LAND PROTECTION DIVISION

Research Report No. 5

Logging Alpine Ash in the East Kiewa River Catchment

Part II: Prediction of Sedimentation Effects in Junction Dam and Clover Dam

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1. INTRODUCTION

A report describing the effects of alpine ash logging on stream sediment concentrations in the East Kiewa Catchment has been published separately (Papworth et al, 1990). That report contains results obtained from ten years of measurement of streamflow and sediment concentrations in two small experimental catchments in the East Kiewa Area. One of these catchments (Slippery Rock Creek) was the control; the other (Springs Creek), was subject to roading, logging and regeneration over a four year period. Thirty per cent of the catchment area was logged.

One application of the results from the above study is to predict sediment export from similar areas proposed for logging. The information generated can then be used as a tool to help evaluate the possible effects of roading and logging activities on downstream water values.

Commercial logging has been proposed in the near future, for an area in the East Kiewa River Catchment, which has implications for water quality in the State Electricity Commission's hydroelectric headwaters system.

This area consists of 1792 ha within the A17 and approximately 260 ha within the Little Arthur Creek sub-catchment. The are is upstream of Junction Dam and Clover Dam (LCC, 1983). A map showing the relationship of all these areas is included in Appendix 1. Note that Junction Dam is called Lake Guy on some maps of the area.

2. AIM AND SCOPE

The principal aim is to determine what additional level of sediment is likely to accumulate in Junction and Clover storages as a result of roading and logging within the A17 and Little Arthur Creek sub-catchment.

The study uses the results obtained in Part I of the Report to estimate the potential increase in sediment contribution to the stream system arising from the proposed logging operations.

Assumptions can be made (Section 4) to characterise behaviour and treatment of these sub-catchments appropriate to the proposed activities. The following approach can then be taken to predict sediment export.

a) estimate yields from the experimental catchments using the sediment concentration data from Part I, (Papworth *et al*, 1990)

b) derive a method for separating total sediment into the respective contributions from roading and coupe operations

c) extrapolate sediment yields to the A17 and Little Arthur Creek areas to predict the impact of logging on sediment contribution to Junction and Clover Dams

d) compare values for the extrapolated sediment yields (c) above with known data for Junction Dam and several major water storages within Victoria. This will indicate the validity of the approach.

This information can be used by the Department and the Commission to aid them in evaluating the acceptability of logging the proposed areas from the sedimentation point of view.

3. CALCULATION OF SEDIMENT YIELD FROM THE EXPERIMENTAL CATCHMENTS

3.1 Data Set – Limitations and Estimated Values

Base information used in this study are the streamflow and sediment concentration record from the experimental catchments.

Base data relating to streamflow is given as mean daily values; this record is complete.

The sediment concentration record was available at hourly intervals during eventflow and on a daily basis at other times. Missing values in the record were estimated; in the case of eventflow by using the regression equation from Section 2.3.8 Part I Report, and in the case of baseflow by assigning the last measured value as illustrated below for the period 28/01/85 to 05/02/85.

Date	Sediment Concentration (mg/l)	Remarks
28/01/85	4.5	Measured
29/01/85	4.5	Estimated (no record)
30/01/85	4.7	Measured
31/01/85		Event 6.2
01/02/85	4.7	Estimated (no record)
02/02/85	4.7	Estimated (no record)
03/02/85	4.7	Estimated (no record)
04/02/85	6.5	Measured
05/02/85	6.5	Estimated (no record)

Limitations concerning the data-set are discussed in Section 2.1 of Part I (Papworth *et al*, 1990).

3.2 Sediment Yield from the Experimental Catchments

Sediment yield has been calculated on a daily basis from the production of streamflow and its corresponding sediment concentration.

As event flow is considered to make the major contribution to sediment export, the method used in the calculation requires analysis of the streamflow record into its component parts: event related and base related. For the purposes of the study an event has been defined as a mean daily flow increase greater than seven litres per second. Flow increases less than this value has been included in the baseflow component and analysed accordingly.

The data-set has significant limitations which do not allow precise estimates of sediment yield to be made during eventflow. The reason for this is the difference in interval over which streamflow (mean daily) and sediment concentration (hourly) readings were recorded during eventflow. Daily records of streamflow and sediment concentration have been used in baseflow estimates of sediment yield; this is considered to be a close approximation to the true value. However, using mean daily values underestimates sediment yield during storms. The method used to obtain a more exact value is discussed below under 3.2.2.

3.2.1 Sediment Yield from Baseflow

During baseflow sediment yield is given by multiplying the mean daily streamflow by the corresponding sediment concentration for that day. Sediment yield from baseflow is included in Table 3.1, columns 1 and 4.

3.2.2 Sediment Yield from Event Flow

Section 3.2 refers to the limiting nature of the data-set for estimating sediment yield from eventflow. In this later study a more accurate estimate of yield during periods of rapid flow increase is required. The approach used requires and examination of the raw data to obtain hourly rates from which a relationship with the mean daily value can be derived. The procedure is outlined below.

a) sixteen events representative of the pre-treatment period were chosen from the catchment record for analysis. For the days on which these events occurred streamflow was digitized to match the corresponding record of sediment concentration

b) the more exact figure for daily sediment yield (DSY_I) was calculated by multiplying the instantaneous (hourly) values for flow rate (*l/s*) by the corresponding sediment concentration (mg/*l*) and summing over the 24-hour period

c) the average sediment (DSY_A) was calculated by multiplying the mean daily flow by the mean daily sediment concentration

d) a relationship was then derived for each catchment to correct from the average to the more exact incremental totals for daily sediment yield.

The relationships are given in the following formulae:

Springs Creek: $\log(DSY_1) = 1.07 \log(DSY_A) - 0.08$ $R^2 = 0.985$ SE = 0.062
Slippery Rock Creek: $\log(DSY_1) = 1.02 \log(DSY_A) + 0.02$ $R^2 = 0.992$ SE = 0.049

The formulae were applied to the data-set to give the annual sediment yields during event periods from the experimental catchments (Table 3.1 columns 2 & 5).

Table 3.1 – Sediment Yield from Experimental Catchments (tonnes) – Summary

	Slippery Rock Creek			Springs Creek					
Year	Baseflow Component	Eventflow Component	Total	Baseflow Component	Eventflow Component	Total	Due to treatment Total	Due to treatment Eventflow	Treatment
Column	1	2	3	4	5	6	7	8	9
1978	10.0	19.8	29.8	9.1	17.1	26.2			-
1979	13.2	20.2	33.4	14.0	15.7	29.7			-
1980	11.1	13.4	24.5	14.5	19.1	33.6			-
1981	20.8	30.5	51.3	24.5	108.2	132.7			-
1982	7.0	3.2	10.2	9.0	9.7	18.7	5.0	6.2*	roading
				10.2	**3.5**	**13.7**			
1983	10.2	21.8	32.0	14.1	54.1	68.2	36.3	35.8	logging
				13.6	**18.3**	**31.9**			
1984	11.8	22.9	34.7	14.2	106.2	120.4	89.1	88.0	logging
				13.1	**18.2**	**31.3**			
1985	8.0	21.8	32.0	12.2	80.9	93.1	64.9	63.6	logging
				10.9	**17.3**	**28.2**			
1986	13.9	34.7	48.6	15.4	87.6	103.0	61.4	61.9*	Regeneration burn
				15.9	**25.7**	**41.6**			
1987	13.2	11.1	24.3	16.9	27.9	44.8	18.9	17.8	Post-treatment
				15.8	**10.1**	**25.9**			

(shaded box) expected in absence of treatment

* Anomolies in these figures are due to unseasonal years in the regression procedure

3.2.3 Total Sediment Yield

To arrive at a figure for sediment yield due to treatment the expected background or natural level of sediment yield in the absence of treatment is subtracted from the observed reading.

In the case of baseflow little difference between the observed and the expected sediment yields would be expected and this is confirmed by the values in column 4 Table 3.1 over the treatment and post-treatment period.

The expected background levels of sediment yield over the treatment period during eventflow were estimated as follows:

a) calculate sediment concentration from the regression equation below (Section 2.4.8 Part I),

$$y = 0.891x + 0.106$$

Where y = Springs Creek sediment concentration
x = Slippery Rock Creek sediment concentration

(b) multiply sediment concentration by daily streamflow to give daily sediment yield (this equates to the average (DSY_A) value in 3.2.2)

(c) correct to the more exact daily sediment yield, (DSY_1) (Section 3.2.2)

(d) sum over 12 months to give expected yield (Table 3.1, column 5).

The difference between observed and expected values (Table 3.1, column 8) is due to treatment. The components of the treatment, roading and coupe operations, are discussed separately in the following sections.

The observed and expected values for the contribution to sediment yield from baseflow over the period 1982-1987 differ by less than 12 per cent confirming that baseflow sediment yield is relatively dependent of the treatment. This being so the **remaining calculations and derivations made under Section 3 have considered only the additional sediment contributed by eventflow.**

3.3 Separation of the effects of roading and coupe operations on the experiment catchments

Sediment measures were made at the catchment outlet, so that separate effects of roading or coupe operations could not be easily identified. Therefore any model of sediment from roading or coupe operations must accord with the experimental data (column 1, Table 3.2), and should reflect the real situation.

The roading operation considers only the major access roads; the coupe operations include all activities within the coupe.

3.3.1 Sediment yield from roading operations

Two factors were considered important in the analysis and evaluation of roading operations.

Firstly, the roading operation was done during a drought period (1982-83), so that sediment yield for that period would be low. To account for the low result the roading effect was scaled up in proportion to total eventflow.

Secondly, it was assumed that the intensity of road use was proportional to coupe size. Values in column 3 Table 3.2 relate to the 1983 coupe area of 15 ha. Subsequent coupe areas were 33 ha in 1984, and 25 ha in 1985. A value of 1.0 was applied in 1986 to allow for road use associated with regeneration burning. A value of 0.8 in 1987 was consistent with calculations in Section 3.3.2.

With the exception of 1982, for which 6.2 tonnes of sediment was estimate as the roading effect, the above factors have been incorporat4ed into the relationship given below to calculate sediment contribution from the road in other years.

$$\text{Roading effect in given year} = 6.2 \text{ x } \frac{\text{Eventflow}}{109.3} \text{ x relative use}$$

For example, the sediment yield from the road in 1984 is:

$$6.2 \text{ x } \frac{306.8}{109.3} \text{ x } 2.2 = 38.3 \text{ tonnes}$$

Results are shown in Table 3.2, column 4.

Table 3.2 – Contribution to sediment yield from roading and coupe operations in Springs Creek Catchment

Year	Sediment yield due to treatment* (tonnes)	Eventflow (Ml)	Relative use	Sediment yield due to roading (tonnes)	Sediment yield due to coupe operations (tonnes)
Column	**1**	**2**	**3**	**4**	**5 = 1-4**
1982	6.2	109.3	-	6.2	
1983	35.8	366.2	1.0	20.8	15.0
1984	88.0	306.8	2.2	38.3	49.7
1985	63.6	258.2	1.7	24.3	40.2
1986	61.9	438.9	1.0	24.9	37.0
1987	17.8	215.7	0.8	9.8	8.0

* data from Table 3.1, column 8

3.3.2 Sediment yield due to coupe operations and during recovery period

The sediment yield due to coupe operations is given by subtracting the roading effect from the sediment yield due to treatment. Values are shown in Table 3.2, column 5.

The task is to derive a value or values for a coupe operations constant which reflects the production of sediment over the period of operations and the recovery period and which can be used in the later extrapolation exercise. It is assumed that the constant is related to sediment yield, eventflow and area.

Because the experiment was terminated one year after the forestry operations ceased it is difficult to determine the persistence of elevated sediment yields following cessation of coupe activities. The allowance made here is empirical.

A reduction in sediment production with time is expected following cessation of coupe activities. Thus, the effective sediment production area is the area logged in a given year plus a proportion of the coupe logged in the previous year, if applicable, plus a proportion of the couple logged in the year prior to that, and so on. If the correct proportion is applied, the per-hectare effect of the logging should be approximately constant, which is the assumed result. If the proportion is too high, the constant (Table 3.4) falls rapidly with time; if the proportion is too low, the converse occurs.

The logging operations in Springs Creek catchment are well fitted by a coupe proportion of 50% per year. Details of this are shown in Table 3.3. For example, the effect from the 15 hectares logged in 1983 reduces to 50%, i.e. 7.5 ha in 1984, and by a further 50%, i.e. 3.75 ha, in 1985, and so on. This continues until the effective area drops below 1 ha. This arbitrarily defines the 'end' of the recovery period (Table 5.5). The same calculation is made for the other coupes. The total effect at the catchment outlet is the sum of yearly effective areas from each couple (Table 3.3).

Table 3.3 – Calculation of effective area logged

Year	**Coupe size (ha)**	**Effective area (hectare)**				
		1983	**1984**	**1985**	**1986**	**1987**
1983	15	15	7.5	3.75	1.875	0.9+
1984	33		33	16.5	8.25	4.13
1985	25			25	12.5	6.25
1986	0					
1987	0					
Total effective area (hectare)		15	40.5	44.5	24.0	10.5

+ only values greater than one hectare included

Therefore, the constant for coupe activities is given by:

$$\text{Coupe operations constant} = \frac{\text{coupe sediment yield in given year}}{\text{effective area x eventflow}}$$

Values are shown in Table 3.4.

Table 3.4 – Derivation of coupe operations constant for sediment generation

Column 1	2	3	4	5
Year	**Sediment yield due to coupe operations***	**Effective area (ha)#**	**Eventflow (Ml/ha)**	**Coupe operations constant (t/Ml/ha)**
1983	15.0	15.0	1.5	0.668
1984	49.7	40.5	1.25	0.977
1985	40.2	44.5	1.05	0.853
1986	37.0	24.0	1.80	0.857
1987	8.0	10.5	0.88	0.864

* values from column 5, Table 3.2
\# values from Table 3.3

4. PREDICTION OF SEDIMENT YIELDS IN OTHER CATCHMENT IN THE EAST KIEWA VALLEY

In this part of the study the findings of Section 3 are extrapolated to the area proposed for logging, i.e. the A17 and Little Arthur Creek sub-catchment.

4.1 The extrapolation model

It is assumed the areas to be logged are characteristic of the experimental catchments and would therefore behave similarly when treated similarly. These and other factors characterising this approach are included in the assumptions that follow:

a) the storages are perfect sediment traps and contribute nothing downstream

b) the Bogong Creek race redirects water from Bogong Creek back into Clover Dam

c) the whole of the East Kiewa Valley above the storages responds similarly to the experimental catchments in terms of climate, runoff and sediment generation

d) the 10 years of data collected in the experimental catchments are representative of any 10 year period

e) the roading and logging practices to be adopted in an extension of operations would be consistent with those used in the Springs Creek catchment (i.e. the same care taken)

f) there is a similar proportion and standard of stream crossing and coupe activity in the proposed operations as there were in the experimental operations

g) other current land use activities in the East Kiewa Valley, such as roading and alpine resort development, are not considered in this study

h) sediment yield due to baseflow is constant over the entire Valley

i) the recovery of the treated catchment follows a simple empirical relationship. (Due to premature termination of the experiment following cessation of logging, insufficient data is available.)

j) the experimental data is representative of the long-term behaviour of the East Kiewa Valley

It is acknowledged that these assumptions do not overcome the limitations of the initial experiment. For instance the assumption made in (c) above is at odds with the findings that the experimental catchments do not behave similarly. However rational assumptions are needed so that the best possible approximation can be reached based on known behaviour including the measured data of sediment accumulation of the whole catchment.

4.2 Methodology

The aim here is to reach broad conclusions from existing information. This has been done by sequentially offsetting the calculations. As an initial step the final year, 1987 of the data-set was wrapped around to the front to give a continuous repeating record. This preserves the original sequence of data, while allowing for different scenarios. Then, the starting time of the given logging plan was defined, and sediment yield calculated. The starting point was then offset one year and sediment yield calculated. The sequential offset was repeated to give ten estimates of sediment yield for the given logging plan. The median, maximum and minimum values of these estimates are given in the tables in the following sections.

Specific details of the method are as follows:

a) Decide on a definite logging plan (i.e., percentage of catchment logged over a given time period.

b) Calculate the annual logging rate, or the coupe size to be logged each year. This assumes that an equal area is logged each year.

c) Use the 10 years of data from the experimental catchments in their original sequence to predict the forestry operation effects.

d) Multiply the coupe size by the flow and the coupe operations constant (Table 3.4) to give the sediment effect derived from **logging** (coupe operations).

e) Calculate the **roading effect**, (Table 3.2).

f) Sum results to give totals.

g) Offset the starting point one year and repeat steps (c) to (f) for the new sequence. Note that 10 years of data is used throughout. On the first iteration, data 1978 to 1987 is used; on the second iteration 1979 to 1987, plus 1978; on the next 1980 to 1987, pus 1978 and 1979, and so on. The final iteration has starting point 1987 and data 1987 plus 1978 to 1986. This gives a set of 10 values for logging and roading effects for each logging plan to allow for annual variation.

h) The biggest (UL), smallest (LL) and the median (50%) values are selected (e.g. Table 5.1) for comparison in the calculations and tables which follow. Values in Tables have been rounded to two significant digits for presentation because of the assumption involved in the derivations.

5. APPLICATION OF THE MODEL TO SEDIMENTATION IN JUNCTION DAM AND CLOVER DAM

5.1 Definition of areas

The area under consideration for future logging consists of the A17 area of 1792 hectares, plus an area of 260 hectares in Little Arthur Creek catchment.

In this section the model is applied to the above areas to estimate the levels of sediment following logging that could be expected to accumulate in Junction Dam and Clover Dam storages over and above the 'naturally' occurring levels.

As an initial step it is assumed that all storages/pondages are perfect sediment traps, and contribute nothing downstream. The Junction Dam catchment is 105 km^2. This includes 13 km^2 of A17 area and portion of the Little Arthur Creek area (195 ha). The Clover Dam catchment is 20 km^2, of which 488 ha is within the A17 area and 65 ha is within the Little Arthur Creek area.

The areas proposed for logging (available area) are: 1499 ha in Junction Dam catchment, and 309 ha in Clover Dam catchment. The actual areas logged will be a fraction of this, i.e. between 20 and 40 per cent of the available area, due to exclusions including buffer strips, steep slopes and other environmental considerations. It is noted that Springs Creek catchment has been logged already, which removes 244 ha from the potential harvesting area in Clover Dam catchment. The increased sediment due to the experimental treatment amounts to approximately 280 tonnes (column (1), Table 3.2). This has been exported from the catchment. These areas are indicated on the plan in Appendix 1.

5.2 Extra predicted sediment from defined logging plans

Calculation of the additional sediment resulting from the proposed logging have been made for both 4-year and 8-year logging plans. The results are shown in Table 5.1 and 5.2

Table 5.1 – 4 year logging plan
Extra predicted sediment (tonnes) from logging specified percentages of the are available to operations.

Catchment above Junction Dam

Percentage of available area (for three regimes of sediment generation)		**Coupe**	**Road**
20%	median	880	410
	UL	960	440
	LL	780	390
30%	median	1300	610
	UL	1400	660
	LL	1200	590
40%	median	1800	830
	UL	1900	890
	LL	1600	800

Catchment above Clover Dam

Percentage of available area (for three regimes of sediment generation)		**Coupe**	**Road**
20%	median	180	70
	UL	200	80
	LL	160	70
30%	median	270	120
	UL	300	130
	LL	240	120
40%	median	360	160
	UL	390	180
	LL	320	160

Table 5.2 – 8 year logging plan
Extra predicted sediment (tonnes) from logging stated percentages of the area available to operations.

Catchment above Junction Dam

Percentage of available area (for three regimes of sediment generation)		**Coupe**	**Road**
20%	median	880	540
	UL	900	550
	LL	790	530
30%	median	1300	810
	UL	1400	830
	LL	1200	790
40%	median	1800	1100
	UL	1800	1100
	LL	1600	1100

Catchment above Clover Dam

Percentage of available area (for three regimes of sediment generation)		**Coupe**	**Road**
20%	median	180	100
	UL	190	100
	LL	160	100
30%	median	270	160
	UL	280	160
	LL	240	150
40%	median	360	210
	UL	370	220
	LL	330	200

5.3 Predicted background sediment yields

The percentage increase in sediment yield on the whole catchment basis can now be calculated using the information in Table 5.1 to 5.4. Springs Creek and Slippery Rock Creek have been used separately as reference catchments. The assumptions made are that the whole catchment behaves similarly, and is similarly pristine.

The relative contribution is given by:

Table 5.3 – 4 year logging plan
Predicted background sediment yields (tonnes) from Junction and Clover Dams catchments

Catchment above Junction Dam

Percentage of available area (for three regimes of sediment generation)	**Coupe**	**Road**
Springs Creek		
median	7200	12000
UL	7800	16000
LL	7100	12000
Slippery Rock Creek		
median	1600	2600
UL	1600	2900
LL	1400	2400

Catchment above Clover Dam

Percentage of available area (for three regimes of sediment generation)	**Coupe**	**Road**
Springs Creek		
median	1000	1900
UL	1100	2000
LL	1000	1200
Slippery Rock Creek		
median	1600	2600
UL	1600	2900
LL	1400	2400

Table 5.4 – 8 year logging plan
Predicted background sediment yields (tonnes) from Junction and Clover Dams Catchments

Catchment above Junction Dam

Percentage of available area (for three regimes of sediment generation)	**Coupe**	**Road**
Springs Creek		
median	9100	16000
UL	9400	18000
LL	8800	14000
Slippery Rock Creek		
median	14000	23000
UL	14000	24000
LL	13000	22000

Catchment above Clover Dam

Percentage of available area (for three regimes of sediment generation)	**Coupe**	**Road**
Springs Creek		
median	1400	2400
UL	1500	3100
LL	1300	2300
Slippery Rock Creek		
median	2100	3500
UL	2200	3800
LL	2000	3300

5.4 Relative contribution of logging sediment

The percentage increase in sediment yield on the whole catchment basis can now be calculated using the information in Tables 5.1 to 5.4. Springs Creek and Slipper Rock Creek have been used separately as reference catchments. The assumptions made are that the whole catchment behaves similarly, and is similarly pristine.

The relative contribution is given by:

$$\text{extra sediment yield (\%)} = \frac{\text{extra predicted sediment yield}}{\text{background sediment yield}}$$

Where data in the numerator comes from Table 5.1 or 5.2, and data in the denominator comes from Table 5.3 or 5.4, depending on the specified scenario.

The analysis is considering extremes. Therefore, the maximum value in the above equation is obtained from the maximum value (UL) in the numerator, and minimal value in the denominator: conversely for the minimum.

For example: consider the catchment above Junction Dam, the four-year logging plan, logging 20% of catchment, reference catchment is Springs Creek in Table 5.3

Using the above equation we obtain:

$$\text{median}: \frac{\text{median Table 5.1}}{\text{median Springs Creek Table 5.3}} = \frac{(880+410)}{(12000+7200)} \text{ x } 100\% \text{ -> } 7\%$$

$$\text{UL}: \frac{\text{maximum from Table 5.1}}{\text{minimum from Table 5.1 for Springs Creek}} = \frac{(960+440)}{(12000+7100)} \text{ x } 100\% \text{ -> } 7\%$$

$$\text{LL}: \frac{\text{minimum from Table 5.1}}{\text{maximum from Table 5.3 for Springs Creek}} = \frac{(780+390)}{(7800+1600)} \text{ x } 100\% \text{ -> } 7\%$$

Results are expressed as percentages and are shown in Table 5.5.

Table 5.5 – Percentage of extra sediment yield resulting from logging

Junction Dam

Percentage of available area (for three regimes of sediment generation)		**4 year logging ‘Recovery 8 years’**		**8 year logging ‘Recovery 11 years’**	
Reference		**Springs Creek**	**Slippery Rock Creek**	**Springs Creek**	**Slipper Rock Creek**
20%	Median	7	4	6	4
	UL	7	5	6	4
	LL	5	4	5	4
30%	Median	10	7	8	6
	UL	11	8	9	6
	LL	7	6	7	5
40%	Median	13	9	11	8
	UL	15	10	13	8
	LL	10	8	10	7

Clover Dam

Percentage of available area (for three regimes of sediment generation)		**4 year logging 'Recovery 8 years'**		**8 year logging 'Recovery 11 years'**	
Reference		**Springs Creek**	**Slippery Rock Creek**	**Springs Creek**	**Slipper Rock Creek**
20%	Median	9	6	8	5
	UL	13	7	8	6
	LL	7	5	6	4
30%	Median	13	10	11	8
	UL	19	11	12	8
	LL	11	8	9	7
40%	Median	18	13	15	10
	UL	27	15	16	11
	LL	15	11	12	9

5.5 Data supplied by SECV

The SECV has supplied data on the measured values of sediment in Junction Dam and some major storages with much larger areas. These values are shown in Table 5.6.

Calculations by the SECV for the sediment reaching Junction Dam are given in Appendix 2. The years 1972 to 1982 are not included in these calculations.

Table 5.6 – Volumetric yields of sediment ($m^3/km^2/ha$)

Data supplied by SECV

Storage	**Volume**
Hume	40
Eildon	70 (including 1939) 50 (without 1939)
Snowy	19-90 (11 sites)
Junction Dam	20-50

5.6 Calculation of background sediment volumes

This step in the analysis converts the results of Section 5.2 and 5.3 into volumes to allow comparison of results from previous sections with data supplied by SECV (Section 5.5). The conversion value of $0.35/tonne/m^3$ has been chosen from the results of Langford and O'Shaughnessy (1980) for Maroondah Reservoir and from Wu *et al* (1984) for the Reefton experimental catchments.

Values are given by:

$$\text{Background volume} = \frac{(\text{base} + \text{event})}{0.35 \text{ x area x time}} \text{ m}^3/\text{km}^2/\text{a}$$

Where the numerator is the row total from Table 5.3 or 5.4 (tonnes),
0.35 tonnes/m^3 is the conversion value
Area is catchment area (km^2
Time is in years.

Predicted background sediment volumes are shown in Table 5.7.

Table 5.7 – Predicted background sediment volume ($m^3/km^2/a$) for the whole catchment over logging plus recovery period

Above Junction Dam

Percentage of available area (for three regimes of sediment generation)	**Coupe**	**Road**
Springs Creek		
median	70	80
UL	80	70
LL	60	60
Slippery Rock Creek		
median	100	90
UL	110	100
LL	90	90

Above Junction Dam

Percentage of available area (for three regimes of sediment generation)	**Coupe**	**Road**
Springs Creek		
median	60	40
UL	60	50
LL	40	40
Slippery Rock Creek		
median	90	60
UL	90	70
LL	80	60

The general values from this table indicate that annual sediment volume using Springs Creek as reference is approximately 60 $m^3/km^2/a$. This is about 3 times the minimum value from sediment accumulation measured in Junction Dam (Table 5.6). The corresponding value using Slippery Creek as reference is 90 $m^3/km^2/a$. This is about twice the maximum measured value (Table 5.6).

5.7 Predicted extra volume of sediment

The values calculated in previous section in this report are in close agreement with the data supplied. This means that sediment volumes arising from forestry operations can be predicted with reasonable accuracy.

Values are given by:

$$\text{Extra volue} = \frac{(\text{coupe} + \text{road})}{0.35 \text{ x area x time}} \text{ m}^3/\text{km}^2/\text{a}$$

Where the numerator is row total from Table 5.1 or 5.2 (tonnes),
0.35 tonnes /m^3 is the conversion value
Area is catchment area (km^2)
Time is in years

Results are shown in Table 5.8. These figures may be an overestimate by a factor of two to three times, in view of the findings stated above. Note that these figures are the extra volume over and above the level of 20-50 $m^3/km^2/a$ measured for Junction Dam.

Table 5.8 – Extra predicted sediment volume ($m^3/km^2/a$) from proposed logging

Above Junction Dam

Percentage of available area (for three regimes of sediment generation)		**Coupe**	**Road**
20%	median	4	4
	UL	5	4
	LL	4	3
30%	median	7	5
	UL	7	5
	LL	6	5
40%	median	9	7
	UL	10	7
	LL	8	7

Above Clover Dam

Percentage of available area (for three regimes of sediment generation)		**Coupe**	**Road**
20%	median	5	3
	UL	6	3
	LL	5	3
30%	median	8	5
	UL	9	5
	LL	7	4
40%	median	11	6
	UL	12	7
	LL	10	6

6. SUMMARY AND CONCLUSIONS

In this report, sediment yields from the experimental catchments have been estimated from the sediment concentration data in Part I. From there, sediment yields and volumes have been predicted for different logging scenarios proposed fro the East Kiewa River catchment.

The assumptions involved in the derivation have been listed. The intermediate steps in the calculations have been expanded for clarity.

The increased sediment due to experimental treatment amounts to approximately 280 tonnes. This has been exported from Springs Creek catchment.

Calculated sediment volumes agree quite well with long-term volume data supplied by SECV.

Going by the experience of the experimental logging, the most likely intensity of logging favoured by the Department for the remainder of the A17 area would be 30% logged over 4 years. From Table 5.5, the projected impact of this scenario on Junction Dam is an approximate 10% increase in sediment above existing levels over a total period of 8-10 years. This would amount to approximately 2000 tonnes or 5500 m^3 extra sediment over the total period. The corresponding figures for Clover Dam area approximately 13% increase above existing levels over the same total period; the amounts are 400 tonnes or 1100 m^3 extra sediment over the total period.

Given that the storage capacity of Junction Dam is 1480 M*l*, and for Clover Dam is 255 M*l*, the extra sediment volumes correspond to approximately 0.4% storage capacity over the 8-10 year period.

7. REFERENCES

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Appendix 2 – Sedimentation into Junction Dam

(Information supplied by SECV)

Dam	Year Completed	Natural Catchment (km^2)
Junction	1944	105
Rocky Valley	1959	18
Pretty Valley	1959	21

Year desilted - 1972

Estimated silt volume = 78,500 yd^3
= 60,000 m^3

Effective catchment area

$$= \frac{(1972-1959)\,105 + (1959-1944)\,(105+18+21)}{1972-1944}$$

= 114 km^2

Silt generation $= \dfrac{60{,}000}{114\,(1972-1944)}$

= 17 $m^3/km^2/a$

Between surveys in 1982 and 1984, the accumulated silt – 11,000 m^3. Note that 82/83 was a drought period.

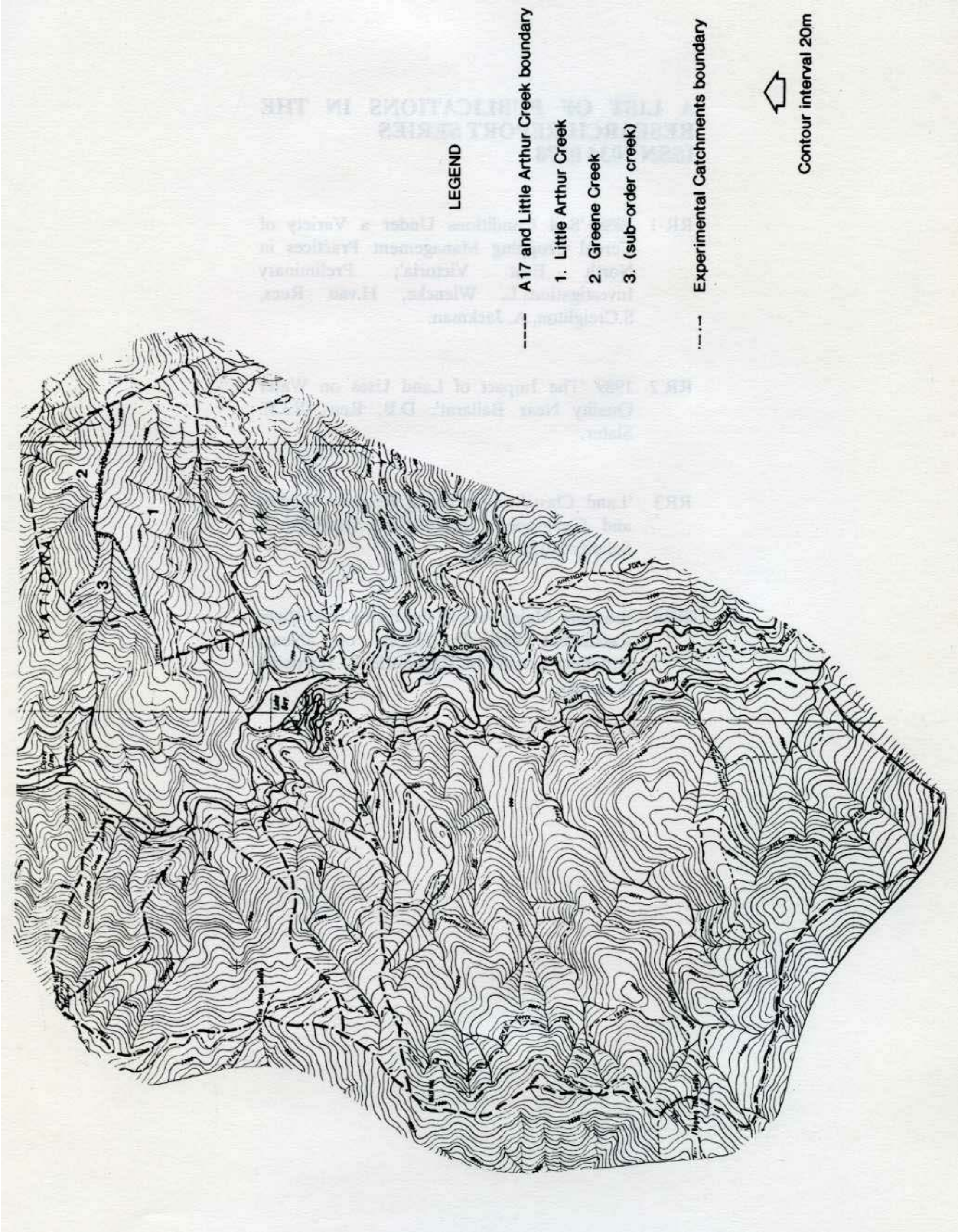
Silt generation $= \dfrac{11{,}000}{105\,(1984-1982)}$

= 52 $m^3/km^2/a$

The sluice gates are opened very 5 years. No appreciable amount of silt escapes during this operation.

Therefore, natural sedimentation rate is likely to be in the range 20 – 50 $m^3/km^2/a$.

Appendix 1 – A17 and Little Arthur Creek Catchments



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