WATER AS A SCARCE RESOURCE

WATER RESEARCH FOUNDATION OF AUSTRALIA

NORTH QUEENSLAND REGIONAL COMMITTEE

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HAMILTON AQUIFER - CURRENT DEVELOPMENT
AND LONG TERM FUTURE

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A recent study of the lower reaches of the Taughton River supplies
Hamilton aquifer. The Taughton River discharges into Stradbroke Creek
in Cape Cleveland and Cape Bowling Green (Fig. 1). The focal point of
sugar producing area in the Taughton Sugar Company's Estates 1871, which
located at the township of Gira 48 km south-east of Townsville on the
Bast Railway. The Bruce Highway from Cairns to Brisbane passes near
the three kilometers.

Temperature in the area ranges from a minimum of 16°C in January to a
maximum of 33°C in July. The annual pan evaporation is 1660 mm. Eighty
percent of the mean annual rainfall of 1292 mm falls in the four monthly
months, June to September.

Apart from drier beef cattle production, sugar cane growing and rice sugar
industry are the sole industries of the Gira-Taughton River area. Sugar cane
first began in 1908 and cane was first sent to the Pioneer Mill until crushing
at Ingham Mill in 1920. Until about 30 years ago cane for Ingham Mill
was taken from parts of the Ingham district as well as from the area around
Gira. The cane from Ingham is now crushed at Victoria Mill and has been
replaced by cane which is transported some 32 km by rail from the Murrihnie
Valley areas of Millarint, Millarand and Delby. The area of 4,500 ha in
the cane is approximately half the total cane area of 9,800 ha for
Victoria Mill.

In the earliest days of sugar production, irrigation was provided by
water in surface water from the Taughton River and from Mackay's Lagoon.
In excess of rainfall and production, supplies of water were progressively
supplied from underground resources by means of pumps. Today, sugar cane
irrigation in the Gira area is heavily dependent upon irrigation.
The Houghton River represents the northern part of the broad expanse of upper alluvial sediments which thicken to the east, and is currently referred to as the Nirimba Plains. The lower estuary parts of the successive deltas contain about one million cubic feet, which provide irrigation water for the cotton grown in the area, More Mill and bonhomia sediments.

In the vicinity of the Houghton River to the west however, these older river sediments are in the porous mud beds, and such groundwater can be used for agricultural purposes. The Houghton River is not only fed by the upper sediments and it in the current channel is captured by the Houghton River that constitutes the Houghton Aquifer.

Between the present ends of the Houghton, the underlying muddy sediments and the aquifers of the successive basins to the east, are based geologically on Figure 2. It should be recognized that the aquifer is restricted to present and former part channels of the river course, and is geologically and hydraulically distinct from the sands of adjacent valley.
Figure 2 shows the relationship between the Burdekin Delta aquifer system and the Haughton aquifer system.

Figure 3 shows the distribution of the Haughton Aquifer. It may be regarded as comprising two parts:

(a) The Haughton River Section consists of sands along the Haughton River itself and some abandoned channels which leave the river upstream of the North Coast Railway.

(b) The Healey's Lagoon Section is a major abandoned channel to the west of the river. The remnants of the channel still exist as a series of partially interconnected waterholes, the major one of which is Healey's Lagoon.

With the limited distribution apparent from Figure 3, and having an average depth of only 8.5 m, the aquifer clearly has a small storage capacity. While some 18,000 ML are held in storage, the usable storage is only some 13,000 ML. The aquifer is unconfined, and bore yields often exceed 40 L/sec.


### Table 3
Distribution of the Haughton aquifer, supplementation works, and irrigation areas.

#### 1.3. Replenishment

The principal source of natural replenishment is the Haughton River itself. High river flow levels have been observed throughout the area following floods in the river. As long as flow persists in the Haughton River, the aquifer is maintained in a full or near full condition. When flow ceases irrigation water is drawn from storage, with consequent depletion of this storage. The exact behaviour of the aquifer is therefore closely related to the irrigation needs and the frequency and duration of periods of no river flow. High flows in the Haughton River permit diversion of some flow to the Realey's Lagoon.
section via Ironbark Creek. A contributory source of replenishment to Hailey's Lagoon is run-off from rainfall on Mt. Elliott.

**Availability of Water from Aquifer**

In 1967 the Commission assessed the reliability of the groundwater resources as an irrigation supply (1). The available storage of 13,000 ML was considered sufficient to meet the irrigation needs of the irrigated cane land for a period of 160 days after the cessation of river flow. Streamflow measurements were available for the Haughton for the period 1952 to 1970. Streamflows were calculated from rainfall records for the period 1926-1952. A study of this data showed that during the 44 years there were 32 periods of no flow in excess of 160 days. Of these, 19 periods exceeded 210 days and 10 periods exceeded 250 days. Significant deficiencies in available irrigation supplies were considered likely during no flow periods of 160 to 210 days, and this situation could therefore be expected in most years. Substantial deficiencies were considered likely to affect crop production when there is no recharge for 130 days or more, a situation which has occurred on an average of once every 4½ years.

**Supplementation**

The Commission then undertook a study of possible supplementation schemes (2). The schemes considered were:

(a) Provision of weirs on the Lower Haughton River.

(b) Provision of weirs and additional offstream storage on the Lower Haughton and in the Giru Area.

(c) Delivery of water to the Haughton River from the Burdekin River.

(d) The possibility of a larger storage further upstream on the Haughton River.

The report concluded that the weirs on the Haughton River combined with diversion to Hailey's Lagoon would provide a significant improvement to supplies in the area. As well as the surface water stored, the weirs would increase the storage capacity of the associated aquifers. It was recognized however that the weirs would not completely safeguard supplies in the area under severe drought conditions. The report noted that when water became available from a major storage on either the Haughton or the Burdekin Rivers, the presence of the weirs would substantially increase the regulated supply from such a storage. On the basis of this report construction of weirs at 15.6 km and 22.7 km...
The Langhorne River has been undertaken (Fig. 5). The lower weir has completed a 1,600 ml (surface plus increased groundwater storage) available to irrigators. The upper weir is currently under construction and will take an additional 3,700 ml (surface plus increased groundwater storage) available to irrigators. Detailed investigation and design of the proposed diversion to Deady's Lagoon has not been finalised.

III. Evaluation of Inflows to Haughton River Weir Area

Selected results of a model study carried out by Henry (1) serve to illustrate the reduced risk of deficit in supply of irrigation water to farmers in Haughton River Weir area, resulting from construction of the Weir. The work improved upon previous assessments in that the irrigation requirement of the area was recalculated under more reliable climatic conditions, rather than being assessed on an average basis using average annual data.

The first stage of the work was to carry out a daily water balance for the soil moisture store in the root zone of the crop. For each day rainfall was added to the store and the moisture requirement of the crop was subtracted. If the level in the store fell below a specified level, the store was filled with irrigation. The moisture requirement of the crop used in this calculation was determined from evaporation data, a continued rate of crop growth, and the stage of development of the crop. Given that practical factors constrain actual growth from ensuring optimal irrigation practice, an irrigation efficiency factor was also employed. When this was calculated, a record was maintained of the volume of irrigation water that needed to be applied to result in a certain yield of corn at harvest. This is the irrigation demand.

The second stage of model development was to carry out a water balance only of the unconfined groundwater working storage of 3,600 ml. For each of the periods for which historical data was available, streamflow was added to the store and irrigation demand was subtracted. The rainfall recognition that a portion of the unconfined area was not irrigated. Obviously the streamflow was assumed into the store only until it was full, and irrigation requirement was derived from storage only while the store was not effectively empty. The store was considered effectively empty when it was reduced to dead storage level, the level from below which water could not be effectively pumped. When this was calculated, a record was maintained of the irrigation deficit, or the irrigation requirement that could not be met because the aquifer was effectively empty. The results of this stage of modelling are given on Figure 4, where the risk
of the aquifer failing to achieve a range of supply/demand ratios is plotted.

This water balance model was then run again, but on this occasion with the size of the store increased by 3,250 ML, to simulate the increased aquifer storage and surface storage resulting from a 2,000 ML weir. The risk curve resulting from this model run is also given on Figure 4. The weir currently under construction actually has a surface storage capacity of 3,500 ML.

From Figure 4 it may be seen that for the unsupplemented supply, there is 0.87 risk that a supply/demand ratio of 0.8 will not be achieved. This might alternatively be stated, 'it is probable that in 87 out of 100 years, supply from the aquifer will be less than 80% of the irrigation requirement'. We may compare this situation with the curve for the supplemented supply where we find that there is a risk of only 0.1 that the supply demand ratio of 0.8 will not be achieved. The results then indicate that the weir will dramatically reduce the risk of irrigation supply being less than 80% of irrigation demand. From these curves it may be generally inferred that the weir will significantly reduce
risk of small and moderate deficits, but a small risk of large deficits will continue to exist.

Modelling of the Supplemented Haughton-Healey Aquifer System

In 1981 Cuppy (4) developed a model of the whole of the Haughton-Healey system. The model incorporates the Giru and Haughton River Weirs. An no final decision has been taken as to the design of the proposed diversion from the Haughton River into Healey’s Lagoon, Cuppy assumed values for the rate of diversion, and the manner in which the diversion would be operated. The modelling study is similar in principle and was developed from the work by Henry which was described previously.

The model maintains a water balance in the three groundwater/surface water storages which are:

(a) Healey’s and other interconnected lagoons, and associated aquifers.

(b) The Haughton River Weir and associated essentially underlying aquifers.

(c) The Giru Weir and associated aquifers.

Recharge and discharge from each store, and the relationship between the stores is shown on Figure 5. The model uses irrigation demands calculated in the manner outlined previously. Recharge to the Giru Weir/aquifer store is essentially overflow from the Haughton River Weir. Recharge to the Healey’s Lagoon and associated aquifers is from local run-off and the proposed diversion. It was assumed that a diversion operates only while the Haughton River Weir is overflowing and the Healey’s Lagoon system is not full. A variety of diversion rates were modelled, but the results given here are for a diversion of 700 ML/month. A supply restriction was imposed progressively with falling storage level in recognition of the fact that as levels fall, less favourably located irrigation facilities are not able to pump the required irrigation water. As simulated levels fell the supply restriction was progressively imposed, until at the dead storage level the supply restriction was total, preventing any further removal from storage. The model was calibrated using the period for which water levels are available, a period of 16 years. In determining the irrigation demand, the target yield of cane was set at 100 tonnes per hectare. This is approximately the average yield achieved in recent years. The area under cane was set at the 1980 assigned area.

The model was run for the period for which adequate climatic and streamflow data was available, a 26 year period. It was found that the annual
irrigation demand during this period ranged from 341 mm to 761 mm. The ability of the three storage areas to supply demand is given on Figure 6. It can be seen from these curves that throughout the area the risk of a 20% deficit (a supply/demand ratio of 0.8) is less than 0.25 (one year in four). The Haughton River Weir area will be more prone to small annual deficits than the other storage areas. The study reinforces the previously recognized fact, that with supplementation a significant risk of deficit in supply exists.

Any increase in the area under cane will increase the risk. The model was again run using the maximum area of land suitable for cane production in the three storage areas, as advised by the Invicta Local Assignment Committee. The 1980 irrigated area (20% of the assigned area) and the maximum likely irrigated area in the three storage areas is given in Table 1.
Figure 6: Haughton-Deeley supplemented aquifer system risk curves, showing the risk of failing to achieve various supply/demand ratios, for the 1980 irrigated area.

Table 1

<table>
<thead>
<tr>
<th>Present and Future Irrigated Areas</th>
<th>Deeley's Area (ha)</th>
<th>Haughton River Area (ha)</th>
<th>Gurn Weir Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Irrigated Area</td>
<td>930</td>
<td>925</td>
<td>955</td>
</tr>
<tr>
<td>Likely Maximum Irrigated Area</td>
<td>1,850</td>
<td>1,200</td>
<td>1,500</td>
</tr>
</tbody>
</table>

The results of this model run are given as Figure 7. By comparing Figures 6 and 7 it is seen that the projected expansion in irrigated area will significantly increase the risk of deficits in irrigation supply.
FIGURE 7 Haughton-Hesley supplemented aquifer system risk curves, showing the risk of failing to achieve various supply/demand ratios, for the likely maximum area under irrigation (Table 1).

Additional Supplementation

As stated in a previous section, weirs and the diversion to Hesley's Lagoon are seen as only the first stage of supplementation and it is proposed to make additional water available to the area as part of the Burdekin River Project. Burdekin River flow, regulated by the Burdekin Dam, will be pumped from a pumping station near Clare into the proposed Haughton Main Channel (Fig. 6). Supplementation of the three groundwater/surface water storages in the Gnu area by diversion of water from the Burdekin River will be possible when these works are complete.
FIGURE 4 Location of the proposed Haughton Main Channel.

REFERENCES

1. QUEENSLAND WATER RESOURCES COMMISSION (1967)

2. QUEENSLAND WATER RESOURCES COMMISSION (1971)
   "Report on Improvement to Water Supplies, Haughton River (Gladstone Area), Queensland Government, Brisbane.

3. HENRY, R.J. (1976)

4. GUTFY, B. (1977)