The Maribyrnong River, Lessons from a Decade of Stream Stabilisation Works

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SUMMARY: In 1989 Melbourne Water commissioned an assessment of erosion occurring along the floodplain reach of the Maribyrnong River in Keilor, Victoria. The study identified an average of one severely eroded site per river kilometre, with the majority occurring adjacent to market gardens. Removal of riparian vegetation, catchment clearing and channel shortening through human induced meander cut-offs were considered to be the major causes of instability rather than increased rainfall or major floods. Techniques to stabilise banks have evolved over the past decade to reflect both the original causes of instability and local site conditions. Stabilisation projects now link revegetation with the placing of field rock on a granular filter layer. Priority is given to sites where landowners agree to retire a riparian strip from cultivation. The program also aims to enhance biological values through the installation of rock fishways around gauging and diversion weirs, riparian plantings and the monitoring of platypus populations.

THE MAIN POINTS OF THIS PAPER

- Approximately 1000 m of severely eroded banks has been treated for a cost of $1,000,000.
- Bank protection works have been linked to the establishment of a riparian strip to increase long term stability
- Negotiations to retire a riparian strip from cultivation have only succeeded once river processes were generating economic loss
- A change in land tenure or land owner attitudes is required to address chronic issues such as weed control
- Banks stabilised with single sized large rock without riparian plantings are prone to failure.

1. INTRODUCTION

This paper examines the evolution of river stabilisation techniques adopted along the floodplain reach of the Maribyrnong River north-west of Melbourne after a decade of field experience. An erosion survey undertaken by consultants in 1989 (Anon 1990) formed the basis for the stabilisation program. As all high priorty sites downstream of the Arundel Road Weir (Figure 1) have now been treated, a review is timely.

1.1 Background

The Maribyrnong River drains a 1400 km^2 catchment north-west of Melbourne (Moore 1976). The floodplain has developed within a deeply incised valley, with the river cutting through the overlying basalt exposing Ordovician and Silurian sedimentary rocks. During recent geological time alluvial terraces have developed on the valley floor (Hills 1975). These deposits are currently being eroded by river processes.

Rainfall averages within the catchment range from 549 mm at Keilor to 935 mm at Mt. Macedon (Anon 1986). Although the catchment encompasses some of the lowest annual rainfalls in Victoria south of the Dividing Range, the river flats are inundated approximately every three years. The last significant flood occurred on September 15 1993 (Anon 1998). The second largest recorded flood occurred in 1974 with a discharge peak of 714 m^3/s (61,700 ML/d) (Moore 1976).

Rosslynne Reservoir, completed in 1974, has increased extractions from the river to 9% of the mean annual flow at Keilor (Anon 1981). Additional low level weirs were installed during drought periods to provide pumping pools for the adjoining farmers (Scott 1993). A concrete weir was also installed adjacent to Garden Avenue in Brimbank Park to form both a flow gauging station and to protect a sewer pipe crossing the river.

Since European settlement human induced meander cut-offs have reduced the length of the river channel by approximately 20%. Figure 1 depicts the location of meander cut-offs evident by the 1920's and the erosion sites noted in 1989 (Anon 1990). The original subdivision of the parish placed title boundaries down the middle of the river channel.

Riparian and floodplain vegetation along the Maribyrnong has been cleared to make way for intensive agriculture, with approximately 55 hectares of the floodplain in the Keilor area cultivated for vegetable growing (Kelliher 1988).

Of the 233 plant species recorded along the Keilor reach of the river, 52% are exotic. Species such as willows (*Salix spp*), fennel (*Foeniculum vulgare*), artichoke thistle (*Cynara cardunculus*), phalaris (*Phalaris aquatica*) and boxthorn (*Lycium ferocissimum*) have totally replaced the native vegetation on most river banks (Fisher 1989). Land management practices on the adjoining fields such as rubbish burning and the application of fertilizer and herbicides is contributing to the decline of the isolated remaining mature river red gums (*Eucalyptus camaldulensis*).

Previous river management practices such as the removal of snags and small bushes obstructing flow have also adversely affected the riparian vegetation.

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The local rarity of river bottlebrush (*Callistemon sieberi*) can be partly attributed to selective removal during previous management regimes.

Removal of riparian vegetation, catchment clearing and channel shortening through human induced meander cut-offs are the major causes of instability rather than increased rainfall or major floods. Weirs are currently limiting further downcutting of the river channel (Anon 1990).

Biological surveys indicate the fish fauna within the river is predominantly native (97%) of which 73% are migratory. Such migratory species as common galaxias (*Galaxias maculatus*) and Tupong *(Pseudaphritis urvillii*) are currently restricted to only 10 % of the catchment due to barriers in the river. Three of the recorded migratory species are considered threatened in Victoria (Raadik 1997). Surveys have also identified platypus populations upstream of the Arundel Road Weir (Williams et al. 1998).

2. BANK STABILISATION PROGRAM

2.1 Rock Work

Stabilisation techniques at individual sites have favoured direct protection works rather than alignment training. The use of timber groynes was precluded by the high banks and poor access to the river channel. Using pile driving equipment from the top of unstable 5 metre high banks was deemed too dangerous. Diversion weirs also precluded instream installation by both providing deep water which limits vehicle access to the river bed and by creating barriers to any use of barges. A further impediment to groynes was the outcrops of sedimentary rock evident along the river channel and the risk posed to the environment from treated timbers breaking down over time .

Initial direct protection works concentrated on placing single sized large basalt field rock on geotextile with no associated plantings of stabilising vegetation. Figure 2 depicts the failure of a bank (site 67) stabilised using this technique only two years after installation. The lack of binding vegetation, cultivation to the bank edge and the large rocks slipping on the geotextile allowed the bank to readily fail. Flood waters flowing across the top of the bank and steep batter slopes further accelerated the failure process.

To reduce rock movement the batter slopes were reduced in subsequent projects and geotextile fabric replaced with a filter layer of crushed rock. A 300 mm layer of crushed rock is laid on the batter shaped for subsequent beaching and compacted using the bucket of an excavator. On river banks typically containing a high silt and clay content (Anon 1996) this has proved to be an effective strategy in reducing soil loss from behind the beaching The crushed rock filter also allows riparian plant species to colonise niches within the rock work, softening the visual impact and further stabilising the bank.

A further evolution of the beaching specification has seen single sized rock replaced with a mixture of rock sizes keyed together on the bank. Although field rock is still the preferred material given the ready and cheap supply from development sites, the mixture of sizes reduces the percentage of voids within the rock face. This proportion is further reduced by placing 100 mm rock spalls across the face using hand work if necessary to fill voids. The granular filter layer aims to further boost the quantity of fines in the placed field rock, especially at the soil/rock interface. The final product approximates a well graded rock blanket typically achieved at other sites with blasted quarry rock.

To soften the visual impact of the beaching and aid revegetation, topsoil is placed across the upper rock work. Topsoiling close to summer water levels has proved to be largely ineffective, being generally lost in the first flow of the season before vegetation can become established. The topsoiling necessitates more frequent inspections of rock work to avoid the prospect of contractors disguising the quantity of voids beneath 100 mm of topsoil.

Evolution of the beaching specifications is evident in Figure 2 contrasting the original works at site 67 completed in 1987 and Site 59 completed in 1995. The inclusion of riparian plantings and the mixture of different sized field rock are evident in the later works.

2.2 Revegetation

The shift to include revegetation within bank stabilisation works requires excision of a riparian strip from cultivation in contrast to the management practice evident behind the original work at Site 67 (Figure 2). In areas where agreements have proved elusive, such as upstream of Arundel Road, bank stabilisation is not undertaken and arable land remains unprotected from river processes.

Voluntary revegetation programs have failed within the catchment due to a lack of landowner interest. Extension of the stabilisation scheme to river banks upstream of Arundel Road is likely to require a change in landuse or a change in landowner attitudes (Anon 1990). The absence of significant bank collapses in recent times may explain the reluctance.

Natural regeneration of riparian species along the Maribyrnong is sporadic reflecting the dry climate, a limited and declining seed supply and extensive weed coverage. Summer drought is a regular occurrence and sapling recruitment only occurs in exceptional years.
Due to the weed dominance of the ground flora, revegetation strategies have concentrated on establishing shrub and tree canopy closure rapidly on the site. Particular priorty has been attached to establishing species such a river bottlebrush and river red gums overhanging the watercourse to provide both organic material to the aquatic food chain and a future seed source for downstream colonisation.

Attempts to establish seedlings without cover crops or guards have failed. At Site 75, wood duck grazing eliminated 80% of the planted tubestock and totally consumed rye corn seeds spread on the bank. Rabbit predation was a significant cause of mortality at Site 59. Duck grazing drops once vegetation gains sufficient height to shelter possible predators. Provided seeds are adequately raked into the topsoil, a cover crop of rye corn can achieve sufficient height to discourage ducks within two months.

The use of ground covering saltbush (*Atriplex semibaccata*) and Hop Goodenia (*Goodenia ovata*) has been unsuccessful in Maribyrnong plantings, despite being common colonising species at other sites. This once again reflects the impact of dry summers and intense weed competition.

To date approximately 1000 metres of severely eroded banks have been treated for a cost of $1,000,000. A breakdown of the expenditure on civil works and revegetation is given below (Table 1). Due partly to the ready supply of rock, costs per metre have been decreasing despite additional requirements for beaching such as the inclusion of the granular filter layer. Expenditure for Site 67 represents repairs to damage evident in Figure 2.

3. HABITAT IMPROVEMENT PROGRAM

With major erosion sites downstream of Arundel Road treated (Table 1), the rehabilitation program funds are increasingly being allocated to improve instream habitat. The initial aim is to construct fishways around the four major barriers, allowing migratory species greater access to the catchment. Previous surveys indicate barrier removal will not increase the distribution of exotic fish (Raadik 1997).

Two fishways were completed in January 1998 for a cost of $60,350. Total removal of the weirs was precluded by the risk of increasing bed incision and the need to both protect the sewer crossing under the concrete Garden Avenue weir and maintain the gauging station.

Followup fish surveys are scheduled for October 1998 to assess the effectiveness of the completed fishways. Low flows during the 1997/98 summer precluded an earlier assessment.

Future environmental improvements need to address the quality of stormwater runoff from Melbourne Airport which enters the Maribyrnong River at Arundel Creek and low summer flows due to extractions by irrigators.

4. LESSONS TO BE LEARNT

To date the stabilisation program on the Maribyrnong River through Keilor has been ‘catastrophe’ driven. As the majority of sites are privately owned, the need to stabilise banks only becomes evident once productive land is slumping into the adjoining river. Negotiations to retire a riparian strip from cultivation have only succeeded once river processes are generating economic loss.

Unfortunately, this approach leaves minor erosion untreated and weed infestation unresolved. The continued dominance of boxthorn, a rigid thorny shrub which is readily wrenched from the bank during flood flows, ensures minor slips occur after each flood. The prospect of undertaking minor repair works and weed control is remote given landowner indifference. Exposed banks are likely to be colonised by further weed growth given the poor natural regeneration of native riparian species evident along the river channel.

Balanced against this potential for ongoing erosion is the apparent stability of erosion sites upstream of Arundel Road. Vertical banks with no stabilising vegetation photographed in 1989 have exhibited little movement in a decade and minor sites have stabilised with weed species other than boxthorn covering the face. Anecdotal evidence suggests a degraded, yet at least partially stable environment.

Table 1: Treatment Costs for Bank Stabilisation on the Maribyrnong River, Keilor.

Site Number	Date Treated	Civil Costs	Reveg Costs	Total Cost	$ per metre
59	May 1995	$244,364	$20,000	$264,364	$1,888/ m
75	March 1996	$329,163	$34,703	$363,866	$1,233/m
63	May 1997	$90,935	$24,600	$115,535	$1,050/m
67	March 1997	$108,000	$41,590	$149,590	$935/m
69	April 1998	$146,176.	$13,000	$159,176.	$485/m
Totals		**$918,638**	**$133,893**	**$1,052,531**	

Only the advent of the next major flood will determine whether anecdotal stability is a temporary aberration or a longer term trend. Similarly, the success of the adopted stabilisation specifications, especially adjacent to meander cut-offs where river processes are most active, can only be truly assessed after being subjected to major flows such as a September 1993 flood. Earlier assessments that major floods were minor contributors to bank instability may prove to be flawed (Anon 1990).

Departure from the current 'catastrophe' approach to bank stabilisation depends on a major shift in landowner attitudes or a change in land tenure. Until this occurs, chronic issues such as controlling weed invasion and establishing an indigenous riparian environment will remain difficult to resolve and treatment costs (Table 1) will remain high.

A review of previous surveys (Anon 1990) indicates visual erosion assessment can prove to be an inaccurate estimate of actual losses. Long term monitoring of erosion rates is required to adequately assess the magnitude of erosion losses and the need for human intervention especially on minor bank slips.

5. CONCLUSIONS

The major conclusions are:

- a program targeting erosion sites generating economic losses on adjoining land can successfully argue the need for riparian plantings;
- chronic problems such as weed control are difficult to address without landowner support;
- significant flows are required before the merits of stabilisation techniques are assessed, even when major floods are not a significant cause of erosion losses;
- stabilisation works selected using a 'catastrophe' model cost approximately $1000 a metre to construct; and
- a better assessment of long term erosion losses is required to assess the need for human intervention.

6. REFERENCES

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