Department of **Water**
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Foreshore and channel assessment of the Dale River South Branch

Water resource management series

Report No. WRM 50
June 2008

Department of Water
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This report was prepared by Lucy Sands (BlueSands Environmental) for the Department of Water, Northam.
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The following people are acknowledged for their assistance and knowledge during the project:

- Kate Gole (Department of Water, Northam) for her assistance during the preparation of the survey, development of the Microsoft Access database, advice and report editing
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- Bernard Kelly (Department of Water, Northam) for report editing and project support
- Erin Byrne Ibbertson for map production and GIS support.

Cover photo: Granite outcropping in a reach of the Dale River South
(Photo: Lucy Sands)

Unless otherwise stated, all photograph taken by Lucy Sands or Viv Read.

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Abbreviations

GIS	Geographical information system
OSEHR	Overall stream environmental health rating
TDS	Total dissolved salts
UCL	Unallocated Crown land
ZRD	Zone of rejuvenated drainage
TN	Total nitrogen
TP	Total phosporous

Summary

The Dale River South Branch is an important tributary of the Dale River. The Dale River is a significant contributor of relatively fresh water to the Avon River. In June–July 2007, a foreshore and channel assessment of the condition of the Dale River South was undertaken to provide information for waterway management.

In general, the Dale River South is degrading as a result of decades of agricultural land use. The majority of the river is accessible to stock and, compared with other assessed waterways such as the Dale River and Talbot Brook, has a low proportion of fencing.

Stock access has had a direct impact on the structure and health of riparian vegetation, with the remaining thin strip of vegetation being dominated by weeds in the understorey and native vegetation of deteriorating health in the upperstorey. However, natural regeneration is apparent in the majority of sections, so the river still has the ability to recover, if managed appropriately.

The loss of riparian vegetation has directly impacted the health of the channel. Sedimentation and bank undercutting are the most active forms of erosion. Left unmanaged, the erosion in some sections will exacerbate and not only consume valuable farm land but cause significant problems downstream.

The Dale River South has some interesting, picturesque features, including a large natural riffle, which appears to have been created by the river breaking through granite bedrock. The river also has a naturally braided double channel and anabranches downstream of the Brookton Highway Bridge.

Large woody debris was observed in most sections, and there are large build-ups in some downstream reaches that are causing erosion of the banks and require management to prevent further erosion.

It is evident that management is required to protect the remaining assets of this waterway. The most effective technique would be to fence both sides of the waterway, allowing for designated stock watering points because, although the water is saline, many landholders rely on the river for stock watering.

1 Introduction

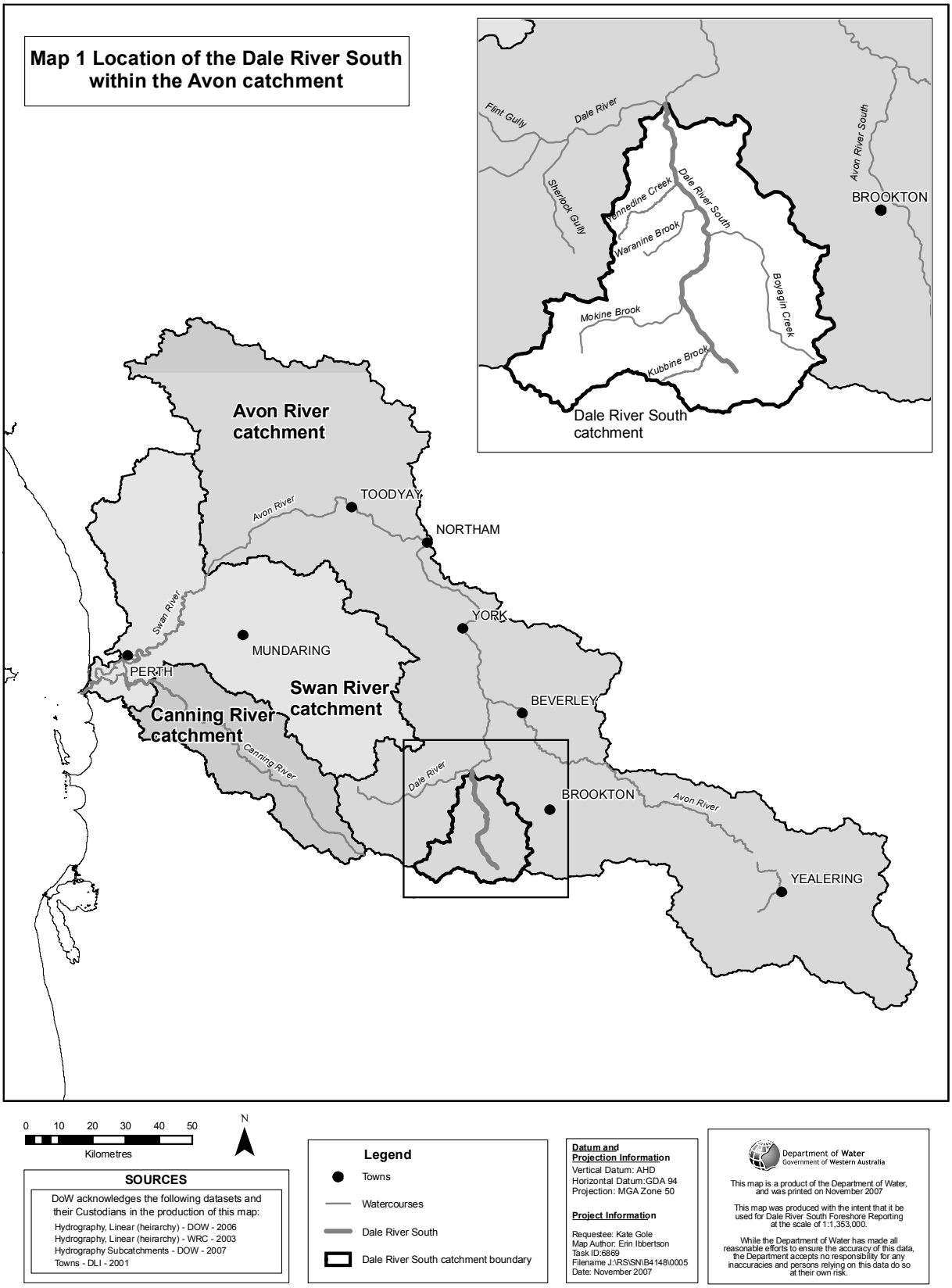
Purpose of the survey

Foreshore and channel assessments have been completed for a number of waterways in the Avon River catchment, including the nearby Dale River and Talbot Brook (Department of Environment, 2006; Water and Rivers Commission, 2002). These assessments are designed to provide a consistent approach to collecting baseline information to assist in the future management of these waterways.

The purpose of the assessment is to collect information on current condition, health, past and current management practices and disturbances relating to the Dale River South. This information will provide landholders, community members and organisations with the information required to manage this waterway effectively.

The overall objectives of this assessment are to:

- provide landholders and organisations with baseline information that will allow changes in condition and health to be measured
- highlight issues and areas that require urgent management
- engage landholder interest in the causes of waterway degradation and possible management techniques to overcome these issues.


Map 1 Location of the Dale River South within the Avon catchment
Flint Gully
Dale River
Avon River South
Shellpok Gully
Kennedine Creek
Dale River South
BROOKTON
Waranine Brook
Boyagin Creek
Mokine Brook
Kubbine Brook
Dale River South catchment
Avon River catchment
Avon River
TOODYAY
NORTHAM
Swan River
YORK
MUNDARING
PERTH
Swan River catchment
Canning River catchment
BEVERLEY
Canning River
Dale River
BROOKTON
Avon River
YEALERING
0 10 20 30 40 50
Kilometres
N
SOURCES
DoW acknowledges the following datasets and their Custodians in the production of this map:
Hydrography, Linear (heirarchy) - DOW - 2006
Hydrography, Linear (heirarchy) - WRC - 2003
Hydrography Subcatchments - DOW - 2007
Towns - DLI - 2001
Legend
Towns
Watercourses
Dale River South
Dale River South catchment boundary
Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA Zone 50
Project Information
Requestee: Kate Gole
Map Author: Erin Ibbertson
Task ID:6869
Filename J:\RS\SN\B4148\0005
Date: November 2007
Department of Water
Government of Western Australia
This map is a product of the Department of Water, and was printed on November 2007
This map was produced with the intent that it be used for Dale River South Foreshore Reporting at the scale of 1:1,353,000.
While the Department of Water has made all reasonable efforts to ensure the accuracy of this data, the Department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

2 Description of the Dale River South

2.1 Location, land use and tenure

The Dale River South Branch catchment covers an area of 567.4 km^2 and is located approximately 20 km west of the town of Brookton. Map 1 shows the location of the Dale River South Branch in relation to the Avon River catchment.

The river flows in a north-westerly direction towards its confluence with the Dale River. The main channel runs through the shires of Beverley, Brookton and Wandering, and the headwaters extend into the Shire of Pingelly.

The land adjoining the Dale River South is predominantly privately owned, with the exception of three small strips of unallocated Crown land (UCL). Two of these parcels of Crown land are grazed as part of the adjoining farmland, as there is no defining fence line. Additional Crown lands exist within the catchment, including Boyagin Nature Reserve, which is managed by the Department of Environment and Conservation.

Most of the privately owned land is used for cropping and sheep-grazing. No hobby farmers or special residential properties exist within the catchment.

2.2 Landform and soils

The Avon River catchment has three distinct drainage zones. The Dale River South Branch lies within the zone of rejuvenated drainage (ZRD). This zone includes the land between the Darling Range (to the west) and the Meckering Line (to the east).

The ZRD is characterised by a more undulating landscape than the zone of ancient drainage (which encompasses much of the central and eastern Wheatbelt) with defined drainage lines that flow every winter (average rainfall is 375–550 mm/yr). In its natural state, this portion had a broad, highly braided floodplain (Lantzke & Fulton, n.d.).

2.3 Climate

The Dale River South catchment has a Mediterranean climate, represented by hot, dry summers and cool, wet winters. The closest, most representative, weather station to the Dale River South is located at Brookton, approximately 20 km east. At this station, average yearly rainfall is 453 mm, with June being the wettest month and December the driest. Table 1 provides temperature ranges for summer and winter, as recorded by the Australian Bureau of Meteorology.

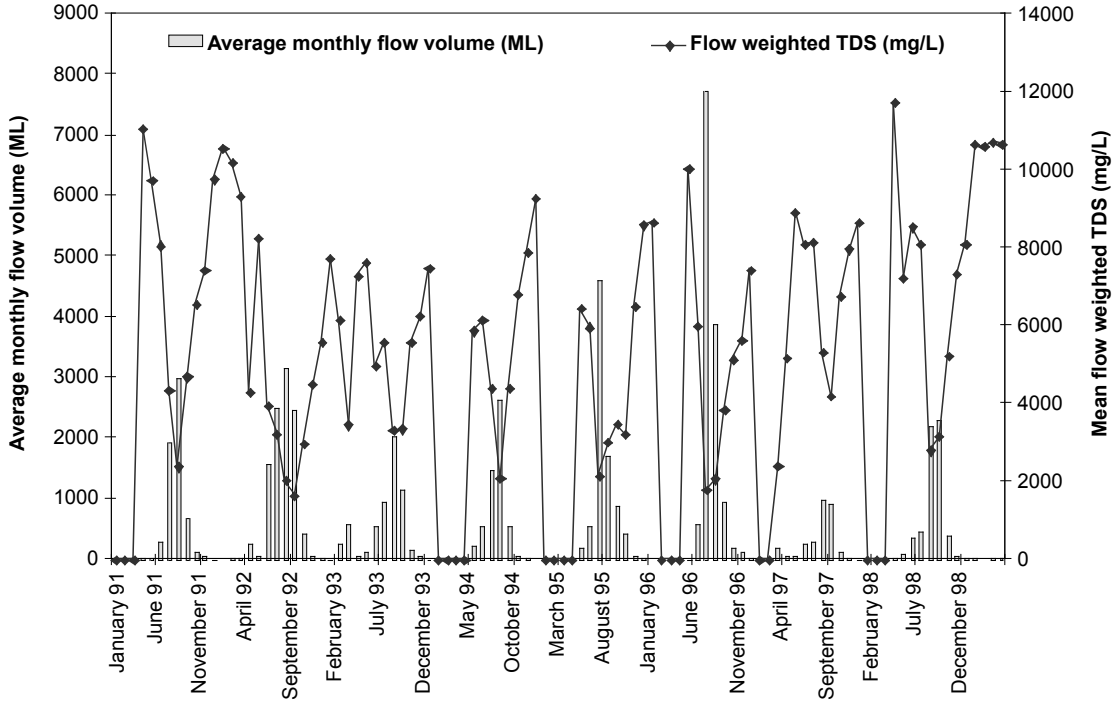
Table 1 Average yearly rainfall and temperature ranges for Brookton

Average rainfall (mm)	Summer maximum (°C)	Summer minimum (°C)	Winter maximum (°C)	Winter minimum (°C)
453	31.1–32.8	13.6–15.9	16.1–17.1	4.6–5.6

Source: Australian Bureau of Meteorology, 2007

2.4 Historical water monitoring

There is a stream-gauging station on the Dale River South at Brookton Highway (Department of Water gauging station reference 615222), where streamflow data was collected from 1966–May 1999 (Figure 1).



Source: adapted from Department of Environment, 2006

Figure 1 *Average monthly flow and flow-weighted salinity (total dissolved salts) for the Dale River South Branch at Brookton Highway*

Water quality parameters were measured at this site from 1994–98, including nitrogen and phosphorus. Various physical parameters were also monitored from the inception of the gauging station in 1966 until its closure in 1999. Table 2 provides a summary of this data, which is presented in detail in Appendix 1.

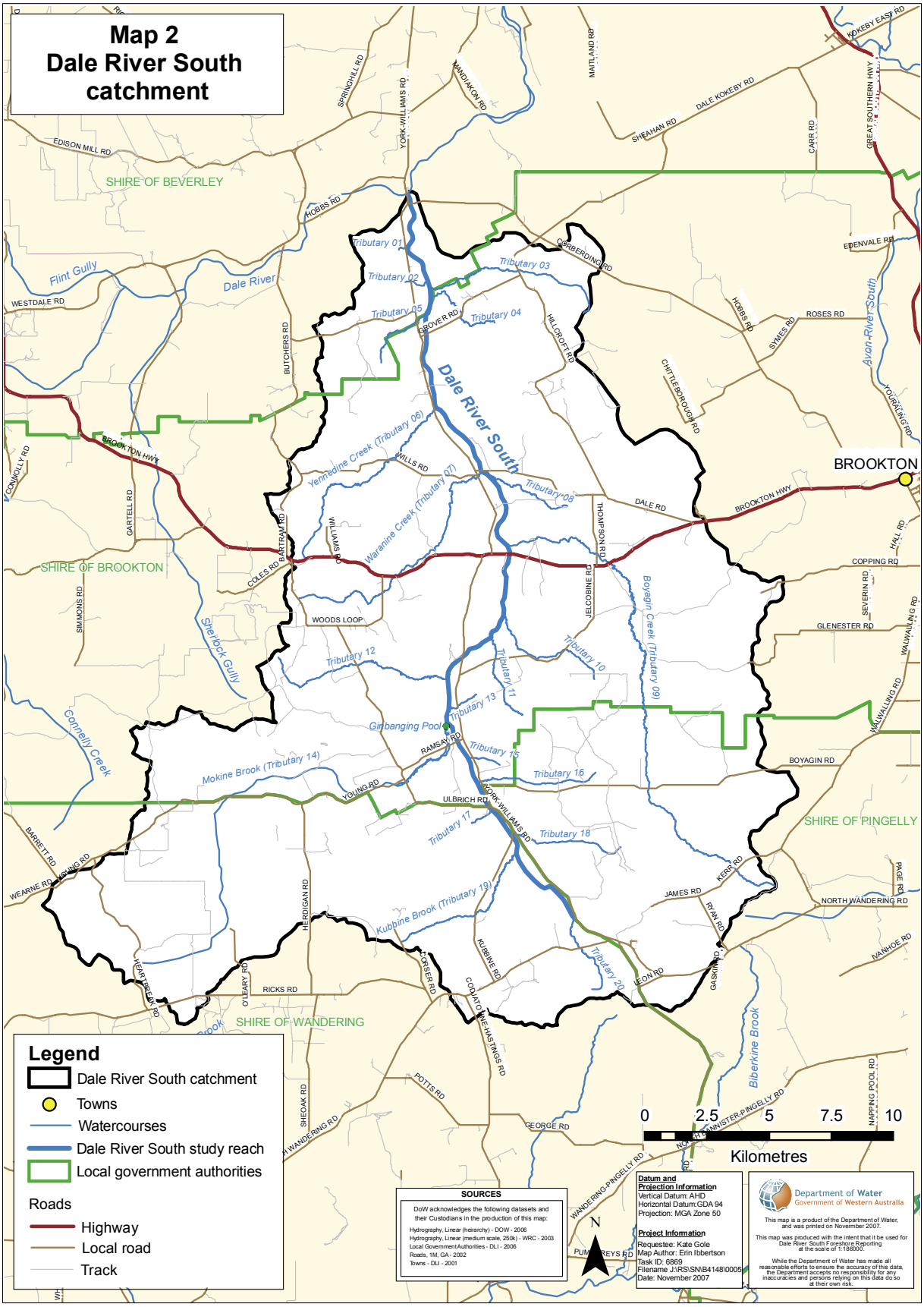
Table 2 Median water quality data for the Dale River South Branch gauging station

Gauging station reference	**Site description**	**Total phosphorus** (mg/L)	**Total nitrogen** (mg/L)	**Salinity classification**
615222	Brookton Highway	0.05	2.20	Saline

[1] *Mayer et al (2005)*

2.5 Tributaries

There are 45 tributaries flowing into the Dale River South. Of these, 20 are considered to be major tributaries, determined by their channel width, depth and flow discharge, which are often influenced by the size of their catchment area. The remaining 25 are minor tributaries that flow intermittently, some of which have a small catchment area. Of the major tributaries, five are named: Yennedine Brook, Waranine Brook, Boyagin Creek, Mokine Brook and Kubbine Brook (refer to Map 2).


Map 2
Dale River South catchment
SHIRE OF BEVERLEY
SHIRE OF BROOKTON
SHIRE OF WANDERING
SHIRE OF PINGELLY
BROOKTON
Dale River South
Dale River
Flint Gully
Yennedine Creek (Tributary 06)
Weramine Creek (Tributary 07)
Sherlock Gully
Connelly Creek
Mokine Brook (Tributary 14)
Kubbine Brook (Tributary 19)
Boyagin Creek (Tributary 09)
Avon River South
Biberkine Brook
Tributary 01
Tributary 02
Tributary 03
Tributary 04
Tributary 05
Tributary 08
Tributary 10
Tributary 11
Tributary 12
Tributary 13
Tributary 15
Tributary 16
Tributary 17
Tributary 18
Tributary 20
Ginbanging Pool
BROOKTON HWY
DALE RD
WOODS LOOP
COPPING RD
GLENESTER RD
BOYAGIN RD
NORTH WANDERING RD
RAMSAY RD
YOUNG RD
ULBRICH RD
RICKS RD
JAMES RD
KERR RD
GEORGE RD
POTTS RD
EDISON MILL RD
WESTDALE RD
HOBBS RD
ROSES RD
EDENVALE RD
KOKEBY EAST RD
DALE KOKEBY RD
SHEAHAN RD
GREAT SOUTHERN HWY
GORBERDING RD
HILLCROFT RD
CHITTLEBOROUGH RD
SIMES RD
YOURALING RD
WILLS RD
BUTCHERS RD
GARTELL RD
CONNOLLY RD
BARTRAM RD
COLES RD
SIMMONS RD
WILLIAMS RD
THOMPSON RD
JELCOBINE RD
SEVERIN RD
HALL RD
WAUWALING RD
NAMMALING RD
YORK-WILLIAMS RD
HERDIGAN RD
O'LEARY RD
KUBBINE RD
CORBALLIS RD
CORBALLIS-HASTINGS RD
GASKIN RD
IVANHOE RD
NAPPING POOL RD
PAGE RD
RYAN RD
WEARNE RD
BARRETT RD
NEARBY CREEK RD
SHEOAK RD
WANDERING-PINGELLY RD
MINISTER-PINGELLY RD
PUMPEREYS RD
MAITLAND RD
SPRINGHILL RD
YORK-WILLIAMS RD
MANDIAKON RD
Legend
Dale River South catchment
Towns
Watercourses
Dale River South study reach
Local government authorities
Roads
Highway
Local road
Track
SOURCES
DoW acknowledges the following datasets and their Custodians in the production of this map:
Hydrography, Linear (heirarchy) - DOW - 2006
Hydrography, Linear (medium scale, 250k) - WRC - 2003
Local Government Authorities - DLI - 2006
Roads, 1M, GA - 2002
Towns - DLI - 2001
N
0 2.5 5 7.5 10
Kilometres
Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum:GDA 94
Projection: MGA Zone 50
Project Information
Requestee: Kate Gole
Map Author: Erin Ibbertson
Task ID: 6869
Filename :J:\RS\SNIB4148\0005
Date: November 2007
Department of Water
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This map was produced with the intent that it be used for Dale River South Foreshore Reporting at the scale of 1:186000.
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3 Description of methods

3.1 Foreshore and channel assessment method

Survey preparation

Before undertaking the foreshore and channel assessment, a letter was sent to landholders along the Dale River South explaining the purpose of the field assessment. Each landholder was then contacted by phone prior to the assessment to gain access to the river.

Landholders were invited to be present during the assessment to gain a familiarity with the assessment process. Some landholders accepted this invitation and provided useful information on historical recreational use, waterway features, and past and current river management practices.

The foreshore and channel assessment was planned using 1:30 000 cadastre maps and 1:10 000 aerial photographs. These maps helped to identify roads, property boundaries, fence lines, tributaries and significant landforms that helped to plan approximate survey sections, and which were later confirmed during the assessment.

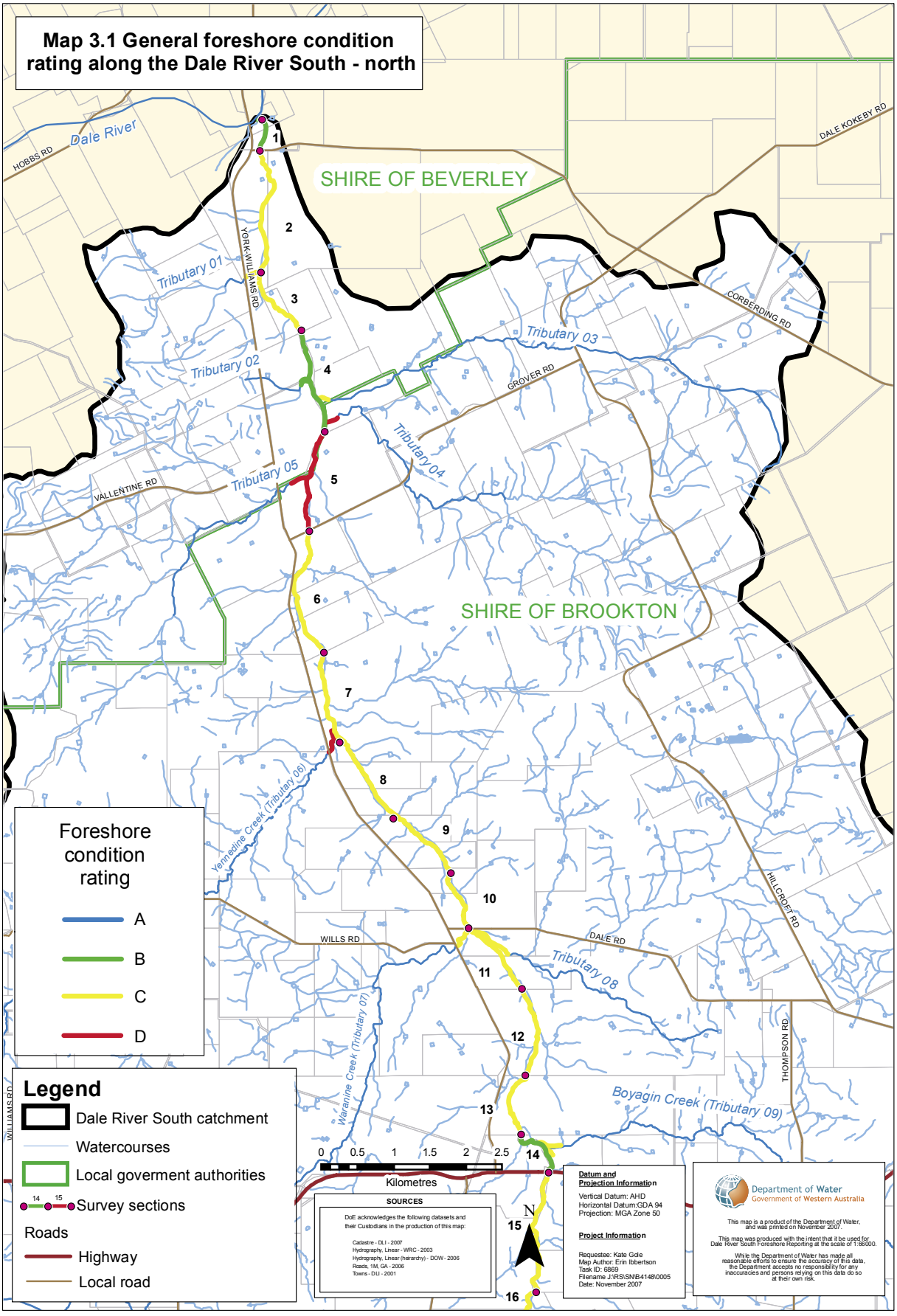
Foreshore and channel assessment method

The current foreshore and channel assessment method has been adapted by the Department of Water for the Avon River catchment from the *Stream foreshore assessment for farming areas* developed by Pen & Scott (1995). This method is detailed in *Foreshore and channel assessment in the Avon River catchment* (Department of Water, 2007).

The foreshore and channel assessment of the Dale River South Branch began at its confluence with the Dale River at Boyadine and was conducted walking upstream towards its headwaters. Both banks were assessed; left and right banks were determined by facing upstream.

The river was divided into 35 sections, the boundaries of which were usually defined by paddock boundaries (refer to Map 3). However, if a significant change in foreshore and channel condition occurred, a new assessment form was completed (refer to Appendix 3). The river was surveyed up to where it branches into two distinct tributaries, just before it crosses the York–Williams Road, north-west of the intersection of North Wandering Road.

It was at this point that it was difficult to ascertain which tributary was actually the main channel, although the linear hydrography on the cadastral maps indicated the main channel crosses the York–Williams Road.


Map 3.1 General foreshore condition rating along the Dale River South - north
Dale River
HOBBS RD
SHIRE OF BEVERLEY
DALE KOKEBY RD
YORK-WILLIAMS RD
Tributary 01
Tributary 02
Tributary 03
CORBERDING RD
GROVER RD
Tributary 04
Tributary 05
VALLENTINE RD
SHIRE OF BROOKTON
Yermedine Creek (Tributary 06)
HILLCROFT RD
WILLS RD
DALE RD
Tributary 08
Waranine Creek (Tributary 07)
THOMPSON RD
Boyagin Creek (Tributary 09)
WILLIAMS RD
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Foreshore condition rating
A
B
C
D
Legend
Dale River South catchment
Watercourses
Local goverment authorities
Survey sections
Roads
Highway
Local road
0 0.5 1 1.5 2 2.5
Kilometres
N
SOURCES
DoE acknowledges the following datasets and their Custodians in the production of this map:
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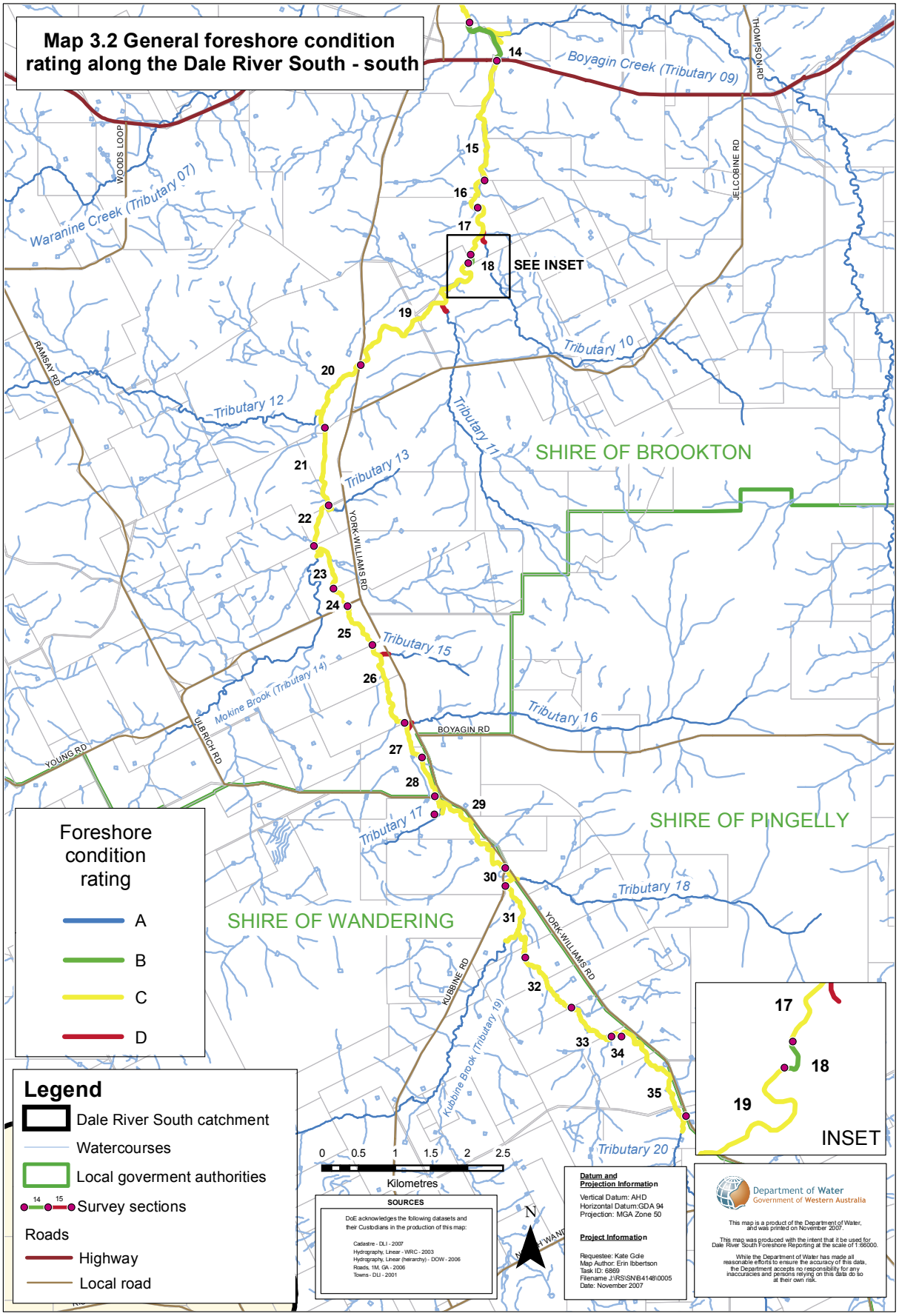
Map 3.2 General foreshore condition rating along the Dale River South - south
Boyagin Creek (Tributary 09)
THOMPSON RD
JELCOBINE RD
WOODS LOOP
Waranine Creek (Tributary 07)
SEE INSET
RAMSAY RD
Tributary 10
Tributary 12
Tributary 11
SHIRE OF BROOKTON
Tributary 13
YORK-WILLIAMS RD
Tributary 15
Mokine Brook (Tributary 14)
ULRICH RD
Tributary 16
BOYAGIN RD
YOUNG RD
SHIRE OF PINGELLY
Tributary 17
Tributary 18
SHIRE OF WANDERING
KUBBINE RD
Kubbine Brook (Tributary 19)
Tributary 20
INSET
Foreshore condition rating
A
B
C
D
Legend
Dale River South catchment
Watercourses
Local goverment authorities
Survey sections
Roads
Highway
Local road
0 0.5 1 1.5 2 2.5
Kilometres
SOURCES
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In addition to the 35 sections assessed in the main channel, 200–300 m of 20 significant tributaries were also assessed (refer to Maps 3.1 and 3.2). The general condition and location of the remaining minor tributaries were recorded and are included in the survey section descriptions in Appendix 2.

Whilst walking along the river banks, the following information was recorded on the foreshore and channel assessment form (Appendix 3):

- GPS coordinates (using a Garmin GPS 76)
- bank stability and erosion
- waterway features
- channel width and depth
- vegetation health
- habitat quality and diversity
- water quality (pH, temperature and electrical conductivity – using an MC81 pH -Cond-Salinity metre)
- fencing condition and stock access
- foreshore condition rating
- overall stream environmental health rating
- evidence of management
- management issues (such as rubbish and fire risk)
- ideas for management (such as fencing and crossing repair)
- riparian vegetation species (including a snapshot of native and introduced species identified in the field)
- species of native and introduced fauna (including a snapshot of bird species, native fauna and introduced fauna identified by sightings, calls or ground disturbance, e.g. feral pigs).

A photographic record was also taken during the assessment, some photos of which are included in this report. The remaining photos are on file at the Department of Water, Northam.

3.2 Information analysis

On completion of the assessment, the results were entered into a Microsoft Access database, designed and created by the Department of Water in Northam. The database is designed to record data from multiple foreshore and channel assessments for analysis and interpretation to assist in future river management.

Queries run in Microsoft Access were then analysed in Microsoft Excel to provide the analysis results provided in Chapter 4.

4 Main findings of the foreshore and channel assessment

4.1 Foreshore condition rating system

One of the main pieces of information collected about the heath of the Dale River South was the foreshore condition rating of each section. The rating indicates the level of degradation by characterising the foreshore in terms of vegetation structure, the balance between native and exotic vegetation and bank stability. Both an overall rating and a 'best' and 'poorest' rating were recorded. The overall rating of each section was determined as the average rating along the whole length of the section and was recorded as A-grade (pristine) through to D-grade (eroding ditch). The 'best' and 'worst' ratings were respectively the highest and lowest ratings determined within the section and were recorded as A1 (pristine) through to D3 (weed-infested drain). The first 300–500 m of significant tributaries was also given a general foreshore rating of A-grade through to D-grade. Appendix 4 shows diagrammatically the overall foreshore condition ratings. A description of each rating and its sub-grades are outlined below.

A-grade foreshore

For a section to be rated as A-grade, the riparian zone must be entirely vegetated with native species. Some weeds may be present but native species still dominate the understorey and there is little or no evidence of disturbance from human activities or feral animals. This general rating is further divided to reflect the level of weed invasion and disturbance.

Rating	Key features
A1 Pristine	The river embankments and floodway are entirely vegetated. with native species and there is no evidence of human presence or livestock damage
A2 Near pristine	Native vegetation dominates. Some introduced weeds may be present in the understorey but not as the dominant species. Otherwise, there is no evidence of human impact.
A3 Slightly disturbed	Native vegetation dominates, but there are some areas of human disturbance where soil may be exposed and there are local weed infestations along tracks. Native vegetation would quickly recolonise if human disturbance declined.

B-grade foreshore

A general B-grade foreshore rating is given to sections where the majority of the vegetation structure is intact but where the understorey has been invaded by weeds. The sub-grades are divided based on the level of weed invasion and its affect on the regeneration of some shrubs and trees.

Rating	Key features
B1 Degraded – weed-infested	Weeds have become a significant component of the understorey vegetation. Native species are still dominant but a few have been replace by weeds.
B2 Degraded – heavily weed-infested	Understorey weeds are nearly as abundant as native species. The regeneration of trees and large shrubs may have declined.
B3 Degraded – weed-dominant	Weeds dominate the understorey, but many native species remain. Some trees and large shrubs may have disappeared.

C-grade foreshore

A C-grade foreshore rating indicates that the foreshore supports only trees over weeds or pasture. As a result of the dominance of weeds in the understorey, bank erosion and subsidence occur in localised areas. The sub-grades for this rating are divided based on the amount of groundcover provided by weeds and the susceptibility of the banks to erosion.

Rating	Key features
C1 Erosion prone	Trees remain with some large shrubs. The understorey consists entirely of weeds (i.e. annual grasses). There is little or no evidence of regeneration of tree species. River embankment and floodway are vulnerable to erosion due to the shallow-rooted weedy understorey providing minimal soil stabilisation and support.
C2 Soil exposed	Older trees remain but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock grazing and trampling or through humans use and activity. Low level soil erosion has begun.
C3 Eroded	Soil is washed away from between tree roots. Trees are being undermined and unsupported embankments are subsiding into the river valley.

D-grade foreshore

A D-grade foreshore rating indicates that there is not enough remaining vegetation to control erosion and the waterway is little more than an eroding ditch or weed-infested drain. Sub-grades are determined by the amount of vegetation present and the severity of erosion.

Rating	Key features
D1 Ditch – eroding	There is not enough fringing vegetation to control erosion. Remaining trees and shrubs act to impede erosion in some areas, but are doomed to be undermined eventually.
D2 Ditch – freely eroding	No significant fringing vegetation remains and erosion is out of control. Undermined and subsided embankments are common. Large sediment plumes are visible along the river channel.
D3 Drain – weed dominant	The highly eroded river valley has been fenced off, preventing control of weeds by stock. Perennial weeds have become established and the river has become a simple drain.

4.1.1 General condition

Table 3 indicates the general condition ratings for the Dale River South. The majority of the main channel and surveyed tributaries were rated as C-grade foreshore (refer to Maps 3.1 and 3.2).

Most of the channel was accessible by stock. Consequently, most sections only support a narrow strip of native trees and shrubs, and a weed-dominated understorey. As with a C-grade foreshore, most sections have bank erosion, sedimentation and some subsidence of the banks.

No sections were rated as A-grade. Four relatively short sections of the main channel and one tributary were rated as B-grade, which were either fenced from stock or had well-managed stock access. Although only one section of the main channel was rated D-grade, six tributaries were rated D-grade, mainly due to the absence of riparian vegetation, dominance of weeds and a significant level of erosion.

Table 3 General condition of the Dale River South

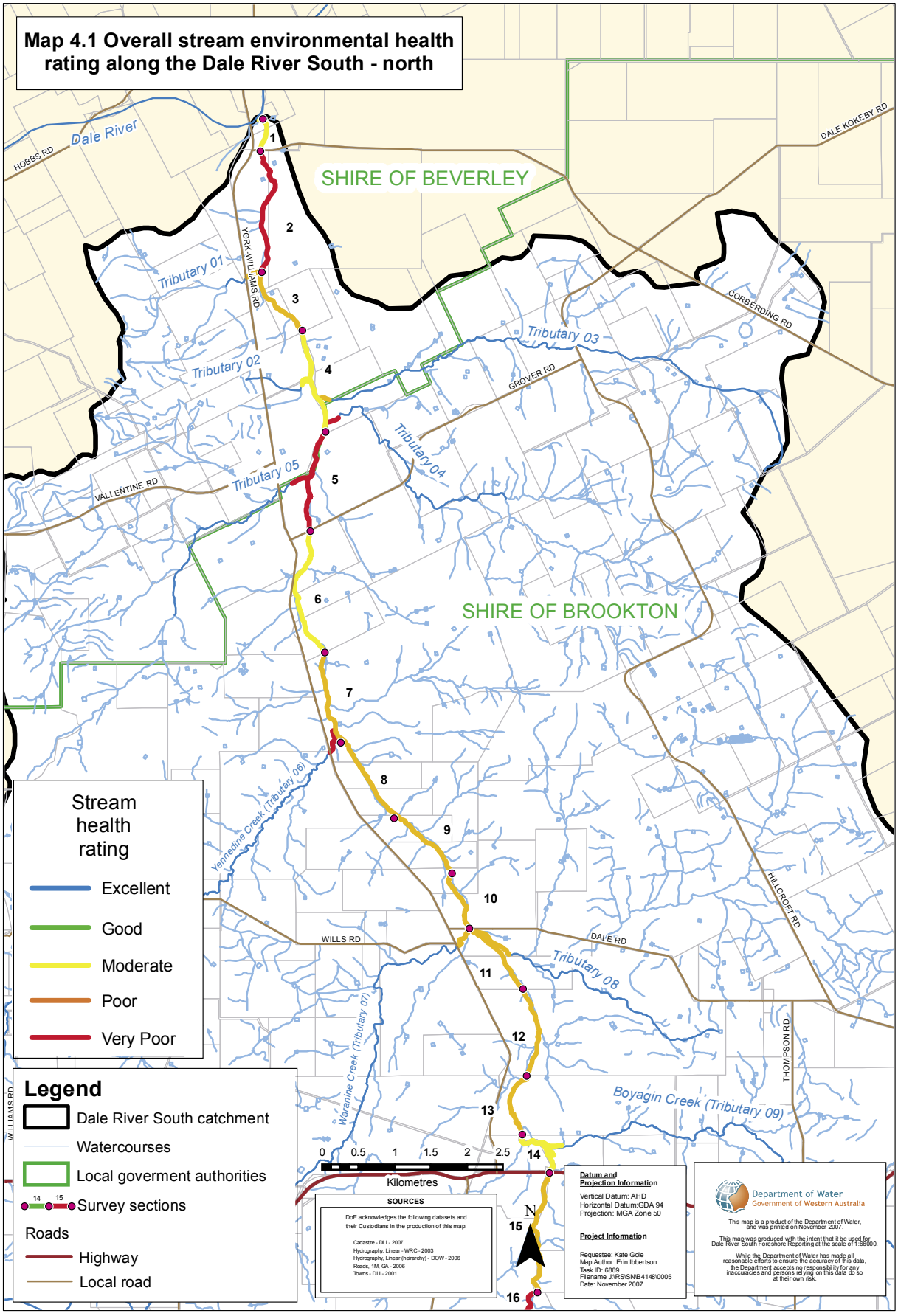
Grade	Main channel (n=35)	Tributaries (n=20)
A-grade foreshore	-	-
B-grade foreshore	4	1
C-grade foreshore	30	13
D-grade foreshore	1	6

Photo 1 *An A-grade reach of the Dale River (Photo: K. Gole, Department of Water)*

Photo 2 *A B-grade reach of the Dale River South*

Photo 3 *C-grade foreshore along the Dale River South*

Photo 4 *D-grade foreshore along the Dale River South*


Map 4.1 Overall stream environmental health rating along the Dale River South - north
SHIRE OF BEVERLEY
SHIRE OF BROOKTON
Dale River
HOBBS RD
DALE KOKEBY RD
YORK-WILLIAMS RD
Tributary 01
Tributary 02
Tributary 03
Tributary 04
Tributary 05
CORBERDING RD
GROVER RD
VALLENTINE RD
WILLS RD
DALE RD
HILLCROFT RD
THOMPSON RD
Yenmedine Creek (Tributary 06)
Waranine Creek (Tributary 07)
Tributary 08
Boyagin Creek (Tributary 09)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Stream health rating
Excellent
Good
Moderate
Poor
Very Poor
Legend
Dale River South catchment
Watercourses
Local goverment authorities
Survey sections
Roads
Highway
Local road
0 0.5 1 1.5 2 2.5
Kilometres
SOURCES
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Datum and Projection Information
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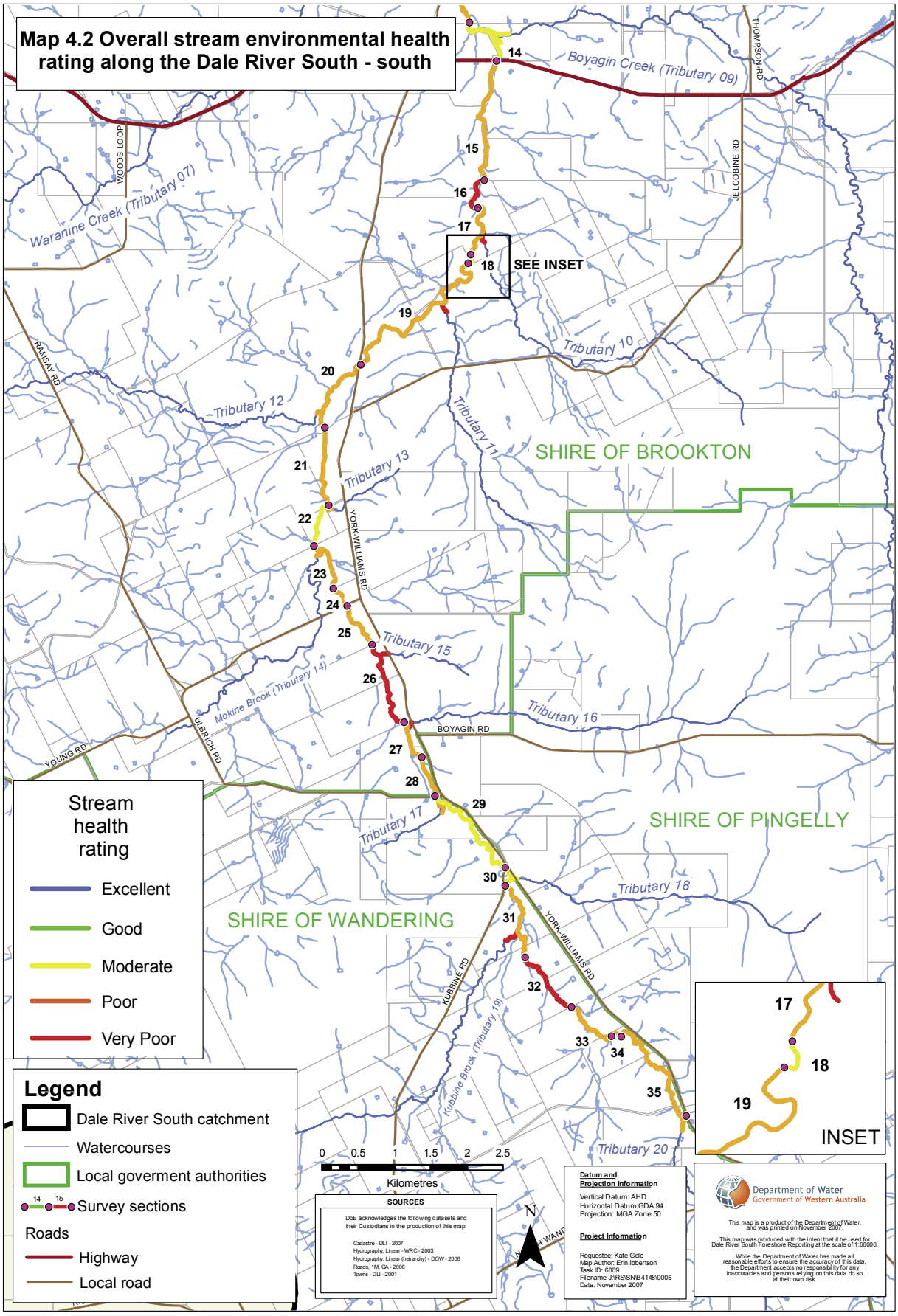
Map 4.2 Overall stream environmental health rating along the Dale River South - south
Boyagin Creek (Tributary 09)
THOMPSON RD
JELCOBINE RD
WOODS LOOP
Waranine Creek (Tributary 07)
SEE INSET
RAMSAY RD
Tributary 10
Tributary 12
Tributary 11
Tributary 13
SHIRE OF BROOKTON
YORK-WILLIAMS RD
Tributary 15
Mokine Brook (Tributary 14)
Tributary 16
BOYAGIN RD
YOUNG RD
ULBRICH RD
Tributary 17
SHIRE OF PINGELLY
Tributary 18
SHIRE OF WANDERING
KUBBINE RD
Kubbine Brook (Tributary 19)
Tributary 20
INSET
Stream health rating
Excellent
Good
Moderate
Poor
Very Poor
Legend
Dale River South catchment
Watercourses
Local goverment authorities
Survey sections
Roads
Highway
Local road
0 0.5 1 1.5 2 2.5
Kilometres
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4.1.2 Best and poorest condition

In the main channel, the best foreshore rating ranged from B1–C3, with the B1 rating being allocated to a portion of section DRS4, which is Crown reserve, although it currently has some stock access. The poorest foreshore rating ranged from D2–B3, with the D2 rating being allocated to the majority of section DRS5, a section which is unfenced and has little riparian vegetation remaining, allowing the banks to erode freely into the channel.

Of the tributaries, the best rating ranged from B3–D1, with tributaries DRSTrib 02, DRSTrib 09 and DRSTrib 18 being allocated a B3 rating. The poorest rating ranged from D2–C1, with six tributaries being allocated a D2 rating.

4.2 Overall stream environmental health rating

In addition to the foreshore condition rating, each section is also rated according to its overall environmental health. The overall stream environmental health rating (OSEHR) is determined according to the following factors:

- floodway and bank vegetation
- verge vegetation
- stream cover
- bank stability and sedimentation
- habitat diversity
- surrounding land use.

The OSEHR for each survey section is shown in Maps 4.1 and 4.2 and Tables 4 and 5. Each of the factors is given a ranking (excellent to very poor) and a corresponding score (refer to Appendix 5). Once each factor is assessed, an overall score is allocated to each section to determine its overall environmental health. An excellent rating is allocated to those waterways in pristine condition, with healthy undisturbed native vegetation, a variety of instream and terrestrial habitats, no weeds or erosion. In contrast, a very poor rating is reserved for waterways that have little to no vegetation, are actively eroding and have lost their ability to provide habitat.

Along the Dale River South, there were no sections rated as excellent or good. Eight sections were rated as moderate, some of those also being rated as B-grade foreshore. The majority of sections were assessed to be in poor environmental health. This was primarily due to the lack of healthy, dense riparian vegetation, presence of weeds and level of erosion, which in turn are leading to a decline in stream cover and habitat diversity.

A similar situation is apparent for the assessed tributaries, with most being assessed as having poor or very poor environmental health. All but three sections were surrounded by agricultural land, which appears to be a contributing factor to the decline in environmental health.

Table 4 Overall stream environmental health rating results for the Dale River South

	No. of sections (n=35)				
	Excellent	**Good**	**Moderate**	**Poor**	**Very poor**
Overall Rating	–	–	8	22	5

Table 5 Overall stream environmental health rating results for assessed tributaries of the Dale River South

	No. of sections (n=20)				
	Excellent	**Good**	**Moderate**	**Poor**	**Very poor**
Overall Rating	–	–	3	10	7

4.3 Waterway features

Every waterway is different with its own set of features that set it apart from neighbouring waterways. The presence of waterway features such as deep pools, riffles, anabranches, large woody debris and wetlands provide an indication of the health of the waterway. Features such as dams, sediment slugs, bridges and crossings are often present as a result of human use or disturbance and may relate to poor waterway health. A summary of the waterway features observed along the Dale River South is provided in Table 6.

Table 6 Summary of waterway features for Dale River South and its tributaries

Waterway feature	**Dale River South (n=35)**	**Tributaries (n=20)**
Single channel	23	20
Braided channel	16	–
Deep pool	15	2
Wetlands	2	–
Groundwater seep	1	1
Natural riffle	12	–
Anabranch	11	–
Tributary	45	2
Large woody debris	33	18
Vegetated island	6	–
Constructed riffles	14	4
Sediment slug	33	15
Crossing	22	–
Dam	2	1
Bridge	9	1

4.3.1 Channel and floodplain morphology

Channel braiding can be classified into two distinct groups: braiding that occurs as a result of vegetation colonising sediment slugs and natural braiding, where the river naturally forms two channels. In their natural state, many of the waterways in the ZRD, including the Avon River, were braided.

The majority of the Dale River South is contained within one channel, although some sections are naturally braided, forming a double channel. Braiding tends to be restricted to the lower reaches, downstream of the Brookton Highway Bridge, where the floodplain is broader.

Braiding as a result of water being forced around vegetated sediment slugs occurs in a number of sections, usually those with a high level of erosion or where saltwater couch (*Paspalum vaginatum*) has colonised a sediment slug.

There are a greater number of anabranches downstream of the Brookton Highway Bridge. Anabranches are side channels that carry water in high flow events and consequently serve an important hydrological and ecological function. However, it appears as though many of these anabranches seldom carry water now, possibly as a consequence of the main channel being incised by erosion, coupled with reduced streamflow in the past few decades.

Generally, the width of the channel decreased upstream due to the decreased volume of water it carries in the upper reaches. The depth of the channel varied. The depth appeared greatest in the middle reaches, rather than the lower reaches, which was probably due to the large amount of sediment that has shifted downstream, filling the channel in the lower reaches.

4.3.2 Pools and riffles

Many of the waterways in the ZRD flow intermittently, which raises the importance of river pools as the only local source of permanent water for aquatic and terrestrial fauna.

Along the Dale River South, many of the original river pools have been filled with sediment. Of the 35 sections surveyed, only 15 had deep pools that would hold water over the summer months.

Anecdotal evidence from some landholders suggests that many of the current pools were much larger and deeper, but have filled in with sediment over the last 15 or so years. This may be related to the reduced rainfall over a similar period, which has been insufficient to produce flushing flows that will scour the sediment from these pools. This situation is also evident in the Canning River catchment, south-east of Perth, where river pools have filled with sediment due to fewer flushing flows in the past 25 years, a trend which has been linked to a decline in rainfall.

Riffles are essentially a shallow stretch of the waterway where the water flow becomes turbulent as it passes over rocks, woody debris or pebbles. Riffles are an important waterway feature, as they provide important habitat for aquatic invertebrates and juvenile fish. Riffles also help oxygenate the water column, as the turbulent water increases its contact with the air, allowing oxygenation of the water (Pen 1999).

Naturally occurring riffles were present in 12 of the 35 surveyed sections. Some of these riffles were created by accumulated woody debris, some were formed by granite bedrock intrusion, and others were the classic cobble and pebble stone variety. The most significant riffle, and waterway feature of the Dale River South, occurred in Section DRS26 (Photo 5). This large riffle is approximately 70 m long and forms the widest point of the river, stretching approximately 30 m across. This riffle occurs in an area that has granite outcrops both sides of the river and has probably formed as a result of weathered granite bedrock.

Riffles also act to trap sediment, which is later removed by flushing flows. However, much of the Dale River South is actively eroding, therefore it is assumed that many of the cobble and pebble riffles that once existed along this waterway are now completely covered with sediment.

Photo 5 *Significant riffle in survey section DRS26*

4.3.3 Large woody debris

Large woody debris includes fallen trees, logs, branches and twigs. It is also referred to as snags. Woody debris is essential to the functioning of waterways, as it slows the flow of water and also provides habitat and food to aquatic and terrestrial animals.

Of the 35 sections surveyed, 33 had woody debris present, and all but two tributaries also had some woody debris. Sections DRS7 and DRS8 had a large build-up of debris on some meanders that was causing lateral erosion of adjacent banks. It is important to leave woody debris alone in most cases, but in some individual instances where it is deflecting flow into the bank, it should be carefully repositioned. Specific locations and recommendations for management of these sites are included in Appendix 2.

4.3.4 Constructed features

The survey also assessed the number of constructed features along the waterway including dams, constructed riffles, crossings and bridges.

There were only two dams directly adjacent to the main channel, and neither appeared to be causing any significant impact. There was another dam on DRSTrib 01 that was seeping groundwater, but again, it was not causing adverse impacts.

There were 11 fixed road crossings including:

- Dale Kokeby Road – bridge (survey section DRS01)
- Grover Road – two box over ten pipes culvert (DRS05)
- Blight's access road – five-piped culvert (DRS07)
- Dale Road – three-box culvert (DRS10)
- Meecham's farm sheds access road – three-piped culvert (DRS12)
- Brookton Highway – bridge (DRS14)
- York–Williams Road – bridge (DRS19)
- Matthews Road – bridge (DRS24)
- Ulbrich Road – two-piped culvert (DRS28)
- Kubbine Road – three-box culvert (DRS29)
- York–Williams Road – four pipes and one-box culvert (DRS35)

There were also numerous other farm crossings which were designed to enable stock and vehicle access. Many of these crossings have been stabilised with field stone, which means they double as a constructed riffle, allowing oxygenation of the water.

Photo 6 *Farm crossing stabilised with field stone*

4.4 Channel stability, bank stability and sediments

Channel and bank stability are directly influenced by vegetation cover. Fringing vegetation protects the banks from the erosive capacity of water. If the fringing vegetation is removed, the banks will erode, undercutting will occur and banks will collapse into the channel. This sediment is then transported downstream, often settling in pools and forming sediment deposits.

Table 7 explains the rating system used to determine bank stability. Sedimentation and undercutting were the most significant forms of erosion along the Dale River South, with all sections having sediment slugs, even if only localised. Sedimentation was rated as significant in 27 sections and severe in three sections. Undercutting was significant in 13 sections and severe in two (Table 8).

Table 7 Rating system used to determine bank stability

Proportion (%) of river bank affected	Rating
0–5%	Minimal
5–20%	Localised
20–50%	Significant
>50%	Severe

Source: adapted from Water and Rivers Commission, 1999

Photo 7 *Sedimentation deposit in a degraded section of the Dale River South*

Photo 8 *Significant undercutting of a flooded gum (*Eucalyptus rudis*)*

Table 8 Bank stability rating results for main channel (main channel n=35)

Rating	Erosion process					
	Undercutting	Track washout	Subsidence	Gully erosion	Sedimentation	Slumping
Minimal	5	28	24	8	–	15
Localised	15	7	11	27	5	17
Significant	13	–	–	–	27	3
Severe	2	–	–	–	3	–

There was some correlation between undercutting and sedimentation, with all sections having significant or severe undercutting also having significant or severe sedimentation. However, many sections had minimal or localised undercutting but significant sedimentation, meaning that the sediment had probably washed in from tributaries, overland flow or from further upstream.

The Dale River South is predominately contained within private land holdings and most of it has been grazed for many decades. This has resulted in a loss of understorey along most of the river, which is important for protecting and stabilising the banks and floodplain.

In many areas, even weed growth was minimal, as the survey was conducted just before significant rainfall. Some of this exposed soil would undoubtedly be transported into the river during significant rainfall events.

Track washouts and gully erosion were either absent or localised along all of the Dale River South. Most of the track washouts were restricted to a few farm crossings, where soil was soft along the sides of the track, and had been washed away. Gully erosion was restricted to the confluence of a few tributaries or within the tributaries themselves.

The stability of the tributaries varied (Table 9). Some of the tributaries had no flow, very broad channels and moderately sloping banks, making them quite stable. Others had steep, exposed banks making them vulnerable to undercutting and subsidence. The majority of tributaries were unfenced and grazed with little riparian vegetation, so even if they had little active erosion, they would be contributing sediment via overland flow into the main channel.

Photo 9 *Erosion and washout of a track crossing the Dale River South*

Photo 10 *Tributary with moderately sloping, stable banks*

Table 9 Bank stability rating results for tributaries (tributaries n=20)

Rating	Erosion process					
	Undercutting	Track washout	Subsidence	Gully erosion	Sedimentation	Slumping
Minimal	5	13	14	17	2	10
Localised	8	7	5	3	9	5
Significant	6	–	1	–	8	5
Severe	1	–	–	–	1	–

4.5 Fencing and stock access

Controlling stock access by fencing the waterway is the single most effective technique for stabilising banks and reducing erosion. During the survey, the presence and condition of fencing was assessed along each section and tributary. Approximately 39 km of the river was surveyed, of which 15.1 km (38%) of the left bank and 13.6 km (35%) of the right bank was fenced. Only 2.5 km (6%) was fenced on both sides (refer to Appendix 6).

Along most of the Dale River South, the position of fencing is such that most of the river is contained within farm paddocks, usually used for stock grazing for some part of the year, with the fence line making the boundary fence of the paddock. In most cases the fence was positioned 20 m or more away from the channel.

Stock and vehicle access was also recorded during the survey. Ninety-one per cent of the main channel is accessible by stock and 51% is accessible by vehicle, with many sections having vehicle crossings, many of which double as constructed riffles (refer to Photo 11). Most of the Dale River South appears to be actively used in current farm management practices, either as a source of water or feed for stock.

The condition of existing fencing varies considerably. Condition was recorded as:

- good – relatively new and expected to remain stock-proof with minor maintenance for >30 years
- moderate – fence is stock-proof but will need maintenance or replacement within 10–20 years, or
- poor – fence is barely stock-proof and will need to be replaced within 5 years.

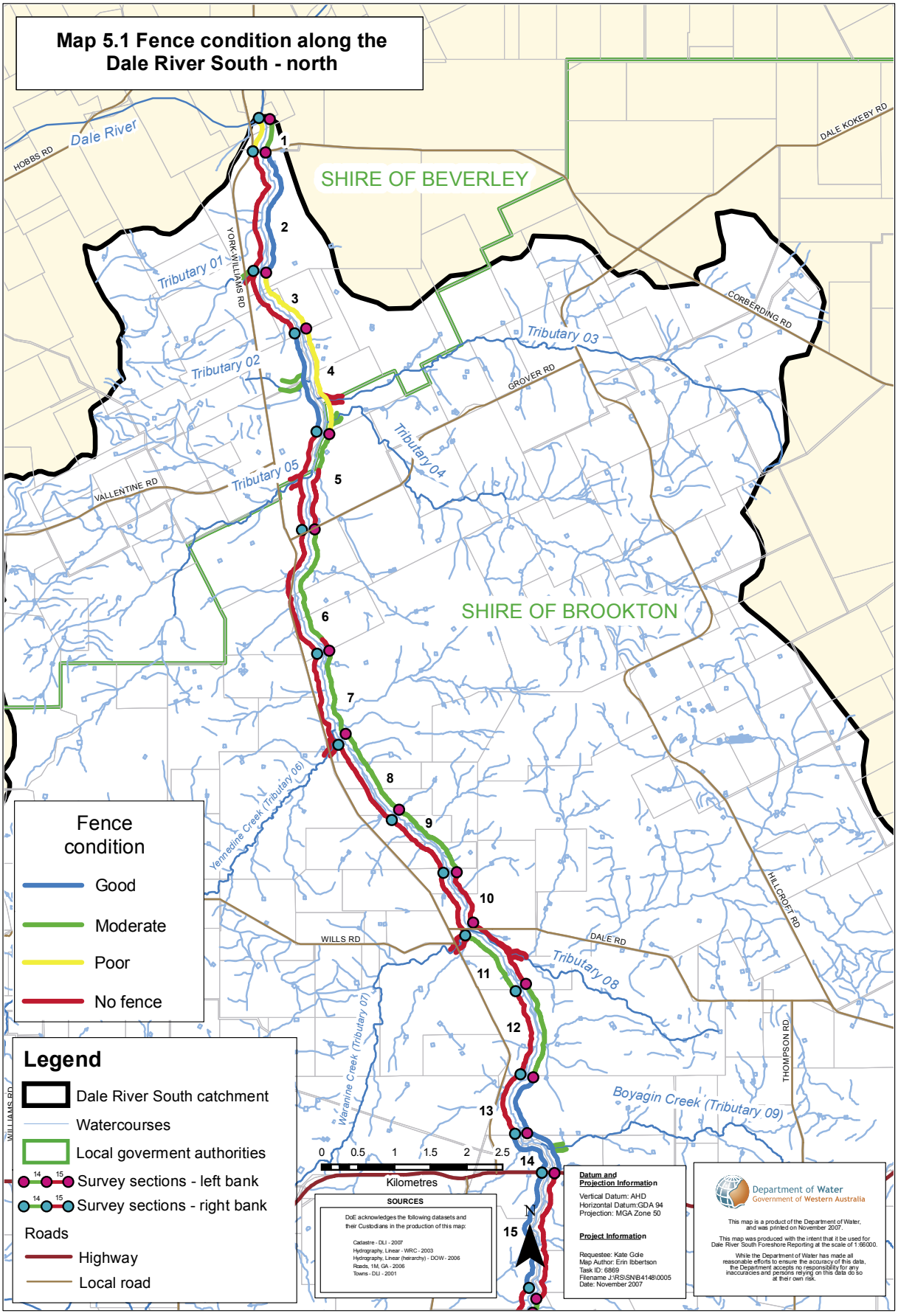
Photos in Appendix 7 show examples of good, moderate and poor fence condition.

Appendix 6 provides detail on the length and condition of fencing along each section. Most of the fencing was in moderate to good condition, with only 2.1 km (5%) being rated as poor.

Photo 11 *Vehicle crossing which doubles as a riffle*

Most of the tributaries are accessed by stock, with only two tributaries (DRSTrib 02 and DRSTrib 18) being fenced from stock, although both are unfenced after approximately 150–200 m. Forty per cent of the tributaries are accessible by vehicle, with all of these sections having a vehicle crossing, allowing farm machinery access.

Landholders interested in fencing the Dale River South or its tributaries may be eligible to receive fencing materials through the Avon Fencing Project. For more information refer to Section 5.5.


Map 5.1 Fence condition along the Dale River South - north
Dale River
HOBBS RD
SHIRE OF BEVERLEY
DALE KOKEBY RD
YORK-WILLIAMS RD
Tributary 01
Tributary 02
Tributary 03
CORBERDING RD
GROVER RD
Tributary 04
Tributary 05
VALLENTINE RD
SHIRE OF BROOKTON
Yennedine Creek (Tributary 06)
WILLIAMS RD
WILLS RD
DALE RD
HILLCROFT RD
Tributary 08
Waranine Creek (Tributary 07)
THOMPSON RD
Boyagin Creek (Tributary 09)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Fence condition
Good
Moderate
Poor
No fence
Legend
Dale River South catchment
Watercourses
Local goverment authorities
Survey sections - left bank
Survey sections - right bank
Roads
Highway
Local road
0 0.5 1 1.5 2 2.5
Kilometres
SOURCES
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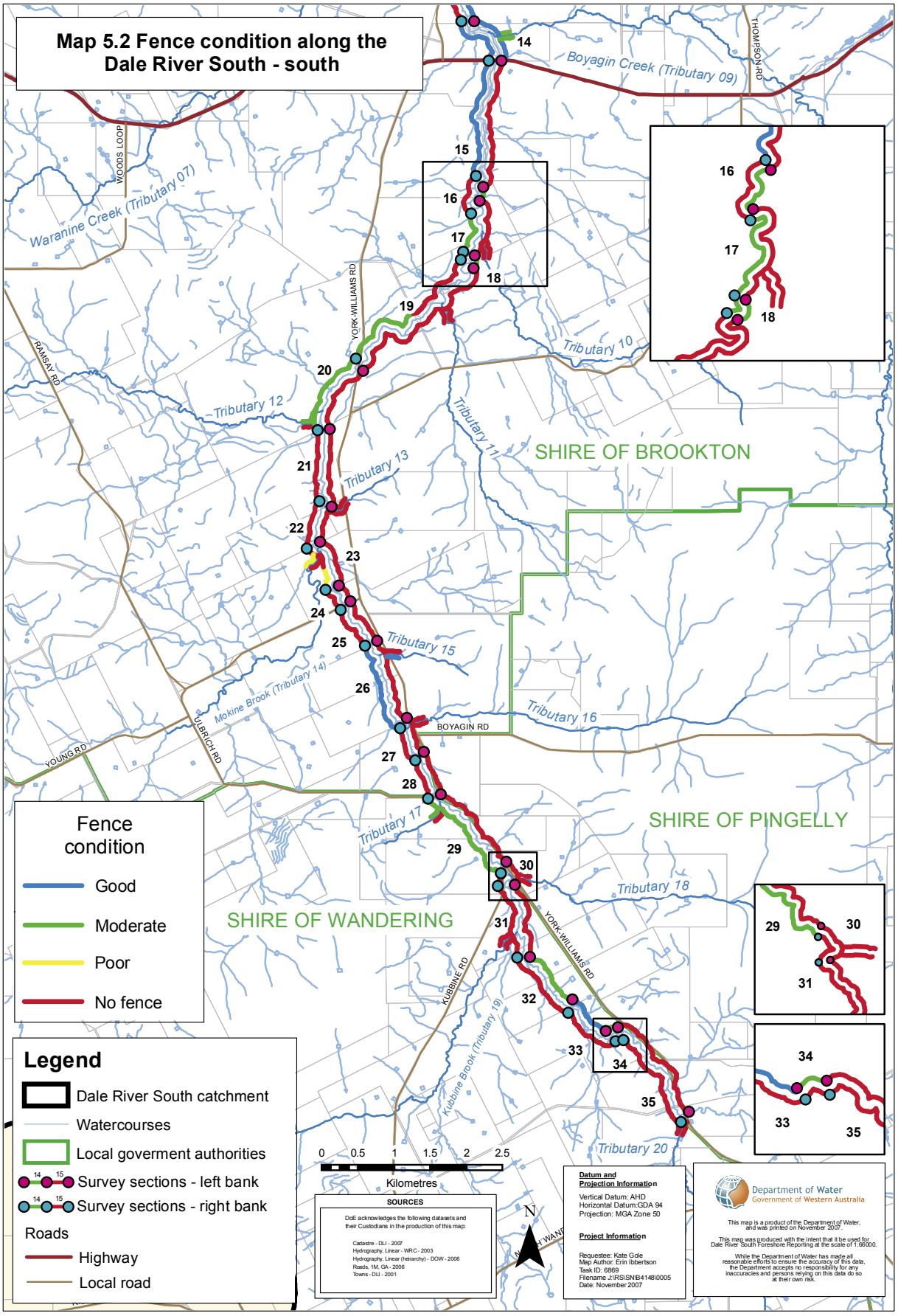
Map 5.2 Fence condition along the Dale River South - south
Boyagin Creek (Tributary 09)
THOMPSON RD
WOODS LOOP
Waranine Creek (Tributary 07)
YORK-WILLIAMS RD
RAMSAY RD
Tributary 10
Tributary 12
Tributary 11
Tributary 13
SHIRE OF BROOKTON
Tributary 15
Mokine Brook (Tributary 14)
ULBRICH RD
YOUNG RD
BOYAGIN RD
Tributary 16
Tributary 17
SHIRE OF PINGELLY
SHIRE OF WANDERING
Tributary 18
KUBBINE RD
Kubbine Brook (Tributary 19)
Tributary 20
Fence condition
Good
Moderate
Poor
No fence
Legend
Dale River South catchment
Watercourses
Local goverment authorities
Survey sections - left bank
Survey sections - right bank
Roads
Highway
Local road
0 0.5 1 1.5 2 2.5
Kilometres
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4.6 Water quality

Water quality parameters were tested during the survey, which was undertaken in June–July 2007. Water quality parameters tested included pH, temperature and electrical conductivity (as a measure of salinity) and a general observation was made about water turbidity (clarity). Samples were collected at the start of each section and parameters were analysed immediately.

All salinity levels recorded in Dale River South are considered to be saline (Figure 2). A salinity classification is provided in Table 10.

Table 10 Salinity ranges and classifications with a comparison to sea water

Salinity status	mg/L	mS/m	mS/cm	grains/gallon
Fresh	0–500	0–91	0–0.9	0–35
Marginal	500–1 000	91–182	0.9–1.8	35–70
Brackish	1 000–2 000	182–364	1.8–3.6	70–140
Moderately saline	2 000–5 000	364–909	3.6–9.1	140–350
Saline	5 000–10 000	909–1 818	9.1–18.2	350–700
Highly saline	10 000–35 000	1 818–6 363	18.2–63.6	700–2 450
Brine	> 35 000	> 6 363	> 63.6	> 2 450
Sea water	35 000	6 363	63.6	2 450

Adapted from Mayer et al, 2005 and Department of Fisheries, 2007

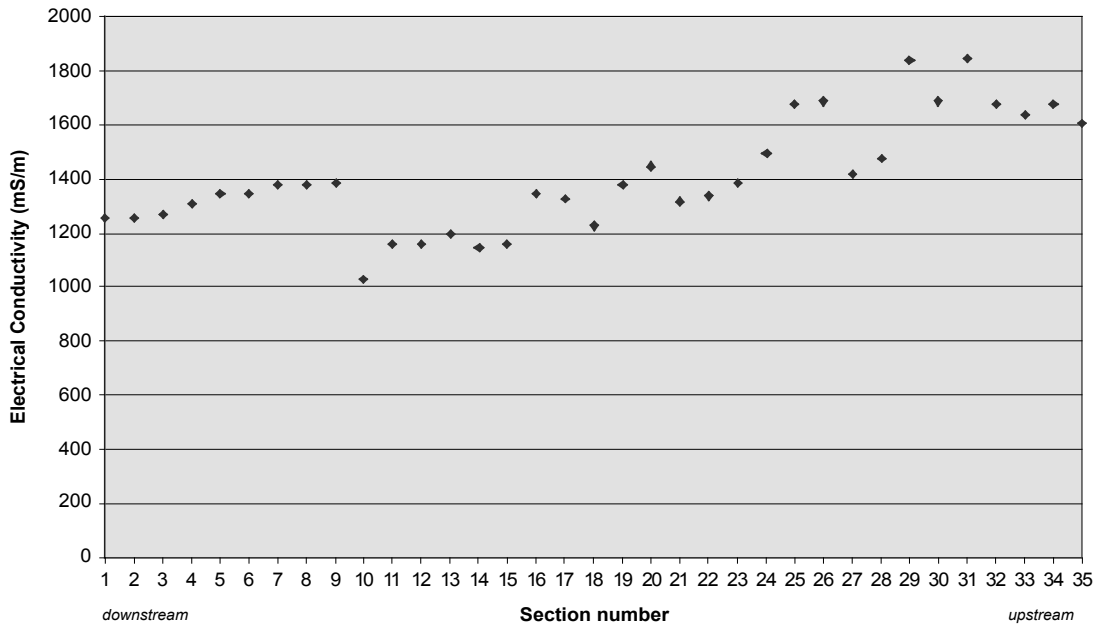

Figure 2 *Salinity levels recorded for each survey section on the Dale River South, June–July 2007 (Section number 1 indicates downstream end, 35 indicates upstream end)*

Salinity levels generally increased upstream, although survey section DRS10 recorded a lower reading (1030 mS/m), probably because the sample was taken a week after the previous section, during which time there were a few days of rainfall.

Eight of the surveyed tributaries had no flow, therefore no water quality parameters were tested. Of the remaining tributaries, salinity levels were consistent with those recorded in the main channel, with the exception of DRSTrib 08 and DRSTrib 19, which had readings of 2030 mS/m and 2110 mS/m respectively.

General observations of water quality were recorded during sampling. In most sections a clear base flow with a fine sediment load was observed. However, a stagnant, low flow was observed in some sections of DRS30. Of the 12 tributaries that had flow, six had cloudy or stagnant water.

It should be noted that the samples taken during the survey are one-off snapshot samples and cannot be used to indicate water quality trends. Refer to Section 2.4 and Appendix 1 for detailed historical water quality data.

4.7 Riparian zone vegetation

There were 16 native species identified during the survey, dominated by an overstorey of flooded gum (*Eucalyptus rudis*) and wandoo (*Eucalyptus wandoo*), with York gum (*Eucapltus loxophelba*) being more common in the upper reaches of the river. The middlestorey was dominated by swamp paperbark (*Melaleuca rhaphiophylla*) in the lower reaches; jam (*Acacia acuminata*) and golden wreath wattle (*Acacia saligna*) occurred throughout.

The understorey was dominated by weeds, with 12 introduced species identified. The most dominant weeds included flatweed (*Hypochaeris spp*), soursob (*Oxalis pes-caprae*), capeweed (*Arctotheca calendula*), wild oats (*Avena fatua*) and barley grass (*Hordeum leporinum).* Saltwater couch (*Paspalum vaginatum)* only occurred in sections that were not heavily grazed, as it appears to be palatable to sheep, with one landholder commenting on its usefulness to fatten young lambs.

In sections where there was limited or no stock access, native species occurred in the understorey, including pithy saw sedge (*Lepidosperma longitudinale*), pale rush *(Juncus pallidus),* shore rush (*Juncus kraussii*) and bare twigrush (*Baumea juncea).*

This is a snapshot of the species present and it is possible there are some species present that were not identified during the survey, including some annual agricultural weeds. A full list of species identified during the survey can be found in Appendix 8.

Photo 12 *Dense stand of shore rush (*Juncus kraussii*) in the floodway*

4.7.1 Vegetation health

Along each section, an assessment was made on the overall health of vegetation. The presence of dead trees and/or foliage loss may be an indication of disease, insect attack, waterlogging, salinity or stock pressures.

The vegetation appeared healthy in only two (5%) sections. There were signs of declining health in 17 (48%) sections, mostly as a result of jarrah leafminer (*Perthida glyphopa*) affecting the flooded gum (*Eucalyptus rudis*). In 16 (45%) sections there were dead trees and in some of these sections, little regeneration. This may be due to a combination of disturbances including salinity, waterlogging and stock grazing pressures.

The vegetation along the tributaries appeared in poor health, with 12 (60%) sections having foliage loss and eight (40%) having dead trees.

4.7.2 Regeneration of native species

Regeneration of native species is critical to ensure there is adequate replacement of the species that die as a result of natural or human disturbances (i.e. disease, fire, erosion, grazing). Regeneration will only be successful if disturbances are limited during the plants' critical growth period.

Of the 35 sections surveyed, 22 sections had regeneration of one or more species. Only four of the tributaries had regeneration of one or more species. Regeneration was more frequent in areas with limited stock access or where stock could not easily get to, such as vegetated islands, and under shrubs and low branches. The sections with no stock access had some regeneration, although seedlings were competing with the significant weed infestation in the understorey.

Dominant regenerating species included:

- flooded gum (*Eucalyptus rudis*)
- jam (*Acacia acuminata*)
- swamp paperbark (*Melaleuca rhaphiophylla*)
- golden wreath wattle (*Acacia saligna*)
- pithy saw sedge (*Lepidosperma longitudinale*)
- shore rush (*Juncus kraussii*).

4.8 Habitat diversity and animals

The habitat of aquatic and terrestrial animals varies greatly in a river system, with some being able to utilise the entire waterway and others being restricted to localised areas, such as pools or riffles.

Aquatic habitat diversity usually increases when there are a variety of waterway conditions and features, such as fast and slow moving water, shaded and exposed areas, sandy and rocky beds, shallow and deep water, and inundated floodplains or anabranches.

Terrestrial habitat diversity is directly related to the species diversity of riparian vegetation, a variety of under-, middle- and upperstorey species providing a variety of micro-habitats for birds, reptiles, frogs and mammals.

In the Dale River South, aquatic habitats (refer to Table 11) were dominated by meanders and shallow–deep pools in the main channel, present in 33 (94%) sections. The deeper pools provide important summer refuge for aquatic and terrestrial animals. There were also 32 (91%) sections that had instream logs, and 18 (51%) sections had instream rocks or boulders, many of which were protruding granite outcrops. There were only two aquatic species observed, being the introduced mosquitofish (*Gambusia holbrooki*) and gilgie (*Cherax spp.*).

Trees and shrubs were the dominant terrestrial habitat (refer to Table 12), with all sections of the main channel having trees and 28 (80%) sections having shrubs. The over- and middlestorey provide a good habitat for birds, with 23 species observed during the survey (Appendix 8). Only three sections had dense protective vegetation (usually sedges) for mammals. This was reflected in the low occurrence of native mammals, with only one echidna (*Tachyglossidae spp.*) observed and a few western grey kangaroos (*Macropus fuliginosus*).

Table 11 Aquatic habitat diversity recorded on the Dale River South

Aquatic habitat	Dale River South (n=35)	Tributaries (n=20)
Aquatic invertebrates, reptiles and fish		
Riffles	16	2
Meanders, pools	33	11
Instream rocks, boulders	18	3
Instream logs	32	19
Variety of instream and bank vegetation	8	1
Frogs		
Emergent plants	10	2

Table 12 Terrestrial habitat diversity recorded on the Dale River South

Terrestrial habitat	Dale River South (n=35)	Tributaries (n=20)
Terrestrial invertebrates		
Variety of vegetation types	4	–
Protected basking sites	18	4
Birds		
Trees	35	19
Shrubs	28	10
Rushes	10	2
Reptiles		
Variety of vegetation types	2	1
Protected basking/nesting sites	15	4
Mammals		
Dense protective vegetation	3	–
Frogs		
Dense riparian vegetation	3	1

4.9 Feral animals

Feral animals can be a nuisance to landholders and place additional pressures on riparian vegetation and native animals. They also exert pressure on soil stability, with the disturbance they create through digging and burrowing. European red fox (*Vulpes vulpes)* were observed in five sections (15%), some of which had been recently culled by landholders during lambing. There were three feral cats (*Felis catus)* observed during the survey and evidence of feral pigs (*Sus scrofa*) in the upper reaches.

5 Interpretation of results and implications for management

The Dale River South was surveyed to determine the foreshore and channel condition of the waterway. The Dale River South is an important tributary of the Dale River, which in turn flows into the Avon River. Therefore it is important to protect its remaining assets and, where possible, improve those that are degraded.

This section provides a brief interpretation of the main findings and a discussion on the most appropriate way to manage the main issues of concern. Appendix 2 provides a description of each section and specific management options.

Additional information and practical advice on river management can be found in the *Field guide for managing waterways in the Avon Wheatbelt,* available from the Department of Water, Northam.

5.1 River features

Although the river is degraded, interesting natural features of the Dale River South are still evident. Many of the deep, long, river pools have filled with sediment and a number of anabranches have now been cut off from the main channel due to downward incision of the main channel. A large riffle in section DRS26 occurs between two granite outcrops and is a picturesque section of the river, although it is degraded and the riparian vegetation is under pressure. It is recommended that this riffle and the upstream pool are fenced to protect this asset.

The natural braiding of the river downstream of the Brookton Highway Bridge is a significant feature, although the current level of stock access has compromised the health of vegetation and stability of banks along the islands. To protect the banks from further erosion and improve the health of vegetation on the islands, it is recommended that both sides of the river are fenced to limit stock access.

5.2 Riparian vegetation and foreshore condition

Riparian vegetation is vital to the health of waterways and ensures the protection of adjacent land. Riparian vegetation stabilises banks, provides terrestrial and instream habitat, slows the flow and erosive capacity of water, filters sediment and nutrients, and provides an important source of carbon to the ecological functioning of the river.

There are no sections of the Dale River South that resemble the original state of the riparian vegetation that would have existed before European settlement. Only three sections have dense understorey vegetation, usually comprised of one or two species of native sedges or rushes.

The C-grade rating allocated to most of the Dale River South is a reflection of decades of intensive agricultural use. Most of the river and its tributaries are accessible by stock and most landholders depend on the river for stock watering.

5.3 Erosion and sedimentation

Uncontrolled stock access leads to the destruction of fringing vegetation, especially understorey species that are essential for stabilising banks. Exposed banks are eroded and collapse into the channel causing sediment slugs.

The Dale River South has a high level of bank undercutting, in many instances near large trees, which over time will cause the trees to collapse into the channel. Sedimentation is also significant, which leads to the infilling of pools and smothering of aquatic habitat.

The level of erosion should be of concern to adjacent landholders. As the banks collapse, the main channel will continue to erode into adjoining farmland and may impact upon fence lines and bridges. Failure to manage erosion early may require landholders to fence off much larger areas of valuable farmland in the future in an effort to protect crops and grazing land.

5.4 Protection of assets

Past land management practices have degraded most of the Dale River South. However, it still retains valuable ecological and hydrological functions, which should be protected to improve the health of the catchment and downstream waterways.

5.4.1 Pools

There are a number of deep pools along the river that, although partially filled with sediment, still provide important refuge for terrestrial and aquatic wildlife, especially throughout the summer months.

Significant pools exist in sections DRS12, DRS14 (Crown reserve), DRS19, DRS20, DRS22, DRS23 (Ginbanging Pool, immediately downstream of the Mokine Brook confluence), DRS26 and DRS34. In all sections except DRS14 these pools have been, or are, used as stock watering points.

These pools are at risk of eventually being filled in with sediment, due to the lack of fringing vegetation and level of bank erosion in the Dale River South. Additional fencing to limit stock access and encourage regeneration of fringing vegetation will enable the banks to stabilise and slow the sedimentation of these pools. Off-stream stock watering points or fenced crossings stabilised with field stone would enable landholders to continue to use the river for stock watering, but reduce the erosion caused by stock trampling.

More information and practical advice on designing stock watering points can be found in Water Notes WN6 and WN7 (Water and Rivers Commission, 2000a; Water and Rivers Commission 2000b) available through the Department of Water website.

5.4.2 Fringing vegetation

It is important that fringing vegetation (i.e. sections with healthy, dense vegetation including native understorey species) is protected. The most effective method of protection is fencing to limit stock access.

Section DRS14 is unallocated Crown land (UCL) and is fenced to exclude stock. Section DRS18 is the only fenced private land that has no stock access. Weed infestation is a problem in these sections and the fringing vegetation could benefit from weed suppression, which may be relatively inexpensive given that they are both short sections (~900 m and ~200 m respectively).

Section DRS04 is designated as UCL, although there are obvious signs of stock access due to the poor condition of fencing on the left bank and at the start and end of the section. To protect the significant stands of pithy sword sedge (*Lepidosperma longitudinale*) that are stabilising the bank, filtering sediment and providing important habitat, the fencing should be improved. The adjacent farmland has recently been purchased by a neighbouring landholder. The vesting authority should hold discussions with the new owner to confirm property boundaries.

Sections DRS01, DRS06, DRS19, DRS22 and DRS29 would benefit significantly from fencing. These sections have relatively healthy fringing vegetation and understorey species, mostly sedges or rushes, which are stabilising the banks. Limiting stock access will enable the understorey species to spread and native tree species to regenerate.

5.4.3 Remnant vegetation

Western Australia is a biologically diverse state. Nature reserves aid in conserving this diversity of plants and animals and often preserve geologically important areas as well.

Waterways act as ecological corridors or ‘transport routes’ for plants and animals moving between nature reserves and areas of remnant vegetation. Waterways are also biologically diverse. Maintaining and improving ecological links between areas of remnant vegetation will assist in conserving the diversity of native plant and animal populations.

There is one relatively small area of remnant vegetation directly linked to the Dale River South, which is part of DRS14, at the corner of Brookton Highway and York–Williams Road. There are other larger areas of remnant vegetation within the catchment, including the Boyagin Nature Reserve to the east and Lupton Nature Reserve to the west.

These nature reserves are linked to the Dale River South by tributaries. Boyagin Creek and DRSTrib 10 are linked to Boyagin Nature Reserve and Mokine Brook is linked to Lupton Nature Reserve. There is also an Aboriginal art site of significance called The Caves in an area of remnant vegetation close to sections DRS8 and DRS9, although there is no vegetation linking this site to the Dale River South.

These nature reserves, and links to them via tributaries, are significant assets that are worth protecting. This can be achieved through protecting fringing vegetation through fencing and stock management.

5.5 Fencing

Compared to other nearby waterways that have also been surveyed, such as Talbot Brook and the Dale River, Dale River South has a proportionately low percentage of fencing.

Some landholders indicated that they had intentions to fence both sides of the river but cost and time were prohibitive factors. Many landholders also expressed their concern over the weed infestation and subsequent fire hazard caused by excluding stock from the waterway.

Fencing both sides of the channel will, over time, improve the condition and health of this waterway. In the short term, weeds will proliferate, but over time native species will regenerate and shade out the weeds. It is considered to be acceptable practice to ‘crash graze’ fenced off areas to suppress weed growth and reduce the fire risk during growing periods. This will have two main effects, reducing seed set and the amount of combustible material.

Landholders interested in fencing the Dale River South or its tributaries may be eligible to receive fencing materials through the Avon Fencing Project. The project, funded by the Avon Catchment Council and Department of Water, provides ringlock, posts and strainers to fence priority riparian areas.

5.6 Tributaries

Most of the tributaries flowing into the Dale River South are managed as part of the adjacent farmland and have little to no fringing vegetation. In total there are 45 tributaries flowing into the Dale River South, 20 of which are considered to be major tributaries due to their channel width, depth, flow discharge and/or catchment area. A foreshore and channel assessment form (Appendix 3) was completed for 300–500 m of each of these major tributaries.

Some of these tributaries have valuable assets that should be investigated. Boyagin Creek (DRSTrib 09), Mokine Brook (DRSTrib 14) and DRSTrib 10 are linked to large nature reserves, acting as an ecological corridor between the reserves and the Dale River South. Yennedine Brook (DRSTrib 06), Boyagin Creek and Mokine Brook flow through properties where either the landholder or neighbouring landholder has an interest in the tributary.

In contrast, there are a few tributaries that pose a threat to the Dale River South. DRSTrib 04, Yennedine Brook (DRSTrib 06), DRSTrib 12 and DRSTrib 19 all appear to contribute significant sediment loads to the main channel of the Dale River South.

Salt scalds were observed in paddocks adjacent to DRSTrib 08, DRSTrib 19 and DRSTrib 20. Salinity levels were high in DRSTrib 08 and DRSTrib 19, although this did not appear to be directly influencing salinity levels in the main channel. Rubbish dumping was evident in DRSTrib 17, although most of the rubbish was inert.

Table 13 summarises the significant threats and assets of the tributaries of the Dale River South. It is recommended that foreshore surveys be completed for Boyagin Creek and Mokine Brook, given their links to significant nature reserves and level of landholder interest.

Table 13 Tributaries with significant threats or assets

Tributary	Threats	Assets
DRSTrib 04	Sediment contribution	
Yennedine Bk (Tributary 06)	Sediment contribution	Landholder interest
DRSTrib 08	Salinity (2030 mS/m recorded), salt scald in paddocks and waterlogging in channel	
Boyagin Creek (DRSTrib 09)		Links to Boyagin Nature Reserve, landholder interest
DRSTrib 10		Partial links to Boyagin Nature Reserve
DRSTrib 12	Sediment contribution	
Mokine Brook (DRSTrib 14)		Links to Lupton Nature Reserve, landholder interest
DRSTrib 17	Rubbish dumping	
Kubbine Brook (DRSTrib 19)	Sediment contribution, salinity (2110 mS/m recorded), salt scald in paddocks	
DRSTrib 20	Salinity risk (salt scald in paddocks)	

5.7 Salinity risk

The water quality samples taken during the survey only provide a snapshot of salinity levels in the Dale River South. Historical water quality monitoring indicates average salinity levels were around 957 mS/m (refer to Table 2), which is lower than the snapshot readings taken during the survey.

It is difficult to ascertain from this data if there has been any increase in salinity levels since the closure of the gauging station in 1999. This could only be confirmed if the gauging station was redeployed. The Dale River South contributes significant flows into the Dale River, and this is an important contributor of fresh water into the Avon. For this reason, the redeployment of this gauging station, or the inclusion of the Dale River South in the Avon River Catchment Water Quality and Nutrient Monitoring Program, should be considered.

There are some signs of salinisation of the catchment that were noted during the survey. Salt scald in adjacent paddocks was noted in sections DRS19, DRS31, DRS32 and DRS35. It is possible that more sections are affected by salinity but it was difficult to ascertain as the survey was undertaken in June–July when there was patchy growth in adjacent grazing paddocks and many crops had just been planted.

Salinity levels were highly saline in two tributaries that had flow, including DRSTrib 08 (2030 mS/m) and DRSTrib 19 (2110 mS/m). There was other evidence indicating that these tributaries may be at risk of salinisation. Approximately 150 metres upstream of DRSTrib 08 there was an area where the channel broadened considerably and became waterlogged. There were a number of dead trees in and alongside the channel and salt scald was observed in the adjacent paddocks. Salt scald was also observed in paddocks adjacent to Kubbine Brook.

Although DRSTrib 08 and DRSTrib 19 had high salinity levels, they did not appear to affect the salinity levels in adjacent or downstream sections of the main channel, which was surprising since Kubbine Brook was contributing a significant flow into the Dale River South.

6 Glossary

Acid(ic)	See pH.
Alkaline	See pH.
Alluvial	Transported by water flow processes, for example alluvial plain.
Alluvium	Sediment deposited by flowing water.
Aquifer	A layer of rock or soil capable of receiving, storing and transmitting quantities of water.
Catchment	The area of land which intercepts rainfall and contributes the collected water to a common point through surface and groundwater.
Confluence	Flowing together or intermingling; for example, where a tributary joins the main river channel.
Crash graze	Aims to maintain and enhance native vegetation by carefully managing stock grazing pressure. Allows stock to graze riparian areas for short periods, normally during mid-winter through to early spring, removing them before they start to damage native vegetation.
Discharge	Volumetric outflow rate of water, typically measured in cubic meters per second. Applies to both groundwater and surface water.
Discharge area or zone	Area where groundwater discharges to the surface.
Ecosystem	A biological community of interacting organisms and their physical environment.
Floodplain	Broad, flat, low lying area of land within the valley floor that is inundated during a 100-year flood. Includes the floodfringe and floodway.
Flood – 100 year	The 100-year flood has a statistical probability of occurring, on average, once every 100 years. The 100-year flood level is the contour to which this flood will rise.
Floodfringe	The area of the floodplain, outside of the floodway, which is affected by flooding.

Floodway	The river channel and portion of the floodplain which forms the main flow path for flood waters once the main channel has overflowed.
Geomorphology	The study of the origin, characteristics and development of landforms.
Gigalitre (GL)	1000 000 000 litres or 1 million cubic metres or 1 million kilolitres (kL).
Groundwater	Water which occupies the pores and crevices of rock or soil.
Hydrology	The study of water, its properties, distribution and utilisation, on and below the earth's surface.
Kilolitres (kL)	1000 litres or one cubic metre.
Kilotonne (kt)	1000 000 kilograms or 1000 tonnes.
Macroinvertebrates	Aquatic invertebrates (animals without backbones) that are retained on a 0.25 mm mesh net and are therefore big enough to be seen with the naked eye.
Natural resource management	The ecologically sustainable management of the land, water, air and biodiversity resources for the benefit of existing and future generations.
Nutrient load	The amount of nutrient (usually nitrogen and/or phosphorus) reaching a waterway over a given time period from its catchment area.
pH	The concentration of hydrogen ions in solution that indicates the acidity or alkalinity in water. A pH value of 7 is neutral, above 7 is alkaline and below 7 is acidic.
Recharge	Volumetric inflow rate of water to an aquifer, typically measured in cubic metres per second.
Recharge area or zone	An area through which water percolates to replenish (recharge) an aquifer. Unconfined aquifers are recharged through rainfall. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Remnant vegetation	An area of vegetation remaining after a major disturbance, such as land clearing.

Riparian zone	The riparian zone includes the floodplain and adjacent verge. The width of the riparian zone varies greatly, from tens of metres to kilometres, depending on the type of waterway and its catchment.
Riparian vegetation	Vegetation growing within the riparian zone.
River basin	The area drained by a waterway and its tributaries (see catchment).
Runoff	Water that flows over the soil surface when rainfall is greater than the infiltration capacity of the soil. Flow in waterways results from rainfall runoff.
Salinity	A measure of the total soluble (dissolved) salts in water. Commonly measured in terms of total dissolved salts (TDS), in milligrams per litre (mg/L), or Electrical Conductivity, in millisiemens per metre (mS/m) or millisiemens per centimetre (mS/cm). Water resources are classified as fresh, marginal, brackish or saline on the basis of salinity. Refer to Table 10 for a salinity classification in relation to sea water.
Salinisation	An increase in the concentration of soluble salts in soil or water.
Sediment load	The amount of sediment reaching a waterway over a given time period from its catchment area. Also refers to the amount of sediment being transported by a waterway.
Surface water	Water flowing or held in waterways.
Tributary	A waterway that flows into a larger waterway.
Verge	Upland area adjacent to the floodplain.
Water quality	The physical, chemical and biological measures of water.
Waterlogging	Excess water close to the soil surface.
Watertable	Saturated level of unconfined groundwater. Wetlands in low lying areas may be surface expressions of groundwater.
Waterway	Surface water bodies, including streams, rivers, lakes, wetlands, estuaries, coastal lagoons and inlets. Can be seasonally or permanently inundated.

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Appendix 1 Historical water quality results for Dale River South Branch

Snapshot results, Dale River South Branch, 2006 (collected by Department of Water as part of the Avon River Catchment Water Quality and Nutrient Monitoring Program)

Site details

Site code	Site description	Easting	Northing
AV30	Dale River South, Dale-Kokeby Road	480 150	6429 660
AV31	Dale River South, Brookton Highway	484 130	6415 550

Water quality results for September, 2006

Site code	pH	**TDS** (mg/L)	**TN** (mg/L)	**TP** (mg/L)
AV30	8.09	8169	0.78	<0.005
AV31	8.13	9399	0.83	0.012

Summary of streamflow and water quality data for Department of Water gauging station on Dale River South Branch, Brookton Highway

Parameter	Unit	Minimum	Maximum	Average	No. of readings	First reading	Last reading
Al (tot)	mg/L	0.10	0.10	0.10	1	17 Nov 97	17 Nov 97
Alkalinity (CO_3-CO_3)	mg/L	0.00	11.00	0.88	32	03 June 81	08 June 88
Alkalinity (HCO_3-HCO_3)	mg/L	23.00	531.00	202.34	32	03 June 81	08 June 88
Alkalinity (tot) ($CaCO_3$)	mg/L	18.86	516.00	194.78	61	18 Nov 69	08 June 88
C (sol org) {DOC}	mg/L	6.87	16.06	10.98	4	11 Oct 94	31 July 96
Ca (sol)	mg/L	14.00	206.00	118.69	32	03 June 81	08 June 88
Cl (sol)	mg/L	287.00	12132.00	4087.64	230	12 July 66	08 June 88
Colour (TCU)	TCU	48.00	48.00	48.00	1	21 May 99	21 May 99
Colour (hazen)	Hu	18.00	300.00	58.71	51	20 July 77	30 June 86
Colour (true)	Hu	5.00	700.00	71.16	1508	18 Nov 69	14 Oct 98
Cond calc 25°C	µS/m	1572000.00	1572000.00	1572000.00	1	05 Dec 94	05 Dec 94
Cond uncomp (in situ)	µS/m	162400.00	1561000.00	957166.69	30	01 Sept 83	23 Sept 03
Cond uncomp (lab)	µS/m	100300.00	2510000.00	1060683.38	1642	04 April 73	21 May 99
Fe (tot)	mg/L	0.15	1.28	0.52	7	05 May 92	17 Nov 97
Groundwater level (SLE)	m	10.80	10.80	10.80	1	12 July 95	12 July 95
Hardness (tot)	mg/L	85.00	4940.00	1956.60	61	18 Nov 69	08 June 88
K (tot)	mg/L	3.00	17.00	10.34	32	03 June 81	8 June 88
Mg (sol)	mg/L	28.00	582.00	318.75	32	03 June 81	8 June 88
Mn (tot)	mg/L	0.04	0.16	0.09	7	05 May 92	17 Nov 97
N (sum sol ox) {NOx-N, TON}	mg/L	0.00	11.62	1.06	15	09 June 94	14 Oct 98
N (tot kjel) {TKN}	mg/L	0.70	2.30	1.11	15	09 June 94	14 Oct 98
N (tot) {TN, pTN}	mg/L	0.72	12.51	2.19	12	14 Sept 94	14 Oct 98
NH_3-N/NH_4-N (sol)	mg/L	0.01	0.24	0.07	13	09 June 94	13 Dec 95
NO_2-N (sol)	mg/L	0.01	0.04	0.02	2	11 Oct 94	23 May 95
NO_3 (sol)	mg/L	1.00	21.00	4.31	32	03 June 81	8 June 88
Na (sol)	mg/L	134.00	2670.00	1494.63	32	03 June 81	8 June 88
O - DO	mg/L	8.40	9.30	8.85	2	14 Oct 98	23 Sept 03
O - DO %	%	85.10	85.10	85.10	1	23 Sept 03	23 Sept 03
P (tot) {TP, pTP}	mg/L	0.01	0.15	0.05	14	09 June 94	14 Oct 98
PO_4-P (sol react) {SRP, FRP}	mg/L	0.00	0.05	0.01	13	09 June 94	13 Dec 95

Parameter	Unit	Minimum	Maximum	Average	No. of readings	First reading	Last reading
SO_4 (tot)	mg/L	30.00	327.00	178.34	32	03 June 81	8 June 88
SiO_2 (sol react)	mg/L	3.00	28.00	10.59	32	03 June 81	8 June 88
Suspended solids (EDI)	mg/L	20.38	20.85	20.62	2	21 Aug 75	24 Aug 76
Suspended solids (ETR)	mg/L	8.72	98.48	39.31	8	26 June 75	28 July 76
Suspended solids <63u (EDI)	mg/L	284.70	284.70	284.70	1	21 Jan 82	21 Jan 82
Suspended solids <63u (gulp)	mg/L	4.83	452.53	52.89	12	10 Aug 77	31 July 86
Suspended solids <63u (pump)	mg/L	3.16	583.85	237.52	41	27 July 85	21 Sept 90
Suspended solids >63u (EDI)	mg/L	10.10	10.10	10.10	1	21 Jan 82	21 Jan 82
Suspended solids >63u (gulp)	mg/L	0.11	22.28	6.21	4	28 June 78	17 Aug 78
TDSalts (sum of ions)	mg/L	538.00	9610.00	5522.28	32	03 June 81	8 June 88
TDSolids (calc @180°C-by cond)	mg/L	1572.00	16524.00	7794.28	32	18 Nov 69	24 Aug 76
Turbidity	NTU	0.40	188.00	9.56	1478	19 July 78	21 May 99
Turbidity (JCU)	JTU	25.00	25.00	25.00	29	18 Nov 69	24 Aug 76
Water temperature (in situ)	deg C	6.10	36.70	15.14	342	30 May 67	23 Sept 03
Water temperature (test)	deg C	13.00	26.30	24.70	1644	04 April 73	21 May 99
pH	(none)	6.40	8.60	7.66	234	18 Nov 69	23 Sept 03
pH (in situ)	(none)	7.60	7.80	7.70	2	23 Nov 83	14 Oct 98

Appendix 2 Description and management options for each surveyed section

Survey section	Section description	Management options
DRS01 Section length ~470 m	The first section of Dale River South extends from its confluence with the Dale River to the Dale Kokeby Road. This section was in moderate condition, with good verge vegetation, although much of the understorey is dominated by weeds. Stock access is well-managed, allowing some regeneration. There is a significant sediment deposit at the confluence of Dale River. One sharp rush (*Juncus acutus*) plant was found (E 480242 N 6429952) and fencing will need to be replaced within five years.	• Replace fencing within three–five years. • Remove sharp rush (*Juncus acutus*) before it spreads. • Erect stock proof fence at Dale Kokeby Road bridge as current fence is choked with debris and ineffective. • Use crash grazing to reduce weed growth.
DRS02 Section length ~1820 m	There is severe undercutting of the banks and significant sedimentation in this section. The section appears to have been heavily stocked for a number of years and consequently there is little remaining vegetation, no regeneration and lateral erosion of the channel. Although there is little remaining vegetation, there was, at the time of the survey, considerable birdlife. This section is rated to be in very poor condition. A fence exists along the left bank. One major tributary and two minor tributaries (no flow) are located along this section (1st = E 480162 N 6428709; 2nd = E 480158 N 6428618) . DRSTrib 01 – This tributary was in poor condition and is heavily grazed, as with DRS02. A small farm dam exists on the right bank and is creating some seepage flows into the tributary, which had very low, stagnant flow at the time of the survey (5 June 2007). Filamentous green algae and the introduced mosquitofish (*Gambusia holbrooki*) were present at the end of the surveyed section at the crossing of the York–Williams Road.	• Fencing the right bank and excluding stock (with crash grazing to control weeds) would allow natural regeneration to occur. This would enable the banks to stabilise and would slow and possibly halt the lateral erosion, which will eventually consume valuable adjacent agricultural land. • Direct seeding could be trialled to assist the natural regeneration process. • DRSTrib 01 should be fenced to exclude stock.

Survey section	Section description	Management options
DRS03 Section length ~1090 m	This section is managed similarly to DRS02. There is no regeneration, sedimentation is high and lateral erosion is also evident. Granite outcrops protect some of the bank and provide some instream habitat. There is a farm crossing at the end of the section that has shifted and requires repositioning to prevent further erosion of the left bank. Sharp rush (*Juncus acutus*) exists along this section. There is one minor tributary (E 480552 N 6427362) which is fairly stable and has no gully erosion, as it flows into a braid rather than the main channel. There is low level pollution from a concentration of sheep manure at this site.	• This section would benefit from fencing the right bank, allowing natural regeneration to occur (with crash grazing for weed control). • The farm crossing needs surveying to reposition the main flow to the centre of the waterway. Additional rock will be required to assist in directing the flow away from the left bank. • Sharp rush (*Juncus acutus*) needs to be controlled.
DRS04 Section length ~1485 m	This section is in moderate condition. There is some undercutting and bank erosion, but there are some significant stands of pithy sword sedge (*Lepidosperma longitudinale*) that have stabilised the bank and provide good habitat. DRSTrib 02 – This tributary was in moderate condition, primarily as part of it has been fenced to exclude stock (first 150 m surveyed). It has no gully erosion and the stands of pithy sword sedge (*Lepidosperma longitudinale*) provide good habitat. DRSTrib 03 – This tributary skirts along the southern side of a large granite outcrop, which is grazed but well-vegetated. There are some sick trees, affected by jarrah leafminer (*Perthida glyphopa*) and a small patch of sharp rush (*Juncus acutus*) in the waterway. There was no flow and only one small stagnant pool at the time of the survey (6 June 2007). DRSTrib 04 – Only a few hundred metres south of DRSTrib 03, this tributary obviously conveys a larger flow, which has incised the channel and caused bank erosion. The verge vegetation is comprised of flooded gum (*Eucalyptus rudis*) and has no understorey vegetation.	• This section would benefit from limiting stock access. The fence on the right bank is in good condition, but the fence on the left bank is insufficient to exclude stock, as are the fences at each end of the section. • There is an informal stock crossing which would benefit from being made into a formal crossing with fencing and large rocks to stabilise the soft bed. • The stand of sharp rush (Juncus acutus) in DRSTrib 03 should be removed.

Survey section	Section description	Management options
DRS05 Section length ~1523 m	There is little to no verge vegetation present along this section and the little remaining bank vegetation is at risk of falling into the channel with the significant bank erosion and undercutting that is occurring. Only a small section of the left bank is fenced. There are some dead trees and jarrah leafminer (*Perthida glyphopa*) present along this section. DRSTrib 05 – As with section DRS5, this tributary is in very poor condition, resembling little more than an open drain. There is very little bank or verge vegetation and although there was no flow at the time, the bed was very muddy and the eventual inflows would be turbid.	• This section would benefit from fencing and total stock exclusion. Ripping and direct seeding may assist in the regeneration process, as the banks are hard and have been compounded by stock.
DRS06 Section length ~1894 m	Although grazed, this section was in moderate condition with healthy vegetation along the banks and some verges and sedges stabilising the banks. Sediment heaps were apparent and the channel was braided along most of this section. One minor tributary occurred.	• Although stock access is obviously managed, fencing the waterway so that it is not part of a paddock would enable the waterway to recover. Stock could still be allowed access to suppress weeds and the fire risk, so long as access was carefully managed. • There is some farm rubbish which should be removed (E 480746 N 6423134) to prevent it shifting downstream in a flood.
DRS07 Section length ~1330 m	Although this section has some parts that were in moderate condition, it was rated poor overall. There were some sections that had good vegetation cover, including some stands of pale rush (*Juncus pallidus*) and regeneration of flooded gum (*Eucalyptus rudis*) and swamp paperbark (*Melaleuca rhaphiophylla*). There was an old pool (possibly Yennedine Pool) that has filled with sediment and sediment heaps were evident along the section. There were some parts where trees have died and fallen into the channel, creating a considerable build-up of debris in some areas. DRSTrib 06 (Yennedine Brook) – This tributary was in poor condition and the little native vegetation that was left was sick or dying. The understorey was comprised exclusively of weeds. In some cases there was no overstorey and the waterway resembled little more than an open drain.	• Fence right bank to limit stock access and control grazing. • Reposition last crossing so that the flow does not undermine tree (E 481149 N 6421812). • Fence tributary (Yennedine Brook). • Reposition woody debris (E 481150 N 6421628) as it is currently causing bank erosion. • Remove old wooden crossing near start of section.

Survey section	Section description	Management options
DRS08 Section length ~1351 m	This section was rated to be in poor condition. There was a significant number of dead trees, possibly lost to disease and some to stock. The entire length of this section was braided, with the main channel running mostly along the western side. There was severe sedimentation in this section and significant undercutting of the banks. There was a considerable amount of debris built up in the channel, directing flow into the banks.	• Fence right bank to limit stock access, control grazing and allow waterway to recover. • Reposition and anchor some woody debris to direct flow away from the banks.
DRS09 Section length ~1190 m	The braiding of the channel continued through most of this section. The section appears to be heavily stocked which has resulted in the destruction of much of the fringing vegetation. This section was rated to be in poor condition. There was significant sedimentation and undercutting in this section and jarrah leafminer (*Perthida glyphopa*) appears to have caused some damage to the flooded gum (*Eucalyptus rudis*). There was one minor tributary that was completely grazed with no fringing vegetation but had little erosion as the channel was quite broad. There was one farm crossing that was in reasonable condition and not causing erosion at the time of the survey.	• Fence right bank to limit stock access, control grazing and allow waterway to recover.
DRS10 Section length ~918 m	This section has no fencing and is part of a large paddock. To begin with, the channel is braided and then forms a single channel. There is significant undercutting, especially along the left bank. Large portions of the bank are slumping into the channel, resulting in large sediment heaps. This is causing lateral erosion. There is no regeneration of native species and the understorey is comprised exclusively of weeds. This section was rated to be in poor condition. There is one crossing (E 482825 N 6419442) that is used by vehicles and stock, and although the bed is hard in this location, the banks are denuded of vegetation. DRSTrib 07 (Waranine Brook) – The confluence of this tributary is located adjacent to Dale Road (E 483023 N 6418925). The tributary is in poor condition and is unfenced. There are two crossings approximately 200 m apart, with the first being eroded on the right bank.	• Fence both banks to limit stock access and control grazing. • In the fence line, construct a crossing point at the current location and harden the bank up with field stone to create a rocky riffle and prevent track washouts. • Fence tributary (Waranine Brook) and stabilise crossing with extra field stone and planting of some seedlings.

Survey section	Section description	Management options
DRS11 Section length ~1260 m	This section was rated to be in poor condition. Although the banks were exposed, the river bed and banks were quite hard and clayey. If the banks were softer this would normally result in 'severe' sedimentation, but this was rated to be 'significant' instead. There was one well-constructed river crossing which is not causing any erosion of the banks. The right bank was fenced. The channel braided again towards the end of the section. DRSTrib 08 – This tributary was unfenced and in poor condition. Approximately 300 m upstream the channel broadened and was waterlogged. Water quality was highly saline (2030 mS/m) at the time of the survey.	• Fence the left bank to limit stock access and manage grazing. • Fence tributary and revegetate with species tolerant to salinity and waterlogging.
DRS12 Section length ~1370 m	The channel is braided at the start of this section, with the main channel crossing from the west to the east side a number of times. The first large and deep pool of the river exists on this reach. The crossing immediately downstream of the pool is backing up the water, contributing to the size of the pool. There were some dead trees at the start of this section and the diversity of native vegetation was limited. This section was rated to be in poor condition. There was a pile of rocks in the river at the end of this section (E 483811 N 6416897). It was difficult to determine if they were placed there as a crossing or a riffle. It has since been blown out as most of the rock has been dislodged, although it is not causing any erosion problems. There was some farm rubbish (fencing materials, etc.) near the shearing and farm sheds.	• Fence the right bank to limit stock access and control grazing. • Remove farm rubbish to prevent it being washed downstream in a flood event.
DRS13 Section length ~1000 m	This section was rated to be in poor condition. There was some localised slumping of the banks at the start of the section and significant sedimentation along the section. Regeneration was fairly limited but there was a patch of pithy sword sedge (*Lepidosperma longitudinale*) around the middle of the section. Some areas were in very poor condition, with little to no fringing vegetation, and the banks were freely eroding. A significant anabranch split off from the main channel toward the end of this section, which originally appeared to be a tributary. This anabranch rejoined the main channel in the next section.	• Fence the right bank to limit stock access and control grazing.

Survey section	Section description	Management options
DRS14 Section length ~900 m	This section is in Crown Land and fenced from stock. Although there is a high fire risk from the dense weed mass and build-up of leaf litter, this is the best section of the Dale River South. It contains the best diversity of native vegetation and erosion is minimal. It was rated to be in moderate condition. The channel has a number of meanders and high sinuosity. A large pool exists on the second meander, where the anabranch also flows back into the main channel. There is a considerable amount of roadside rubbish from Brookton Highway at the end of the section. DRSTrib 09 (Boyagin Creek) – This tributary was rated to be in moderate condition. However, beyond the surveyed area it is apparent that its condition deteriorates due to stock grazing pressures. There is minimal erosion and regeneration of native species is apparent.	• Remove rubbish from along Brookton Highway. • Consider options for weed suppression to reduce fire risk. • Fence the right bank of DRSTrib 09 (Boyagin Creek) to limit stock access.
DRS15 Section length ~1950 m	This section was rated to be in poor condition. There was heavy stock grazing pressure and severe sedimentation along this section. There were many dead trees, which are falling into the main channel. There is a pipe in the river (E 484062 N 6415192) where the land holder has attempted a river crossing. This is not currently causing erosion but if the crossing was filled, the culvert would be inadequate to take the flow and the fill for the crossing would be eroded. There is an old V-notch weir immediately upstream of Brookton Highway that is currently not deployed (Department of Water stream gauging station 615222).	• Fence the right bank to exclude stock access for five years to allow waterway to recover and control grazing. • Remove pipe at attempted crossing and consider the use of field stone to create a crossing instead. The piles of dirt on the left bank will need to be flattened to prevent the dirt washing into the river. • Consider the removal of the V-notch weir if there is no intention to reinstate the gauging station in the near future.
DRS16 Section length ~600 m	This section was rated to be in very poor condition. The channel has high sinuosity and little fringing vegetation, therefore there is a significant amount of undercutting and sedimentation occurring. There is a small amount of fencing rubbish in this section (E 483851 N 6413680).	• Fence the right bank to exclude stock access for five years to allow waterway to recover and control grazing. • Remove fencing rubbish to prevent it being swept downstream in a flood event.

Survey section	Section description	Management options
DRS17 Section length ~1100 m	This section had a number of major meanders and was heavily grazed. There was a significant amount of undercutting, especially on the bank opposite the confluence with DRSTrib 10, where a large flooded gum (*Eucalyptus rudis*) is at eventual risk of collapsing into the channel. This section was rated to be in poor condition. There were some areas where the fringing vegetation was in good condition, although there was no regeneration (except on the tributary DRSTrib 10). DRSTrib 10 – This tributary had good verge vegetation but the channel itself was heavily eroded with little vegetation remaining to support its banks. The channel ends abruptly where gully erosion is taking place.	• Fence the left bank to exclude stock access for five years to allow waterway to recover and control grazing. • Fence DRSTrib 10 to protect verge vegetation and encourage natural regeneration.
DRS18 Section length ~200 m	This section was fenced and appears to have had no stock access for a number of years. Although only a short section, it included a large meander bend, where the left bank was steep. The channel was heavily infested with saltwater couch (*Paspalum vaginatum*) which has stabilised some old sediment deposits. Consequently, there was minimal undercutting or slumping of the banks in this section. There was a considerable amount of natural regeneration taking place.	• Consider options for weed suppression to reduce fire risk. This could include spraying or crash grazing.

Survey section	Section description	Management options
DRS19 Section length ~3050 m	The channel in this section is quite sinuous and contains one of the larger meander bends of the river. The river begins to change course and meanders its way towards the south-west, towards the York–Williams Road, where this section ends. There are a number of small tributaries in this section that are in very poor condition, with no fringing vegetation. There is also a levee drain flowing into the channel where there is active gully erosion at the confluence (E 482882 N 6411770). There has been an attempt to control this erosion with the use of farm rubbish (tin, rock, etc.) but the ground is subsiding behind this material and it is at risk of falling into the main channel. Most of the right bank is fenced in this section and the left bank is steep, so it is difficult for stock to access the small area of bank and floodway on the right. This has allowed some regeneration of flooded gum (*Eucalyptus rudis*) and number of areas are well vegetated with bare twigrush (*Baumea juncea).* There are two crossings, with the first being open and exposed (E 483427 N 6412313). However, the bed here is hard and there is little active erosion occurring. Towards the end of the section there are some fencing coils that are embedded into the bank, possibly placed there to control erosion. They do not appear to be at risk of shifting during a flood. DRSTrib 11 – This tributary is in very poor condition. There are only a few flooded gums (*Eucalyptus rudis*) remaining and there is no fencing. The channel is quite broad, so although there is little vegetation there is also little active erosion occurring. One crossing exists but the culvert is inadequate to carry the flow and water obviously washes around the crossing during peak flows.	• Fence the left bank to limit stock access and control grazing. • Actively control gully erosion at the confluence of the levee drain. Remove farm materials and stabilise with rock and vegetation. This area will need to be fenced from stock until the erosion stabilises. • In the fence line, construct a crossing point at the current location and protect the bank with field stone to create a rocky riffle and prevent track washouts.

Survey section	Section description	Management options
DRS20 Section length ~3050 m	This section is in poor condition due to the sparse riparian vegetation which is affected by stock grazing. In contrast to the previous section, the channel is not as sinuous and the banks are not as steep, so there is only localised undercutting. There was one area near the farm houses where a few small pools exist which are frequented by a number of Pacific Black Duck (*Anas superciiliosa*) and Australian Shelduck (*Tadorna tadornoidies*). Consequently, there was a large amount of bird droppings present. DRSTrib 12 – This tributary was fenced on the right bank only and was in poor condition due to the lack of fringing vegetation. There was no flow at the time of the survey. No gully erosion was present.	• Fence left bank to limit stock access and control grazing. • Remove introduced tree species (E 481871 N 6411032). • Fence the left bank of DRSTrib 12.
DRS21 Section length ~1200 m	Although this section was unfenced, it had only localised undercutting and bank erosion and there was moderate bank vegetation. However, it was still rated to be in poor condition due to the amount of sedimentation and lack of verge vegetation present. There were some large pools that have silted up over a period of time. The channel was quite straight with a few gentle meanders toward the end. There was one stock/vehicle crossing (E 481772 N 6410339) that has begun to erode. There was one minor tributary flowing in from a large granite outcrop.	• Fence both banks to limit stock access and control grazing. • Stabilise stock crossing with some field stone to prevent erosion.

Survey section	Section description	Management options
DRS22 Section length ~650 m	The river continues to be relatively straight in this section. There are a number of long pools, which have silted somewhat but are well-shaded and provide important refuge to wildlife. There is only localised undercutting and sedimentation is also localised to a few areas. There was a small patch of shore rush (*Juncus krausii*) and there was some regeneration of flooded gum (*Eucalyptus rudis*). This section was rated to be in moderate condition, probably as it is a small paddock which appears to be used for crop production, and limited grazing. The vegetation appears to be healthy with no jarrah leafminer (*Perthida glyphopa*) present. DRSTrib 13 – The channel of this tributary was very broad and flat, hence there was limited erosion. However, there was very little fringing vegetation and no habitat diversity so the tributary was rated to be in poor condition.	• Fence both banks to limit stock access or continue with limiting stock access to entire paddock.
DRS23 Section length ~800 m	This section was rated to be in poor condition, but only just, rating 19 out of 55, which is only one score below moderate in the overall stream environmental heath rating. The right bank was fenced and quite high in places. The channel is also quite broad in this section, meaning that there is limited stock access to the left bank. This has resulted in a denser weed growth on the right bank. There is some regeneration and sedimentation was only localised. However, there was limited verge vegetation. There was one sharp rush stand (*Juncus acutus*) recorded (E 481890 N 6408501), which was adjacent to a natural riffle. DRSTrib 14 (Mokine Brook) – This tributary is highly sinuous and flows into the Dale River South from a south-westerly direction. It is a large tributary, with the channel being almost the same width and depth as the Dale River South at this point. Ginbanging Pool, located at the confluence of Mokine Brook and the Dale River South, still exists, although it has partially silted up. The tributary was rated to be in poor condition, as there were a number of dead trees, the understorey was dominated by weeds and there was localised undercutting and sedimentation occurring.	• Fence left bank to limit stock access. • Remove sharp rush (*Juncus acutus*). • Limit stock access to DRSTrib 14 (Mokine Brook).

Survey section	Section description	Management options
DRS24 Section length ~390 m	This was a short section that has been heavily grazed, with neither bank fenced. This has resulted in bare verges with little weed growth. The remaining fringing vegetation appears quite sick and at risk of falling into the main channel if erosion continues unchecked. There were a number of large granite boulders in one part of the river providing some bank protection. Overall this section was rated to be in poor condition. There is a significant amount of gully erosion on the right bank at the end of this section. The end of this section includes the bridge at Matthews Road.	• Fence both banks to manage stock access and to allow the waterway to recover.
DRS25 Section length ~780 m	This section has steep, rocky banks with localised undercutting and significant sedimentation. The fringing vegetation is in poor condition due to the unlimited stock access, as neither bank is fenced. This section was rated to be in poor condition. There are some sharp rush stands (*Juncus acutus*) near the bridge at Matthews Road.	• Fence both banks to manage stock access. • Remove sharp rush (*Juncus acutus*).
DRS26 Section length ~1450 m	This section has significant undercutting of the banks and the channel is choked with large sediment deposits. The banks are quite exposed and much of the section is sparsely vegetated. Consequently, this section was rated to be in very poor condition. Toward the end of the section, the bed became quite rocky, forming the largest natural riffle of the river, and a large pool exists upstream of a large boulder. There is an excavated pit within 50 m of the channel that has been used to dispose of farm and household rubbish (E 482778 N 6406411). DRSTrib 15 – This tributary starts as a broad channel and within 50 m becomes a significantly incised and eroded channel. The banks are collapsing into the channel and there are numerous dead trees. This continues a short distance until the channel ends abruptly (with gully head erosion) and becomes more of a depression in the landscape, which continues the other side of the York–Williams Road (the tributary has been revegetated and fenced on the other side of this road). The tributary was rated as very poor and scored only 2 out of a possible 55 points.	• Fence left bank to exclude stock and allow the waterway to recover. • Ripping and direct seeding could be trialled to assist the natural regeneration process. • Remove farm and household rubbish and consider alternative options for disposal. • Fence DRSTrib 15 and stabilise gully head erosion before it consumes more agricultural land and nearby infrastructure (fence line and York–Williams Road).

Survey section	Section description	Management options
DRS27 Section length ~630 m	This section was unfenced and had some significant sedimentation. The channel was narrower than the previous section and has low sinuosity. This section was rated to be in poor condition. Granite boulders exists in the river, providing additional instream habitat. There were some sick and dead trees but overall the vegetation was in reasonable condition and there were seven bird species identified. York gums (*Eucalyptus loxophleba*) were noted in the floodway. There is a large farm crossing at the beginning of this section that is well-used and is eroding. DRSTrib 16 – This tributary was rated to be in very poor condition, as it had basically no fringing vegetation (only three individual plants on one meander) and severe undercutting of the banks. There was also significant sedimentation and bank slumping. The crossing on DRS27 also crosses this tributary, although the erosion is less as the banks are not as steep.	• Fence both banks to limit stock access and manage grazing • Manage erosion at farm crossing by placing field stone. along edge of track and planting native seedlings. • Fence tributary (exclude stock access to this corner of the paddock).
DRS28 Section length ~650 m	This section had low sinuosity and the channel was quite broad in a number of places. There was some regeneration of jam (*Acacia acuminata*), flooded gum (*Eucalyptus rudis*) and shore rush (*Juncus krausii*) (which had been grazed) and the fringing vegetation was in reasonable condition, although there were a few dead trees. An echidna was sighted in this section. This section was unfenced and rated to be in poor condition. There was a minor tributary that had some gully erosion at the confluence to the river.	• Fence both banks to limit stock access and manage grazing.

Survey section	Section description	Management options
DRS29 Section length ~1840 m	This was quite a long section, which had a sinuous meander pattern. Apart from a few rocky, steep embankments on some meanders, the channel was narrower than previous sections and quite broad and flat. One small section had a significant stand of shore rush and the fringing vegetation was healthy and dense. Although there were some areas in poor condition, this section was rated overall to be in moderate condition. Three minor tributaries existed, one of which was being used to dispose of dead sheep carcasses, some of which have washed downstream. This section ends at Kubbine Road. DRSTrib 17 – There was little fringing vegetation to support the banks along this tributary and in turn there was a significant amount of undercutting. There is a large area that has been used to dump farm rubbish, car bodies and refuse (E 483359 N 6405184).	• Fence left bank to limit stock access and manage grazing. • Remove farm and household rubbish from tributary and consider alternative options for disposal.
DRS30 Section length ~350 m	This is a relatively short section that is fenced from stock and is essentially remnant bushland, although it is not a Crown reserve. This section was rated as being in moderate condition. The channel has two major meanders and continues to form a narrow channel. Streamflow is low and the water is stagnant, probably due to the amount of saltwater couch colonising the sediment deposits in the channel. There are some dead trees, possibly lost to disease or waterlogging, as the floodway is quite broad and damp in this section. DRSTrib 18 – This tributary was in moderate condition with little active erosion and moderate fringing vegetation. The channel was quite narrow (2–4 m). There was evidence of feral pigs at this location.	• Consider options for weed suppression to manage the fire risk. • Following weed management, plant native seedlings or use direct seeding technique, using salt- and waterlogging-tolerant species, to encourage the growth of appropriate species for this soil type.

Survey section	Section description	Management options
DRS31 Section length ~2300 m	This was a long section, all managed as one large paddock. There was little fringing vegetation in this section and the banks were exposed to erosion, the result being significant undercutting and sedimentation and a shallow channel. This section was rated to be in poor condition. There were two minor tributaries, one near Kubbine Brook that had gully head erosion at its confluence with the main channel. The other was in poor condition with many dead trees and a freely eroding drain 50 m upstream from its confluence with the main channel. DRSTrib 19 (Kubbine Brook) – This tributary was almost as large as the main channel itself. The condition of the tributary is similar to DRS31, with little fringing vegetation and significant undercutting and sedimentation.	• Fence both banks to exclude stock access to allow the waterway to recover. • Fence DRSTrib 19 (Kubbine Brook).
DRS32 Section length ~673 m	There was little fringing vegetation and a significant amount of undercutting of the banks in this section. In some localised areas the banks were slumping into the channel. This section was rated to be in very poor condition. There was salt scald in a paddock 50 m away from the waterway. There were two minor tributaries, one being an open drain with no vegetation and gully erosion at the confluence with the main channel (E 484838 N 6402747), although the landowner has tried to limit erosion by placing fencing materials at this site. The other tributary has a small dam at its confluence, although this is not causing any problems. There is one farm crossing that has been stabilised with field stone and is not causing any erosion.	• Fence the right bank to limit stock access. • Remove fencing materials from confluence of tributary and stabilise with rock and vegetation. This area will need to be fenced from stock until the erosion stabilises.
DRS33 Section length ~300 m	This section had a considerable number of dead trees and very limited species diversity (three native species identified). The channel braided again for portions of this section. There was a significant amount of sedimentation. This section was rated to be in poor condition. One crossing exists on this section which has been stabilised with field stone and is causing no erosion problems. A new fence has been erected along the left bank. An individual plant of sharp rush (*Juncus acutus*) occurs at the end of this section (E 485716 N 6402087).	• Fence the right bank to limit stock access and manage grazing. • Remove sharp rush (*Juncus acutus*).

Survey section	Section description	Management options
DRS34 Section length ~130m	The river flows past the base of a granite outcrop at this point, creating a number of pools and riffles. A number of major meanders occur and the river changes course, heading in an easterly direction and then south-east at the end of this section. The banks are quite exposed but minimal undercutting has occurred, possibly due to the banks being quite hard (some are granite) and sloping. Very little fringing vegetation remains, with little stream cover. The understorey is dominated by weeds. This section was rated to be in poor condition.	• Fence the right bank to limit stock access.
DRS35 Section length ~1700m	The river was highly sinuous throughout this section and the channel narrowed. There was significant undercutting and sedimentation of the channel, especially towards the end of this section. There was no fencing, which has obviously had an impact on the health and frequency of native vegetation, with the verge vegetation being rated as very poor. A large anabranch, which had no fringing vegetation, occurred near the end of the section. There were a number of informal stock crossings where the bed was quite soft, and erosion and sedimentation was occurring. A small dam is located offstream but is not of concern. This is the last surveyed section of the Dale River South. Beyond the York–Williams Road the channel narrows and appears to dissipate into its headwaters. DRSTrib 20 – This tributary has a similar channel width and depth to the Dale River South. Whether this tributary could be called a continuation of the main channel or that the main channel is the waterway that crosses the York–Williams Road is ill-defined. This tributary was rated to be in poor condition, with significant sedimentation, poor fringing vegetation and poor habitat diversity. Beyond the surveyed section, the tributary resembles little more than a drain, with little to no fringing vegetation. It appears to be salt-affected.	• Fence right bank to create a ‘river paddock’ using the fence line along the York–Williams Road as the left bank fence. • Manage stock access. • Harden up stock crossings with field stone. • Fence DRSTrib 20 to exclude stock to allow the tributary to recover. Plant salt- and waterlogging-tolerant species to control erosion and slow down salinisation.

Appendix 3 Foreshore and channel assessment form

For property and paddock scale surveys

General details

Recorder's name: …….. Survey date: ……

Tributary name: …….Section number: …DRS …….

Catchment name: Avon River Length of section: ……...

Sub-catchment name: ……... Shire:……

GPS (start of survey section – left bank) E: ……..…… N:…..……

GPS (end of survey section – left bank) E: …….. N: …….

Landholder contacted: Yes ❒ No ❒ Bank(s) surveyed (facing upstream)
Landholder consent obtained: Yes ❒ No ❒ Left ❒ Right ❒ Both ❒
Landholder present during survey: Yes ❒ No ❒

Landholder: …….. Contact Number: .....

Property address: …….

Bank stability

Proportion of bank affected (% of survey area)	Undercutting	Firebreak/track washouts	Subsidence (sinking of soil)	Gully erosion	Sedimentation	Slumping (mass movement)
0-5% Minimal						
5-20% Localised						
20-50% Significant						
>50% Severe						

Are the banks subject to any artificial stabilisation?: ❒ Yes ❒ No
Give details:
……
……

Waterways features

❒ Single channel
❒ Braided channel
❒ Deep pool
❒ Wetlands
❒ Groundwater seep
❒ Natural riffle
❒ Anabranch
❒ Tributary
❒ Large woody debris
❒ Vegetated island
❒ Constructed riffles
❒ Sediment slug
❒ Crossing
❒ Dam
❒ Bridge
❒ Other
……
……

Channel width (m)…….. Channel depth (m)……..

Vegetation health

❒ Looks healthy ❒ Some sick trees (some foliage loss) ❒ Many sick or dying trees ❒ Some dead trees ❒ Many dead trees

Are there any tree seedlings or saplings present?: ❒ Yes ❒ No Species: ……

Leaf litter: ❒ Absent ❒ Minimal cover ❒ Good cover ❒ Deep cover

Bare Ground: % cover: …….

Native vegetation: ❒ Abundant ❒ Frequent ❒ Occasional ❒ Rare ❒ Absent

Exotic vegetation: ❒ Abundant ❒ Frequent ❒ Occasional ❒ Rare ❒ Absent

Instream cover: ❒ Leaf litter/detritus ❒ Rocks ❒ Branches ❒ Vegetation

Vegetation cover (native and weeds)

Proportion cover	Overstorey	Middlestorey	Understorey
> 80% Continuous			
20-80% Patchy			
< 20% Sparse			
0% Absent			

Proportion of native species

	Proportion (%) of native species
Overstorey	
Middlestorey	
Understorey	

Habitats

Aquatic invertebrates, reptiles and fish
- ❒ Cascades, rapids, riffles
- ❒ Meanders, pools
- ❒ Instream cobbles, rocks
- ❒ Instream logs
- ❒ Variety of instream and bank vegetation types

Terrestrial invertebrates
- ❒ Variety of vegetation types
- ❒ Protected basking sites (tree bark, leaf litter)

Birds (roosting/nesting sites)
- ❒ Trees
- ❒ Shrubs
- ❒ Rushes

Frogs
- ❒ Dense fringing vegetation
- ❒ Emergent plants/soft substrate for eggs

Reptiles
- ❒ Variety of vegetation types
- ❒ Protected basking/nesting sites (leaf litter, logs)

Mammals
- ❒ Dense protective vegetation

Water quality

pH……

Salinity (ms/m)……

Temperature (ºC)……

Comments on water quality:

Fencing status

Fence section 1

Start……E Start……..N End……..……E End…….……..N

Left bank ❒ Right bank ❒

Fence condition: ❒ Good ❒ Moderate ❒ Poor ❒ No fence

Fence style: ❒ Barbed wire ❒ Electric ❒ Fabricated ❒Ringlock ❒ Plain wire

Approximate distance [m] from main channel: ❒ <10m ❒ 10-20m ❒ 20-30m ❒ >30m

Fence section 2

Start……E Start……..N End……..……E End…….……..N

Left bank ❒ Right bank ❒

Fence condition: ❒ Good ❒ Moderate ❒ Poor ❒ No fence

Fence style: ❒ Barbed wire ❒ Electric ❒ Fabricated ❒Ringlock ❒ Plain wire

Approximate distance [m] from main channel: ❒ <10m ❒ 10-20m ❒ 20-30m ❒ >30m

Fence section 3

Start……E Start……..N End……..……E End…….……..N

Left bank ❒ Right bank ❒

Fence condition: ❒ Good ❒ Moderate ❒ Poor ❒ No fence

Fence style: □ Barbed wire □ Electric □ Fabricated □Ringlock □ Plain wire

Approximate distance [m] from main channel: ❒ <10m ❒ 10-20m ❒ 20-30m ❒ >30m

Fence section 4

Start……E Start……..N End……..……E End…….……..N

Left bank ❒ Right bank ❒

Fence condition: ❒ Good ❒ Moderate ❒ Poor ❒ No fence

Fence style: □ Barbed wire □ Electric □ Fabricated □Ringlock □ Plain wire

Approximate distance [m] from main channel: ❒ <10m ❒ 10-20m ❒ 20-30m ❒ >30m

Stock access to foreshore: ❒ Yes ❒ No Vehicle access to foreshore: ❒ Yes ❒ No

Crossing Point: ❒ Yes ❒ No

Foreshore condition rating

A-Grade foreshore	**B-Grade foreshore**	**C-Grade foreshore**	**D-Grade foreshore**
A1 Pristine	B1 Degraded – weed infested	C1 Erosion prone	D1 Ditch – eroding
A2 Near pristine	B2 Degraded – heavily weed infested	C2 Soil exposed	D2 Ditch – freely eroding
A3 Slightly disturbed	B3 Degraded – weed dominant	C3 Eroded	D3 Drain – weed dominant

(Choose one of the above. Use Grades A, B, C or D for General condition and use sub-grades for best and poorest ratings ie A1 through to D3)

General:…… Best: …… Poorest: ……...

Overall stream environmental health rating

Rating	Floodway & bank vegetation	Verge vegetation	Stream Cover	Bank stability & sediment	Habitat diversity
Excellent	15	8	8	8	6
Good	12	6	6	6	4
Moderate	6	4	4	4	2
Poor	3	2	2	2	1
Very poor	0	0	0	0	0

Surrounding landuse:

Conservation reserve (8) Urban (2) Agricultural (2)

Rural residential (4) Remnant bush (6) Commercial/industrial (1)

Total score = ☐

Score	40-55	30-39	20-29	10-19	0-9
Rating	Excellent	Good	Moderate	Poor	Very poor

Tributary assessment

Tributary survey section number: ……..

GPS (start of survey section – left bank) E:…….. N:……

GPS (end of survey section – left bank) E:…….. N:……

General foreshore rating: ……..

Comments:

Evidence of management

Tick the appropriate boxes:

❒ Prescribed burning
❒ Firebreak control
❒ Fencing
❒ Weed control
❒ Revegetation
❒ Erosion control
❒ Sediment management
❒ Other:……..

Management issues

Tick the appropriate priority box for each management issue. If the issue does not exist along this section of the waterway it can be crossed out.

Issue	Priority		
	High	**Medium**	**Low**
Fire			
Disease			
Weeds			
Erosion			
Salinity			
Sediment			
Stock Access			
Vehicle Access			
Rubbish			
Pollution			

Issue	Priority		
	High	**Medium**	**Low**
Recreation			
Service Corridors (roads)			
Crossing point			
Feral Animals			
Point source discharge			
Pumps or off-take pipes			
Dam/weir			
Cultural Features			
Other			

Ideas for management

Tick the appropriate boxes:

❒ Firebreak control
❒ Fencing
❒ Erosion control
❒ Stock/vehicle crossing
❒ Revegetation
❒ Weed control
❒ Riffles
❒ Sediment management
❒ Other: ……

Native plant list

Introduced plant list

Native fauna list

Introduced fauna list

GPS coordinates

Coordinate	Description

Photos

Photo number	Description

Appendix 4 Foreshore rating grading system

A-grade – Foreshore has healthy native bush similar to that found in nature reserves, state forests and national parks:

A1. Pristine – river embankments and floodway are entirely vegetated with native species and there is no evidence of human presence or livestock damage.

A2. Near Pristine – Native vegetation dominates. Some introduced weeds may be present in the understorey but not as the dominant species. Otherwise, there is no evidence of human impact.

A3. Slightly Degraded – Native vegetation dominates. Some areas of human disturbance where soil may be exposed and weeds are relatively dense (i.e. along tracks). Native vegetation would quickly recolonise if human disturbance declined.

B-grade – The foreshore vegetation had been invaded by weeds, mainly grasses, and looks similar to typical roadside vegetation:

B1. Degraded – weed infested – Weeds have become a significant component of the understorey vegetation. Native species are still dominant but a few have been replace by weeds.

B2. Degraded – heavily weed infested – Understorey weeds are nearly as abundant as native species. The regeneration of trees and large shrubs may have declined.

B3. Degraded – weed dominant – Weeds dominate the understorey, but many native species remain. Some trees and large shrubs may have disappeared.

C-grade – The foreshore supports only trees over weeds or pasture. Bank erosion and subsidence may occur in localised areas:

C1. Erosion prone – Trees remain with some large shrubs or tree grasses and the understorey consists entirely of weeds (i.e. annual grasses). There is little or no evidence of regeneration of tree species. River embankment and floodway are vulnerable to erosion due to the shallow-rooted weedy understorey providing minimal soil stabilisation and support.

C2. Soil exposed – Older trees remain but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock grazing and trampling or through human use and activity. Low level soil erosion has begun.

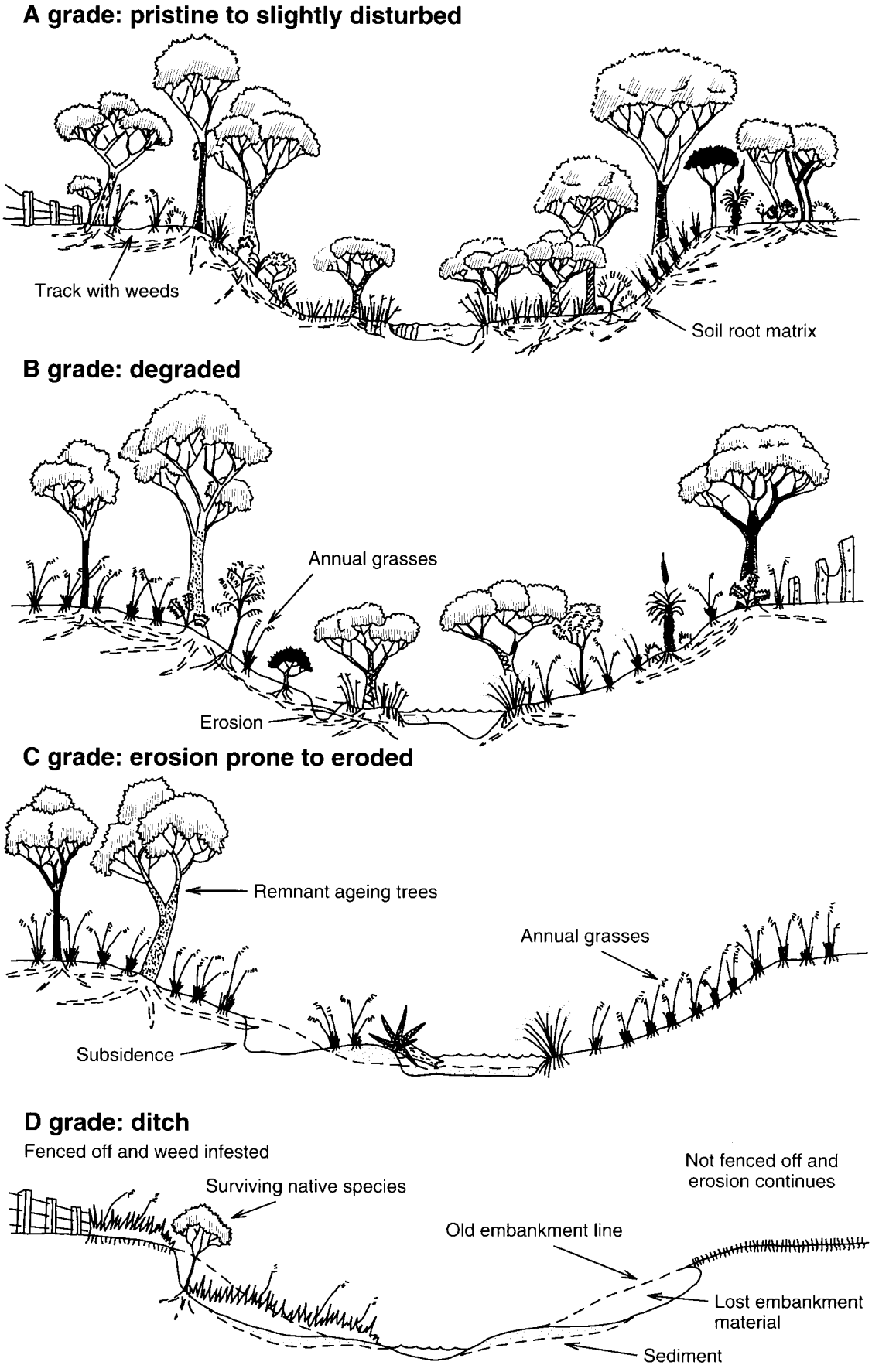
C3. Eroded – Soil is washed away from between tree roots. Trees are being undermined and unsupported embankments are subsiding into the river valley.

D-grade – The stream is little more than an eroding ditch or a weed infested drain:

D1. Ditch – eroding – There is not enough fringing vegetation to control erosion. Remaining trees and shrubs act to impede erosion in some areas, but are doomed to be undermined eventually.

D2. Ditch – freely eroding – No significant fringing vegetation remains and erosion is out of control. Undermined and subsided embankments are common. Large sediment plumes are visible along the river channel.

D3. Drain – weed dominant – The highly eroded river valley has been fenced off, preventing control of weeds by stock. Perennial weeds have become established and the river has become a simple drain.



Source: Water and Rivers Commission (1999)

Appendix 5 Factors and scoring for determining the overall stream environmental health rating (OSEHR)

	Floodway and bank vegetation	Verge vegetation	Stream cover	Bank stability and sedimentation	Habitat diversity
Excellent	Healthy undisturbed native vegetation. Virtually no weeds. No disturbance. **(15 points)**	Healthy undisturbed vegetation. Verges more than 20 m wide. **(8 points)**	Abundant cover: shade, overhanging vegetation, snags, leaf litter, rocks and/or aquatic vegetation. **(8 points)**	No erosion, subsidence or sediment deposits. Dense vegetation cover of banks and verge. No disturbance. **(8 points)**	3 or more habitat zones. Some permanent water . **(6 points)**
Good	Mainly healthy undisturbed native vegetation. Some weeds. No recent disturbance. **(12 points)**	Mainly healthy undisturbed native vegetation. Verges less than 20 m wide. **(6 points)**	Abundant shade and overhanging vegetation. Some instream cover. **(6 points)**	No significant erosion, subsidence or sediment deposits in floodway or on lower banks. May be some soil exposure and vegetation thinning on upper bank and verge. **(6 points)**	2 habitat zones. Some permanent water. **(4 points)**
Moderate	Good vegetation cover, but mixture of native and exotic species. Localised clearing. Little recent disturbance. **(6 points)**	Good vegetation cover, but mixture of native and exotic species. Verges 20 m or more. **(4 points)**	Some permanent shade and overhanging vegetation. Some instream cover. **(4 points)**	Good vegetation cover. Localised erosion, bank collapse and sediment heaps only. Verges may have sparse vegetation cover. **(4 points)**	Mainly 1 habitat type with permanent water, OR range of habitats with no permanent water. **(2 points)**
Poor	Mainly exotic groundcover. Obvious site disturbance. **(3 points)**	Narrow verges only (< 20 m wide). Mainly exotic vegetation. **(2 points)**	Channel mainly clear. Little permanent shade or instream cover. **(2 points)**	Extensive active erosion and sediment heaps. Bare banks and verges common. Banks may be collapsing. **(2 points)**	Mainly 1 habitat type with no permanent water. **(1 point)**
Very poor	Mostly bare ground or exotic groundcovers (i.e. pasture, gardens or weed infestations, but no trees). **(0 points)**	Mostly bare ground or exotic groundcovers (i.e. pasture, gardens or weed infestations, but no trees). **(0 points)**	Virtually no shade or instream cover. **(0 points)**	Almost continuous erosion. Over 50% of banks collapsing. Sediment heaps line or fill much of the floodway. Little or no vegetation cover. **(0 points)**	Stream channellised. **(0 points)**

Scores for surrounding landuse:

Conservation reserve	**(8 points)**	Rural residential	**(4 points)**	Agricultural	**(2 points)**
Remnant bush	**(6 points)**	Urban	**(2 points)**	Commercial/ industrial	**(2 points)**

Adapted from Water and Rivers Commission (1999)

Appendix 6 Fencing information for surveyed sections of Dale River South

Length and condition of fencing for each surveyed section

Section	Left bank fence (m)	Right bank fence (m)	Length of section (m)
DRS1	470 (G)	470 (P)	470
DRS2	1820 (G)		1820
DRS3	1089 (M)		1089
DRS4	1485 (G)	1485 (P)	1485
DRS5	500 (M)		1523
DRS6	600 (P)		1894
DRS7	1330 (G)		1330
DRS8	1351(M)		1351
DRS9	1194 (M)		1194
DRS10			918
DRS11		1257 (M)	1257
DRS12	1370 (M)		1370
DRS13	992 (G)		992
DRS14	906 (M)	906 (G)	906
DRS15		1949 (M)	1949
DRS16	608 (M)		608
DRS17		1096 (M)	1096
DRS18	190 (M)	190 (M)	190
DRS19		1200 (M)	3050
DRS20		1180 (M)	1180
DRS21			1207
DRS22			650
DRS23	650 (P)		809
DRS24			385
DRS25			780
DRS26		1445 (G)	1445
DRS27			630
DRS28			650
DRS29		1840 (M)	1840
DRS30			340
DRS31			2315
DRS32	673 (M)		673
DRS33	300 (G)		300
DRS34	250 (M)		350
DRS35			1000
Total	**15 128**	**13 668**	**39 046**

Fence condition – (G) = good, (M) = moderate, (P) = poor

Appendix 7 Examples of fence condition ratings

Fence in poor condition

Fence in moderate condition

Fence in good condition

(Photos: K. Gole, Department of Water)

Appendix 8 Plants and animals identified during the survey of the Dale River South

Plants identified during the survey

Common name	Scientific name
Native species	
Flooded gum	*Eucalyptus rudis*
Swamp paperbark	*Melaleuca rhaphiophylla*
Wandoo	*Eucalyptus wandoo*
York gum	*Eucalyptus loxophelba sub. loxophelba*
Jam	*Acacia acuminata*
Golden wreath wattle	*Acacia saligna*
Manna wattle	*Acacia microbotrya*
Mohan	*Melaleuca viminea sub viminea*
Grass tree	*Xanthorrhoea preissii*
Swamp sheoak	*Casuarina obesa*
Pithy sword sedge	*Lepidosperma longitudinale*
Pale rush	*Juncus pallidus*
Shore rush	*Juncus krausii*
Bare twigrush	*Baumea juncea*
Fungus species (orange)	
Moss species	
Introduced species	
Barley grass	*Hordeum leporinum*
Cape tulip	*Homeria species*
Capeweed	*Arctotheca calendula*
Flatweed	*Hypochaeris species*
Guildford grass	*Romulea rosea*
Love grass	*Eragrostis species*
Onion weed	*Asphodelus fistulosus*
Nightshade	*Solanum species*
Saltwater couch	*Paspalum vaginatum*
Soursob	*Oxalis pes-caprae*
Sharp rush	*Juncus acutus*
Wild oats	*Avena fatua*

Animals identified during the survey

Common name	Scientific name
Native mammals	
Western grey kangaroo	*Macropus fuliginosus*
Echidna	*Tachyglossidae* species
Crustaceans	
Gilgie	*Cherax* species
Bird species	
Australian magpie	*Gymnorhina tibicen*
Australian magpie-lark	*Grallina cyanoleuca*
Australian raven	*Corvus coronoides*
Australian ringneck	*Barnardius zonarius*
Australian shelduck	*Tadorna tadornoidies*
Crested pigeon	*Ocyphaps lophotes*
Galah	*Eolophus roseicapilla*
Golden whistler	*Pachycephala pectoralis*
Grey fantail	*Rhipidura fuliginosa*
Grey teal	*Anas gracilis*
Inland thornbill	*Acanthiza pursilla*
Laughing kookaburra	*Dacelo novaeguineae*
Pacific black duck	*Anas superciliosa*
Rufous treecreeper	*Climacteris picumnus*
Rufous whistler	*Pachycephala rufiventris*
Singing honeyeater	*Lichenostomus virescens*
Scarlet robin	*Petroica multicolour*
Silvereye	*Zosterops luteus* race *chloronotos*
Splendid fairy-wren	*Malurus splendens*
Weebill	*Smicronis brevirostris* race *occidentalis*
Western thornbill	*Acanthiza inornata*
White-faced heron	*Egretta novaehollandiae*
Willie wagtail	*Rhipidura leucophrys*
Introduced mammals	
European red fox	*Vulpes vulpes*
Feral cat	*Felis catus*
Feral pig	*Sus Scrofa*
European wild rabbit	*Oryctolagus cuniculus*
Introduced fish	
Mosquitofish	*Gambusia holbrooki*

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