Report ... 2/83

REPORT OF THE SURVEY OF SEDIMENT BELOW STREAM GAGING SITES 1, 2 AND 3 IN THE H. J. ANDREWS EXPERIMENTAL FOREST WATER YEAR 1981

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SITE HISTORY

Experimental timber harvest on Watersheds 1, 2, and 3 was an early forest research project in the H. J. Andrews Experimental Forest after its establishment in 1952. Watershed 2 was designed as the undisturbed control. Road building was completed in Watershed 3 during 1959 and after 3 years of monitoring for road building influences on the watershed, logging took place in 1962 and 1963. Approximately 30% of the watershed is in clearcut and road. Extensive road repairs were made in the summer of 1968. Logging in Watershed 1 was accomplished without road building. Cutting continued from 1962-1966, when the entire watershed had been clearcut and slash burning had been completed. No other major management activities have occurred within the watersheds.
Large mass movements have been important in the production of bedload in the study watersheds. Swanson (unpublished data) has done a field reconnaissance study of mass movement features and the watershed project field crew have made observations that have generated a partial history of recent mass-movement events in the basins. Dyrness (1967 and unpublished data) and Fredriksen (1963, 1965) have also documented failures in the study watersheds (see fig. 1).

Roadfill failures have frequently delivered sediment to the stream channel in Watershed 3. Such a failure in WY 1962 (S29, fig. 1) entered the channel and eroded 3000 feet of tributary and mainstream. The debris torrent did not reach the gaging station or settling pond (Dyrness, 1967).

In December 1964, heavy rain and melting snow triggered three large (volumes over 500 yd^3) road fill failures (D39 A&B, D40) in Watershed 3. The resulting debris torrents buried the gaging station and sediment basin under tons of mud and debris. Mass movement resulting from road failures also occurred in Watershed 3 in WY 1968 and 1972 (S30, S101).

Storms of WY 1965 also triggered four substantial slides in Watershed 1 (D44, D45, D46, D47). In WY 1968 two large slides (S99, S100) related to earthflow activity began delivering sediment to the stream in Watershed 1. This area continues to be active. Heavy rainfall in 1972 triggered two slides (S97, S98) on the south slope, low in the watershed that continued to be a source of bedload material. Mass movement in Watershed 2 has been rare during the length of the study.

Figure 1 - Mass Movement Reference Map

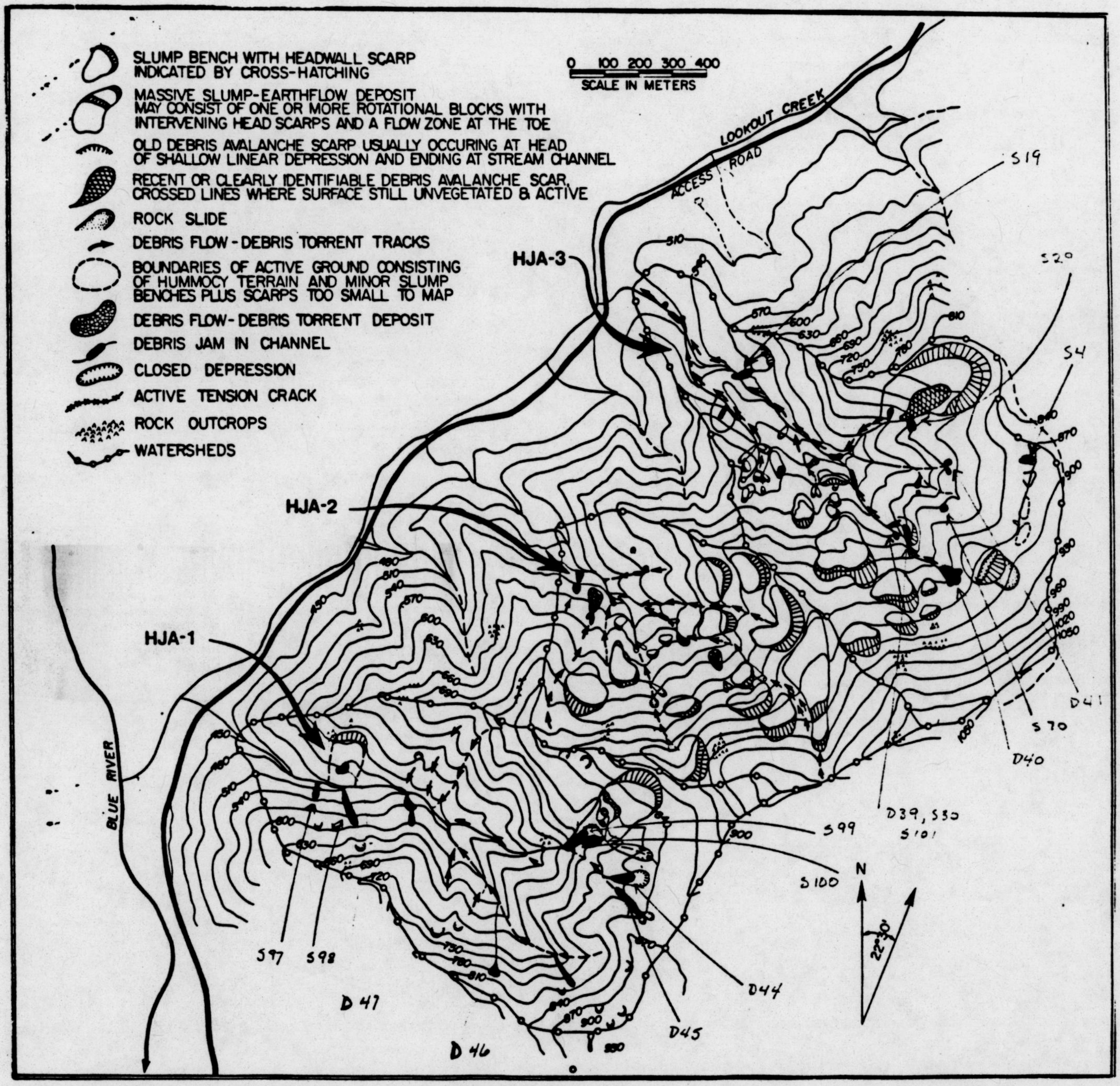

Figure 1 - Unpublished map of mass movements in HJA 1, 2, and 3 (Fredriksen, personal communication). Colored areas indicate mass movement contributing to bedload (Dyrness, 1967; F. J. Swanson, unpublished data).

MEASUREMENTS

Basin surveys have been designed to determine a change in average bottom elevation between annual surveys. Monumented cross sections are spaced at regular intervals along a primary control line, which runs the length of the basin dam. Survey points are spaced at intervals along the cross section lines, three-foot intervals at Watershed 1 and Watershed 2 and two-foot intervals at Watershed 3.

The survey is conducted using a level or a transit, a tape, and a leveling rod. The tape is run between cross section end posts and the rod is placed on the basin bottom at each of the prescribed survey points. At each point a level reading is made with the surveying instrument and recorded.

Permanent bench marks have been established near all three gage houses and in 1977 auxiliary bench marks (1/4" bolts set in concrete) were established near each catchment basin. These new bench marks replace nails or spikes driven into stumps or trees as reference points. Annual checks, monitoring elevational distance between bench marks and reference points, showed unexpected changes. The reference point on the Watershed 3 dam was actually sinking, while at Watershed 1 and Watershed 2 stumps containing the reference spikes were deteriorating and reliable measurements became increasingly difficult. The elevational difference between auxiliary bench marks and permanent bench marks continues to be monitored.

As part of the sediment basin survey, a check on the auxiliary bench mark elevation is made at the end of alternate cross-section transects. This procedure reveals any change in the elevation or level of the surveying instrument.

When catchment basins near or reach capacity, they are emptied. Local contractors are employed and usually a front-end loader or clam-shovel is used to clean the basin. After emptying, the basin is resurveyed--this survey being used as the baseline for comparison.

Following debris torrents and subsequent burial of the gaging station and sediment basin at Watershed 3 (see 1965 report), the catchment basin was remodeled in December of 1965. Details can be found in the 1966 report. A new survey was made in that month, but further modification was done in April 1966, followed by a new base survey in August 1966.

In 1976, the channel between the flume and the sediment basin at Watershed 2 was excavated to reduce the entrainment of bedload material in this seciton. In order to detect any accumulation or degradation in the channel several survey lines were extended.

CALCULATIONS

The determination of sediment accumulation is based on the average change in bottom elevation between two annual surveys. This is accomplished by comparing the change for the same survey points between any two surveys. Originally all points between cross section end posts were included in the calculations, but in years of little or no bedload accumulation small errors began to compound and led to negative values for bedload accumulations. Errors in rod placement or instrument readings are difficult to quantify, however some potential errors can be eliminated. One such potential error is rod placement on steep slopes at the edges of the sediment basin. These slopes accumulate virtually no sediment and may provide some very misleading rod readings. The entire cross section line is surveyed to monitor bank slumping. However, during years of low sediment yield, in an attempt to hold errors to a minimum only points on the bottom are used in calculations--slope points are eliminated. When slope points have been eliminated, the area they represented is less than 10 percent of the sediment basin area.

The number of points included in any calculation is variable, depending on the amount of filling. The catchment basins often fill to, and sometimes beyond, capacity. When a basin is filled near capacity, points on the bottom may have been on a steep slope in a previous survey and are included in the calculations. Therefore, all points along the survey line must be recorded.

Rod measurements for survey points used are totaled and averaged; yielding an average rod reading. A line of sight is determined by adding the mean of the bench mark readings to the elevation of the auxiliary bench mark (designated as 100.000 meters) and adjusting further by any change in the elevational difference between the permanent bench mark and the auxiliary bench mark. The average rod reading subtracted from the line of sight provides an average bottom elevation. By subtracting the previous bottom elevation from the current value and multiplying by sediment basin area, the volume of sediment accumulation is determined. This volume divided by watershed area determines yield of bedload per unit area of watershed.

Example

$\frac{\text{rod readings}}{\text{\# of points}}$ = average rod reading

Elevation of auxiliary bench mark + $\bar{X}$ bench mark reading +correction value = line of sight

Line of sight - average rod reading = average bottom elevation

Current average bottom elevation - previous bottom elevation = change in bottom elevation

% Bottom elevation x sediment basin area = accumulation

Accumulation - watershed area = accumulation/unit Watershed area

Sediment Basin Summary WY1981

The removal of the WY1981 WS#1 bedload accumulation was completed on July 22, 1980 and surveyed the same day. The full basin survey was done on August 4, 1981. Neither WS#2 nor WS#3 was emptied in 1980. Resurveying was completed on August 4 and 6, 1981, respectively.

The excavation (in 1976) of the channel between the WS#2 flume and sediment had raised questons regarding the reliability of sediment accumulation measurements. No distinction could be made among sediment generated in this section, sediment trapped in this section, or material that moved through it. In August 1980 the Blue River YACC lined the channel with concrete. We now expect that all sediment accumulated in the sediment basin will have come from the watershed study area.

Storm season precipitation on the study watersheds was slightly below the long term average (see Table 1). Three major storms were recorded in WY1981. All featured intense rainfall, but melting snow was a minor factor in streamflow peaks. During the largest run-off event over 320 mm. of precipitation was recorded from 12-19-80 to 12-25-80; 205 mm. of which was recorded in the 48 hours prior to peak flows early on the morning of 12-25 and again near 1400 hours that same day.

Filling of the sediment basins corresponded to storm events, but did not correspond to storm intensity. Field notes indicate that on 12-18 approximately 15 m^3 of inorganic sediment had accumulated in the WS#1 sediment basin. This material had been generated during the first storm of the season (12-2 and 12-3-80). At WS#2 only about one cubic meter, half inorganic and half organic material, was reported. The 1.5 m^3 observed at WS#3 was about 80% inorganic.

The most intense storm of the year (12-25-80) produced very little sediment. An additional 5 m^3 was observed at WS#1 during the 1-7-81 check and no change was reported at WS# 2. Some additional material was noted at WS#3, but there was some question as to whether this was really new material or reworking of sediment previously in the basin.

Streams were very high during the 2-18-81 watershed check and turbidity in the sediment basins made observation of the sediment piles quite difficult. Observations were made during the next check on 3-11-81, however, and at WS#1 an estimated volume of 70 m^3 of sediment accumulation was reported. No change was reported for accumulation at WS#2 and an additional 2 m^3 was noted at WS#3.

DISCUSSION

The liklihood of the storm of 2-16-81 producing 50 m^3 of material is slight since no mass movements in the watershed were reported. A more plausible explanation relates to the conditions under which estimates of sediment accumulation are made. If estimates are made when stream flow is high (as is often the case during the winter months) the water is often turbid and the full extent of the sediment pile is hard to determine. In addition viewing the pile under a meter or two of water does distort the image. Under lower stream flow conditions in the spring, however, much more of the sediment pile is near or above the surface, the water is less turbid, and more accurate estimates are possible. There is little doubt that the WS#1 estimate on 3-11-81 was close to the actual accumulated total of material in the sediment basin; but since the reports of earlier accumulations are likely underestimated, using the spring estimate for comparison should be avoided

The behavior of bedload discharge during WY1981 is probably no different than other years when no large amount of material was contributed to the stream system from mass movement events. The first storm of the season (12-2 and 3) probably carried the greatest amount of material into the sediment basins. This sediment was derived from summer surface erosion processes occurring in proximity to the stream channels. Dry ravel and weathering by heating and cooling are two examples. Organic material such as leaves, twigs, and branches also entered the channel margins during the dry period. When the stream system began to expand with the onset of wetter conditions, this material was washed into the main channels where it could be transported during the first large storm of the season. During later storms much less of this material was available as bedload material. The sources of bedload in these storms were likely small streamside slumps and mobilized areas of stream bed. My estimate is that the storms of 12-25-80 and 2-16-81 produced nearly equal amounts of bedload discharge at WS#1

In an effort to reduce confusion over the timing and volume of material delivered to the WS#1 sediment basin during individual storm events, a device for measuring the profile of the sediment pile was installed in September, 1981. Pulleys were fixed to two trees which were growing in strategic positions at either end of the long axis of the sediment delta. A nylon rope (later replaced by a plastic coated wire) was run between the two pulleys - washline style. A hook was tied into the rope and a tape weighted with a lead clock weight was run through the hook. A nail driven into one of the trees was used as a measurement point. The rope was run out one meter at a time and at each meter interval the weight was lowered to the water surface, tape distance recorded, lowered to the bottom and a second tape distance recorded. This procedure was repeated at each meter interval along the axis of the delta. A meter stick, partly submerged, attached to another basin-side tree served as a staff gage and was used to normalize water surface differences between any two surveys.

LITERATURE CITED

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Table 1 Storm Season (October through April) Precipitation

Water Year	PPT (mm)	PPT (in)	# Major* Storms	% of Storm Season $\overline{x}$
1975	2100	82.68	2	106
1976	2302	90.63	3	116
1977	860	33.86	0	43
1978	1996	78.58	3	101
1979	1588	62.52	2	80
1980	1776	69.94	1	90
1981	1742	68.59	3	90

Mean of storm season precipitation 1958-1980
$\overline{x}$ = 1998 mm
* = A storm during which the discharge at Watershed 2 exceeds 7.6 cfs

Table 2 Major storms for WY 1979 - WY 1981, peak flow

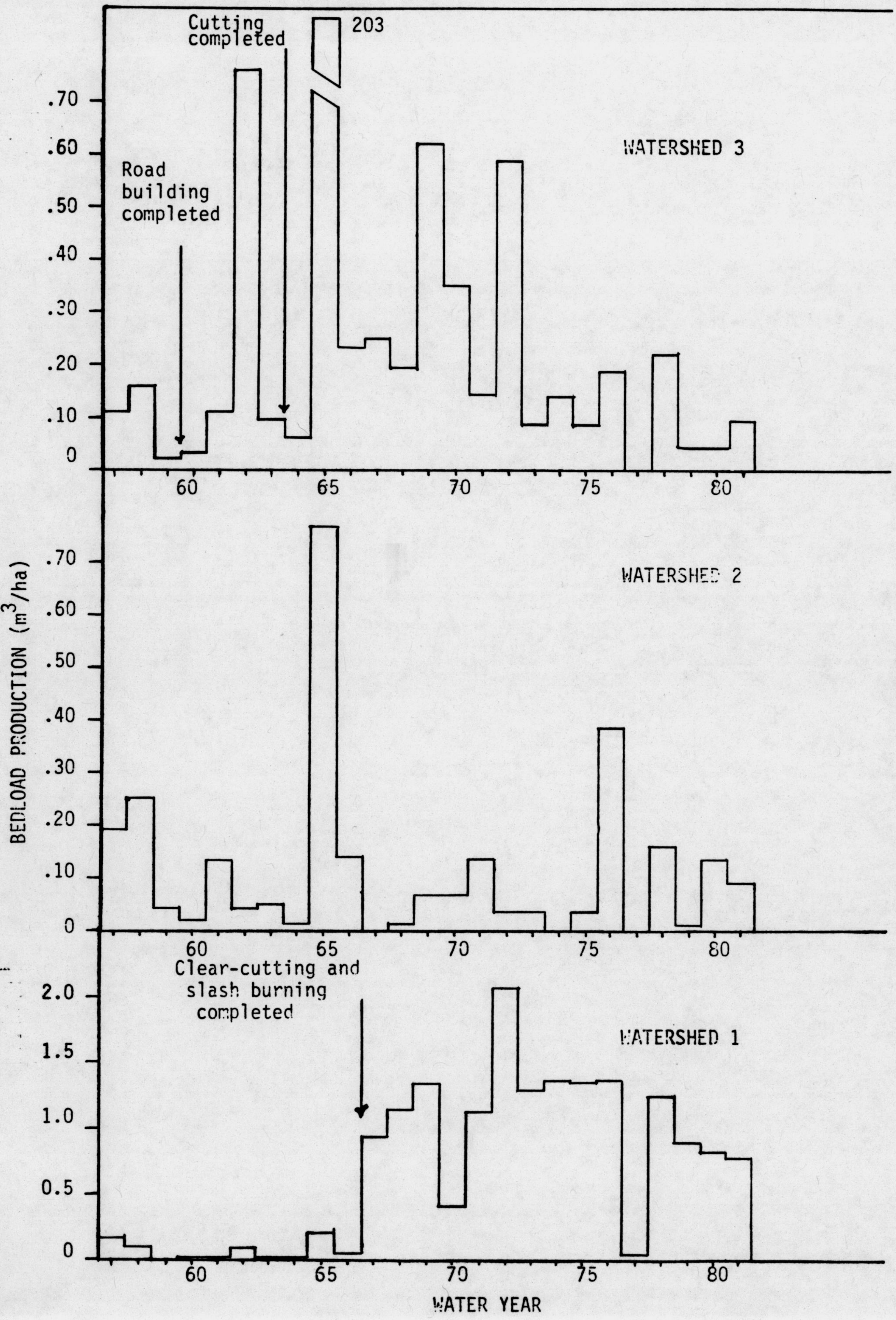
WY	Date	Watershed 1 (ft)	Watershed 1 (cfsm)	Watershed 2 (ft)	Watershed 2 (cfsm)	Watershed 3 (ft)	Watershed 3 (cfsm)
1979	12-4-78	1.089	79.61	.643	37.56	.85	40.28
	2-7-79	1.245	103.72	.780	55.04	1.125	66.49
1980	1-13-80	1.233	102.22	.844	70.49	1.074	61.11
1981	12-3-80	.964	62.28	.715	46.33	.919	46.03
	12-25-80	1.144	87.91	.886	70.81	1.158	70.08
	2-16-81	1.117	80.94	.691	43.31	.978	51.54

Table 3 Sediment Accumulation WY 1981

Site	Year	Number of points	Line of sight (m)	Avg. Rod Reading (m)	Mean bottom elev.(m)	Δ bottom elev.(m)	Total accum (m^3)	Prod. (m^3 /ha)	Ratio
WS 1	1980	186	101.29	3.23	98.05				
	1981	186	101.37	2.94	98.43	.38	74.60	.78	8.39
WS 2	1980	204	100.90	2.53	98.37				
	1981	204	101.21	2.81	98.40	.03	5.12	.09	
WS 3	1980	221	100.36	2.95	97.41				
	1981	221	100.34	2.82	97.53	.11	9.46	.09	1.00

	WS#1	WS#2	WS#3
Watershed area (ha)	96	60	101
Sediment basin area (m^2)	198	175	83

Figure 2. Annual bedload production in sediment basins watersheds 1, 2, and 3, H. J. Andrews



RI - NW
SOIL STABILIZATION
Watersheds
Benchmark: 1.365
H.I.
Elev.

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

FULL SURVEY

Experimental Area: HJA
Basin Location: WS #1

Date: 8-4-81
Party: Level TG
Rod RM
Notes GL

Station*	Transects (Designated in ft. starting at crest of dam)													
	1		2		3		4		5		6		7	
	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.
0														1.55
3						1.52		1.35		1.25		1.21	BE 4	1.33
6		1.43		1.44	BE 7.5	1.51		1.39		1.39	BE 5	1.66	SLOPE	1.79
9	BE	1.69	BE	2.83	SLOPE	2.80	BE/SL	2.86	BE/SL	2.69	SLOPE	2.64		2.38
12		3.14	SLOPE	3.34	BOT	3.54	SL	3.45	↓	3.35	↓	3.24	↓	3.17
15		3.36	BOT	3.58		3.66	BOT	3.71	BOT	3.76	BOT	3.68		3.66
18	SLOPE	3.35		3.65		3.74		3.84		3.68	ORG	3.62		3.57
21		3.41		3.75		3.86		3.78	ORG	3.39		3.48		3.51
24		3.35		3.62		3.78	ORG	3.64		3.34		3.39		3.38
27		3.35		3.55		3.76		3.61		3.36		3.37		3.40
30		3.15		3.46		3.68		3.58		3.50		3.38		3.37
33		2.91		3.32		3.55		3.62		3.42		3.44		3.42
36		2.57		3.11		3.33		3.48		3.54		3.50		3.44
39		2.15		2.91		3.23		3.42		3.50		3.49		3.32
42		1.92		2.89		3.24		3.39		3.42		3.05		2.66
45	BE	1.45		2.84		3.08		3.30		2.89		2.47		2.18
48		1.18	SLOPE	2.66		2.91		3.08		2.45		2.16		2.14
51				2.49		2.70		2.85		2.24		2.35		2.29
54				2.24		2.58		2.74		2.44		2.62		2.40
57			BE	1.68	BE 58	2.24	ROCK	2.40		2.72		2.68		2.44
60					ROCK	1.76	↓	2.29		2.62		2.65		2.41
63					ROCK	1.76	STREAM	2.19		2.30		2.60		2.76
66					STREAM	2.01	↓	2.08	BE	2.06		2.37		2.64
69					↓	1.91			ROCK	1.56	BE	2.04		2.28
72												1.65		2.30
75													BE	1.96
78														1.71
		BM	START			1.360								
		BM	LINE	1										
				3		1.366								
				5		1.367								
				7		1.367								
Total														
Average														

*Numbered to right starting with 0 at borderline which extends upstream from left end of dam.

RI - NW
SOIL STABILIZATION
Watersheds

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

Benchmark: 1.365
H.I. FULL
Elev.

FULL SURVEY
Experimental Area: HJA
Basin Location: WS #1

Date: 8-4-81
Party: Level TG
Rod RM
Notes GL

Station*	8		9		10		11		12		13		14	
	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.
0		142												1.48
3		1.31		1.32		1.43		(1.39)		1.3				1.59
6	SLOPE	1.75	BE	1.42	BE	1.24		1.30		1.31			BE	1.75
9		2.44	SLOPE	2.14	SLOPE	1.75	BE	1.48	BE 10	1.51				2.66
12	↓	3.11		2.79		2.38	SLOPE	2.25	SLOPE	2.14				2.74
15	BOT	3.59	↓	3.41		3.08		2.82		2.65				2.80
18		3.68	BOT	3.66	↓	3.50		3.28		2.89				2.84
21	ORG	3.61	ORG	3.75	BOT	3.70		3.44		2.81			SLOPE	2.21
24		3.54		3.65		3.70		3.37		2.75			BE	1.74
27		3.48		3.57		3.68		3.30	↓	2.64				1.66
30		3.44	↓	3.51		3.61		3.26	P	1.71				
33		3.42		3.44		3.51	↓	3.19		1.90		1.62		
36	↓	3.51	Δ	3.34	Δ	3.34		3.24	BE37	1.94	BE35	2.58		
39	Δ	2.95		2.68		2.76	Δ	2.94		2.88		2.94		
42		2.35		2.11		2.24		2.61	Δ	2.94		2.88		
45		2.02		2.00		2.01		2.38	BOT	2.72		2.79		
48		2.04		1.99		2.00		2.32		2.67		3.04		
51		2.09		2.00		1.99		2.54		2.81	SLOPE	2.82		
54		2.15		2.04		2.06		2.69		3.05	SLOPE	1.58		
57		2.20		2.13		2.38	↓	2.84		2.92	BE	1.78		
60		2.44		2.52	↓	2.76		3.00	SLOPE	2.48		1.74		
63	↓	2.86	↓	2.96		3.00		2.78		2.77		1.62		
66		2.74		2.79		2.75	BE/SL	2.15		1.70				
69		2.34		2.38		2.35		1.84						
72	BE	1.98	BE	2.00	BE	2.04		1.62						
75		1.85		1.82		1.74								
78														
		BM	LINE	9	1.367									
				11	1.365									
				13	1.364									
		BM	END		1.363									
Total														
Average														

*Numbered to right starting with 0 at borderline which extends upstream from left end of dam.

RI - NW
SOIL STABILIZATION
Watersheds
Benchmark: 1.285
H.I.
Elev.

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

Date: 7-22-80
Party: Level GL
Rod RM
Notes TL

Experimental Area: HJA #
Basin Location: WS #1

Station*	Transects (Designated in ft. starting at crest of dam)													
	1		2		3		4		5		6		7	
	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.
00														1.84
03						1.41		1.24		1.11		1.11		1.21
06		1.40		1.38		1.48		1.27		1.81		1.65		1.64
09		1.61		2.74		2.82		2.82		2.76	BE	2.63		2.46
12		2.93		3.20	↑	3.45	↑	3.10	↑	3.35		3.37		3.15
15		3.18	↑	3.46		3.65		3.85		3.84	↑	3.69	↑	3.59
18		3.28		3.60		3.73		3.85		3.83		3.80		3.83
21		3.33		3.67		3.77		3.85		3.87		3.82		3.85
24		3.24		3.61		3.74		3.80		3.85		3.82		3.77
27		3.14		3.51		3.76		3.83		3.85		3.79		3.74
30		3.00		3.41		3.70		3.75		3.72		3.80		3.75
33		2.79		3.26		3.47		3.71		3.65		3.75		3.70
36		2.41		3.03		3.29		3.54		3.63		3.55		3.62
39		2.46		2.86		3.18		3.41		3.49		3.52		3.56
42		1.71		2.84		3.11		3.49		3.43		3.44		3.39
45		1.27	↓	2.84		3.03		3.14		3.39		3.37		3.32
48		1.10		2.59		2.85		3.12		3.27		3.43		3.21
51				2.40		2.53		2.91		3.08		3.38		3.26
54				1.88		2.42		2.81		2.96		3.24		3.37
57				1.53	BE	1.85		2.23		2.89		3.15		3.34
60					E	1.60	R	2.19		2.52		2.98		3.18
63					R	1.69		1.98		2.12		2.67		3.01
66						1.90	↓	2.02	BE ↓	1.93		2.24		2.65
69					↓	1.86		[illegible]	1.38	1.38	BE ↓	1.91	↓	2.14
72												1.48	BE	1.81
75													BL	1.52
78														
Total														
Average														

*Numbered to right starting with 0 at borderline which extends upstream from left end

RI - NW
SOIL STABILIZATION
Watersheds

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

Benchmark:
H.I.
Elev.
after sediment removed

Experimental Area: HJA
Basin Location: WS#1

Date: 7-22-80
Party: Level GL
Rod RM
Notes TL

Station*	8 H.I.	8 Elev.	9 H.I.	9 Elev.	10 H.I.	10 Elev.	11 H.I.	11 Elev.	12 H.I.	12 Elev.	13 H.I.	13 Elev.	14 H.I.	14 Elev.
	Transects (Designated in ~~ft.~~ meters starting at crest of dam)													
00		1.44												1.38
03		1.17		1.21		1.33								1.47
06	BE	1.66	BE	1.31		1.13		1.26		1.21			BE	2.01
09		2.32		2.02	BE	1.29	BE	1.36		1.42			↑	2.69
12		3.03		2.86		2.39		2.36		2.04				2.63
15	↑	3.53		3.38		3.01		3.47		2.62				2.74
18		3.76	↑	3.64		3.30		3.19		2.76			↓	2.79
21		3.76		3.76	↑	3.61		3.22		2.72				2.42
24		3.81		3.75		3.62		3.13		2.57			BE	1.63
27		3.77		3.76		3.64		3.11		2.58			TR	1.51
30		3.67		3.67		3.53		3.11		2.59		~~X~~	TR	
33		3.55		3.53		3.44		2.91	P	1.67		1.53		
36		3.56		3.53		3.43	↑	2.92	P→37	1.68	↑ 35	2.40		
39		3.40		3.45		3.43		3.08	↑	2.66		2.83		
42		3.35		3.52		3.30		3.07		3.18		2.98		
45		3.31		3.28		3.23		3.24		3.15		3.08		
48		3.31		3.29		3.27		3.29		3.27	↓	2.96		
51		3.46		3.47		3.35		3.26		3.26		2.67		
54		3.36		3.45		3.41		3.25		3.15	BE	2.40		
57		3.41		3.38		3.37		3.21	↓	2.75		1.63		
60		3.35		3.35		3.27		3.08		2.24		1.64		
63		3.02		3.01		3.04	↓	2.45	TRBE	1.63		1.52		
66		2.80		2.74		2.75	BE	1.98		1.55		~~X~~		
69	↓	2.27	↓	2.35	↓	2.13	TR	1.64		~~X~~				
72	BE	1.80	BE	1.87	BE	1.83	BUSH	1.47						
75		1.67		1.65		1.58								
78														
BM	start of survey			1.284										
BM	End of line 3			1.284										
BM	" " " 5			1.284										
BM	" " " 7			1.285										
BM	" " 9			1.286										
			11	1.285										
	END OF SURVEY			1.285										
Total														
Average														

*Numbered to right starting with 0 at borderline which extends upstream from left end of dam

RI - NW
SOIL STABILIZATION
Watersheds

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

Benchmark: 1.211
H.I.
Elev.

FULL

Experimental Area: HJA
Basin Location: WS#2

Date: 8-4-81
Party: Level Lienkaemper
Rod Gurtner
Notes Mersereau

Station*	Transects (Designated in ft. starting at crest of dam) 1		2		3		4		5		6		7	
	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.
0														
3				1.73		1.89		1.98		2.04	BE4'	1.99		1.88
6			BE	2.02	BE5'	2.35	BE4'	2.47	BE	2.52	Slope	2.37	BE5'	2.47
9			slope	2.35	Slope	2.96	slope	3.28	slope	3.07	slope	2.94	Slope	2.90
12			slope	2.69		3.31		3.48		3.41		2.35		3.33
15			slope	2.95		3.35		3.51		3.36		3.18		3.20
18	Bank	1.93	"	3.13		3.50		3.34	organic	3.02	organic	2.98	organic	2.97
21	slope	2.51	0	3.30		3.42		3.21	"	3.12	↕	3.08	↕	3.08
24	Slope	2.84	"	3.32		3.29		3.32	"	3.24		3.16		3.12
27	slope	2.97		3.36		3.31		3.39	"	3.37		3.23		3.14
30	slope	3.02		3.19		3.32		3.39		3.42	organic	3.33		3.12
33 Rock	slope	2.54		3.19		3.34		3.47		3.41		3.40		3.10
36 Rock	slope	2.29		3.25		3.33		3.39		3.32		3.21	organic	3.16
39			Delta	3.17		3.25		3.32		3.25		3.12		3.04
42			Delta	2.92	Delta	2.81	Delta	2.84	Delta	3.02	Delta	2.95	Delta	2.93
45			"	2.48	"	2.36	"	2.26	"	2.56	"	2.71	Delta	2.77
48			"	2.18	"	2.14	"	2.18	"	2.35	"	2.51	"	2.25
51			"	2.05	"	2.19	"	2.24	"	2.21	"	2.28	"	2.19
54			BE	2.21	"	2.30	"	2.26	"	2.21	"	2.22	"	2.11
57			BE	1.84	"	2.32	"	2.22	"	2.22	"	2.24		
60														
63														
66														
69														
72														
75														
78														
81														
Total														
Average														

AUX BM START 1.205 (OLD BM 1.810 End 1.845)

AUX BM END OF LINE 1 —
AUX " " " " 3 —
AUX " " " " 5 1.210
AUX " " " " 7 1.210

*Numbered to right starting with 0 at borderline which extends upstream from left end of dam.

RI - NW
SOIL STABILIZATION
Watersheds

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

Benchmark: 1.211
H.I.
Elev.

FULL

Experimental Area: HJA
Basin Location: WS#2

Date: 8-4-81
Party: Level GL
Rod TG
Notes RM

Station*	Transects (Designated in ft. starting at crest of dam)													
	8		9		10		11		12		13		14	
	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.
0												1.67		1.65
3	BE	1.93	BE 5'	1.90	BE 5'	1.89		1.89		1.90	slope	2.26	slope	2.20
6	slope	2.54	slope	2.41	slope	2.59	slope	2.42	slope	2.57	slope	2.61	slope	2.55
9	"	3.15	"	2.95	slope	3.03	slope	2.89	"	2.79		2.85		2.75
12	organic	3.28		3.29		3.19		3.13	organic	2.98	organic	280	organic	2.72
15	↑	3.10	organic	3.12	organic	3.06	organic	2.96	↑	2.88	↑	2.76	↑	2.70
18		2.94	↑	2.94	↑	2.91	↑	2.90		2.84		2.72	↓	2.67
21		2.98		2.93		2.94		2.91		2.83	↓	2.73	organic	2.71
24		3.01		2.97		2.97		2.95	↓	2.85	organic	2.75		2.68
27	↓	3.01		2.96		2.98		2.95		2.80		2.81		2.48
30		3.12		2.99		3.02	↓	2.91	organic	2.79		2.70		2.41
33	organic	3.11		3.09	↓	2.99	organic	2.85		2.90	slope	2.43	BE	2.18
36		3.21	↓	3.13		2.96		2.89		2.89	B.E	2.20		
39	Delta	3.01	organic	3.01	organic	2.93		2.80		2.75				
42	"	2.80	Delta	2.89		2.68		2.60		2.44				
45	"	2.58	"	2.69		2.49		2.36	BE	2.03				
48	"	2.28	"	2.43		2.33	BE	2.03						
51	"	2.17	BE	2.20	BE	1.96								
54	"	1.84												
57														
60														
63														
66														
69														
72														
75														
78														
81														
84														
87														
90														
93														
96														
99														
102														
	BM	END OF LINE	9	1.210										
	"	" "	" 11	1.211										
	"	" "	" 13	1.211										
Total														
Average														

*Numbered to right starting with 0 at borderline which extends upstream from left end of dam.

RI - NW
SOIL STABILIZATION
Watersheds
Benchmark: 1.211
H.I.
Elev.

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

FULL

Experimental Area: HJA
Basin Location: WS #2

Date: 8-4-81
Party: Level GL
Rod TG
Notes RM

Station*	Transects (Designated in ft. starting at crest of dam) 15		16		17		18							
	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.
0		1.79		1.98		2.37								
3	Slope	2.36		2.38		2.35								
6		2.58		2.42		2.35								
9		2.56		2.45		2.30								
12		2.52		2.44		2.27	BE	2.12						
15		2.55		2.40		2.22								
18		2.55		2.23	BE	1.89								
21		2.36	BE	2.00										
24		2.24												
27	BE	2.07												
30														
33														
36														
39														
42														
Total														
Average														

1980 SURVEY
TOTAL ROD READINGS 516.75
TOTAL ROD POINTS 204
$\bar{X}$ ROD READING 2.53

1981 SURVEY
TOTAL ROD READING 527.57
TOTAL ROD POINTS 204
$\bar{X}$ ROD READING 2.81

	1980		1981
BENCHMARK	100.00	BENCH MARK	100.00
$\bar{X}$ BENCH MARK LEVEL	.90	$\bar{X}$ BM LEVEL	1.21
LINE OF SIGHT	100.90	Line of sight	101.21
$\bar{X}$ ROD READING	2.53	$\bar{X}$ ROD READING	2.81
$\bar{X}$ BOTTOM ELEV.	98.37	$\bar{X}$ BOTTOM ELEV	98.40

BM END OF LINE 15 1.211
" " " " "

BM END 1.211

*Numbered to right starting with 0 at borderline which extends upstream from left end of dam.

RI - NW
SOIL STABILIZATION
Watersheds
Benchmark:
H.I.
Elev.

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

Date: 8-6-81
Party: Level GL
Rod BG
Notes RM

Experimental Area: HJA
Basin Location: WS #3

Station*	Transects (Designated in ft. starting at crest of dam)													
	1B		1A		1		2		3		4		5	
	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.
00														
12.5						3.07		3.29				3.74		3.64
4						3.03		3.30	2.5 —	3.63		3.74		3.80
6						2.98		3.13		3.39		3.46		3.69
8						2.98		3.07		3.16		3.39		3.62
10						3.07		3.06		3.13		3.44		3.61
12						3.14		3.10		3.15		3.46		3.52
14						3.16		3.09		3.25		3.40		3.44
16						3.00		3.04		3.17		3.21		3.34
18						2.97		2.92		3.00		3.05		3.25
20						2.81		2.90		2.95		3.04		3.17
22						2.65		2.65		2.93		2.89		3.00
24						2.55		2.53		2.82		2.72		2.82
26						2.46		2.50		2.78		2.52		2.62
28						2.33		2.31		2.44		2.30		2.41
30						2.15		2.14		2.28		2.12		2.29
32						2.03		2.04		2.00		2.02		2.20
34		1.50		1.93		1.98		2.01		1.99		2.02		2.07
36		1.52		2.03		2.05		1.99		2.05		2.03		2.01
38		1.87		1.96		1.95		1.99		2.02		2.00		1.95
40		1.92		1.92		1.92		1.98		2.01		1.94		1.90
42		1.92		1.95		1.90		1.94		1.95		1.96		1.82
44		1.85		1.89		1.89		1.96		1.94		1.84		1.80
46		1.86		1.88		1.88		1.91		1.78		1.89		1.78
48		1.91		1.89		1.90		1.87		1.96		1.88		
50		1.88		1.84		1.87		1.81		1.88		1.88		
									50 —	1.96				
			BM START			0.346								
			"	End	Line	11	= 0.346							
				End	Line	8	0.315	?→ Line 8 only						
				Start	Line	7	0.344							
				Start	Line	6	0.344							
				End	Line	5	0.344							
				"	"	3	0.343							
				"	"	1	0.343							
				End of Survey			0.343							
Total														
Average														

*Numbered to right starting with 0 at borderline which extends upstream from left end of dam.

RI - NW
SOIL STABILIZATION
Watersheds

ELEVATIONS OF SEDIMENT ACCUMULATED IN CATCHMENT BASINS

FORM RI-2

Benchmark:
H. I.
Elev.

Experimental Area: HJA
Basin Location: WS#3

Date: 8-6-81
Party: Level GL
Rod BG
Notes RM

Station*	Transects (Designated in ft. starting at crest of dam) 6		7		8		9		10		11		12	
	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.	H.I.	Elev.
0														
2.5		3.74		3.71		3.80		3.84		3.75		3.64		3.58
4		3.82		3.89		3.80		3.87		3.71		3.72		3.65
6		3.81		3.87		3.90		3.87		3.78		3.84		3.80
8		3.65		3.65		3.64		3.56		3.70		3.73		3.77
10		3.60		3.49		3.42		3.30		3.42		3.54		3.60
12		3.51		3.38		3.28		3.23		3.23		3.34		3.50
14		3.34		3.30		3.17		3.14		3.15		3.22		
16		3.30		3.16		3.07		3.06		3.09		3.11		
18		3.20		3.15		3.14		3.03		3.21		3.21		
20		3.18		3.19		3.17		3.24		3.21				
22		3.12		3.15		3.17		3.18		3.10				
24		2.95		2.98		3.07		2.99						
26		2.89		2.84		2.91								
28		2.75		2.78										
30		2.56		2.57										
32		2.38												
Total														
Average														

TOTAL ROD READING 622.34
TOTAL PTS 221
AVG RD READING 2.816

Line of Sight 100 + .344 = 100.344

Avg Bottom Elev = 100.344
− 2.816
97.528
1980 Bottom Elev 97.414
Δ 0.114

*Numbered to right starting with 0 at borderline which extends upstream from left end of dam.