REPORT ON RURAL WATER SUPPLY

Prepared by:
D. Tilakaratne
September 1984
REPORT ON RURAL WATER SUPPLY

APPENDICES

FIG.
1. Palmerston - Rural Water Supply with McMinns Pumps On
2. Palmerston - Rural Water Supply with McMinns Pumps Off
3. Pressure Observations along 300 NB main from Palmerston to Manton
4. Population Projections for Rural Area
5. Water Supply to Rural Area from possible tank on Manton Hill
6. Pumping to possible tank on Manton Hill at 1190 RPM
7. Pumping to possible tank on Manton Hill at 1400 RPM
8. Operation philosophy for possible rural water supply from a tank on Manton Hill
9. Layout showing possible tank site with gravity and rising mains at Manton

TABLE
1. Pressures at Critical Nodes when McMinns pumps are Off and On
2. Possible stages for pump use for option (iii)
REPORT ON RURAL WATER SUPPLY

INDEX

Section
1. Objectives
2. Current Arrangements
3. Field Tests
4. Options Considered
5. Future Demand
6. Initial Construction Work for Option (iii)
7. Operational Strategy using Option (iii)
8. Estimate of Capital Costs for Option (iii)
9. Comments
REPORT ON RURAL WATER SUPPLY SYSTEM

1. Objectives

As a component of the Bulk Transmission Study which is currently being undertaken, the question of rural water supply was addressed in the following manner.

(i) analysis of the current arrangements for rural water supply

(ii) carrying out field tests to determine pressures along mains

(iii) examining future options for this supply and their feasibilities

(iv) determination of possible long and short term strategies for rural water supply.

2. Current Arrangements

The current arrangements for rural water supply are based on McMinns old pump station and Palmerston elevated tank being capable of sustaining the required pressures for distribution (Figs. 1 & 2).

A computer aided analysis of this system showed that while there were adequate pressures during the periods when McMinns pumps were on, the pressures when the pumps were off, dropped as low as 11m. The attached Table 1 shows the comparison of pressure variations during different hours of a peak day for the two conditions.

3. Field Tests

In order to verify the above theoretical figures, a field test was carried out at 10.00 a.m. and pressures as low as 9m were recorded in the system. These observed results are shown in the annexed longitudinal section of the main between Palmerston and Manton (Fig. 3).

The discrepancy between the observed and theoretical figures may be due to any or all of the following:

(a) inaccuracy in available data on the number of consumers in the rural system

(b) per capita rural demands and demand patterns used in the computer model being different to those actually in this area
(c) testing instrument errors.

However, in spite of this 2m difference between theoretical and observed figures, it has become evident that **the pressure variations in the current rural water supply system are below the levels of normally accepted urban water supply standards.**

4. Options Considered

In view of the inadequacy of the present system, the following options were considered, bearing in mind the short and long term requirements of the rural water supply system.

(i) Humpty Doo tank to contribute to the rest of the rural water supply system (at present, Humpty Doo tank is restricted to catering for the requirements in Humpty Doo area by means of existing valving arrangements).

(ii) Possible location of a tank in the vicinity of Noonamah.

(iii) Possible location of a tank on Manton Hill.

**Option (i)**

The possibility of improving the pressures in the rural water supply system by opening Humpty Doo tank to the rest of the rural system was examined, and it was found that it would provide only a very limited improvement and that too would be to a relatively small portion of the system, which in any case does not experience pressure problems due to the low elevation in certain areas.

The areas known as "31 Mile" and "37 Mile" along the Stuart Highway, which are the worst affected areas, are located at high elevations, and being so remote from Humpty Doo would not experience any benefit from the tank at Humpty Doo whose top water level is only 14m above this high area.

**Option (ii)**

In view of the fact that there is a considerable draw-off near Noonamah from the rural supply system to the Power Station in Channel Island, it seems possible that it might be beneficial if some storage and elevated distribution facilities be provided in the vicinity of Noonamah.
However, the possible future development of Middle Arm New Town needs to be examined in relation to any water storage or distribution facility in this area. At present, there are no definite plans or timings for such development at Middle Arm New Town.

Having examined the area in general in relation to the existing water supply facilities, it seems clear that a separate system needs to be designed in relation to a distribution network which would incorporate the township of Middle Arm New Town and Channel Island. This however, could only be carried out at a later stage in the future when more data would be available to enable tanks and pumping stations to be located at most beneficial positions.

Option (iii)

Owing to the difficulties discussed above, it appears that Options (i) and (ii) would not be the most suitable to cater for the immediate problems in the rural water supply system.

The option (iii) is for a possible ground level tank to be located on Manton Hill to provide the necessary head for distribution in the system (Fig. 5). The possibility of the tank being supplied by the existing pumps at Manton Pump Station was also considered as a part of the exercise (Figs. 6 & 7).

Analyses were carried out to determine the benefits of this option under present and future conditions, and it appears that substantial benefits could be achieved from this option with immediate effect, as shown later in the results of analyses.

The existing chlorination facilities at Manton appear to be capable of satisfying the present requirements. With future increase in demand, it will become necessary at a later date to examine the chlorination capabilities in relation to demand.

As there are no fluoridation facilities at Manton, they will need to be provided as a part of this scheme.

This option seems to be capable of providing a solution to the immediate problem of the system at relatively low cost, using existing facilities. However, this would not be an obstacle for future implementation of other options.
5. Future Demand

As this area is very sparsely populated at the moment, with a population of only 400 (approx.) scattered along the Stuart Highway between Arnhem Highway junction and Manton River bridge, the following assumptions were made with regard to the future demand of the area.

(i) The area of development being 1 km on either side of the Stuart Highway between Arnhem Highway junction and Manton Bridge

(ii) the above area of approximately 80 sq. km being ultimately divided into 5 hectare blocks, i.e. 1600 blocks

(iii) an ultimate population of 6400 for the area based on 4 persons per block

(iv) a peak hour flow rate of 0.226 L/s per capita based on currently available data for rural demand, thus a peak rural demand of 145 L/s

(v) the present demand of 30 L/s (approx.) from the 375 NB main for the supply to Channel Island Power Station being ultimately increased to 40 L/s (the current high demand of 30 L/s being mainly due to construction work which is only short term).

Population growth rates for the area were assumed as shown in Fig. 4.

Initial Construction Work for Option (iii)

The following are the main items of initial construction work:

1. Construction of a ground level tank of capacity 6.0 ML on Manton Hill with a top water level of 115.00 (approx.).

2. Construction of a 450 NB rising main from Manton Pump Station to the tank.

3. Use of existing variable speed Kelly & Lewis pumps at Manton Pump Station with them being set at 1190 RPM (which is their lowest operable speed) for the purpose of water supply to the tank.

4. A buried liquid filled control cable to be laid between the tank and pump station for the starting and stopping of pumps.

5. Construction of a 450 NB gravity main from the tank
to be connected to the existing 300 NB and 375 NB mains along the Stuart Highway.

6. Installation of fluoridation facilities at Manton Pump Station.

7. Provision of a sealed access road to the tank along the shortest possible route.

Operation Strategy using Option (iii)

(Refer Table 2 and Fig. 8)

(a) Initial

At the start, the pumps may be set to operate at 1190 RPM which appears to be the lowest practical speed for these pumps. Initially during an average day, the operation of a single pump should be sufficient to meet the demand, while on a peak day two pumps would be needed to operate in parallel to meet the required supply rate. Initially, this mode of operation should not require more than 8 hours on a peak day. Based on currently available data on the rural population and its expected growth rates, it appears that this mode of operation should be able to meet the demand till the year 1995 (approx.), when the peak day demand is likely to be in excess of 3.0 ML/day.

(b) Future

The pump speeds could be increased to 1400 RPM at the stage when the peak day demand exceeds 3.0 ML/day. On an average day, a single pump would then be able to meet the required pumping rate. However, on a peak day, two pumps would be needed to operate in parallel in order to meet the demand.

With increasing population, the hours of pumping could be increased until the peak day demand exceeds 6.5 ML/day. At this stage, the current arrangements of supplying Channel Island power station from this system will need to be discontinued. Based on currently available data, it appears that this situation will not arise till the beginning of the next century. According to information supplied by the Department of Lands, it seems likely that the development of the town of Southport could commence around this period. In view of this, it appears logical to develop a separate strategy for the water supply to the area in the region of Channel Island and Southport beyond that point in time.
(c) **Ultimate**

Analysis of this system has shown that long before the existing pumps are unable to meet to the demand, the inadequacy of the capacity of the distribution system will dictate the ultimate condition for this system. Based on currently available data, it appears that this condition might not arise before year 2115. However, as this point in time will be so far into the future, it appears reasonable that any further predictions should be reserved to be examined in the light of future developments.

In assessing the future water supply strategy for areas south of McMinns, the following issues will require closer examination:

(i) new pipelines which may need to be built southwards from McMinns
(ii) possibility of obtaining supply directly from the 1350 NB main
(iii) water treatment facilities being carried out at Darwin River Dam.

**Estimate of Capital Costs for Option (iii)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modification and control of pumps</td>
<td>20,000</td>
</tr>
<tr>
<td>600m of rising main @ $200/m</td>
<td>120,000</td>
</tr>
<tr>
<td>750m of gravity main @ $200/m</td>
<td>150,000</td>
</tr>
<tr>
<td>6 ML concrete g.l. tank</td>
<td>300,000</td>
</tr>
<tr>
<td>Control cable</td>
<td>80,000</td>
</tr>
<tr>
<td>Fluoridation facilities</td>
<td>50,000</td>
</tr>
<tr>
<td>Access road</td>
<td>150,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$870,000</strong></td>
</tr>
</tbody>
</table>

**Comments**

The rural water supply system in its present condition appears to be in a state where existing demand cannot be met with adequate pressures. This condition is likely to become worse with progress of time due to increase in demand.

Since there is a potential for this area to serve as an agricultural and rural residential base for greater Darwin, it is likely that there could be an accelerated growth rate in the rural area, particularly along the Stuart Highway.

It therefore seems appropriate that this project be included as a new item on the Capital Works Programme as a matter or priority.
MACPAML.DAT, 31

S.W.L. = STARTING WATER LEVEL
T₁ = RURAL DEMAND TYPE
T₂ = URBAN RESIDENTIAL DEMAND TYPE
T₃ = SERVICE COMMERCIAL DEMAND TYPE
T = RESERVOIR DEMAND.

PAMERSTON - RURAL WATER SUPPLY WHEN McMINNS PUMPS ARE ON (DEMANDS AS AT AUGUST 1984)
PALMERSTON—RURAL WATER SUPPLY WHEN McMINNS PUMPS ARE OFF (DEMANDS AS AT AUGUST 1984)
POPULATION PROJECTIONS FOR RURAL AREA

1. Population growth rates as supplied by Department of Lands.

2. Assumed population which might be likely if water supply and electricity are available.

3. Likely time at which Channel Island Power STN. will need an alternative source of supply.
DEMANDS WITHOUT BRACKETS ARE FOR PRESENT CONDITIONS MANTANK.DAT: 2

DEMANDS WITH BRACKETS ARE FOR FUTURE CONDITIONS MANTANK.DAT: 3

WATER SUPPLY TO RURAL AREA FROM POSSIBLE TANK TO BE LOCATED ON MANTON HILL.
EFFICIENCY CURVE FOR 1 PUMP AT 1190 R.P.M.

EFFICIENCY CURVE FOR 2 PUMPS AT 1190 R.P.M.

74% SYSTEMS CURVE USING ONE 450 N.B. RISING MAIN

PUMPING TO POSSIBLE TANK ON MANTON HILL USING EXISTING PUMPS AT MATON PUMP STATION

Fig. 6
Fig. 7

EFFICIENCY CURVE FOR 1 PUMP AT 1400 RPM.

EFFICIENCY CURVE FOR 2 PUMPS AT 1400 RPM.

PARALLEL PUMP AT 1400 RPM.

PARALLEL PUMPS NO. 1 & 2 AT 1400 RPM.

H m

80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0

Q l/s

0
100
200
300
OPERATION PHILOSOPHY FOR POSSIBLE RURAL WATER SUPPLY FROM A RESERVOIR ON MANTON HILL.

1. PUMP SPEEDS SET AT 1190 R.P.M.
2. CHANGE PUMP SPEEDS TO 1400 R.P.M.
3. DISCONTINUE SUPPLY TO CHANNEL ISLAND FROM THIS SOURCE.
4. DISTRIBUTION SYSTEM WILL REQUIRE UPGRADING.

---

Fig. 8

PEAK DAY DEMAND (ML)

YEAR

<table>
<thead>
<tr>
<th>Time Period (Hrs)</th>
<th>Node 11</th>
<th>Node 12</th>
<th>Node 13</th>
<th>Node 16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pressure</td>
<td>Pressure</td>
<td>Pressure</td>
<td>Pressure</td>
</tr>
</tbody>
</table>
|                  | m
|                  | H
| 0                | 12.30 | 11.44 | 10.52 | 13.12 |
| 1                | 14.57 | 13.91 | 11.13 | 12.41 |
| 2                | 12.81 | 12.28 | 10.59 | 12.45 |
| 3                | 13.83 | 13.77 | 12.32 | 12.52 |
| 4                | 13.29 | 12.43 | 11.55 | 12.03 |
| 5                | 14.65 | 13.66 | 12.14 | 12.62 |
| 6                | 12.51 | 12.12 | 11.24 | 12.20 |
| 7                | 12.47 | 12.28 | 11.14 | 12.09 |
| 8                | 13.89 | 13.28 | 12.19 | 13.15 |
| 9                | 13.78 | 13.91 | 12.38 | 13.12 |
| 10               | 12.54 | 11.67 | 10.79 | 12.68 |
| 11               | 12.33 | 11.45 | 10.53 | 12.10 |
| 12               | 12.11 | 11.25 | 10.43 | 12.09 |
| 13               | 11.88 | 11.02 | 10.08 | 11.87 |
| 14               | 11.67 | 11.00 | 10.46 | 11.67 |
| 15               | 12.29 | 11.73 | 11.45 | 12.23 |
| 16               | 12.66 | 11.58 | 11.21 | 12.17 |
| 17               | 12.52 | 11.67 | 11.77 | 13.27 |
| 18               | 13.23 | 12.79 | 12.67 | 13.07 |
| 19               | 12.39 | 11.58 | 11.01 | 12.18 |
| 20               | 14.62 | 13.59 | 12.32 | 12.20 |
| 21               | 12.98 | 12.12 | 11.45 | 12.77 |
| 22               | 14.57 | 12.69 | 11.63 | 13.42 |
| 23               | 14.57 | 12.69 | 11.63 | 13.42 |
**TABLE 2**

POSSIBLE STAGES OF PUMP USE FOR OPTION (iii)

<table>
<thead>
<tr>
<th></th>
<th>TOTAL DAILY DEMAND (population 500)</th>
<th>PEAK DAY (population 500)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>AVERAGE DAY</td>
<td>1.4 ML</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>2.5 ML</td>
</tr>
<tr>
<td>E</td>
<td>PUMPING RATE</td>
<td>50 L/s</td>
</tr>
<tr>
<td>S</td>
<td>NO. OF HOURS PUMPING/DAY</td>
<td>8</td>
</tr>
<tr>
<td>E</td>
<td>PUMPS USED</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>SPEED</td>
<td>1190 RPM</td>
</tr>
<tr>
<td>T</td>
<td></td>
<td>1190 RPM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>TOTAL DAILY DEMAND (population 6000)</th>
<th>PEAK DAY (population 6000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>AVERAGE DAY</td>
<td>5.7 ML</td>
</tr>
<tr>
<td>L</td>
<td></td>
<td>10 ML</td>
</tr>
<tr>
<td>T</td>
<td>PUMPING RATE</td>
<td>80 L/s</td>
</tr>
<tr>
<td>T</td>
<td>NO. OF HOURS PUMPING/DAY</td>
<td>20</td>
</tr>
<tr>
<td>M</td>
<td>PUMPS USED</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>SPEED</td>
<td>1400 RPM</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>1400 RPM</td>
</tr>
</tbody>
</table>

*Includes a draw-off of 30 L/s for Channel Island Power Station which could increase to 40 L/s (ultimate)*