorly cemented sandstone aquifer with the resultant intrusion of sand into both the bore and pump.

The operation of production bores be tailored such that they are operated on a continuous basis to meet the community's water demand.

3. A monitoring programme be initiated to assess the long term performance of both the aquifer system and the production bores. This should incorporate:

   (a) A log of the performance of production bores to include - discharge rates, times, pumping and static water levels, and any observed operational problems.

   (b) Complete chemical analyses of water samples from each production bore at 12 weekly intervals.

   (c) Monitoring of water levels at 12 weekly intervals in bores 7263, 7266, 24670 and any unequipped production bores.
6. REFERENCES


Minjilang Groundwater Investigation - 1986

1. Drilling

Drilling was carried out between 8 July and 13 August 1986, using an Ingersol Rand TH60 top head drive drilling rig. The majority of drilling was undertaken using mud circulation with development of constructed bores being done with water jetting and airlifting.

Six bores were drilled with three being constructed as production bores and three as observation bores. A discussion on each is below. Bore locations are shown on Figure 1(c) with interpretative logs included in Table A1.

Bore 22475 was sited 61 metres west of production bore 7839. It was constructed as a production bore. Fibreglass casing of 203 mm internal diameter (ID) was "cemented in" at 22.8 m. The hole was completed at 28.5 m and constructed using 152 mm ID stainless steel screened with a 0.9 mm aperture. All drilling was undertaken using mud circulation. The screens were located against a more competent zone of what could be described as a very poorly cemented laterised clayey sandstone. When development was attempted approximately 10 L/s plus large quantities of sand were airlifted. This was stopped after less than 10 minutes and a decision was made to drill investigation hole 22476 approximately eleven metres to the south west. Information gained during drilling of 22476 indicated that the sandstone was less competent than expected and that jetting with water first followed by airlift development at a lower rate (4 L/s) would result in a successful production bore. This work was undertaken and the bore successfully cleared up.
Bore 22476 was drilled to obtain information to assist in the completion of bore 22475. This bore was drilled with mud to 30 m (stratigraphically below the bottom of 22475) and cased with 203 mm steel casing. The bore was then air drilled to 45 m through predominantly white then grey clays. No water was intersected between 30 and 45 m. Telescopic screens were then inserted in the hole and the 203 mm casing pulled back to 24 m so that development techniques could be tested over the 24 - 30 m interval. Airlifting from 22 m produced no water, so jetted with water for 30 minutes, then airlifted again. Airlifting was attempted at a much lower rate than in 22475 and airlifting at 3 L/s resulted in a water supply that cleared up quickly. This indicated that airlift development should only occur at a rate of approximately 3 L/s and further development if required be undertaken when test pumping the bore. This bore was subsequently converted to observation bore status by:

1. inserting 50 mm PVC casing with 50 mm stainless steel screens (0.9 mm aperture) at the bottom between 22 and 26 m,

2. gravel packing with lateritic gravel, and

3. cementing 6 m of 152 mm ID steel casing at the surface to protect the 50 mm PVC casing.

Bore 24477 was constructed in a similar manner to 22475 with 203 mm ID fibreglass casing "cemented in" at 25 m and the interval 25 to 31 m screened. Screens with a 0.5 mm aperture were used because the correct aperture screens were not available.
Bore 24478 was also constructed as a production bore with 203 mm ID fibreglass casing "cemented in" at 26.5 m and the interval 26.5 to 32.2 m screened with screens with an aperture of 0.9 mm. When airlift development was first attempted on this bore it was found that the cement job at the bottom of the fibreglass casing had failed. Subsequently the screens were withdrawn, the hole backfilled to 26 m and the annulus between the casing and the 315 mm diameter drilled hole filled with cement slurry by use of a tremmie pipe. The hole was cleaned out, screens re-run and then successfully developed.

Bore 24479 was constructed as an observation bore approximately eleven metres south east of bore 24475. It was completed at a depth of 11.6 m with 50 mm stainless steel screens (0.9 mm aperture) between 7.6 and 11.6 m to monitor water level variations at the water table due to pumping.

Bore 24670 was drilled as an investigation bore 700 m east-south east of bore 24475 and was constructed as an observation bore with 50 mm PVC casing with 50 mm stainless steel screens (0.9 mm aperture) between 28 and 32 metres.

All bores were constructed with steel surface casing to protect both the fibreglass and PVC casing against damage.

Bores 24476, 24477 and 24788 drilled during this investigation were downhole gamma logged. The base of the clayey sandstone was readily discernible from the gamma log. All other bores on Croker Island that could be logged were also logged. As a result gamma logs
were obtained from cased bores 5540, 7263, 7266, 7269 and 7839. Correlation of the gamma log of bore 7263 (a bore mentioned in Reference 3 as a possible production bore) with that for bore 24476 indicates that the base of the clayey sandstone is at seventeen metres. This would suggest that the majority of any water intersected in bore 7263 should have been intersected above 12 m, a suggestion supported by the Regulation 8 form for this bore. This bore should not be equipped as a production bore.

(2) Rehabilitation

Rehabilitation work was attempted on all three existing production bores. Bores 7836 and 9455 were successfully worked over and re-lined with Class 9 PVC casing to a depth just above the screens.

An obstruction believed to be caused by a pump stuck down the bore was encountered in bore 7839 at a depth of 23.5 m. Attempts utilising the drilling rig and appropriate "fishing" tools failed to remove this obstruction. Since this obstruction is above the screens it is expected that in the future this bore will become inoperable. However, since all headworks already exist at this bore it was lined with PVC casing to 23.5 m and subsequently developed and recommended for further use at a rate of 2.5 L/s. Should this bore again become inoperable it should be abandoned and bore 24477 equipped.

In none of the production bores was the ingress of sand a problem at their recommended pumping rates.
(3) **Test Pumping**

Each of the existing bores - 7836, 7839 and 9455 - was re-tested using step drawdown tests.

The new production bores - 24477 and 24478 - had step and one day constant rate tests carried out. Bore 24475 had step and three day constant rate tests carried out. Some of the results of these tests are shown on Figures A3(i) to A3(vii).
TABLE A1  

<table>
<thead>
<tr>
<th>BORE RN</th>
<th>TOTAL DEPTH (m)</th>
<th>INTERVAL (m)</th>
<th>LITHOLOGIC DESCRIPTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>24475</td>
<td>28.7</td>
<td>0 - 3</td>
<td>Brown clayey loam</td>
<td>Mud drilled to total depth.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 - 6.8 Ferruginous gravelly clay</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.8 -16 White sandy clay</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16 -20 White and yellow sandy clay, yellow brown sandstone and red sandstone</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 -22.7 Red and grey sandstone</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>22.7 -27.7 Red, brown and yellow sandstone</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>27.7 -28.7 Pink and white clay</td>
<td></td>
</tr>
<tr>
<td>24476</td>
<td>45</td>
<td>0 -28.7 As for 24475</td>
<td>Mud drilled to total depth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28.7 -29.5 Red indurated siltstone</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>29.5 -31 Grey, yellow, brown sandstone and white clay</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>31 -34.2 White clay</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>34.2-34.9 Red siltstone</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>34.9-45 Grey clay</td>
<td></td>
</tr>
<tr>
<td>24477</td>
<td>31</td>
<td>0 - 3</td>
<td>Clayey sandy loam</td>
<td>Mud drilled to total depth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 - 6 Clayey gravel-ironstone (probably coarse grained ferruginous sandstone)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 - 9 Red sandy clay 70%, yellow sandy clay 20%, ironstone 10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9 -12 Yellow sandy clay 70%, white sandy clay 30%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 -15 White sandy clay 70%, yellow sandy clay 25%, yellow sandstone 5%</td>
<td></td>
</tr>
</tbody>
</table>
**TABLE A1**  
**GEOLOGICAL LOGS (cont'd...)**

<table>
<thead>
<tr>
<th>BORE</th>
<th>TOTAL INTERVAL</th>
<th>LITHOLOGIC DESCRIPTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DEPTH (m)</td>
<td>(m)</td>
<td></td>
</tr>
<tr>
<td>24477</td>
<td>31</td>
<td>15 -18</td>
<td>White sandy clay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18 -20</td>
<td>Yellow sandy clay 50%, white sandy clay 30%, yellow sandstone 10%, grey sandstone 10%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 -22</td>
<td>White sandy clay 60%, yellow sandy clay 20%, yellow sandstone 10%, grey sandstone 10%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22 -24</td>
<td>White sandy clay 30%, yellow sandy clay 30%, yellow sandstone 5%, grey sandstone 20%, red sandstone 15%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 -25</td>
<td>Red sandstone 25%, grey sandstone 25%, white sandy clay 25%, yellow sandy clay 25%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25 -26</td>
<td>White sandy clay 30%, red sandy clay 20%, yellow sandy clay 20%, red and grey sandstone 30%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26 -27</td>
<td>Yellow and white sandy clay 80%, red grey and yellow brown sandstone 20%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27 -28</td>
<td>Grey brown sandstone (with yellow stained surfaces) hard with &quot;wavy&quot; surfaces 60%, white sandy clay 30%, yellow sandy clay 10%.</td>
</tr>
<tr>
<td>BORE RN</td>
<td>TOTAL DEPTH (m)</td>
<td>INTERVAL (m)</td>
<td>LITHOLOGIC DESCRIPTION</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>--------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>24477</td>
<td>31</td>
<td>28 - 29</td>
<td>Yellow sandy clay 50%, white sandy clay 40%, hard grey brown sandstone 10%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>29 - 30</td>
<td>Yellow sandy clay 70%, white sandy clay 25%, red sandstone 5%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 - 31</td>
<td>White sandy clay 70%, yellow sandy clay 30%.</td>
</tr>
<tr>
<td>24478</td>
<td>32.5</td>
<td>0 - 1</td>
<td>Brown clayey loam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 - 3</td>
<td>Gravelly clay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 - 8</td>
<td>Brown clay, ironstone nodules, ferruginous coarse sandstone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 - 13</td>
<td>As above, plus white sandy clay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13 - 18</td>
<td>White sandy clay 80%, yellow sandy clay 20%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18 - 21</td>
<td>Yellow sandy clay 30%, white sandy clay 40%, grey and red sandstone 20%, yellow brown sandstone 10%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21 - 25</td>
<td>White sandy clay 30%, yellow sandy clay 20%, red and grey sandstone 30%, yellow brown sandstone 20%.</td>
</tr>
</tbody>
</table>
### TABLE A1

GEOLOGICAL LOGS (cont'd...)

<table>
<thead>
<tr>
<th>BORE RN</th>
<th>TOTAL DEPTH (m)</th>
<th>INTERVAL (m)</th>
<th>LITHOLOGIC DESCRIPTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 -11.6</td>
<td>24479 11.6</td>
<td>0 -11.6 As for 24475</td>
<td>Seepage 9 m</td>
<td></td>
</tr>
</tbody>
</table>

25 -26.5 Red and grey sandstone (same chips appear vuggy) 50%, yellow brown sandstone 30%, white sandy clay 20%.

26.5 -27.5 Red and grey sandstone (vuggy?)

27.5 -28.5 Red and grey sandstone 60%, yellow sandy clay 35%, white sandy clay 5%.

28.5 -30.5 Yellow sandy clay 60%, white sandy clay 30%, red and grey sandstone 10%.

30.5 -31.5 Grey sandstone (hard "wavy" surfaces yellow stain) 70%, yellow sandy clay 15%, white sandy clay 15%.

31.5 -32.5 Yellow sandy clay 40%, grey sandstone (as above) 30%, white sandy clay 30%. 

---

28a: GDWT2
<table>
<thead>
<tr>
<th>BORE RN</th>
<th>TOTAL DEPTH (m)</th>
<th>INTERVAL (m)</th>
<th>LITHOLOGIC DESCRIPTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>24760</td>
<td>41.7</td>
<td>0 - 3</td>
<td>Brown clayey loam and</td>
<td>Mud drilled to</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ironstone nodules.</td>
<td>total depth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 - 15</td>
<td>Brown and yellow gravelly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>clay.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 - 25.5</td>
<td>White and yellow sandy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>clay.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.5 - 25.7</td>
<td>Red indurated siltstone</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.7 - 28.7</td>
<td>Red, white and yellow</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>clays.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>29.7 - 39</td>
<td>Dark grey and light grey</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>clay.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>39 - 41.7</td>
<td>Dark grey clay.</td>
<td></td>
</tr>
</tbody>
</table>
FIG. A3(1)

PUMPED BORE  24775
OBSERVATION BORE (+)  24779 'r' = 11.4m
OBSERVATION BORE (x)  24776 'r' = 10.2m
DISCHARGE  520 m³/day
DATE  20-23/8/86

CONSTANT DISCHARGE TEST
Fig. A3(1)

PUMPED BORE 24475
OBSERVATION BORE 7839 \( r'=61.2 \text{m} \)
DISCHARGE 520 m\(^3\)/day
DATE 20-23/8/86

CONSTANT DISCHARGE TEST
CONSTANT DISCHARGE TEST

PUMPED BORE 24475
OBSERVATION BORE 24477 'r' = 143.8m
DISCHARGE 520 m³/day
DATE 20-23/8/86
Fig. A3(v)

PUMPED BORE 24478
OBSERVATION BORE 24477 'r' = 116.2m
DISCHARGE 520 m³/day
DATE 18-19/9/86

CONSTANT DISCHARGE TEST
Fig. A3(vi)

COMPOSITE PLOT - DRAWDOWN VERSUS LOG DISTANCE -
FOR TESTS ON BORES 24475, 24477 AND 24478

TIME = 1500 minutes
Q(24475) = 6.0 L/s [X]
Q(24477) = 6.0 L/s [Θ]
Q(24478) = 6.0 L/s [†]
Fig. A3(vii)

INTERFERENCE BETWEEN PRODUCTION BORES

TIME = 300 days

FLOW RATE

Q = 2.5 L/s
Q = 3.0 L/s
Q = 3.5 L/s
Q = 5.0 L/s
Q = 6.0 L/s

DRAWDOWN [metres]

DISTANCE (metres)
APPENDIX B

ESTIMATED SUSTAINABLE YIELD OF THE AQUIFER SYSTEM

(a) Calculation of Annual System Discharges

Due to the paucity of regional data only an order of magnitude estimate of throughflow can be determined.

This estimate is based on data on water levels collected between July and September 1986 (Refer Table B1). This data has been used to estimate the flow across the 15 metre (above mean sea level) potentiometric level contour which has been plotted for July on Figure 2.3. There is no data on the location of the contour to the north of the borefield and hence no estimate of throughflow to the north is possible. The estimate is therefore confined to throughflow to the east, west and south which manifests itself primarily as discharges either to Black Jungle Swamp or to the eastern edge of the extensive plains drained by Ajamuji Creek. This would then be considered as a conservative estimate.

Throughflow = T x i x w

where

T = 400 m³/d (refer Section 2.2)

i = 6 x 10⁻³ (refer Figure 2.1(b) and 2.3)

w = 7000 metres (refer Figure 2.3)

Thus the estimated throughflow is 16800 m³/d. Since the throughflow for July could be considered as indicative of the mean discharge for the year, the annual system discharge would be in the order of 6 million cubic metres.
# TABLE B1

STANDING WATER LEVEL DATA

<table>
<thead>
<tr>
<th>DATE</th>
<th>BORE RN AND SWL (m BELOW TOP OF CASING)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5540</td>
</tr>
<tr>
<td>9.7.86</td>
<td>3.85</td>
</tr>
<tr>
<td>17.7.86</td>
<td>10.7</td>
</tr>
<tr>
<td>18.7.86</td>
<td>23.3</td>
</tr>
<tr>
<td>21.7.86</td>
<td>2.7</td>
</tr>
<tr>
<td>16.8.86</td>
<td></td>
</tr>
<tr>
<td>28.8.86</td>
<td>11.08</td>
</tr>
<tr>
<td>9.9.86</td>
<td></td>
</tr>
<tr>
<td>11.9.86</td>
<td>11.12</td>
</tr>
<tr>
<td>22.9.86</td>
<td></td>
</tr>
<tr>
<td>25.9.86</td>
<td>11.24</td>
</tr>
</tbody>
</table>

28a:GWT2
(b) Calculation of Annual Recharge

Only an order of magnitude estimate of recharge can be indicated by this method. This is because of the currently unknown factors such as recharge capacity and effective recharge area which are largely influenced by the variable soil conditions and infiltration characteristics of any particular area.

Based on rainfall data between 1952 and 1986 which is plotted on Figure B1, Minjilang has a median rainfall of 1330 mm. Annual water year (September to end of August) rainfall has varied from a minimum of 850 mm to a maximum of 2360 mm. The majority of the rainfall is received during the wet season months December to April.

Recharge to that sector of the aquifer for which throughflow was calculated in the preceding section occurs over an area of approximately 9 square kilometres. Recharge to the aquifer is expected to be high for the following reasons:

(1) High water table - usually less than 10 metres below ground level, often less than 5 metres.

(2) The sandy nature of the soil.

An infiltration factor of 20% has thus been chosen to obtain an order of magnitude estimate of recharge.

Therefore, annual recharge is estimated to range from a minimum of 1.5 million cubic metres to a maximum of 4 million cubic metres with a median value of 2.4 million cubic metres.
MINJILANG - ANNUAL RAINFALL

TIME (YEAR - 1 Sept. to 31 Aug.)

RAINFALL (mm)

500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400

51/52 60/61 66/67 70/71 73/74 77/78 80/81 82/83 84/85

MEDIAN 1330
For the 1985/86 water year upon which calculations of throughflow in the proceeding section were based, Minjilang had an annual rainfall of 1560 mm. This would equate to a recharge of 2.8 million cubic metres.

(c) Estimated Sustainable Yield of the Aquifer System

The estimates of system discharges and annual recharge indicated that the aquifer has a sustainable yield of at least 1.5 million cubic metres.
APPENDIX C

BORE COMPLETION REPORTS - MINJILANG

1. INTRODUCTION

In line with the project brief for this investigation the three existing production bores at Minjilang were re-lined and rehabilitation work undertaken on each. Two bores - 7836 and 9455 - were successfully rehabilitated. The third bore - 7839 - was partially rehabilitated. Three new bores were constructed using inert casing.

2. GEOLOGY

All bores were completed in a very poorly cemented laterised sandstone of Cretaceous Age. It is probable that the sandstone is part of the Moonkinu Member of the Bathurst Island Formation.

3. WATER QUALITY

Chemical water quality analyses are summarised in Table 2.3. The water can be described as a low hardness, aggressive water typical of that found in coastal communities of the Northern Territory. It has the potential to be extremely corrosive.

4. BOREFIELD PERFORMANCE

Drawdown in production bores in the Minjilang borefield is dominated by two components:

(1) aquifer and well losses occurring in the first ten minutes of pumping; and

(2) seasonal drawdown
Drawdowns resulting from long term pumping and interference between production bores are usually less than one metre with the current borefield configuration.

Performance curves for each production bore are given for a number of regimes (refer Table 3) ranging from each production bore pumping by itself with no seasonal drawdown to all bores pumping continuously with a predicted seasonal drawdown of 3 m from an end of wet season water level of 19 m above mean sea level. Based on historical data the 19 m level is expected to be the lowest end of wet season water level likely to be encountered. This level needs to be verified by monitoring rainfall and water level variations until such time as a meaningful relationship is established.
WATER DIRECTORATE

TEST REPORT — BORE RN. 7836

Bore location: CROKER ISLAND

Client/owner: MINJILANG TOWN COUNCIL

Map: CROKER 1:100 000 SHEET 5475

Grid reference: 343 666

Client's reference: MINJILANG TOWN COUNCIL

Purpose of supply: TOWN WATER SUPPLY

RECOMMENDATIONS

Pumping rate: 2.5 L/s

Pump setting: 31.0 m below ground level

General recommendations are given on the reverse side.

The aquifer and bore cannot sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from:

(In all correspondence refer to the bore's RN number).

BORE DATA

Finished depth: 37.8 m

Completion date: 29.2.72

Test date: 7.8.86

Standing water level 16.35 m on 7.8.86

Test rates: 1.1.5, 2.2.5, 3.3.5 L/s

Test duration 6 hrs

Construction details:

Interval (m) Description

0 - 32.7 140 mm ID steel casing

31.2 - 37.8 0.9 mm aperture stainless steel screens

0 - 31.2 104 mm ID PVC casing

Notes:

1. Top of casing as constructed was 0.2 m above ground

2. All depths are measured from natural ground level

3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 104 mm SETTING

COMMENTS

1. This bore has been lined with 104 mm internal diameter (ID) PVC casing to extend its life against the effects of corrosion by the acidic groundwater on the steel casing. This work was undertaken on the 8 August 1986.

2. Pump rates in excess of 2.5 L/s may result in sand intrusion. Action should be taken to ensure pumping at rates in excess of 2.5 L/s does not occur.

WATER QUALITY

See water laboratory report (Analysis No.)
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.

2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.

3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.

4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.

5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.

6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division's only reference to the scientific and engineering data on this bore, and hence important to WRD's further advice to bore owners.
RN 7836 CONSTRUCTION LOG

Fig. C(1)
Fig. C(2)

MINJILANG - BORE PERFORMANCE CURVE RN7836

TIME (minutes)

DRAWDOWN (metres)

Q = 2.5 L/s

DRAWDOWN (ONLY BORE PUMPING, NO SEASONAL DRAWDOWN)

AVAILABLE DRAWDOWN WITH PUMP SETTING 3m BELOW G.L.

SEASONAL DRAWDOWN 0.3 m/MONTH = 3 m/YEAR
ASSUME END OF WET SWL = 19m ABOVE MSL
RECOMMENDATIONS

Pumping rate: 2.5 L/s. Pump setting: 22.5 m below ground level

General recommendations are given on the reverse side.

The aquifer and bore cannot sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from:

(In all correspondence refer to the bore's RN number).

BORE DATA

Finished depth: 30.8 m. Completion date: 16.3.72. Test date: 22.9.86
Standing water level: 9.32 m on 22.9.86. Test rates: 1.1, 1.5, 2.2, 3.3 L/s. Test duration 6 hrs

Construction details:

<table>
<thead>
<tr>
<th>Interval (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 21.3</td>
<td>203 mm ID steel casing</td>
</tr>
<tr>
<td>0 - 25.0</td>
<td>140 mm ID steel casing</td>
</tr>
<tr>
<td>24.4 - 30.8</td>
<td>0.9 mm aperture stainless steel screens</td>
</tr>
<tr>
<td>0 - 23.6</td>
<td>104 mm ID PVC casing</td>
</tr>
</tbody>
</table>

Notes:
1. Top of casing as constructed was 0.2 m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS AT RECOMMENDED PUMP SETTING

COMMENTS

1. There is an obstruction in this bore at depth 23.5 m which could not be cleared. When retested this bore performed satisfactorily and thus its further usage is recommended. If this bore fails in the future it should be abandoned and bore 24477 equipped.

2. This bore has been lined with 104 mm internal diameter (ID) casing to extend its life against the effects of corrosion. This work was undertaken on the 6 August 1986.

3. Pump rates in excess of 2.5 L/s may result in sand intrusion and subsequent failure of this bore.

WATER QUALITY

See water laboratory report (Analysis No.)
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.
2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.
3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.
4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.
5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.
6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division's only reference to the scientific and engineering data on this bore, and hence important to WRD's further advice to bore owners.
RN 7839 CONSTRUCTION LOG

NOTE: OBSTRUCTION IN BORE AT 23.55
TIME (minutes)

DRAWDOWN [metres]

DRAWDOWN (ONLY BORE PUMPING, NO SEASONAL DRAWDOWN)

Q = 2.5 L/s

AVAILABLE DRAWDOWN WITH PUMP SETTING 22.5m BELOW G.L.

SEASONAL DRAWDOWN 0.3 m/MONTH = 3 m/YEAR
ASSUME END OF WET SWL = 19m ABOVE MSL

MINJILANG - BORE PERFORMANCE CURVE RN7839
TEST REPORT — BORE RN. 9455

Bore location: CROKER ISLAND

Client/owner: MINJILANG TOWN COUNCIL

Client's reference: 

Purpose of supply: TOWN WATER SUPPLY

Map: CROKER 1:100 000 SHEET 3475

Grid reference: 344 666

RECOMMENDATIONS

Pumping rate: 2.5 L/s. Pump setting: 24.0 m below ground level

General recommendations are given on the reverse side.

The aquifer and bore cannot sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from:
(In all correspondence refer to the bore's RN number).

BORE DATA

Finished depth: 35.1 m Completion date: 15.2.79 Test date: 12.8.86

Standing water level 13.76 m on 12.3.86 Test rates: 1,2,3,4 L/s

Construction details:

<table>
<thead>
<tr>
<th>Interval (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 29</td>
<td>203 mm ID steel casing</td>
</tr>
<tr>
<td>28.1 - 35.1</td>
<td>152 mm ID stainless steel screens with 0.9 mm aperture</td>
</tr>
<tr>
<td>0 - 28.1</td>
<td>146 mm ID PVC casing</td>
</tr>
</tbody>
</table>

Notes: 1. Top of casing as constructed was 0.2 m above ground

2. All depths are measured from natural ground level

3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 146 mm AT RECOMMENDED PUMP SETTING

COMMENTS

1. Pump rates in excess of 2.5 L/s will definitely result in sand intrusion. Action should be taken to ensure pumping at rates in excess of 2.5 L/s never occurs.

2. This bore has been lined with 146 mm interval diameter (ID) PVC casing to extend its life against the effects of corrosion by the acidic groundwater on the steel casing. This work was undertaken on the 11 August 1986.

WATER QUALITY

See water laboratory report (Analysis No.)
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.

2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.

3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.

4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.

5. Pumping the bore at higher than recommended rates may work the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.

6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division's only reference to the scientific and engineering data on this bore, and hence important to WRD's further advice to bore owners.
RN 9455 CONSTRUCTION LOG

Fig. C(5)
Fig. C(6)

MINJILANG - BORE PERFORMANCE CURVE RN9455

TIME (minutes)

DRAWDOWN (metres)

Available drawdown with pump setting 24m below G.L.

Seasonal drawdown 0.3 m/month = 3 m/year
Assume end of wet SWL = 19m above MSL
# TEST REPORT — BORE RN. 24475

**Bore location:** CROKER ISLAND

**Client/owner:** MINJILANG TOWN COUNCIL

**Client's reference:**

**Purpose of supply:** TOWN WATER SUPPLY

**Map:** CROKR 1:100 000 SHEET 5475

**Grid reference:** 341 665

## RECOMMENDATIONS

- **Pumping rate:** 5.0 L/s. **Pump setting:** 20.0 m below ground level

General recommendations are given on the reverse side.

The aquifer and bore cannot sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from:

(In all correspondence refer to the bore's RN number).

## BORE DATA

- **Finished depth:** 28.7 m
- **Completion date:** 16.7.96
- **Test date:** 19.8.96
- **Standing water level:** 7.89 m on 16.8.96
- **Test rates:** 3.4.5.6 L/s
- **Test duration:** 95 hrs

**Construction details:**

<table>
<thead>
<tr>
<th>Interval (m)</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>0 - 22.8</td>
<td>203 mm ID Fibreglass Casing</td>
</tr>
<tr>
<td>22 - 28.7</td>
<td>152 mm ID stainless steel screens with 0.9 mm aperture</td>
</tr>
</tbody>
</table>

**Notes:**

1. Top of casing as constructed was 0.48 m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates.

**WARNING:** MINIMUM INTERNAL BORE DIAMETER IS 203 mm

**AT RECOMMENDED PUMP SETTING**

## COMMENTS

1. Pump rates in excess of 5.0 L/s may result in sand intrusion.
   Action should be taken to ensure pumping at rates in excess of 5.0 L/s does not occur.

## WATER QUALITY

See water laboratory report (Analysis No.)

WRD4020
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.
2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.
3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.
4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.
5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.
6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division’s only reference to the scientific and engineering data on this bore, and hence important to WRD’s further advice to bore owners.
RN 24475 CONSTRUCTION LOG

Fig. C(7)
Fig. C(8)

MINJILANG - BORE PERFORMANCE CURVE RN24475
WATER RESOURCES DIVISION

TEST REPORT — BORE RN. 24477

Bore location: CROKER ISLAND
Client/owner: MINJILANG TOWN COUNCIL
Map: CROKER 1:100 000 SHEET 5475
Grid reference: 343 665

Client's reference:
Purpose of supply: TOWN WATER SUPPLY

RECOMMENDATIONS

Pumping rate: 3.0 L/s. Pump setting: 24.0 m below ground level
General recommendations are given on the reverse side.
The aquifer and bore cannot sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from:
(In all correspondence refer to the bore's RN number).

BORE DATA

Finished depth: 31.0 m Completion date: Test date: 9.9.86
Standing water level 11.03 m on 9.9.86 Test rates: 3,4,5,6 Ls
Construction details: Test duration 40 hrs

<table>
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<tr>
<th>Interval (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 25</td>
<td>203 mm ID Fibreglass Casing</td>
</tr>
<tr>
<td>24.3 - 31</td>
<td>152 mm ID stainless steel screens with 0.5 mm aperture</td>
</tr>
</tbody>
</table>

Notes: 1. Top of casing as constructed was 0.65 m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 203 mm SETTING

COMMENTS

1. Pump rates in excess of 3.0 L/s may result in sand intrusion. Action should be taken to ensure pumping at rates in excess of 3.0 L/s does not occur.

WATER QUALITY

See water laboratory report (Analysis No.) WRD4020
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.
2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.
3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.
4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.
5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.
6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division's only reference to the scientific and engineering data on this bore, and hence important to WRD's further advice to bore owners.
RN 24477 CONSTRUCTION LOG

Fig. C(9)
MINJILANG - BORE PERFORMANCE CURVE RN24477
WATER RESOURCES DIVISION

TEST REPORT — BORE RN. 24478

Bore location: CROKER ISLAND
Client/owner: MINJILANG TOWN COUNCIL
Map: CROKER 1:100 000 SHEET 5475
Purpose of supply: TOWN WATER SUPPLY

Grid reference: 344 666

RECOMMENDATIONS
Pumping rate: 5.0 L/s. Pump setting: 25.0 m below ground level
General recommendations are given on the reverse side.
The aquifer and bore field cannot sustain higher pumping rates with deeper pump settings or for short
periods in favourable seasons. Further advice can be obtained from:
(In all correspondence refer to the bore's RN number).

BOR DATA

Standing water level: 14.17 m on 16.9.86
Test rates: 3, 4, 5, 6 L/s
Test duration: 44 hrs

Test date: 16.9.86
Finished depth: 32.5 m
Completion date:
Construction details:

Interval (m) Description
0 - 26.5 203 mm ID Fibreglass Casing
25.8 - 32.5 152 mm ID stainless steel screens with 0.9 mm aperture

Notes: 1. Top of casing as constructed was 0.59 m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 203 mm AT RECOMMENDED PUMP

SETTING

COMMENTS

1. Pump rates in excess of 5.0 L/s may result in sand intrusion.
   Action should be taken to ensure pumping at rates in excess of
   5.0 L/s does not occur.

WATER QUALITY

See water laboratory report (Analysis No. WR04020)
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.

2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.

3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.

4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.

5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.

6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division’s only reference to the scientific and engineering data on this bore, and hence important to WRD’s further advice to bore owners.
RN 24478 CONSTRUCTION LOG

Fig. C(I)
Fig. C12

**MINJILANG - BORE PERFORMANCE CURVE RN24478**

*Available Drawdown with Pump Setting 25m Below G.L.*

- **Seasonal Drawdown:** 0.3 m/month = 3.6 m/year
- **Assume End of Wet SWL = 19m Above MSL**

**Graph Details:**
- Drawdown in metres
- Time in minutes
- **Q = 5.0 L/s**
- **Available Drawdown with Pump Setting 25m Below G.L.**
- **Seasonal Drawdown (0.3 m/month = 3.6 m/year)**
- **Drawdown Only Bore Pumping, No Seasonal Drawdown**

**Note:**
- Time units for 10,000 and 100,000 days are indicated.

**Legend:**
- Dashed line indicates available drawdown with pump setting 25m below G.L.
- Solid line indicates seasonal drawdown (0.3 m/month = 3.6 m/year)
- Dotted line indicates drawdown only bore pumping, no seasonal drawdown
APPENDIX D

Bore Construction

The construction of production bores during this investigation identified two major problem areas, these being:

1. Hole stability due to erosion of the poorly cemented sandstone aquifer.

2. Extreme corrosivity of the low pH, TDS and alkalinity groundwaters.

Individual production bore yields in excess of the current maximum recommended yield of 430 m³/d for bore 24475 are probable if a suitable formation stabiliser is used. None was used during the current investigation for two reasons:

- no suitable material available (pisolitic laterite not suitable)
- yields attainable from a single bore without using it were equal to current demand requirements for community.

The extreme corrosivity of the groundwater led to the use of fibreglass casing and stainless steel screens, packer and sump, in the construction of new production bores. Existing bores were lined with PVC casing to extend their useful life (i.e. prevent ingress of sand through corroded steel casing).