JUSTIFICATION FOR 1989/90
DESIGN LIST ITEM
ALICE SPRINGS
REHABILITATION OF
PRODUCTION BORES

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ABSTRACT

This report has been compiled as part of the Northern Territory Treasury requirements for justification of all 1989/1990 Design List Items.

Originally this project was titled "Roe Creek Borefield - Equip Two New Production Bores" but this report recommends a change to "Roe Creek Borefield - Rehabilitate Five Production Bores". This change will ensure peak projected water demands for Alice Springs will be met for the next five to six years. If these works do not proceed peak water demands will not be met after early 1993. The necessity for the works is clearly shown graphically and justified economically.
CONTENTS

1. INTRODUCTION
2. BACKGROUND
3. ORIGINAL PROPOSAL
4. PRESENT PROPOSAL
5. JUSTIFICATION
6. TIMETABLE FOR WORKS
7. RECOMMENDATION

ATTACHMENT "A"
ATTACHMENT "B"
APPENDIX "A"
1. INTRODUCTION

Since the early eighties there has been major expansion of the Roe Creek Borefield including development of new production bores, new collection reservoir and upgrading of associated rising mains. These works were justified on the grounds of increased demand.

Twenty six bores have been used as production bores since the borefield was first developed in 1964. Of these bores only bores P8, P9 and P11 to P26 are currently used (18 total), other bores have been decommissioned for various reasons.

Bores P1 to P21 & P24 and P25 draw water from the Mereenie Sandstone. Bores P22 and P23 draw from the base of the Pacoota Sandstone Formation. Bore P26 draws from the Shannon Formation.

The Mereenie Sandstone is the highest yielding, most hydraulically efficient aquifer identified in the Alice Springs area. The Pacoota and Shannon Formations are not as hydraulically efficient but have been developed to supplement the Mereenie resource. It is proposed to utilise the production bores outside the Mereenie Sandstone as much as possible to reduce the extraction rates from the main aquifer and thus slow the rate of decline in the standing water level.

Three production bores (P11, P12 and P13) have been rehabilitated in the last eighteen months. These bores had been decommissioned because the standing water level dropped below the bottom of the bore casing. The works involved the deepening of the bores, the installation of new casing inside the existing casing and the installation of stainless steel screens. With current draw down rates this work is expected to extend the life of these production bores by at least ten years. These works were carried out following recommendations made in a 1987 Water Resources report on rehabilitation options extracts of which are contained in Appendix "A".

2. BACKGROUND

Historically forward planning for the Alice Springs water supply has been based on an increase in peak projected demand of 6.2% per year (Refer Graph Attachment "A"). Production availability had been calculated on a peak daily demand basis with a standby capacity of 85 L/s and a 10% allowance for difference between recommended bore yield and actual pumping rate. This formula was appropriate for many years and development kept abreast of demand. In the last two to three years though, available pumping capacity has slipped below peak projected demand on many occasions because of the increasing incidence of pump failures (Refer Graph Attachment "B"). In an attempt to lessen the
likelihood of not being able to meet peak daily demands
additional pumping capacity of 25% above the projected peak
demand has now been adopted as a new planning criteria. By
February 1990 this situation will have been reached at the
Roe Creek Borefield. This minimum of 25% spare/standby
pumping capacity is considered vital considering motor-pump
failures have been as high as five per year (See Attachment
"B") and delivery period for replacement units as long as
six months. In addition this standby capacity allows
greater flexibility in pumping strategies and thus increased
ability to optimise use of time of day electricity tariff
and allows for planned maintenance of the production bores.

3. ORIGINAL PROPOSAL

This design list project was originally titled "Roe Creek
Borefield - Equip Two New Production Boxes" and was put
forward as a capital works project to equip production bores
P26 and P27. Production bore P26 has already been equipped
and P27 should be equipped by mid 1990. These works were
possible because of savings realised on the 1986/87 capital
works project "Roe Creek Borefield - Upgrade Collection,
Bulk Transmission System, Drill and Test 4 New Production
Bores - Stage 2". There were major savings on this project
because of the deletion of a fluoride dosing plant from the
proposed new water treatment plant. In light of the fact
that pump failures had increased dramatically these savings
were channelled into production bore development with the
result that P26 and P27 will be equipped and rehabilitation
works on P11, P12 and P13 were able to be carried out. This
advancement of the planned development of the Roe Creek
Borefield has now guaranteed security of supply for Alice
Springs for the next three years.

This secure position is one that will not last without
further development of resources to meet future demands.
With the ever present threat of pump failures and
continually decreasing bore pump capacity, due to falling
standing water levels, development must continue to ensure
borefield capacity does not fall below peak projected
demands nor significantly below existing production levels.
4. **PRESENT PROPOSAL**

As production bores P26 and P27 will be equipped using existing capital works money it is now proposed to channel the $0.74 M on the 1989/90 Design List into rehabilitation works.

With an increase in funding from $0.74 M to $0.9 M rehabilitation of five production bores will be possible. These rehabilitation works will realise significant capital saving compared to the development of new production bores. A breakdown of costs is shown below:

**Alternative 1 Two New Production Bores to realise 170 L/s**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling and Development</td>
<td>$500,000</td>
</tr>
<tr>
<td>Pumps</td>
<td>$80,000</td>
</tr>
<tr>
<td>Switchboards</td>
<td>$36,000</td>
</tr>
<tr>
<td>Headworks</td>
<td>$180,000</td>
</tr>
<tr>
<td>Electric Cable</td>
<td>$20,000</td>
</tr>
<tr>
<td>Column</td>
<td>$36,000</td>
</tr>
<tr>
<td>Power Extensions</td>
<td>$50,000</td>
</tr>
<tr>
<td>Equipping</td>
<td>$20,000</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td>$922,000</td>
</tr>
<tr>
<td>Contingency 5%</td>
<td>$46,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$968,000</td>
</tr>
<tr>
<td><strong>SAY</strong></td>
<td>$1.0M</td>
</tr>
</tbody>
</table>

**Alternative 2 Rehabilitate Five Production Bores to realise 430 L/s**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling and Development</td>
<td>$400,000</td>
</tr>
<tr>
<td>Pumps</td>
<td>$200,000</td>
</tr>
<tr>
<td>Modify headworks</td>
<td>$100,000</td>
</tr>
<tr>
<td>Switchboards (Four only required)</td>
<td>$72,000</td>
</tr>
<tr>
<td>Electric Cable</td>
<td>$40,000</td>
</tr>
<tr>
<td>Some New Column</td>
<td>$6,000</td>
</tr>
<tr>
<td>Equipping</td>
<td>$40,000</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>$858,000</td>
</tr>
<tr>
<td>Contingency 5%</td>
<td>$42,200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$900,200</td>
</tr>
<tr>
<td><strong>SAY</strong></td>
<td>$0.9M</td>
</tr>
</tbody>
</table>
Although initial capital costs are practically the same the end results are not. Two new production bores would only realise 170 L/s increase in borefield production capacity whereas rehabilitation of five production bores would realise an increase in borefield production capacity of 430 L/s. To gain an increase in borefield production capacity of 430 L/s through the development of new bores would cost at least $2.5M.

Water Resources see no advantage in the development of new production bores in the Mereenie Sandstone in an area such as the Roe Creek Borefield. New bores will simply have a detrimental effect on pumping capacities of existing bores because of the overlap of the bores zones of influence.

5. JUSTIFICATION

Current borefield pumping capacity is 806 L/s which will be further increased by 90 L/s in February when P12 and P26 are brought on line. The peak projected daily demand for 1989/90 is 695 L/s (55 ML/d for 22 hours pumping). On 30 January 1990 water consumption for Alice Springs was 54.4 ML. The 896 L/s represents a standby capacity of 201 L/s or approximately 29%. As stated above the new planning criteria for the Roe Creek Borefield is to try and have at least 25% standby pumping capacity and this criteria will be met when P12 and P26 are brought into production in February.

In order to maintain this situation production bore P27 will be brought on-line by mid 1990 at a production level of 25 L/s. This extra 25 L/s will overcome the drop in pumping capacity (approximately 13.5 L/s) associated with decreasing standing water levels. This drop in pumping capacity will be continuous and may increase whilst extraction rates from the borefield remain high.

Increases in peak projected demand have previously been calculated at 6.2% per year but population growth and thus projected peak water demand, have slowed resulting in an average growth in demand over the last seven years of 4.2%. This figure has now been adopted for projecting increases in peak demand as shown on the graph Attachment "B". Population increase over the last seven years has averaged 3.5% which is not in line with the increase in water demand and is not readily explained. A possible explanation maybe the increase in 'permanent' population and the decrease in the 'floating' population. People setting up home tend to take more pride in their gardens and thus use more water. The latest draft population projections from the Department of Lands and Housing indicate that population growth will be maintained above the 3% level until 1995.
The minimum 25% standby capacity level is also plotted on this graph. This 25% standby capacity is only slightly above the allowances used for previous projected peak demands as shown on Attachment "A". The significant point to note on this graph is the dramatic loss in pumping capacity at the start of 1989 when five motor-pump units failed and how it took nearly twelve months to bring capacity back to previous levels.

The works proposed under this project would start with decommissioning of P14 and P16 in early 1991 and continue on into mid 1993 when the last of the rehabilitated bores would be brought back into production. During this period the 25% standby capacity is not maintained and close monitoring of the borefield pump capacity would need to occur to ensure peak demands can be met.

The 'dashed' line represents borefield pumping capacity should rehabilitation works not proceed. Production bores P8 and P9 are to be decommissioned at the start of 1992 as standing water levels will have dropped to the bottom of the casings by then. Rehabilitation of these bores is not economical because of their low production capacities. P15 and P24 would need to be decommissioned in mid 1992 followed by P14 and P16 in early 1994. If rehabilitation of these bores does not occur production from the Roe Creek Borefield will be as low as 600 L/s by the end of 1994. This pumping capacity would mean the imposition of water restrictions could not be avoided. Bore construction details and draw down curves are contained in Appendix "A".

The dotted line represents the current pumping rate from the Temple Bar Pump Station, at the Roe Creek Borefield, that is used to optimise the time of day electricity tariff. Ideally bore pumping capacity should not fall significantly below this level as it is one of the objectives of the Authority's Corporate Plan to optimise use of the time of day electricity tariff.

6. TIMETABLE FOR WORKS

The timetable for works as shown on Attachment "B" is notional only, but does represent a realistic time scale. The governing factor in scheduling the works is the availability of Water Resources drilling rigs to carry out the initial rehabilitation works. It will take approximately six months from the initial notice that works can proceed till Water Resources could produce a report on the characteristics of a rehabilitated bore. Two or three bores could be rehabilitated at the one time. Ordering of pumps could not start until these reports are produced and it would be approximately eight months before the pumps would be available for equipping.
A preliminary timetable and cash flow are shown below:

1990/91  
February - Decommission production bores P14 & P16  
- Start rehabilitation works on P14, P16 & P17 $240,000

1991/92  
July/August - Order pumps for P14, P16 & P17  
- Order switchboards, cable and column  
- Design modification to headworks

November - Switchboards, cable, column and pumps delivered $238,000

November/January - Modify headworks and equip P16 and P17 $56,000.

1992/93  
July - Decommission P15 and P24 and start rehabilitation works $160,000.

September - Modify headworks and equip P14 $28,000

November - Order pumps for P15 and P24  
- Design modifications to headworks

February/June - Pumps delivered, headworks modified and P15 and P24 equipped $136,000

7. RECOMMENDATION

It is recommended that the 1989/90 Design List Item "Roe Creek Borefield - Equip Two New Production Bores" be substituted by the proposed project "Roe Creek Borefield - Rehabilitate Five Production Bores" and that funding be increased from $0.74 M to $0.9 M to ensure peak water demands are met in Alice Springs till the year 1995.

NOTE: Estimates are in January 1990 terms and escalation would need to be taken into consideration especially as the project extends over three financial years.
ALICE SPRINGS ROE CREEK BOREFIELD
CAPACITY VS DEMAND

Peak projected demand 62% of recommended bore yield and actual pumping rate

10% Allowance for difference between recommended bore yield and actual pumping rate

Old bore decommissioned
85 L/s
Standby

P23 Equipped

P24, P25 Equipped

P26, P27 Equipped

P28 Equipped

ATTACHMENT A
OPTIMUM PUMPING FROM TEMPLE BAR PUMP STATION FOR USE OF TIME OF DAY ELECTRICITY TARIFF.

25% STANDBY

PEAK PROJECTED DEMAND 4.2% PER YEAR

PUMPING CAPACITY SHOULD REHABILITATION WORKS NOT PROCEED

PUMPING CAPACITY LOSS OF 3% PER YEAR ASSOCIATED WITH FALLING STANDING WATER LEVELS

ALICE SPRINGS ROE CREEK BOREFIELD
CAPACITY vs DEMAND
APPENDIX "A"

EXTRACTS FROM 1987 WATER RESOURCES REPORT ON REHABILITATION OPTIONS AT ROE CREEK BOREFIELD
CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

1. INTRODUCTION

2. HYDROGEOLOGY

   2.1 Geology of the Borefield
   2.2 Meeranie Sandstone Aquifer

3. REHABILITATION OPTIONS

   3.1 Pump and Column Selection
   3.2 Production Bores: 6519 (P7), 6520 (P8), 10501 (P13), 10500 (P12), 10499 (P11)
      3.2.1 Bore RN 6519 (P7)
      3.2.2 Bore RN 6520 (P8)
      3.2.3 Bore RN 10501 (P13)
      3.2.4 Bore RN 10500 (P12)
      3.2.5 Bore RN 10499 (P11)
   3.3 Production Bores: P14 - P21, 14864 (P24), 14867 (P25)
      3.3.1 Bores P14 - P17
      3.3.2 Bores P18 - P20
      3.3.3 Bore 13407 (P21)
      3.3.5 Bore 14867 (P25)
   3.4 Production Bores: 3738 (P1), 6985 (P1A), P2-P6, 7033 (P9)
   3.5 Production Bore: 6986 (P10)

4. RECOMMENDATIONS

5. REFERENCES

APPENDIX A
1. INTRODUCTION

This report identifies rehabilitation options for the existing production bores in the Row Creek borefield which provides the water supply for Alice Springs. This report is the third in a series of reports which will be produced covering aspects of the Alice Springs Water Supply Augmentation Study. Bores will be identified either by their Registered Number (RN) or their local borefield production number (P10).

Twenty four bores have been used as production bores since the borefield was first developed in 1964. Of these bores, only bores P14 to P23 are currently used. Bores P1 (including 1a) to P13 have been decommissioned for various reasons.

Bores P1 to P21 draw water from the Mereenie Sandstone Formation. Bores 13409 (P22) and 13408 (P23) draw water from the base of the Pacoota Sandstone Formation.

The job brief specifically identified a work programme to determine the status of existing production bores 6519 (P7), 6520 (P8), 10499 (P11), 10500 (P12), 10501 (P13) and rehabilitate where feasible.

During the course of this study an option to increase the yields from bores P15 - P21 was identified. This would allow shorter duration, higher rate pumping regimes from the existing production bores to meet increasing peak day demands. Options for checking the feasibility of these rates, the cost of rehabilitation and the life expectancy of the bores under these shorter duration pumping regimes are identified.

Rehabilitation options for production bores 6986 (P10) and 11361 (P14) are also detailed.

The job brief allowed funding for carrying out rehabilitation for bores 6519 (P7), 6520 (P8), 10499 (P11), 10500 (P12), and 10501 (P13). Conducting feasibility tests on the other bores where rehabilitation options have been developed will require further funding.

Rehabilitation options for production bores P23 and P24 in the Pacoota Formation have not been investigated in this report.
2. HYDROGEOLOGY

2.1 Geology of the Borefield

The current borefield shown in Figure 1 has been developed since 1964 in the Mereenie Sandstone Formation, P1 to P21, and from the base of the Pacoota Sandstone Formation, bores P22 and P23. Within the Mereenie Sandstone Formation is the highest yielding most hydraulically efficient aquifer identified in the Alice Springs area. The long-term potential extractable resource from the Pacoota Sandstone has still to be determined but it is not as hydraulically efficient as the Mereenie Sandstone thus indicating a lower economically extractable resource.

A forthcoming report on the regional hydrogeology of the Mereenie Sandstone in the Roe Creek borefield area based on work by Ferguson (1986), Prowse (1987), Woolley (1966), literature review and drilling in 1986/87 will discuss the geology of the aquifer formations in detail. For the purpose of this report the following geological description will suffice.

The Mereenie Sandstone has been divided into two units. The lower unit M1 as observed by Ferguson (1986) is characteristically represented in strata samples as a clean colourless, medium grained quartz sand with no obvious cementing medium and no preservation of chips. This lack of cementing has caused significant flowing sand problems in bores which have attempted to extract water from this unit. This problem and the accompanying drilling difficulties it causes has meant that the current producing production bores have been constructed in the upper unit MII. The only exception to this is possibly RN:13407 (P21).

The upper unit as observed by Ferguson (1986) is harder and more competent than the lower unit. Grain size varies from very fine to medium with occasional thin siltstone bands. The quartz grains are more commonly frosted than the lower unit. The usual cementing matrix is kaolin and some ferruginous material with the content varying greatly. Drilling, geologic and geophysical caliper logs show that major increases in water flow in this unit are associated with fracturing or heavily jointed zones.

The Mereenie Sandstone is overlain by the younger Hermannsberg Sandstone which has very low groundwater potential and is underlain by the older Pacoota Sandstone Formation.
The Pacoota Sandstone formation has been divided into four units by the oil well industry and into four slightly different units by Ferguson (1986), when looking at the formation in the Roe Creek borefield. The existence of these four units along strike of the formation is however uncertain. From the limited borehole data available in the borefield area lateral variations appear to exist. The groundwater resource in this formation was postulated by Ferguson (1986) to be found in the two lower, mainly sandstone units. The third unit is predominately siltstone and is thought to behave as an aquiclude between the upper and lower units.

The Mereenie and Pacoota Sandstone Formations dip southward at approximately 30° at the western side of the current borefield decreasing to 25° at the eastern end. The formations strike approximately east-west with the eastern end, south of the Alice Springs airport, trending towards the south-east.

2.2 Mereenie Sandstone Aquifer

West of Roe Creek production bores 11361 (P14), 11334 (P15), 11168 (P16), 11182 (P17), 6519 (P7), 6520 (P8) were constructed with 387.4 mm ID casing set at 150 m depth below ground level. Below 150 m to total depth the bores are uncased. The total depth in these bores ranges from 183 m to 232 m. Bore 12309 (P18), 12310 (P19) and 12312 (P20), are cased to around 170 m with open hole to 230 m in P18, P19 and 249 m in P20.

The majority of these bores were drilled by contract. There is little lithologic data or geophysical log data on the bores. Interpretation of the available data from these bores indicate that the bulk of fracturing and hence water yields are between 150 m and 200 m. It is uncertain whether significant water yields will be available between 200 m and the MIII/MII contact. Bore 14862 drilled as the investigation hole for the first production bore drilled in 1987, 14864 (P24), gave pumping drawdowns of 0.06 m at 17 L/s with casing set at 180 m and a total depth of 285 m. With the casing set at 200 m the drawdown at 17 L/s was 0.9 m. This indicates that yields of 150 L/s can be obtained efficiently from the major fractured zone below 150 m. This is consistent for production bores P15 to P20. Below 200 m yields in excess of 85 L/s would not be as viable as the pump drawdown would be in excess of 12 m. Pump testing of RN 14436 (X1) approximately 70 m down dip of RN 11168 (P16) and 480 m east along strike of RN 14964 with casing to 150 m and 11 m of MII exposed had 3.2 m pump drawdown at 17 L/s or approximately 11.5 m at 50 L/s.
The caliper log of 14436 also shows the major zone of fracturing is between 150 m and 200 m. The pump drawdown in RN 11168 (P16) was 2.5 m at 85 L/s. This shows variations in water yields that:

1. West of Roe Creek the largest water yields are struck in fracturing down to 200 m below ground level. Pump drawdowns at 85 L/s are less than 5 m.

2. The fracturing and hence higher yields do not extend down dip of the formation but are found at the same topographic interval.

3. Yields from the interval in the MII unit between 200 m and the Mi/MII contact will be less due to significantly higher pumping drawdowns.

The increasing annual extraction from the Roe Creek borefield has reduced the potentiometric water level in the vicinity of the borefield from 451.8 m AHD (96 m below ground level) when pumping commenced in 1964 to a current minimum level of 417.8 m AHD (132 m below ground level). The current annual rate of decline is approximately 2.5 m. Continuing increasing annual extraction will maintain a regional decline in the potentiometric water level and it is this decline which is the prime determinant of the life of the existing production bores as they are currently constructed. Bores 10499 (P11), 10500 (P12) and 10501 (P13) have been decommissioned as the water level has dropped below the bottom of the casing in these boreholes.
3. REHABILITATION OPTIONS

3.1 Pump and Column Selection

Operations Group do not have a guideline for the maximum permissible pump column head losses to dictate increases in column diameter with head loss. Bores 12312 (P20) and 13407 (P21) are pumped at 85 L/s through 203 mm nominal diameter column. This would give a head loss of approximately 5.5 m/100 m at 2.7 m/s. In the absence of other guidelines this study adopts this value as an upper bound for column head losses. Thus 152 mm nominal diameter casing would be suitable for yields up to 42 L/s.

The selection of a submersible pump of 2900 RPM is dictated by the maximum power rating possible for the size of the pump. Information provided by pump manufacturers indicate the following ranges in Table 3.1.

<table>
<thead>
<tr>
<th>Pump Suitable for Casing ID diameter mm</th>
<th>Head Range m</th>
<th>Maximum Power Rating KW</th>
<th>Maximum Discharge (approx) L/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>206</td>
<td>160-180</td>
<td>75</td>
<td>30-25</td>
</tr>
<tr>
<td>254</td>
<td>160-180</td>
<td>150</td>
<td>58</td>
</tr>
<tr>
<td>270</td>
<td>160-180</td>
<td>254</td>
<td>97-80</td>
</tr>
<tr>
<td>335</td>
<td>160-180</td>
<td>321</td>
<td>120</td>
</tr>
</tbody>
</table>

Pump drawdown curves for the current production bores are shown in Appendix A superimposed with annual regional drawdowns across the borefield of 2 m and 3 m. For the historic rate of decline of 2.5 m/year interpolate between the two curves at the respective pump rates.
3.2 Production Bores: 6519 (P7), 6520 (P8), 10501 (P13), 10500 (P12), 10499 (P11)

Bores 6519 (P7) and 6520 (P8) lie west of Roe Creek and are constructed in the Mereenie II unit. Bores 10499 (P11), 10500 (P12), 10501 (P13) are interpreted by Ferguson (1986) to have been constructed in the Mereenie I unit and remain stable. Bore 10501 (P13) down dip of 10499 (P11) and 10500 (P12) struck flowing sand between 206 m and 215.5 m where the hole was stopped. Bore 10499 (P11) however was drilled deeper stratigraphically to 235 m which is also further into the Mereenie I unit without encountering the unstable sequence. 10499 (P11) intersected approximately 160 m of the Mereenie I unit, 10500 (P12) 145 m, 10501 (P13) 120 m, and 13407 (P21) 80 m.

Based on the original test pump results 10499 (P11) was the most hydraulically efficient with a drawdown of 5 m at 85 L/s, 10501 (P13) a drawdown of 6 m, 10500 (P12) a drawdown of 11 m and 13407 (P21) a drawdown of 10 m.

Bore 4969 (P5) was drilled by a percussion drilling rig through the Mereenie I unit into the underlying Pacoota Sandstone. Perforated casing was set from 122-135 m, and 184-263 m. The lower perforations are set mainly against the Pacoota Sandstone with the upper perforations against the Mereenie I unit. Test pumping of bore 14863 approximately 100 m along strike of 4969 with casing to 200 m indicates the majority of the yield in 4969 is coming from the Mereenie I unit. Bore 14863 forked at 14 L/s. Bore 4969 was capable of yielding 50 L/s with a pump drawdown of 7.5 m of which 95 percent was well loss due to the perforated casing.

3.2.1 Bore RN 6519 (P7)

Detailed data on this bore is collated in Appendix A.7. The bore was drilled to 182.9 m with 310 mm ID casing to 152.4 m. The total depth of this bore of 182.9 m may be up to 45 m above the Mereenie II/Mereenie I unit contact. The caliper log indicates fracturing between 151-153 m and 173-177 m.

When constructed and test pumped in 1969 the standing water level was 97.6 m. The test pump results indicated the bore was capable of yielding up to 80 L/s with a pump drawdown of less than 10 m, 90 L/s with a pump drawdown of 20 m. The recommended continuous pumping rate, however, was restricted to 30 L/s due to concerns specified by Roberts (1974) that uphole velocities in excess of 0.75 m/s were likely to cause erosion of the uncased bore hole and hence sanding problems.
At the recommended pump rate and open hole diameter of 279.4 mm the uphole velocity is 0.5 m/s. RN 6519 has been pumped at around 44 L/s during 1985/86 which is an uphole velocity of 0.73 m/s.

The standing water level is currently around 129 m. The pump is currently set at 137 m. At the current pump rate of 44 L/s the pump drawdown is 5 m, leaving at the most 2 m submergence over the pump intake. The bore pump intake should be reset to 150 m this year.

Bores 12310 (P19) and 12312 (P20) down dip and either side of 6519 (P7) gave drawdowns of 5 m at 85 L/s. Both these bores intersected more of the Mereenie II unit than 6519.

The options for the future operation of this bore are:

(a) Continue pumping this bore at 44 L/s. At the current regional decline in the potentiometric water level of 2.5 m per year in this part of the borefield, the bore will operate until mid 1992 when the pumping water level will have declined to two metres above the pump intake. The bore would then be decommissioned.

(b) Increase the pump rate to 60 L/s. At the current rate of decline of the potentiometric water level of 2.5 per year the bore would be operable until mid 1991. This option depends on the borehole being stable at higher pump rates. As the other bores west of Roe Creek constructed since this bore have not exhibited sanding problems, it is reasonable to assume that this bore would not have this problem either. Test pumping however, would be required to confirm this.

(c) Rehabilitate bore hole in attempt to:
   (i) lower depth of casing in bore to extend its operational life,
   (ii) reduce pump drawdown to allow more efficient pumping.

This option involves deepening the total depth of the borehole. However a pump is currently lodged in the bottom of the hole due to a reported failure when the pump was being run. Water Resources drilling plant was used to recover the pump but was unsuccessful.
The existing 310 mm ID casing dictates that 254 mm ID/273.1 mm OD casing will have to be run below the 310 mm ID casing for lower pump settings. A 254 mm nominal bore submersible pump suitable for a 160-180 m head range with 200 mm nominal diameter pump column would yield approximately 58 L/s in this diameter bore casing.

The following testing procedure would be required.

(i) Pull out borehole pump and recover pump from bottom of borehole.
(ii) Run 219 mm OD Steel Casing to 182.9 m.
(iii) Drill a 200 mm hole to around 250 m where the Merensie I/II contact is postulated to be.
(iv) Geophysically log borehole as per (ii) to determine degree of fracturing.
(v) Test pump borehole as 219 mm casing will have sealed off most of water intersected in fractures between 151-153 m and 173-177 m identified by previous logging.
(vi) If test pump results (vi) are favourable insert a pneumatic packer at around 200 m or where dictated by fracturing sequence identified by the caliper log.
(vii) Test pump the section of borehole between 182.9 m and 200 m. Test pump results of (vi) and (vii) will determine where bottom of casing can be set.
(ix) Ream 200 mm diameter hole out to approximately 310 mm down to target depth and run 273.1 mm OD/254 mm ID casing. If test pumping indicates no sanding problems run 219 mm OD casing and screens against aquifer.

RECOMMENDATION

(1) Use drilling rig in attempt to recover pump from bottom of borehole. Allow a maximum of 12 days for recovery of pump. If successful proceed with option (c).

(2) If above unsuccessful pursue option (b) and/or,

(3) Replace 6519 (P7) with a new bore constructed between 12310 (P19) and 12312 (P20) down dip of 6519 (P7) with expectations of achieving similar hydraulic characteristics as 12310 and 12312. That is for casing set to approximately 180 m pump rates up to 120 L/s with lower yield (85 L/s) or higher heads for casing set to 200 m.
3.2.3 Bore RN 10501 (F13)

As discussed in Section 3.1 this bore is interpreted to have been constructed in the Mereenie I unit. The bore was drilled 215.5 m with 387 mm ID casing to 121.4 m. The bore hole was backfilled with cement to 206.7 m due to the intersection of flowing sand below 207 m. As discussed in Section 3.1 this is typical of this unit.

The standing water level (potentiometric level) has now dropped below the bottom of the casing to approximately 128 m and the bore has been decommissioned. (See Appendix A.13).

Caliper logging indicates fracturing between 142-162 m. Circulation problems when drilling were encountered between 150-176 m and 180-197 m. Due to the circulation problems encountered below 180 m the following recommendations are made to assess the feasibility of rehabilitating this bore.

(i) Rerun geophysical gamma and caliper logs.

(ii) Test pump bore to determine its current hydraulic performance and compare with original results.

(iii) Run 355.6 mm OD/335 mm ID casing to 180 m where diameter of bore hole reduces to 311 mm. Test pump bore to determine hydraulic performance.

(iv) If favourable construct bore with 254 mm ID or 206.4 mm ID casing and screens.

(v) If unfavourable, say yield less than 40 L/s at 10 m head loss, attempt to deepen hole to top of Pacoota formation at approximately 290 m.

Attempt to drill a 251 mm diameter bore hole through the unconsolidated interval below 215.5 m until firm sandstone is struck. Run 219 mm OD casing and spot a temporary gypseal plug at the bottom of the 219 mm OD casing to case off the unconsolidated interval.

(vi) Drill a 200 mm diameter hole to the top of the Pacoota Formation.

(vii) Run geophysical gamma and caliper logs.

(viii) Test pump bore to determine hydraulic performance. If favourable undertake step (xiii).

(xiii)...
(ix) If unfavourable pull 355.6 mm OD/335 mm ID casing back to around 160 m and suspend in hole.

(x) Test pump bore. If favourable run 219 mm OD or 273 mm OD casing and screens depending on yield.

(xi) Test pump bore to determine its completed hydraulic performance.

(xii) If (x) unfavourable recover casing in bore and decommission.

(xiii) If step (viii) is favourable recover 219 mm OD and 355.6 mm OD casing strings from borehole.

(xiv) Ream 251 mm diameter hole to 311 mm diameter and run 273 mm OD/254 mm ID below unconsolidated interval and pack back to 406.4 mm OD/387.4 mm ID casing.

(xv) Spot a cement plug at the bottom of the 273 mm OD casing after back filling 200 mm diameter hole if necessary.

(xvi) Clean out and ream 200 mm diameter hole to 251 mm diameter and run 219 mm OD/206 mm ID casing and screens packed back to 254 mm ID casing.

(xvii) Test pump bore to determine completed bore’s hydraulic performance.

RECOMMENDATION

(1) Implement steps (1) to (iv).

(2) Before steps (v) onward are implemented, further testing of investigation bore hole RN 14863 which was drilled through the bottom section of the Mereenie I unit and the core drilling results should be assessed. These will help to determine whether reasonable yields from the Mereenie I unit will be obtainable and the feasibility of drilling and constructing boreholes through the unconsolidated interval in the Mereenie I unit.
3.2.4 Bore RN 10500 (P12)

This bore was drilled to 193.5 m with 406.4 mm OD/387.4 mm ID casing to 121.9 m. The bore was recommended for 70 L/s. The standing water level (potentiometric level) has now dropped below the bottom of the casing to approximately 126 m and the bore has been decommissioned. (See Appendix A.12).

Fracturing, indicated by caliper log, was struck from 128-135.5 m, 143-152.5 m, 164-166 m and 172-175.5 m. As discussed in section 3.2 for bore 4569 (P5) the majority of the water in 10500 (P12) may also be coming from the interval 128-135.5 m. The decline in the regional water level will dewater this interval or it would be cased off as casing is run below 128 when attempting to rehabilitate the bore.

The following recommendations are made to assess the feasibility of rehabilitating this bore.

(i) Run geophysical gamma and caliper logs and check total depth of bore.

(ii) Clean out bore to total depth. Bore has backfilled by 8.5 m.

(iii) Test pump bore to determine its current hydraulic performance. Note whether sand is passed in the discharge. Persistent sand in the discharge would indicate the bottom of the borehole is unstable possibly having struck the unconsolidated interval in the Merenie I unit.

(iv) Run 355.6 mm OD/335 mm ID casing to 172.5 m.

(v) Test pump bore hole to determine whether bore yield is sufficient to warrant leaving hole at total depth of 193.5 m and construct with 273 mm OD/254 mm ID casing and screens, or consider deepening the bore hole to the Merenie I/Pacoosta Sandstone contact postulated to be at 240 m.

(vi) If the borehole is deepened, follow the procedure suggested for 10501 (P13).

(vii) If unsuccessful pull 355.6 mm OD/335 mm ID casing back to 163 m.
(viii) Test pump bore and if favourable construct hole with 273 mm OD/254 mm ID casing and screens packed back to 355.6 mm OD casing.

(ix) Test pump bore to determine its completed hydraulic performance.

RECOMMENDATION

(1) Implement steps (i) to (v).

(2) Implement step (vi) if the results from deepening 10501 (P13) warrant a similar attempt on 10500 (P12).
3.2.5 Bore RN10499 (P11)

As noted for 10500 (P12) and 10501 (P13) this bore is interpreted to have been constructed in the Mereenie I unit. The Mereenie I/Mereenie II unit contact was interpreted by Ferguson (1986) to be around 80 m. The bore was drilled to 235 m with 406.4 mm OD/387.4 mm ID casing to 120.7 m. The potentiometric level in the bore is approximately 128 m. The bore is still operational with the pump set below the bottom of the casing.

Caliper logging indicates fracturing between 152-156 m and 160-202 m with complete loss of circulation at 235m.

The following recommendations are made to assess the feasibility of rehabilitating this bore.

(i) Run geophysical gamma and caliper logs and check total depth of bore.

(ii) Test pump bore to determine its current hydraulic performance and compare with original results. The first water yield was reportedly struck at 122 m in this hole which is now dewatered with the drop in potentiometric level.

Note any ingress of sand during testing.

(iii) Run 355.6 mm OD/335 mm ID casing to 179.8 m where the diameter of the hole reduces from 381 mm to 311 mm.

(iv) Test pump bore to determine whether bore yield is sufficient to warrant leaving the hole at total depth of 235 m and construct with 273 m OD/254 mm ID casing and screens, or consider deepening the borehole to the Mereenie I/Paccoota Sandstone contact postulated to be at 280 m.

Follow procedure as suggest for 10500 (P12) steps (vi) to (viii).

RECOMMENDATIONS

(1) Implement steps (i) to (iv).

(2) Implement step (v) depending on results from 10501 (P13) and 10500 (P12).
3.3 Production Bores P14-P21 14864 (P24) 14867 (P25)

3.3.1 P14-P17

Bores 11361 (P14), 11334 (P15), 11168 (P16), 11182 (P17) have 406.4 mm OD/387.4 mm ID casing to around 150 m with 381 mm diameter open hole below the casing to total depth. (See Appendix A). At continuous pumping rates of up to 120 L/s the pump drawdown (head loss) for these bores is predicted to be less than or equal to 5 m. The drawdown curves for each bore are shown in Appendix A. At continuous pumping rates of 85 L/s coupled with an annual regional drawdown of the potentiometric level of 2.5 m gives P15, P16, P17 a life expectancy of around 5 years from 1987. At higher intermittent pumping rates of 120 L/s for 8 hours per day the life expectancy reduces to around four years when the water level would force pump settings below the bottom of the casing. 11361 (P14) has poorer hydraulic efficiency than the other bores as detailed below.

Bore 11361 (P14)

Ferguson (1986) and investigation drilling in 1986/87 indicates 11361 was constructed in the Mereenie II Unit with the bottom of the borehole within 10-20 m of the Mereenie I/Mereenie II unit contact. As shown in Table 3.3 the bore at its current production rate of 55 L/s will need to be decommissioned around the end of 1987 due to its hydraulic characteristics. At 60 L/s it has a pump drawdown of 15 m which is equivalent to the current maximum available drawdown with the pump set below the bottom of the casing.

Geophysical caliper logs indicate fracturing was encountered between 151-153 m and 200-228 m. Casing run below 150 m will likely reduce the efficiency of the bore at its current total depth. The borehole could be deepened into the Mereenie I unit if the results from the core drilling and the rehabilitation of 10500 (P12), 10501 (P13) and 10499 (P11) indicate such an attempt is warranted.

The following recommendations are made to assess the feasibility of rehabilitating this bore.

(i) Run geophysical gamma and caliper logs.

(ii) Run 355.6 mm OD/334 mm ID casing to at least 180 m. This will depend on the 381 mm diameter open hole being straight due to the small tolerance available between the borehole and the casing. The casing will have to be suspended in the
-17-

borehole from the surface. Alternatively run 273 mm OD/254 mm ID casing but this would restrict the maximum yield from the borehole to around 58 L/s.

(iii) Test pump the borehole to determine its hydraulic performance.

(iv) Deepen the borehole as far as possible dependant on the competency of Mereenie I unit.

(v) Test pump the borehole.
If unfavourable retrieve the 355.6 mm OD or 273 mm OD casing.
If favourable run 219 mm OD/206.4 mm ID casing and screens.

(vi) Test pump the bore up to 60 L/s to determine its completed hydraulic performance and borehole stability.

(vii) This work should be programmed for the beginning of the 1988/89 financial year at an estimated cost of $95,000 including salaries and plant.

Bores 11334 (P15), 11168 (P16), 11182 (P17)

These bores have been drilled to similar depths as 11361 (P14) in respect to the postulated depth of the Mereenie I/Mereenie II contact at each of the bores.

The options for the future operation of these bores are:

(a) If the current pumping rates are to be maintained over the next five years then the pumps in bores 11334 (P15) and 11182 (P17) should be lowered to 148 m and 147 m respectively in mid 1989.

(b) If Operations Group wish to operate these bores at rates in excess of 85 L/s over the next four to five years, and it is recommended that they be pumped at such rates to reduce the number of future 85 L/s bores being planned to meet peak day demand, the following recommendations are made to assess the feasibility of pumping at higher rates and reline the boreholes.

(i) Test pump 11182 (P17) to confirm bore hydraulics at these higher rates and borehole stability.

(ii) If results from step (i) are favourable rerun geophysical gamma and caliper logs on the three bores.

(iii) Run 273 mm OD/254 mm ID casing and screens against the aquifer below 150 m and pack back to the 406.4 mm OD/387.4 mm ID casing.
(iv) The estimated cost of the above work for each bore including salaries and plant is $49,000 thus a total cost of $147,000.

This includes the use of an Operation’s Group submersible pump capable of pumping up to 120 L/s for final pump testing of the relined boreholes. The pump can then be equipped in one of the production bores.

(c) The same recommendations and similar cost per bore as 11361 (P14) are recommended to extend the operational life of these bores once the potentiometric water level drops to around 150 m.

RECOMMENDATIONS

(i) It is recommended that option (b) be adopted at this stage.
3.3.2 Bores P18-P20

Bores 12309 (P18), 12310 (P19), 12312 (P20) have 406.4 mm ID/387.4 mm ID casing to around 167 m with 381 mm diameter open hole below the casing to total depth. (See appendix A). At pumping rates of 120 L/s the pump drawdown (head loss) for these bores is predicted to be 15 m for 12309 (P18) and 7-8 m for 12310 (P19) and 12312 (P20). This suggests the lower casing setting has sealed off some of the water compared to P15-P17 resulting in higher head losses at comparable pumping rates.

At pumping rates of 120 L/s, these bores should have life expectencies of around 10 years.

RECOMMENDATIONS

(i) It is recommended that the feasibility of pumping these bores at higher rates be investigated and that if feasible they be operated at such rates.

(ii) The recommended steps to determine this feasibility are as stated in Section 3.3.1 for bores P15, P16, P17 with the 406.4 mm OD casing set at the current levels.

(iii) The estimated cost for each bore including salaries and plant is $49,000 thus a total cost of $147,000.
3.3.5 Bore 14867 (P25)

This bore was drilled to 205.8 m with 406.4 mm OD/387.4 mm ID casing to 164.1 m with 254 mm ID casing and screens from 162.8 m to total depth. The bore was constructed in the Mereenie II unit. The bore is capable of yields up to 80 L/s with acceptable pump drawdowns.

At 80 L/s with an annual decline in the potentiometric water level of 2.5 m the bore has an operational life of approximately 5 years.

Geophysical caliper logging showed readily detectable fracturing over the screened intervals between 164 m and 206 m. In the investigation pilot hole below 206 m to 283 m the caliper logging indicated only isolated, narrow bands of fracturing which have not yet been tested for potential yield.

Once the water level drops to 158 m below ground level the bore should be investigated to determine its feasibility for rehabilitation with 355.6 mm OD/335 mm ID casing to 200 m and the borehole deepened to 300 m. The likely success of this course of action may be predetermined by the results from the core hole drilling and rehabilitation exercises on the other bores.

RECOMMENDATION

A decision to attempt to rehabilitate 14867, if the water level declines to 158 m below ground level, be based on the results from the other rehabilitation and investigation work in the borefield.
VERTICAL SCALE: 1:1000

PRODUCTION BORE P12
RN 10500
590.9 mm ID SURFACE CASING

387.4 mm ID BLANK CASING

38.1 mm Ø OPEN HOLE

PRODUCTION BORE P14
RN 11361

VERTICAL SCALE: 1:1000
VERTICAL SCALE: 1:1000

PRODUCTION BORE P16
RN 11168
INTERMITTENT PUMPING CURVE

- 85 L/s
- 120 L/s
- 150 L/s

Pumping for 8 hours per day.

LEGEND

b (2 metres per year regional drawdown)

c (3 metres per year regional drawdown)

DRAWDOWN AVAILABLE

to bottom of casing

SWL = 130 m.

TIME (years)

1 2 5 10 15 20

DRAWDOWN (metres)

10 15 20 25 30 35 40 45 50 55 60 65 70
a BEFORE CONSIDERING
ANNUAL REGIONAL DRAWDOWN

b (2 metres per year
regional drawdown)

c (3 metres per year
regional drawdown)

CONTINUOUS PUMPING CURVE
Fig. A17.2

**Legend**
- 85 L/s ————
- 120 L/s ————
- 150 L/s ————

**Continuous Pumping Curve**

**Drawdown Available**
- To bottom of casing SWL-130m.

**Annual Regional Drawdown**
- a — BEFORE CONSIDERING
- b — 2 metres per year regional drawdown
- c — 3 metres per year regional drawdown
Fig. A17.3
INTERMITTENT PUMPING CURVE

LEGEND

<table>
<thead>
<tr>
<th>Drawdown (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 L/s</td>
<td>Pumping for 8 hours per day.</td>
</tr>
<tr>
<td>120 L/s</td>
<td></td>
</tr>
<tr>
<td>150 L/s</td>
<td></td>
</tr>
</tbody>
</table>

DRAWDOWN AVAILABLE to bottom of casing SWL-130m.

- b (2 metres per year regional drawdown)
- c (3 metres per year regional drawdown)