RIPARIAN DEMONSTRATION/ EVALUATION PROJECT

The Importance of Large Woody Debris in Sandy River Systems

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The Importance of Large Woody Debris in Sandy River Systems

Report to the Land and Water Resources Research and Development Corporation (LWRRDC)

Water and Rivers Commission
Regional Services Division

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1. Introduction

In April 1997, the Land and Water Resources Research and Development Corporation (LWRRDC) approved a grant of $20,000 to the Water and Rivers Commission to fund the Commission's proposal to trial the installation of large woody debris on a sandy river system typical of Western Australia's Swan Coastal Plain. The project involved the reconstruction of riffle-pool sequences based on woody debris.

A requirement of the grant program is for recipients to prepare a final report to LWRRDC on completion of the project. This document satisfies that requirement and also provides a valuable record of the project for the Water and Rivers Commission.

1.1. Trial objectives

The objectives of the project are:

1. to develop techniques for the installation of large woody debris;
2. to monitor the ecological response to the replacement of large woody debris in unstable sandy-bed river systems; and
3. to establish a site demonstrating this stream restoration technique.

2. Project background

The majority of the population of Western Australia inhabit the Swan Coastal Plain, on which the city of Perth is located. The rivers of this region are very different from their original state before European settlement. Firstly, most are now downstream of water supply impoundments and much of the native riparian vegetation of the Plain has been cleared for agricultural purposes. The majority of rivers were extensively de-snagged to the extent that little large woody debris (LWD) remains in the channels. The river beds of the Swan Coastal Plain are typically sandy and therefore "unstable". The removal of LWD has consequently increased the amount of unstable habitat, so that during the high flows of winter, the river channels are almost devoid of fauna. Additionally, the lack of LWD has reduced the frequency of pools which are typically a refuge for aquatic fauna and a major focus for fish.

Reaches of the Dandalup River and South Dandalup River in Pinjarra, 70 kilometres south of Perth, were selected for the trial. Restoration of these lower rivers should include three processes:

i. adequate downstream flow from reservoirs for environmental water requirements,
ii. replanting of riparian vegetation, and
iii. installation of instream habitat.

Both major branches of the Dandalup River have been dammed for Perth's drinking water supply. A study by Davies, Bunn and Arthington (1997) determined the environmental water requirements of the North and South Dandalup Rivers. Catchment groups, in particular the Pinjarra Community Catchment Group, have revegetated ('streamlined') substantial reaches of the lower South Dandalup River. Although the first two processes in restoring the river are being addressed, restoration of the instream habitat has not been carried out. This project complements previous and on-going research on sandy river systems of the Swan Coastal Plain.

3. Project description

3.1. Site location

Two river reaches were selected for the project (shown on Attachment 1 – Site Map):

1. A "Demonstration Site" in a highly degraded section of the Dandalup River 2 kilometres upstream of its confluence with the Murray River. This site, which covers a distance of 600 metres and is located immediately upstream of the Paterson Road bridge, is privately owned, unfenced and subject to livestock grazing and trampling.
2. A "Reference Site" is located a further 6 kilometres upstream on the South Dandalup River within Fairbridge Farm. The river has been fenced-off in recent years and the site has good regeneration of riparian vegetation. Fairbridge Farm is owned by ALCOA and leased back to Fairbridge Western Australia Incorporated. The village and farm are being developed to demonstrate best management practices for coastal plain farming and, just as importantly, as a focus for youth activity, whilst assisting young people and other visitors to learn about the environment and sustainable farming.

3.2. Site assessment

A channel survey of the river reaches was undertaken and existing flow records examined.

The Dandalup River site drains a 695 square kilometre catchment emptying into the Murray River and eventually the Peel Estuary. The river flows throughout the year, being usually maintained by dam releases during summer. The average bankfull width and depth at the demonstration site are 14 metres and 0.8 metres respectively. The channel is 21.6 metres wide and 2.3 metres deep on average (to top of bank). The bankfull discharge is approximately 15 cubic metres per second, producing a velocity of about 1.4 metres per second. The average slope of the reach is 0.05 per cent (1:2000).

The catchment area of the South Dandalup site is approximately 388 square kilometres. The reach has an average bankfull width of 10 metres and bankfull depth of 0.7 metres. The bankfull discharge is approximately 4 cubic metres per second, resulting in a velocity of 0.6 metres per second. The reach slope is 0.05 per cent.

3.3. Restoration Design

The riffle-pool sequence was designed based on the principles of habitat enhancement outlined in Newbury and Gaboury (1993) and LWRRDC's Riparian Management Guideline 7 – Managing Snags in Rivers (1998). In contrast to the usual practice of constructing riffles using rock, LWD was used on these sandy rivers. Riffles were constructed at cross-over points, in the middle of meanders. In accordance with the LWRRDC guidelines, the logs were orientated perpendicular to the direction of water flow so as to obstruct less than 10% of the channel and enable the unimpeded passage of peak flows. Logs placed to protect and support the banks were closely aligned to the banks.

4. Installation of large woody debris

4.1. Dandalup River site

The construction of the Dandalup River site, upstream of Paterson Road, was carried out over two days in May 1998 (during the summer to autumn low flow period). Forty large tree trunks (some still including the root-ball) were installed using a 25 tonne hydraulic excavator. The logs ranged in size from 4.7 to 9.4 metres in length and 0.25 to 0.90 metres in diameter. All limbs were removed from the trunks for ease of installation and to prevent the catching of debris once in place. The logs were obtained from three farms in the North Dandalup area.

At three locations (shown on Attachment 2 Site Plan) logs were placed perpendicular to the flow to form "riffles". Two logs were used at each site to build a V-shaped riffle across the low flow channel (figure 1). A trench was excavated into the bed and the logs buried to half their diameter. The riffles were constructed with the root balls of the logs buried into the bank to anchor the logs and the tapered ends pointing slightly upstream. The lowest point of the riffles was at the join of the two logs in the centre of the channel. The riffles were constructed to a maximum height of about 0.3 metres to allow fish migration.

One very large trunk was placed mid-channel about 470 metres upstream of the bridge. The remainder of the logs were orientated to provide "toe protection" to support stream banks either immediately upstream or downstream of the riffles or on the outside of meander bends to direct flows away from the banks. Sections of the banks were stabilised with jute matting, which was pinned down.

A photographic record of the site is included in Appendix 3.

4.1.1. Maintenance and enhancement – Dandalup River site

During the 1998 winter, which produced one major bankfull flow, several logs were shifted. Two of the logs that had been positioned on the outside of meander bends were moved downstream and lodged under the Paterson Road Bridge. The logs in the three riffle structures remained in position. Scour holes formed under and immediately downstream of the riffles. The Jutemaster™ mats trialed by the distributor at the site successfully withstood the high flows during the 1998 winter.

In February 1999, the logs which had moved were re-positioned and an additional twelve logs were placed along the reach. The logs were wired to 3.5 metre long, 100 to 150 millimetre diameter pine posts driven into the bed to secure the logs placed on the outside of bends into position. No significant movement of logs were observed during the 1999 winter, however peak flows were much lower than in 1998. Deterioration of the jute matting was mainly caused by cattle trampling.

4.2. South Dandalup River site

The Dandalup site was monitored during winter 1998 and the technique reviewed before extending to the revegetated reach of the South Dandalup River at Fairbridge. The site was established under the Water and Rivers Commission's South West River Restoration Training and Demonstration Program, part-funded by the Natural Heritage Trust. The Fairbridge site was constructed in March 1999 over a 300 metre reach immediately downstream of a demonstration cattle crossing. As the riparian vegetation is well established in this reach, access by heavy machinery to position the logs would have caused considerable damage to the banks.

In order to minimise disturbance to the riparian zone, the logs were installed manually by Landcare trainees through the Fairbridge "Ecohouse Project". Twelve trainees manually dragged the logs into position. Thirty logs of somewhat smaller size than at Paterson Rd were installed. The logs were retained by wiring and bracing to pine posts and galvanised fencing droppers jetted or driven into the bed. Sedges and rushes were also transplanted and brushing installed to protect banks from undercutting. Some minor movement of logs occurred during the 1999 winter. The movement was due to some of the pine posts being inadequately installed by the Landcare trainees. This was easily rectified.

5. Monitoring Results

The trial sites on the South Dandalup and Dandalup Rivers were monitored to assess the effect of the installation of LWD in improving the ecological "health" of sandy, unstable river systems. The sampling of aquatic macroinvertebrates was compatible with National River Health Program (NRHP) protocols, where macroinvertebrate community structure is used to determine river "health". A BACI designed program (monitoring before and after riffle installation, with control sites in adjacent catchments) was used to evaluate the project. Channel morphology, water quality and fish and macroinvertebrate species diversity and abundance were monitored to assess the benefit of instream habitat restoration.

Dr Peter M. Davies from the Zoology Department at The University of Western Australia undertook the ecological monitoring program for this project. Three sampling surveys have been performed; in November 1997 (prior to LWD installation), February 1999 (after LWD installation) and November 1999. The monitoring results and reports are included in Appendix 4.

An increase in fish biodiversity at the Dandalup site has been measured since the installation of LWD. The number of fish species recorded increased substantially, from one species in November 1997, prior to the installation of LWD, to six species in February 1999.

The macroinvertebrate response has been more difficult to interpret. At the Dandalup site, whilst there was a significant response to the LWD measured in February 1999 (species identified increased from 42 to 52) this was not sustained in the November 1999 sampling. This reduction in biodiversity has been attributed to seasonal differences caused by higher river flows in November (spring) compared to February (summer). The loads of LWD appear insufficient to create enough diversity of hydraulic habitats during high flow periods. However these initial results may be indicative of the benefits of increased LWD during the long periods of low flow experienced during the summer in the south west of Western Australia.

Measurements of water velocity, pool characteristics, hydraulic conditions and LWD were taken at each site. The variety of flow conditions in the channel was increased by the placement of LWD, creating a variety of flow velocities and water depths. The retention of water during summer was improved. A threefold increase in pool area was measured as a result of the placement of LWD.

A photographic record is the primary method of monitoring the stability of the woody debris that has been placed in the channel.

Monitoring will continue to assess the long-term response of these sites to the presence of the LWD.

6. Project expenditure

		Expenditure $		
Dandalup River Site, Paterson Road		**LWRRDC**	**NHT**	**WRC**
Monitoring 6-8 & 16 November 1997		2,200		
April 98 Survey and Cartographics		3,400		
May 1998 Log Riffle Construction				
Supervisor – contractor	33 hours @ $40/hour	1320		
Mileage and incidentals		250		
Chainsaw operator - contractor	16 hours @ $15/hour	240		
Materials – 40 logs	48 m^3 @ $10/$m^3$	480		
Plant hire – 2 chainsaws	2 days @ $130/day	260		
A 64 loader	19.5 hours @ $70/hour	1,365		
Low loader/transporter	18 hours @ $75/hour	1,350		
excavator and bulldozer	2.5 days	2,355		
Jutemats – erosion control mats	Provided by distributor	no cost		
Total		7,620		
Staff time - Design, project management and supervision	5 weeks @ $1120/week			5,600
Mileage – 1997/98	8 trips, 180 km @ $0.63/km			907
25 January 1999 - 3 February 1999 – Maintenance and Enhancement				
Materials – Pine poles	70 (3.5m x 100-150mm dia.)	1120		
Galvanized tie wire		34		
Plant hire – Ford loader rake	3 hours @ $75/hour	225		
Volvo & float	8 hours @ $75/hour	600		
25 tonne Excavator	8 hours @ $85/hour	680		
Labour – Supervision	89.5 hours @ $25/hour	2237		
Plant operation	21 hours @ $75/hour	1575		
Total		6471		
Monitoring 11 February 1999				4,400
Staff time - Design, project management and supervision	1 week @ $1143/week			1,143
South Dandalup River Site, Fairbridge				
May 1998 Survey and Cartographics				3,400
25 Feb–12 Mar 1999 – Log Riffle Construction				
Log retrieval – machinery and operators				1,956
Supervision - contractor		309		211
Tractor/trailer – transportation of logs	16 hours @ $50/hr		800	
Loader	12 hours @ $50/hr		600	
Dumpy level and tripod hire	3 days @ $50/day		150	

Chains, pulleys and post hole digger hire	8 days @ 60/day		480	
Chainsaw hire	9 days @ $65/day		585	
Coordination / supervision – contractor	16 hours @ $30/hr		480	
Ringlock fencing for brushing	2 rolls @ $100/roll		200	
Concrete	5 bags @ $15/bag		75	
Tie wire	1 roll @ $100/roll		100	
Supervision of trainees – contractor	64 hours @ $30/hr		1,920	
Technical supervision	15 hours @ $50/hr		750	
Weed control - Glyphosate	2 x 20 litres @ $150 each		300	
Photographic record			100	
Total		309	6540	2,167
Staff time – Design, project management and supervision	1 week @ $1143/week			1,143
Mileage – 1998/99	5 trips, 180 km @ $0.65/km			585
Monitoring 12 November 1999			7,900	
Photographic record				120
Staff time – monitoring & reporting 99/00	1 week @ $1166/week			1,166
TOTAL PROJECT EXPENDITURE		**20,000**	**19,340**	**20,631**

The total project cost, including monitoring and salaries, was $59,971. Expenditure on the materials and construction of the log riffle structures over the 600 metre reach at the Dandalup River project site and the 300 metre reach at the South Dandalop project site was approximately $23,000, ie. $25,600 per kilometre of rehabilitation.

7. Project achievements

(i) **Stream restoration**

The project enhanced the instream habitat on reaches of the Dandalup and South Dandalup River through the reconstruction of riffle-pool sequences using large woody debris.

(ii) **Establishment of a demonstration site**

- A second river restoration demonstration site (the first is on Spencer's Brook, a tributary of the Avon River near Northam) was established in the State's south west. Additional demonstration sites have since been established. The sites are based on the principles of stream assessment and habitat restoration outlined in Newbury and Gaboury (1993).
- Restoration techniques appropriate to the sandy river systems of the Swan Coastal Plain are being demonstrated.
- Simple and cost effective channel stabilisation and riparian and instream habitat restoration techniques are being promoted.

(iii) **Public benefit and education**

- The project provides public benefit through community education and the enhancement of the habitat and amenity of a local river.
- The project has an important educational component, with many schools, community groups and local landholders visiting Fairbridge.

- The trial sites on the Dandalup and South Dandalup Rivers were used for demonstration and training purposes during a River Restoration Workshop held in May 1998 at Fairbridge. The workshop was part of the South West River Restoration Training and Demonstration Program which received Natural Heritage Trust funding. The aim of the workshop is to conduct an education program that demonstrates practical implementation of restoration works that successfully integrate physical and ecological restoration techniques. Key stream management practitioners were trained who can in turn provide competent advice to local groups and individuals managing waterways. The workshop was the second held in WA based on the stream assessment and restoration principles of Newbury and Gaboury (1993). A very successful workshop was held at Muresk, Northam, in May 1996, which was funded by LWRRDC.
- Sites where existing 'streamlining' has been successfully established along the South Dandalup River are used to actively promotes riparian restoration. These sites have signage outlining the importance of riparian restoration that have generated significant public interest. The combination of the Large Woody Debris project with the existing streamlining sites will lead to considerable benefits by demonstrating two major issues of stream restoration at a single site.

(iv) **Participation**

The project collaborators were the Water and Rivers Commission, University of Western Australia, Fairbridge Western Australia Incorporated and the Riparian Lands Research and Development Program (LWRRDC).

The landowner of the Dandalup River site has supported the project, allowing the works and access to the property for construction, monitoring and training and demonstration purposes. Alcoa of Australia have also been positive to the restoration works and training program undertaken on their property.

Twelve landcare trainees from the Pinjarra Aboriginal Association participated in the construction phase of the South Dandalup River site.

Envirowest of Western Australia donated Jutemaster™ products to assist in the stabilisation of the Dandalup River site.

Members of local community groups and schools groups have also visited and studied the sites.

The Department of Environmental Protection and the Serpentine-Jarrahdale Shire Council were also informed of the project and have indicated their interest and support for the restoration work undertaken.

The River Restoration Workshop was attended by twenty-four participants, as well as various presenters and facilitators. Participants at the workshop were from community groups and Local and State government agencies from the south west region involved in river and catchment management.

(v) **Research and development**

Changes to waterway stability and biodiversity were monitored to evaluate the success of the restoration technique. The site will be used as a case study in the River Restoration Manual for South West Western Australia being developed by the Water and Rivers Commission. The project has further investigated the applicability of the "Newbury Technique" to south-west Western Australian conditions. The demonstration

site will be monitored over the long term to determine the long-term benefits of the installation of LWD and to guide the broader application of the technique to the sandy river systems of the Swan Coastal Plain.

(vi) **Waterways management strategy**

The project is part of the Water and Rivers Commission's strategic priority of demonstrating waterways management in action and developing and implementing strategies for the conservation and management of Western Australia's waterways in partnership with the community. The project is also consistent with the objectives of the National Rivercare Initiative.

The establishment of demonstration sites is part of the role and educational objective of the Water and Rivers Commission River Restoration Action Team (River RATs). The River RATs (formed in 1996) are a team of officers who are dedicated towards educating the community on restoring and managing our rivers. One of the many outcomes of the River Rats is the production of the Water Note series and River Restoration Manual series. All participants who attend the River Restoration Workshops run by the Water and Rivers Commission become honorary River RATs who are actively working at restoring our rivers.

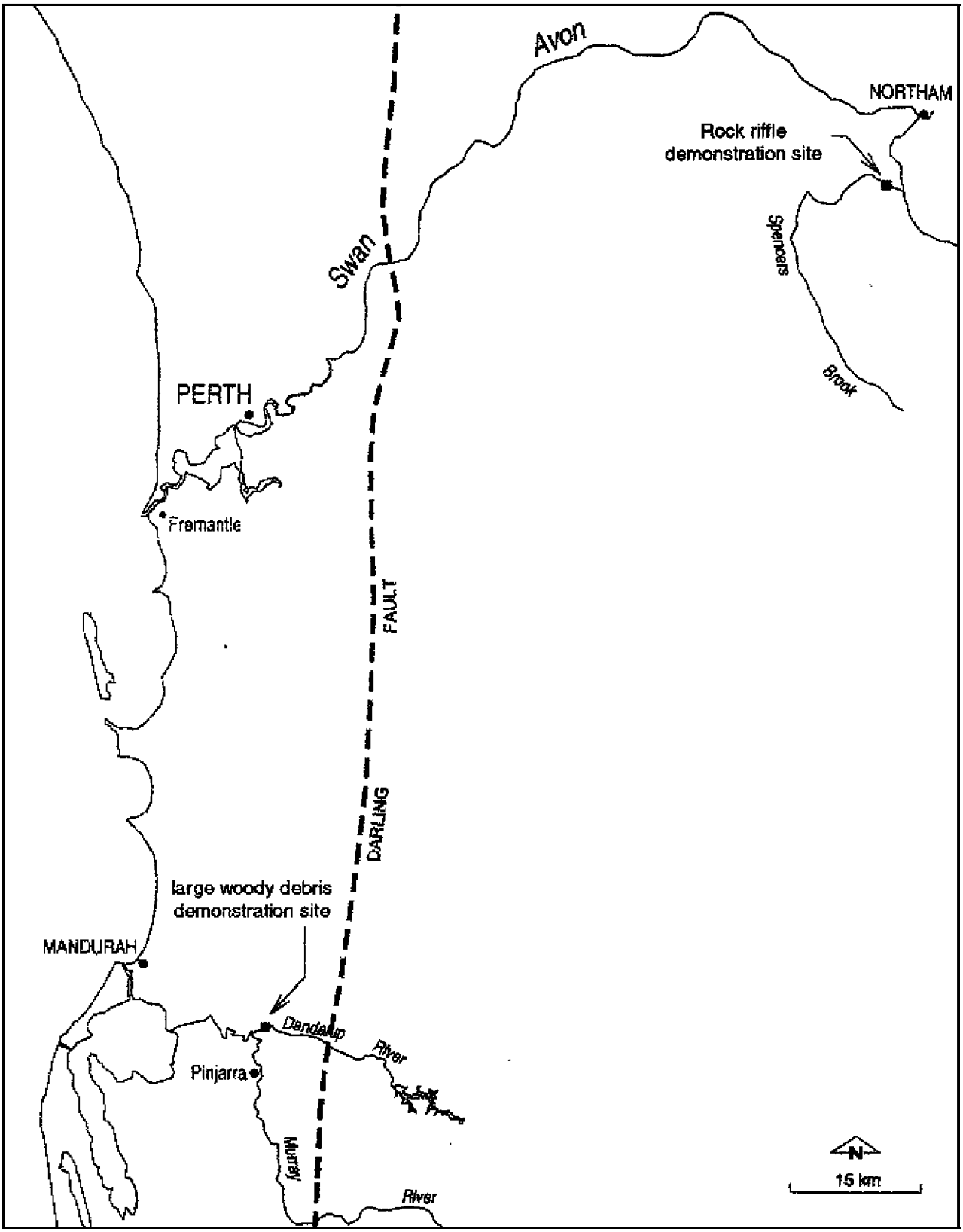
8. Summary

Stream restoration is a combination of natural stream form, re-establishment of native vegetation and foreshore protection. The study reaches were monitored to determine the importance of large woody debris and the resultant pools to macroinvertebrates and fish. Initial monitoring results indicate that the installation of large woody debris improves the instream habitat of degraded rivers, resulting in an increase in fish and macroinvertebrate biodiversity during low flow conditions. It appears that greater loadings of large woody debris are required to have a greater response during higher flow conditions.

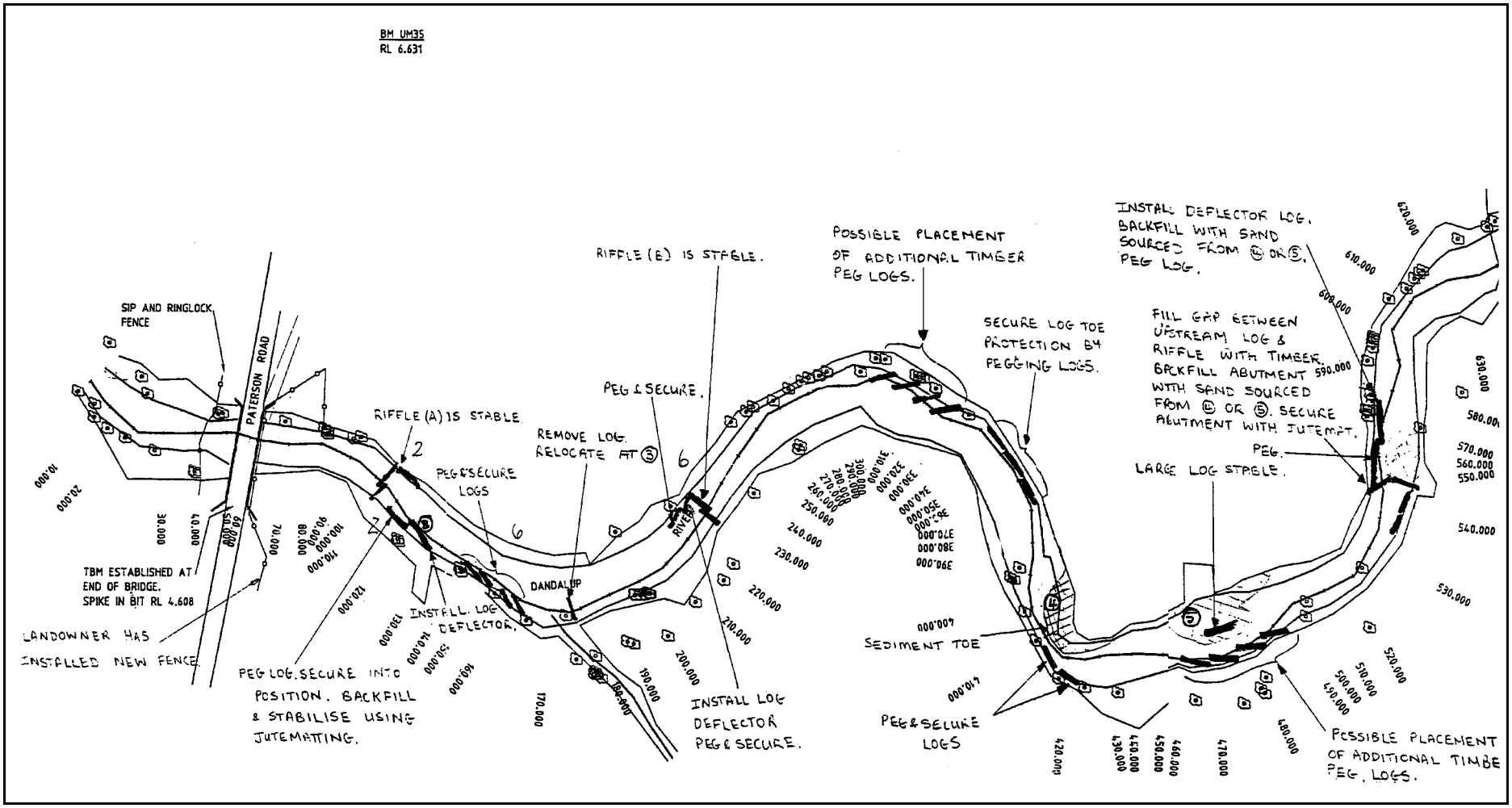
The success of the riffles will continue to be monitored to determine the long-term benefits of the installation of large woody debris and to guide the broader application of the technique to the sandy river systems of the Swan Coastal Plain. A riparian restoration plan involving fencing and revegetation at the Dandalup River "Demonstration Site" is recommended as part of a longer-term strategy.

This project has provided considerable educational learning benefits for the local community and researchers, in addition to its original research objectives. As a key component of the educational training strategy of the Waterways WA Program, this site will continue to be managed and monitored.

Appendix 1: Site map



Appendix 2: Restoration design plan



Appendix 3: Photographic record

Dandalup River - Paterson Road site

Looking downstream at Riffle A. Log toe protection was placed against the left bank and a jute log used to divert flows away from the right bank and towards the riffle. (22.5.1998)

Looking downstream at Log Riffle B. (5.5.1999)

Logs pinned against left bank, looking downstream. (5.5.1999)

Cattle access track prior to construction of Riffle C. (4.5.1998)

During construction of Riffle C, a trench was excavated and the butt of the logs buried into the bank. (4.5.1998)

Log Riffle C. (4.5.1998)

South Dandalup River – Fairbridge Farm Site – March 1999

Landcare trainees installing logs. (March 1999)

Log riffle and bank protection. (5.5.1999)

Looking downstream from cattle crossing. (5.5.1999)

Looking upstream towards cattle crossing. Logs and brushwood were used to protect the banks from undercutting. (5.5.1999)