Repair/Replacement of Concrete Lined Irrigation Channels

Case Study

Pipeline Replacement Methods

Corbie-Merungle Hill Section of the Murrumbidgee Irrigation Area
Leeton, New South Wales, Australia

1. General

1.1 Background

The Corbie-Merungle Hill Section of the Murrumbidgee Irrigation Area is located approximately 4km from the town of Leeton. The Corbie-Merungle Hill Section comprises of some 1280 hectares of horticultural land made up of 78 farms. The farms vary in size from 6 hectares to 70 hectares with the average of about 20 hectares. The system is operated by Murrumbidgee Irrigation, a recently privatised enterprise.

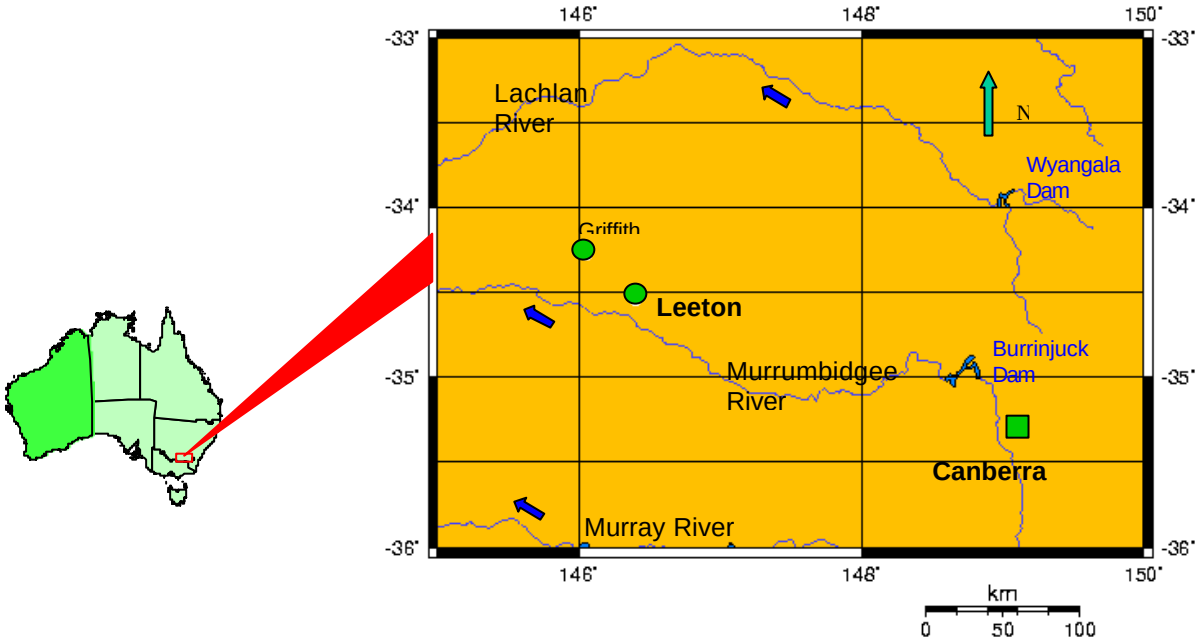

Figure 1 – Leeton Locality Plan

The entire system is currently being rehabilitated progressively over a fifteen year period. The original system consisted of a series of concrete lined channels which were supplied from a single pump station (124 Ml/day total installed capacity) at McMahon's Regulator on the Main Canal. The Main Canal draws water from Berembed Weir on the Murrumbidgee River which regulates flows released upstream from the large water storages of Blowering and Burrinjuck Dams. The original system had approximately 33km of concrete lined channels in the system. Water was delivered to irrigators from the channels through simple slide gates into Dethridge wheel outlets of a nominal maximum capacity of 6 Ml/d.

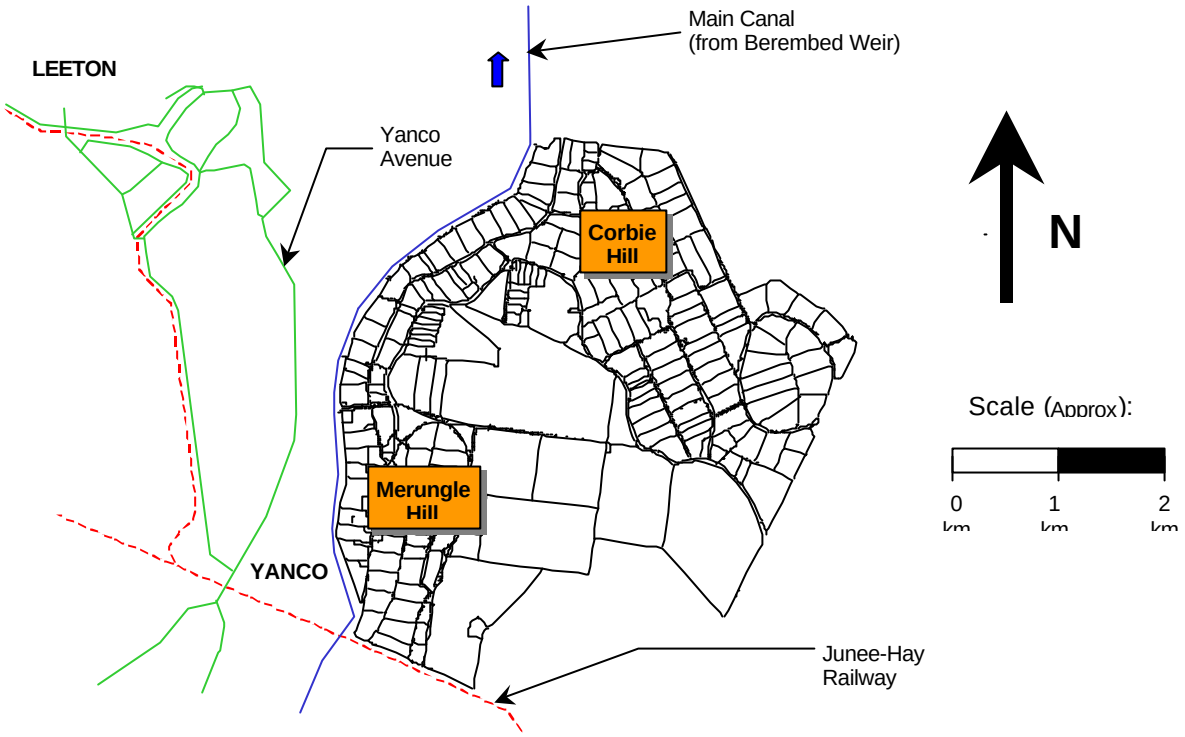

Figure 2 - Corbie-Merungle Hill Section

The system was constructed during the period of the 1920-40's. The concrete lined channels were constructed by applying the concrete as gunite. The gunite thickness varies from approximately 25-35 mm for the smaller laterals to 35-50 mm for the larger main channels. The channels are trapezoidal in shape with side slopes of 0.6H:1V. Typical channel dimensions are 600 mm depth with a 300 mm bed width for the smaller laterals and 1000 mm depth with a 900 mm bed width for the larger main channels.

The main crop within the Corbie-Merungle Hill Section is citrus with some grapes and stone fruit. Citrus is by far the largest crop, accounting for some 87% of all horticultural production in the section. Almost all of the irrigation water applied within the section is done via furrow irrigation (accounts for 92% of all forms of irrigation used within the section).

1.2 Site Conditions

The surrounding topography of the Corbie-Merungle Hill section is like much of the western plains in that it slopes gently westwards (slope is 1:5000). The main distinguishing features are the rock outcrops, which make up Corbie Hill and Merungle Hill. The soils in the section (with the exception of areas adjacent to the hills) are generally a red particle sandy clay with moderate shrink/swell characteristics. Interspersed throughout the section are areas of predominantly sandy nature.

1.3 Extent of Problem

The problems within the Corbie-Merungle Hill section include:-

- marginalisation of farm land due to waterlogging
- low channel water distribution efficiency (approximately 75%)
- high channel seepage losses
- high channel maintenance costs
- high drainage work costs
- some local road damage due to high water table
- uncontrolled discharges into wetlands which have led to changes in vegetation
- degraded water quality due to run-off from farms

These problems can be attributed to three main areas:-

(i) nature of the system open concrete channels)
(ii) state of concrete lining
(iii) on-farm irrigation practices

Nature of the System

The original Corbie-Merungle system was supplied by a single pump station at McMahon's Regulator. This pump station which is still operational is manually operated. The pump units in place whilst enabling a fair degree of matching of output to demand do not prevent releases being made over overflows (or escapes) at the end of laterals. Orders for water deliveries are placed over the telephone by irrigators. The original system is generally inflexible and manually intensive in operation.

State of Concrete Lining

The major cause of problems with the concrete lining is its age and the method of construction. The concrete lined channels are over 70 years old and have deteriorated badly. The unreinforced nature of the gunite lining together with its relative thinness are also contributing factors. In a report by the Department of Water Resources in 1991 (Technical Services Division, January 1991) the following assessment was made of the concrete lined channel system : -

Condition	Life Expectancy (years)	Channel Length (% of total length)
Good	15	5
Fair	10	4
Poor	5	70
Bad	0	21

Figure 3 – Typical Small Concrete Lined Channel (note channel deterioration)

Thus it can be seen that approximately 90% of the channel system needed replacement within ten years. The response in the past has ranged from patching of the lining to complete relining as required. Brick topping has also been constructed along extensive lengths of the channel system in order to increase capacity as a consequence of flow restrictions through access and road culverts and increased demand.

Figure 4 – Mortar Patching of Concrete Channels

Figure 5 – Brick Topping of Concrete Channels (on left hand side of photograph)

On-farm Irrigation Practices

Furrow irrigation as predominantly used within the section, if used in inappropriate circumstances can lead to over watering which inturn can cause waterlogging. Runoff as a result of over watering if not properly controlled can result in on-farm effluent (fertilizers, pesticides, etc) entering the irrigation drainage system and natural swamps and thereby having an adverse environmental impact.

2. Adopted Solution

2.1 Selection of Replacement Option

In selecting a replacement / rehabilitation option it was recognised that any solution would encompass both delivery infrastructure and on-farm infrastructure. To gain the maximum gains in water efficiency, and environmental benefits it was imperative to address both issues in tandem.

Conversion of on-farm irrigation to drip irrigation was viewed as a means to reduce water usage through better targeted watering. It was estimated that crop yields for citrus could increase by approximately 20-25% (Department of Water Resources, July 1991).

The automation of the system was seen to be greatly enhanced by pipeline replacement options.

A wide number of replacement / rehabilitation options were canvassed and investigated culminating in the formation of a Value Management Study Team to assess the various options. As part of the Value Management Study a workshop was held in Yanco in April 1991 at which the various stakeholders participated. The outcomes of the Value Management Study were presented in a report in July 1991 (Department of Water Resources, July 1991). Some of the options considered were:-

- high pressure pipeline (minimum of 12m head at farm gate) with drip irrigation on-farm
- low pressure pipeline (minimum of 1.2m head at farm gate) with drip irrigation possible with on-farm boosting (but still allows for furrow irrigation)
- rehabilitate existing concrete lined channels with drip irrigation on-farm

The latter option was attractive in that it was cheaper however it was decided that the pipeline-based options were more practical and offered the greater environmental benefit through reduction of leakage and uncontrolled discharges. The low pressure pipeline option had the greatest net present value of the pipeline options considered and was thus favoured. The low pressure pipeline option had the added benefit that conversion to drip irrigation by farmers would not be required upfront (with considerable capital expenditure). In this way farmers could gradually convert to drip irrigation within a suitable timeframe.

2.2 Adopted Replacement Option

The adopted replacement option being used within the Corbie-Merungle Hill section comprises two pump stations delivering water to balancing reservoirs which feed into pipeline laterals. The pipeline laterals are low pressure which provide each farm offtake with a minimum operating head of 2m. Under the adopted replacement option, the existing system has been divided into two sub-systems, the Corbie Hill Area (an area of approximately 730 hectares) and the Merungle Hill Area (an area of approximately 240 hectares).

Each sub-system has its own pump station which feeds a balancing reservoir. The Corbie Hill Area has its own pump station located at Stringer's Bridge and a balancing reservoir on Corbie Hill itself. The Merungle Hill Area will utilise the existing McMahon's Regulator pump station (refurbished) and have a balancing reservoir sited at Merungle Hill. The estimated total cost of the replacement option is $12.6M. Under the proposed replacement option the Government will meet the cost of replacing the delivery infrastructure (ie pump stations, pipelines etc) with the farmers meeting the cost of conversion of on-farm irrigation systems.

The replacement of the existing system is being staged over a period of approximately fifteen years. Construction on the replacement of the existing system commenced in 1996. Work to date has concentrated solely on the Corbie Hill Area. Approximately five kilometres of pipeline laterals, the Stringer's Bridge Pump Station and rising main and the Corbie Hill balancing reservoir have been constructed to date. It is anticipated that 70-80% of the replacement of the Corbie Hill Area will be complete by the end of 2001.

Construction of the pipeline laterals is mostly offline (ie the existing channel is in operation during construction). Where excessive bends in the existing channel alignment are encountered or where access to power is a problem, a more favourable alignment for the pipeline is being chosen. In most cases the pipeline is placed adjacent to the existing channel. The construction of the pipelines is generally split into a supply contract for the pipes and fittings with installation by works staff of Murrumbidgee Irrigation. Construction of the pipelines is usually carried out outside of shutdown periods.

Where pipes are being laid in a trench adjacent to the existing channel, only the length of trench that can be laid and backfilled within that day is excavated at any one time. This minimises problems (eg trench sides falling in, pipes floating) associated by possible water infiltration from the adjacent channel.

A special feature of the new pipelines is the provision of pump out scours. It has been estimated that the silt load from an eight month irrigation season is enough to fill 7% of the pipe system volume.

The pipe diameters of laterals in the Corbie Hill Area that have been or will be constructed, range in size from the largest of 600 mm down to 250mm. Murrumbidgee Irrigation has specified a pressure rating of 500 kPa for all pipes and fittings used in the replacement. Despite the low operating pressure in the pipeline a higher pressure class has been adopted to handle traffic loadings (up to T44) and waterhammer effects due to sudden valve closures at farmer's offtakes.

The lateral pipelines constructed to date have been exclusively rubber ring jointed concrete pressure pipe. This has been due to price especially for the larger diameters, especially for the larger diameters (> 300 mm). The pumping station for these laterals is now completed and commissioned and shall be in operation from next season for irrigation areas in Corbie Hill.

Figure 5 – 600 mm diameter concrete pipes (RRJ) being laid as part of Line D replacement

3. Conclusions

The replacement of concrete lined channels in the Corbie-Merungle Hill section is progressing steadily over a fifteen year period. It is too soon to quantify what improvements have been gained in converting from a concrete lined channel system to a fully piped system. No doubt the improvements in the operation of the new system in terms of reliability, flexibility and automation will be greatly appreciated.

The repair/replacement of concrete lined channels with a piped system is different to all other non pipe based repair/replacement options in that the nature of the system is fundamentally changed. The success of other non pipe repair/replacement options is generally based heavily on selecting the right product for the job. With pipeline replacement, provided that certain technical specifications are satisfied, the selection of pipe product is generally inconsequential to the success of the project. The important thing with pipeline replacement is that a systems approach is taken and that the various elements are properly conceived and thought through. The Corbie-Merungle Hill replacement project exemplifies the system approach with its focus on the interplay of the various elements (ie pump stations, rising mains, balancing reservoirs, laterals, farmer offtakes, irrigation practices etc).

4. References

Department of Water Resources (January 1991), *Economic Viability of Drip Irrigation for Merungle Hill Irrigation System*, Technical Services Division, TS 91.001

Department of Water Resources (July 1991), *Value Management Study - Corbie Merungle Hill Irrigation Area*, Sydney

Department of Water Resources (???), Unnamed Report on Corbie-Merungle Hill Irrigation Area Rehabilitation

Murrumbidgee Irrigation Corporation (December 1998), *Specification - Supply of Materials for Stage 2 of Pipeline, Line J - Corbie-Merungle Hills Irrigation Infrastructure Rehabilitation*, Leeton

Acknowledgments

Special thanks to Mr Neil Rickard, Project Engineer, Murrumbidgee Irrigation, Leeton, who provided much of the detail on the proposed system rehabilitation and background information on the existing concrete lined channel system.

Special thanks also to Mr Khalid Nawaz and other staff from Murrumbidgee Irrigation's Leeton office who assisted in the providing information and review of the document.

Further Information

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