JOSEPH CANYON/STARVATION RIDGE FIRE

EMERGENCY REHABILITATION REPORT

SEPTEMBER 1986

CONTENTS

SUMMARY

A. INTRODUCTION

On September 21, 1986, a Burned Area Emergency Rehabilitation Team was requested by the Wallowa-Whitman National Forest to complete an evaluation of the Joseph Canyon/Starvation Ridge Fires on the Wallowa Valley Ranger District. The two fires began during a dry lightning storm on the afternoon of August 10, 1986. Eventually the two fires burned together to form one large fire of approximately 40,000 acres in size. The fire was located in steep canyon country 20 miles north of Enterprise, Oregon east of State Highway 3. The fire burned protions of the following drainages.

Joseph Creek
Swamp Creek
Davis Creek
Peavine-Lupine Creek
Brushy Creek
Rush creek

B. TEAM MEMBERS

Members of the Emergency Rehabilitation Team included:

1.	Steve Howes (Team Leader) Budget Coordinator and Soil Management Specialist Range and Watershed Management, RO	423-6858 (FTS)
2.	Dennis Caird Logging Engineer Timber Management, RO	423-3358 (FTS)
3.	Tom High Soil Scientist Mt. Hood NF	503-666-0766
4.	Steve Kessler Fisheries Biologist Naches RD, Wenatchee NF	509-653-2205
5.	Margo Duncan Silviculturist Fort Rock RD, Deschutes NF	503-388-5673
6.	Bruce Anderson Hydrologist Ochoco NF	503-447-6247
7.	Mike Leonard Wildlife Biologist Wallowa Valley RD	503-432-2171

8. Chuck Anderson
Range Technician
Wallowa Valley RD 503-432-2171

Note: Team members wish to acknowledge the assistance of Ralph Anderson and Dan Ross for providing video camera support and documentation of aerial and field surveys.

C. MISSION

The team's mission was to complete a burned area survey (complete a burn intensity map) and to make an assessment of the effects of the fire on resource values within the firelines and downstream as well. Based on this assessment and resource values involved, the team was to develop a recommended course of action to provide for EMERGENCY rehabilitation and watershed stabilization needs; and to secure necessary funding. An FS-2500-8 was submitted and approved on August 28, 1986.

D. COORDINATION

On the morning of AUgust 23, the team was briefed by District Ranger Frank Olson on the background of the Joseph Canyon/Starvation Ridge Fire, managementissues and concerns and major resource values involved. During the course of the burned area survey, team members interacted with their counterparts in other agencies including:

Oregon Department of Fish and Wildlife
State Water Bureau
Bureau of Land Management
Soil Conservation Service
Agricultural Stabilization and Conservation Service

The team also provided input to the Fire Overhead Team, primarily the Incident Commander and Resource Advisor for development of plans for rehabilitation of suppression caused damage. Contacts included:

Incident Commanders	Resource Advisors
Robert Kitchens, R-8	Bob Barney, WWNF
Jim Stumpf, R-5	Danny Castillo, WWNF

A briefing on the team's tentative findings and recommendations was given to Forest Staff and other interested individuals on August 27. Those present included the Deputy Forest Supervisor; Ranger and Watershed Staff Officer; District Ranger, Wallowa Valley RD; Project Manager, Hells Canyon National Recreation Area; and representatives of ODF, ODF&W and SCS.

E. DOCUMENTATION

The team conducted the burned area survey by making several aerial reconnaissance flights in both fixed-wing aircraft and helicopters; and by making on-the-ground investigations. Documentation of the team's observations can be found in the following written report and in several hours of video camera recordings. Copies of the video tapes and burn intensity map were left with the District upon the team's departure on August 28. Hopefully these materials will provide the District with an historical record of this fire and serve as a basis for future monitoring projects.

F. SUMMARY OF RECOMMENDATIONS

The Joseph Canyon/Starvation Ridge encompased 40,163 acres. Acreages by landownership and burn intensity are listed below:

NFS

Total - 30,165
Moderate - 10,157
Severe - 3,085

BLM

Total - 1,300
Moderate - 710
Severe - 215

State

Total - 280
Moderage - 60
Severe - 0

Private

Total - 7,968
Moderate - 2,358
Severe - 334

Of the 30,165 NFS acres included within the firelines, 17,375 acres were not burned or lightly burned. Within the Davis and Swamp Creek Drainages, 1,184 acres were severely burned and 4,246 acres were moderately burned.

Based on the burned area survey and the resource values involved, the Emergency Burned Area Rehabilitation Team recommended the following treatment measures for NFS lands:

Seed 5,430 acres of moderate and severely burned land within the Davis and Swamp Creek Drainages with the following seed mixture at the rate of 16 pounds per acre.

	lbs/acre
Winter wheat	10
Orchard grass	3
Yellow blossom sweet clover	2
Rhizoma Alfalfa	1
	16

Seed 1,901 acres of severely burned lands within the remainder of the affected area with the following seed mixture at the rate of 19 pounds per acre.

	lbs/acre
Winter wheat	15
Orchard grass	2
Yellow blosom sweet clover	2
	19

Twenty-three miles (33.5 acres) of tractor line and 9.6 miles of handline was constructed on the Joseph Canyon/Starvation Ridge Fire. Rehabilitation of these items and main fire camp was covered under the suppression damage rehabilitation plan.

2. RESOURCE REPORTS

A. Soils

Joseph Canyon and its tributaries are deeply incised into a basalt plateau formed from multiple flows of Columbia River Basalt.

Canyon sideslopes on south, west and east aspects are steep to very steep and have considerable rock outcroppings, talus slopes, and shallow soils. Surface soils are stony to very stony silt loams. Subsoils are very stony to extremely stony silt loams or loams. Depth to bedrock ranges from less than 10 to 20 inches. Soil structure is weak and aggregate stability is low. Infiltration is moderately rapid and permeability is moderate. Vegetation is primarily grassland (see Ecology Section for vegetation information).

Considerable bare soil is present, presumably from past overgrazing, and accelerated soil erosion is indicated by pedestalled plants, ravel scars, and deposition of soil on the upslope sides of rocks. Mass movement hazard is generally low; however, several small (less than 1 acre) shallow mantle failures were observed. Surface ravel is common, especially on steep slopes with little vegetative cover.

Narrow, open ridgetops also have shallow soils except where there is patterned ground (biscuit and swale topography). In these areas, biscuits have deeper soils which contain fewer rock fragments than surrounding scablands.

Most grassland areas did not burn severely. Crowns of perennial grasses remain intact and will presumably sprout with increased vigor next growing season.

North-facing slopes, larger stream bottoms, and broad ridgetops such as Table Mountain have deeper, less stony soils. These areas have greater accumulations of volcanic ash and loess in surface layers. Soils have non-stony to stony silt loam surfaces and stony to very stony subsoils. Depth to bedrock ranges from 20 inches to over 5 feet and averages about 20 to 40 inches. Soil structure is weak and aggregate stability is low. Infiltration is moderately rapid to rapid and permeability is moderate. Vegetaion includes Douglas-fir, Ponderosa pine and some western larch. Understory plants include ninebark, pinegrass, elksedge, snowberry, and other shrubs and forbs.

Most moderate and severe burning took place in timbered areas on steep, north-facing slopes. Moderately burned areas are characterized by partial burning and incomplete consumption of organic soil layers. The ground in these areas appears black. Soil discoloration and non-wettability were not observed in these areas. Included within moderately burned areas are small pockets of severely burned ground.

On severely burned ground (duff layers) have been completely consumed. The only organic material remaining are large downed logs. Soils beneath these large downed logs are red in color. A layer of loose, fluffy ash which covers the mineral soil is very easily displaced and will move downslope if disturbed or if saturated with water. This movement is an avalanche-like density flow. Beneath the ashy material, mineral soils are moderately hydrophobic. This hydrophobicity is probably not fire-induced but is inherent in soils with volcanic ash in the surface. In any case (in severely burned areas), hydrophobic soil is now exposed to raindrop impact. Although no measurements were made, severely burned areas usually lose considerable amounts of soil nutrients by volitalization and through leaching. Nitrogen, which is usually the most limiting nutrient on these sites, is released as ammonia into the air and as nitrate into the soil. Nitrate nitrogen is very soluble and will readily leach or be easily taken up if plants are present.

Lightly burned areas are characterized by lightly singed dust layers and very small spots of moderate to severe burn. These areas are not expected to produce significant soil movement or sedimentation.

RECOMMENDATIONS:

General fire area:

Apply grass seed to all areas that were burned to a moderate or high severity to reduce the hazard of soil erosion. A grass cover will reduce raindrop impact which tends to seal the soil surface. Grass roots will help to hold the soil in place and the crowns of these plants will trap soil. Also, a grass cover will replenish the soil with organic matter and nutrients and will capture considerable amounts of nutrients, especially nitrate nitrogen, which was released by the burn.

Firelines:

Tractor firelines are generally on ridgetops or on the noses of ridges on steeper slopes. Most line is one blade width. Depth averages about 6 inches. Tractor lines on gentle slopes need not be waterbarred. The berms to the sides of these lines should be bladed back into the line, or at least broken downslope occasionally, to allow drainage. Tractor lines on steep slopes have been waterbarred. Some of these waterbars were improperly installed and have created more disturbance than necessary. A recommendation for future fires is to contact the rehabilitation team before this work begins for training and coaching. This may help in proper location and installation.

Hand lines are mostly on steep slopes. These should also have the soil raked back into them or hand water-barred.

All lines should be seeded with grass (preferably not aerially). Drop points and helispots which were bladed should be re-shaped and seeded to the same grass mixture as the firelines.

Fire Camp and Main Heliport:

The fire camp as Sled Springs is largely in a meadow with fine-textured soil. This soil has been compacted by equipment and foot traffic. These areas should be subsoiled with a winged subsoiler to a depth of 18 inches; two passes should be made. If subsoiling is precluded by cultural resource considerations, a spring-toothed harrow or similar device should be used to loosen the upper few inches of soil. Treated areas should be seeded with 2 lbs./acre each of Timothy and yellow blossom sweet clover.

Salvage Logging:

The soil in the hot-burned area is very loose and can be easily displaced. Logging operations should be restricted to periods when there is two feet or more of snow or until after the seeded vegetation has become established. Soil which becomes displaced due to salvage logging operations should be re-seeded and/or mulched with logging slash.

B. HYDROLOGY

The Joseph Canyon/Starvation Ridge Fire affected an area of 40,163 acres. In the Joseph Canyon portion, the steep canyon lands are characterized by timbered draws with grassy uplands. The Starvation Ridge area to the south has a more dissected ridge pattern with timbered north aspects slopes and grassland communities on south slopes. Average annual rainfall is 22.5 inches.

Major streams including: Swamp Cr, Davis Cr.(a tributary of Swamp Cr.), Peavine Cr. and Rush Cr. are tributaries of Joseph Cr. which flows for 16 miles below the fire boundary to its confluence with the Grande Ronde River. Joseph Cr. and to a lesser extent Swamp Cr. drain extensive areas outside the fire. The area within the fire boundary represents only 15% of the watershed above the burned area.

Within the fire boundary, 3,615 acres (9%) burned hot, for the most part on timbered sites; while 13,285 acres (33%), predomi- nantly grassland, burned at moderate intensity. A total of 16,900 acres (42% of the area) of combined moderate to hot burn are distributed throughout the affected area.

From a hydrologic standpoint, this fire had both positive and negative effects. Over the long term, the spotty nature of burn intensity and large amount of moderate burn accomplished a significant reduction of fuels on many sites and will lead to a rejuvination of some species of native vegetation that will benefit the watershed. On the other hand, both runoff and sediment yield can be expected to increase, at least through the first two seasons, even with treatment (see table 1). The majority of sediment reaching perennial streams will be entrained in stream gravels close to their source during normal runoff events, ie. two year return flows. This will have the effect of further impacting spawning gravels particularly in drainages tributary to Joseph Creek. Joseph Cr. itself is not a major site for spawning activity. Also suspended sediment reaching Joseph Cr. will be diluted by flows from the large unaffected portion of the drainage above the fire.

TABLE 1
Estimated increases in runoff and suspended sediment

	with treatment			without treatment		
	runoff(AF)	susp. sed(ppm)		runoff(AF)	susp. sed(ppm)	
		fire area	*		fire area	*
pre fire	33,135(AF)	72(ppm)	65(ppm)	33,135	72	65
fire effect	7,323	200	33	7,323	200	33
post fire year 0	40,457	272	98	40,457	272	98
year 1	37,895	240	92	35,771	106	70
year 2	36,943	210	86	33,648	87	67
year 3	35,991	190	82	33,135	83	66
year 4	34,965	168	79	33,135	83	66
year 5	33,940	140	75	33,135	83	66

* Suspended sediment in lower Joseph Cr. to show the effect of dilution.

A major runoff event, eg. a 25 yr. return flow event(producing flows up to 4,310 cfs. nearly 2.5x the 2 yr. return flow) in Joseph Cr. could be expected to deliver large amounts of sediment to the drainage system within a short period of time. However, much of this sediment could be expected to be flushed rapidly through the system and diluted in downstream flows. On the positive side, higher water velocities associated with such an event would aid in flushing stream gravels of fine sediments resulting in improved spawning habitat. This is part of the natural stream process. On the negative side, many of the tributary drainages especially in the Starvation Ridge area exhibit a lack of riparian vegetation and large organic material, trampled banks and aggraded channels. The cumulative effect of all these factors will likely be negative when combined with fire effects and a major runoff event. One element effective in reducing impacts of a fire of this magnitude is the lack of an extensive road network within the burned area.

It was obvious during a survey of Rush Cr. that this area has a fairly extensive fire history. Most large trees in the drainage bottom showed numerous fire scars. Much of the large organic material (LOM) important in trapping sediments and reducing energy gradients in the stream channels also were blackened by previous fires. While some of this LOM was consumed in the current fire, new contributions were being added to the system as snags and some green trees were burned off at the base and the bole toppled across the channel or sideslope. This drainage showed few grazing impacts, however, recent high intensity runoff from the sparcely vegetated slopes and ridges above this drainage has sent pulses of water and cobble-sized rock sluicing down the drainage. Where LOM in the form of large diameter tree boles were in place to slow the flow, little impact to the channel was evident. On the other hand,where the stabilizing effect of LOM was absent, channel scour and loss of fish habitat was evident for a considerable distance downstream.

Several examples of shallow mantle failures were noted on the south aspect of Table Mountain and on several ridges to the south. These features appeared to be localized phenomena resulting when water saturated soils lost their cohesiveness and flowed for short distances downslope. While these events are not a major cause for concern themselves, soil saturation to the point of slope failure is a factor in potential watershed impacts and demonstrates the need for returning a healthy stand of trees or grass to these sites as soon as possible.

Density flows, avalanches of dry ash and fine soil, were noted at several locations throughout the burn area, usually in association with hotter burned sites. This phenomenon should remain a concern only until soil moisture increases and this material stabilizes. Contour felling of whips to control this erosion potential was discussed; however, it was believed the felling operation and actions taken to insure the whips were in good contact with the soil would create more soil displacement than might occur naturally. Fire is an integral part of the ecology of these sites and yet little past evidence of catastrophic damage to the soils or drainages is evident.

Non-wetability of soils was tested at several sites and showed great variability. Whether natural or fire caused, this non-wettable layer occurring between 1 and 2 inches below the soil surface has the potential to accentuate overland flow resulting from summer thunder-storm events. The 2 yr. (return period) 30 min. rainfall event is estimated at .3 inches. Much of this moisture should be able to be contained in the duff/ash and top 1 to 2 inches of mineral soil. Events of greater magnitude could pose a soil erosion hazard, however, the risk of such an event occurring within 2 yrs. is less than 20%. On one site that was investigated, an estimated .2 to .3 inches of rain fell within a 24 hr. period of time shortly after the fire on a hot burn site. The surface ash layer was still intact, dry and slightly crusted; while a band of moisture 1 to 1.5 inches thick was noted in the mineral soil just beneath. No signs of surface runoff were noted. A more gradual wetting of the soil surface during spring snowmelt should not pose a serious threat of increased surface flow or erosion; particularly on the sheltered north aspect slopes where the majority of the hot burns occurred.

RECOMMENDATIONS

Take steps necessary to re-establish vegetation (trees/grasses) on moderate and hot burned sites as soon as possible in order to reduce erosion and slow runoff.

Defer grazing within the burned area for a minimum of 2 to 3 years in order to reduce the cumulative effects of fire and grazing from further impacting the important fish bearing tributaries of Joseph Cr.

Delay timber salvage operations on hot burned areas until sites are stabilized with vegetation to avoid displacement of soils.

Monitor salvage operations to assure sufficient LOM is left in place to provide long term watershed stability.

While LOM is an important component of Forest streams in trapping sediments; dissipating the energy of flowing water and providing fish habitat, there are some situations, namely in larger stream channels eg. lower Joseph Cr. in which the positive advantages of LOM are outweighed by the possibility of this material being carried away by high flows and causing damage to structures and improvements downstream. With this in mind, any LOM felled across or into Joseph Cr. during fire suppression activities should either be removed from the channel to a position above the high water mark or, if the opportunity presents itself, secured to well anchored bank structures.

C. FISHERIES

The Joseph Canyon Fire, which burned during August, 1986, encompassed approximately 40,000 acres of northeast Oregon. The entire fire perimeter is located within the Joseph Creek watershed which is tributary to the Grande Ronde River, the Snake River and the Columbia River. Included within the fire are numerous streams. These are listed in Table I by Forest Service class (I, II and III), number of miles, stream reach and land manager.

TABLE I
Streams within the Burned Area

Stream	Class	Miles	Watershed (ac)
Joseph Creek -- total	I	31.6	44,000
Swamp - downstream burn	I	19.1	
Swamp - upstream burn	I	12.5	
Nat. Forest Lands	I	18.6	
Other owners	I	13.0	
Rush Creek			
Joseph - upstream end	III	6.2	
Nat. Forest Lands	III	3.5	
Other owners	III	2.7	
Peavine Creek -- total		7.6	
Joseph - Lupine	II	2.3	
Lupine - upstream end	III	5.3	
Lupine Creek			
Peavine - upstream end	III	4.4	
Swamp Creek	I	11.7	4,550
Joseph to Davis	I	5.8	
Davis - upstream burn	I	5.9	
Davis Creek			
Joseph - end of water	I	6.5	3,730
Slide Creek (entering Joseph upstream of Swamp	III	1.4	

In summary, there are 36.8 miles of class I, 2.3 miles of class II and 14.6 miles of class III streams on National Forest Lands plus an additional 13.0 miles of class I and 2.7 miles of class III streams on other land ownerships. Of the streams on National Forest Lands, 48.8 miles are fish bearing with 36.8 available for spawning or rearing of anadromous steelhead trout.

Table II table indicates key streams and number of miles upstream and downstream of the burned area.

TABLE II

Key Streams and Mileage Upstream and Downstream of Burn

Stream	Class	Miles	Watershed
Joseph Creek			
upper burn - end	mostly I		361 MI^2
lower burn - Gr.Ronde	I	16.5	
Swamp Creek			
upper burn - end	mostly I	22.8	45 MI^2
Davis Creek			
end of water - end	mostly I	9.4	11.8 MI^2

Anadromous fish

Anadromous steelhead trout utilize all of Joseph, Swamp and Davis Creeks within the burned area. Steelhead utilize Swamp and Davis Creeks for spawning and all three of the systems for rearing. Estimates of current use for spawning by steelhead within the burned area are as follows:

Swamp Creek (11.7 miles) x (8.3 redds/mile) = 97 redds (see Appendix I for discussion of number of redds/mile)

Davis Creek (6.5 miles) x (4.1 redds/mile) = 26 redds (see Appendix I)

The total number of redds currently in the two systems within the burned area is estimated at 97 + 26 = 123 redds. At a ratio of 1.39 adults per redd (personal communication with Rod Miller, USFS, August 26, 1986), 171 fish would utilize the streams within in the burned area every year.

The number of steelhead spawning has risen dramatically in recent years. Ken Witty, Oregon Dept. of Fish and Wildlife (ODFW) biologist, predicts that the system may be near maximum seeding given current habitat conditions, however. He thinks that approximately 1 additional redd per mile would be maximum seeding. This would result in a spawning population of 197 fish which would form 142 redds.

Maintenance, rehabilitation and enhancement of the anadromous fish runs in the Joseph Creek watershed is of major interest to the Nez Perce Indian Tribe (personal communication with Pat Murphy, Nez Perce Indian Tribe habitat biologist, August 28, 1986). It is the Tribe's desire that the effects of this fire on the steelhead fish are minimized.

The life cycle of the steelhead spawning in Swamp and Davis Creek is as follows (personnel communication with Ken Witty, ODFW):

-- Adult fish spawn in late April to early May. Some may spawn into late May.

-- Juveniles emerge from the gravels in late June to early July, depending on water temperature.

-- The first year following emergence is spent in Swamp or Davis Creeks with some of the fish moving downstream to Joseph Creek.

-- During the second year the steelhead reside primarily in Joseph Creek with some migrating as far as the lower Grande Ronde or Snake Rivers.

-- During the spring of their second year, the fish smolt and begin their downstream migration to the ocean. They are approximately 6 inches in length.

Joseph Creek is a primary rearing ground for larger (Age 1+) steelhead juveniles. As such, the condition of the aquatic habitat is extremely important to fish survival. The main limiting factor affecting steelhead survival and production rates is thought to be temperature. The temperature on an average warm summer day is often 75 - 80 degrees F, considerably above the optimal rearing temperature of 68 deg. F. At this time considerable funds are being spent in the Joseph Creek drainage as part of the Northwest Power Planning Council's Fish and Wildlife Program as funded by the Bonneville Power Adminstration (BPA), to rehabilitate the watershed. The primary goal is to reduce summer temperatures and substantially increase the numbers of steelhead.

The aquatic habitat within Swamp and Davis Creeks has been severely degraded for both steelhead and resident trout spawning and rearing. Surface water flow in Davis Creek begins just downstream of the southern fire boundary at this time. It appears that compaction of the streamside zone accounts for the absence of surface water upstream. Ken Witty, ODFW, feels that the presence of livestock in the riparian zone in the main reason for the intermittent nature (personal communication, August 25, 1980).

Aerial and some ground observation during the emergency fire rehabilitation reconnaissance also indicates that livestock grazing has been the major contributing factor to the reduced capability in both systems. This may have been aggravated by timber harvest activity (personal communication with Ken Witty, ODFW) and sources of sediment from the upper portions of the watersheds (such as farming). High water temperatures, with extreme diurnal fluctuations, as well as very poor instream habitat suitability are the primary contributors to reduced habitat capability. Some of the factors responsible are: loss of riparian vegetation (reduced stream shading), compaction of the riparian zone (decreased temperature/water exchange through the stream banks) and loss of streamside habitat integrity through cattle trampling.

Both Swamp and Davis Creeks have very high stream embeddedness, or almost a cementing over of the stream bottom. Streams appear to have become very difficult for fish to physically utilize for spawning. Insect productivity has been reduced due to the lack of interstitial spaces within the rocks. In addition, the diversity of niches, or types of spaces available for different size classes of fish to use, have been reduced in comparison to similar undisturbed streams. It appears that any additional sediment delivered to the stream bed and further habitat integrity reductions could dramatically reduce the ability of these systems to produce steelhead. Funding has been received by the Forest Service from BPA, under section 700 of the Northwest Power Planning Council's Fish and Wildlife Program, to attempt to correct some of the existing problems in Swamp Creek, including within the burned area. It was not evident that any of the existing structures were affected by the fire.

Although no other streams in the burned area are year-round anadromous fish streams, it is very likely that the lower portions of all the class III streams and many of the class IV streams are important off-channel rearing areas during normal spring runoff and during high flows in the intense winter rain-on-snow events prevalent in this portion of Oregon. During these high flows, high main stream velocities result in considerable energy expenditures for the fish. Using off-main channel areas at these times increases the survival and growth rates of the anadromous fish.

<u>Resident Fish</u>

Resident fish use all the Class I and II streams and a few of the Class III streams in the area. Since the water in Joseph Creek is so warm, some warmwater species of fish including suckers, smallmouth bass and probably carp live as far upstream as Peavine Creek (personnel communciation with Ken Witty, ODFW). Some warm water species are also found in the other fish producing streams.

Of the common game fish species, only rainbow trout are known to reside in the stream systems. Rainbows reside in at least Joseph, Davis, Swamp, Rush and Peavine Creeks. Ken Witty, fisheries biologist with ODFW in Enterprise, made the following <u>very rough</u> estimations of fish production in Joseph and Swamp Creeks.

1 legal (6 inch) fish per every 20 feet of stream
10 sublegal size fish per every 20 feet of stream

In addition he predicted that there are appoximately 300 fishing user days/year in each of Joseph and Swamp Creeks on National Forest lands (or 600 fishing user days, total). The other streams within the burn are thought to contribute an insignificant number of fishing user days.

For calculations in this study, it will be assumed that Davis, Rush and Peavine Creeks produce 1/3 the number of fish that Joseph and Swamp produce.

The following calculations and assumptions were made to assess the numbers of catchable fish in Swamp Creek.

1. In Swamp Creek there is presently one catchable fish per 20 feet.

   Swamp Creek: 11.7 miles x (5280 feet/mile) x 1 fish/20 feet = 3089 catchable fish

2. Assume that 3089 catchable adults would be produced each year.

3. 300 fishing user days/year will harvest no more than 5 fish per day or 1500 fish/year. This is the user demand for fish at this time.

Joseph Creek, on National Forest Lands within the burn, will produce approximately 4910 catchable fish per year. Since Joseph Creek also experiences approximately 300 fishing user days/year, the total demands for fish is approximately 1500 fish per year in this system.

Anticipated Effects of the Joseph Canyon Fire on Fish

Swamp and Davis Creeks

Any additional sediment inputs or loss of streamside habitat integrity could have a very significant effect on the ability of the portions of Swamp and Davis Creeks within the burn area to produce viable steelhead populations. At this time there are very few pools present in the stream, and many of these are clogged with sediment. Potential spawning sites often have cemented gravels. Streamside vegetation has been removed to such a large degree that there is very low shading in these north-south oriented basins (which results in high solar insolation during the hottest part of the day). Maintaining grazing in these watersheds during the next few years of vegetative recovery would very likely magnify the problem.

Using the following assumptions, $132,906 (discounted at the 8.624 rate) in steelhead value over a ten year period could be lost in Swamp and Davis Creeks without any rehabilitation treatment of the land and continued intensive grazing (Table III).

1. 197 adults is the spawning habitat capability at this time. This escapement will likely be achieved in the next one to three years.

2. Up to 75 percent of the spawning capability in Swamp and Davis Creeks may be lost as a result of the additional sediment inputs to these systems.

3. With 197 adults escaping, 394 are available for catch prior to returning to the spawning beds. Of the 394, 82 % are sport caught and 18 % are commercially caught (Meyer, 1982).

4. The value of one sport caught fish is $128 and the value of a commercially caught fish is $20.97 (Meyer, 1982). This results in a value of $42,833 per year for the fish caught or $217 per spawning fish.

5. The percentage of adults lost is roughly proportional to the amount of ground cover (ground cover recovery estimates made by Tom High, in conjunction with the Fire Rehab. team) in the severely burned areas. The rate of recovery of the spawning beds is similar to the rate of recovery of the ground cover.

TABLE III

Lost Value of Spawning Steelhead in Swamp and Davis Creeks
WITHOUT TREATEMENT

Year	Percentage Adults Lost	#'s of fish	# Lost Adults	Value/Fish	Loss in value
1	75	197	147	$217.	29,496
2	70		138		25,435
3	65		128		21,674
4	60		118		18,211
5	50		98		14,108
6	40		79		10,431
7	30		59		7,182
8	20		39		4,361
9	10		20		2,009
10	0				0

Discounting the above figures over the 10 year period, $132,906 in value could be lost as a result of the fire.

Resident fish would also be expected to be reduced, though possibly not to the degree as the anadromous fish. The values for resident fish are primarily based on their value to the recreational fishery. If the numbers of fish available to the recreational fisherman were assumed to be reduced as a result of the fire by 30 percent, then 2162 fish would be available in Swamp Creek. This is in excess of the current demand by 31 percent. Therefore, the fire would not be expected to have a significant effect on the recreational resident fishery.

Joseph Creek

Joseph Creek is of primary value for the rearing of anadromous and resident fish.

The following assumptions and calculations show that $5,523, discounted over a ten year period, could be lost in steelhead rearing capability without treatment of the land to reduce sediments delivered to Joseph Creek (Table IV).

1. Assume 1 smolt produced/20 feet of stream under normal circumstances (Ken Witty, ODFW).

2. 18.6 miles of Joseph Creek are on National Forest Lands = 98,208 feet

3. 98,208 feet x (20 ft/smolt) = 4,910 smolt produced.

4. Rod Miller, USFS, predicts that smolt to escaping adult survival is 1.5 percent. 4,910 smolt x (1.5 percent) = 73.6 escaping adults which would result from the rearing in Joseph Creek.

5. "Guide for Predicting Salmonid Response to Sediment Yields in Idaho Batholith Watersheds," U.S. Forest Service, August 1983, indicates on page 69 that a 29 percent increase in embeddedness results in a 10 percent reduction in density of fish for Age 1 steelhead. Assuming that there is a proportional relationship between embeddedness and sediment delivery to a stream, the following table was developed.

TABLE IV
Lost Value of Rearing Steelhead in Joseph Creek
WITHOUT TREATMENT

Year	Sediment* Increase	Reduction in fish %	# Lost Adults	Value/Fish	Loss in value
1	29	10	7.4	$217.	1605
2	24	9	6.6		1432
3	21	8	5.9		1280
4	18	7	5.1		1107
5	13	6	4.4		955
6	10	5	3.7		803
7	7	4	3.0		651
8	4	3	2.2		477
9	1	2	1.5		325
10		1	.7		152

* From sediment yield increase predictions due to the fire, by Bruce Anderson.

This results in a loss in value of $5,523 discounted over the ten year period, without any watershed treatment.

Loss of resident fishing in Joseph Creek (and its other tributary watersheds within the burned area) would be negligible, based on the same assumptions and considerations shown for the Swamp and Davis Creek drainages.

Anticipated Effects of the Joseph Canyon Fire WITH Rehabilitation

Swamp and Davis Creeks

$55,062 (discounted at the 8.624 rate) in steelhead value over the ten year period could be lost in Swamp and Davis Creeks with rehabilitation treatment of the land and elimination of intensive grazing for at least the next few years. This is based on the same assumptions as for the previous calculations of Swamp and Davis Creeks value of spawning steelhead, except that the recovery time for ground cover has been shortened. Based on the anticipated recovery with the treatment, Table V depicts the possible losses in steelhead value.

TABLE V.
Lost Value of Spawning Steelhead in Swamp and Davis Creeks
WITH TREATMENT

Year	Percentage Adults Lost	#'s of fish	# Lost Adults	Value/Fish	Loss in value
1	55	197	108	$217.	23,512
2	40		79		17,100
3	30		59		12,825
4	20		39		8,550
5	10		20		4,275
6	0		0		0

Discounting the above figures over the same 10 year period, $55,062 in value would be lost as a result of the fire.

Joseph Creek

TABLE VI shows that $1,346, discounted over a ten year period, could be lost in steelhead rearing capability with treatment of the land to reduce sediments delivered to Joseph Creek. The same assumptions are used as in Table IV for predicting losses without treatment.

TABLE VI

Lost Value of Rearing Salmon in Joseph Creek
WITH TREATMENT

Year	Sediment Increase*	Reduction in fish %	# Lost Adults	Value/Fish	Loss in value
1	7	4	2.9	$217.	629
2	3	3	2.2		477
3	2	2	1.5		325
4	2	1	.7		152
5	0	0	0		0

* From sediment yield predictions by Bruce Anderson.

This results in a loss in value of $1,346 discounted over the ten year period, without any watershed treatment.

SUMMARY AND RECOMMENDATIONS

Maintenance of steelhead in Joseph Canyon is extremely important to the overall anadromous fish recovery plans in the Snake and Columbia River Basins and to the Nez Perce Indian tribe.

Negligible losses to resident fish (measured in fishermen user days) are expected as a result of the burn.

Any reduction in spawning habitat quality in Davis and Swamp Creeks is critical to steelhead success. Watershed rehabilitation should be started immediately to minimize habitat capability reductions. Rehabilitation should include immediate vegetative seeding as well as the short term elimination of grazing. Once new vegetation is well established, grazing can be continued (estimated to be at least two years from present).

The following is the estimated loss in value of fish on National Forest Lands with no treatment as a result of the Joseph Canyon/Starvation Ridge Fire.

Steelhead spawning:	$132,906
Steelhead rearing:	5,523
Resident fish:	no monetary loss in recreational fishing
TOTAL (NO TREATMENT)	$138,429

With treatment of the land, including the elimination of grazing for at least two years, the loss in value of fish on National Forest Lands is anticipated to be as follows.

Steelhead spawning:	$ 55,062
Steelhead rearing:	1,346
Resident fish:	no monetary loss in recreational fishing
TOTAL (WITH TREATMENT)	$ 56,408

The values shown do not necessarily reflect the true value of the Joseph Creek steelhead to the overall recovery of anadromous fish in the Grande Ronde, Snake and Columbia River Basins. In fact, the value may be far greater.

* * *

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Persons Contacted

Ken Witty, Willie Noll: Oregon Department of Fish and Wildlife, Enterprise
Pat Murphy: Nez Perce Indian Tribe, Lapwai, Idaho
Alex Heindl: Columbia River Intertribal Fisheries Commission, Portland
Gary James: Umatilla Indian Tribe, Pendleton, OR (did not return call)
Rod Miller: USFS, Baker, Oregon

ADDITIONAL INFORMATION

August 26, 1986

Subject: Interview with Ken Witty, ODFW about Joseph Creek Fire, August 25, 1986 (talked to by Steve Kessler)

(Note: Everything in parentheses are comments of Steve Kessler, not necessarily Ken Witty's.)

Steelhead:

Spawn late April to early May. Some spawn in late May.

Emergence is in late June to early July, depending on temperature.

The first year is spent in the spawning stream (such as Davis or Swamp) or in Joseph Creek.

The entire next year is probably spent in Joseph Creek, or the fish might bump down into the Grand Ronde or the Snake River.

The fish smolt up and move out of the systems at about 6 inches.

Redd counts in Swamp Creek were 7.2 redds/mile in 1985, slightly higher in 1986 (probably about 8 redds/mile) and have averaged 3.5 for the five year average of 1981-1985. In 1985, 18 fish were counted during the spawning survey. (Using this information, I will guess that there would have been about 15 % more redds per mile, or 8.3 redds/mile. SJK). Ken estimated that with full seeding, in present habitat conditons, that there would be about 1 more redd per mile. (Using my above logic, then full seeding, at present habitat conditions, would be approximately 8.3 + 1 = 9.3 redds/mile. 9.3 redds per mile will be used in the calculations. SJK). Ken expects that there are about 1/2 as many redds/mile in Davis Creek as in Swamp Creek in the presently useable area. (Using the above logic, Davis Creek would have approximately 4.6 redds/mile under present habitat conditions.) (Maximum redd counts were used, rather than average counts because it is thought that this is a better indication of the habitat's ability to produce fish. Also, with the major fisheries rehabilitation in progress in the Columbia Basin, it is expected that escapement will seldom, if ever, return to the lower numbers represented in the long term average.)

Probably Swamp and Davis Creek rearing habitat is almost fully seeded for steelhead at present habitat conditions. Joseph Creek is not, but there are severe temperature limitations in Joseph Creek.

Temperatures in Joseph Creek easily are sustained at 80 deg. F during a portion of the summer. The goal for Joseph Creek is to reduce the high temperature to 68 deg. F through rehabilitation and improvement and better riparian management. Joseph Creek is so warm that smallmouth bass and probably carp go upstream to at least Peavine Creek. Warm water does limit the summer distribution of salmonids in Joseph Creek. (Temperatures do not commonly get quite so warm in Davis and Swamp Creeks and there is significant temperature recovery at night in these systems. Therefore temperature is probably not quite the limiting factor in these systems, as compared to Joseph Creek. SJK). In some area streams that have had complete riparian removal, an 11 deg. F increase in 1/4 mile has been recorded. This was in Devil's Run Creek which is similar to Davis Creek. This system also is heavily grazed.

All steelhead are wild, non-hatchery stock.

Resident fish:

Ken made the following estimates for resident fish in Joseph and Swamp Creeks:

1 legal (6 inch) fish per 20 feet of stream
10 sublegals per 20 feet of stream
300 Fishing Days/year in each system on Nat. Forest Service land

All resident salmonids are wild stock.

General comments:

BPA, Fish and Wildlife Program applications are the best to use to get economics from for the steelhead.

Rod Miller should have a couple of reports that are useful -- a response of an appeal by the Umatilla Tribe, Lower Snake River Compensation Program reports, and the U.S. v. Oregon reports.

Joseph Creek averages 10-15 yards wide.

LIVESTOCK MANAGEMENT is the most important item to undertake in all the creeks within the fire area.

Is interested in any cumulative effects of watertemperatures due to additional riparian having burned, primarily in Joseph Creek.

Probably almost fully seeded for rearing available in the Joseph Creek tributaries.

The following people should be contacted on the Nez Perce and Umtilla Tribe fisheries staffs, respectively: Berny Hill at Lapwai, ID and Gary James at Pendleton,OR. Also CRITFC should be contacted (Alex Heindl).

Swamp Creek is a "blue-ribbon" steelhead producer (whatever that means).

Note: I also talked with Willie Noll August 25 at the ODFW fish hatchery. He did not give me any significant information. He did make me a copy of the spawning counts for Swamp Creek.

D. ECOLOGY/VEGETATION

Description of the Burned Area:

The following plant associations are included in the Joseph Creek fire complex:

Grassland types:

Bluebunch wheatgrass - Sandberg's bluegrass	40%
Idaho fescue - Bluebunch wheatgrass/ arrowleaf balsamroot	10%
Idaho fescue - Bluebunch wheatgrass/ silky lupine	5%
Other (Scablands, Idaho fescue-Prairie junegrass)	10%

Forest types:

Douglas-Fir/ninebark	13%
Douglas-Fir/pinegrass	10%
Douglas-Fir/spiraea	2%
Grand fir/ninebark	5%
Grand fir/ big huckleberry and Grand fir/twinflower	2%

Actual plant community composition is variable with early through late seral vegetative stages represented. Bunchgrass communities on the driest sites are mostly dominated by Bluebunch wheatgrass; associated species include Sandberg's bluegrass, arrowleaf balsamroot, yarrow, annual bromes, and perennial forbs.

Bluebunch wheatgrass can be dominant or codominant with Idaho fescue on the more moderate sites; associated species include arrowleaf balsamroot, hot rock penstemon, silky lupine, and numerous annual grasses and forbs. Only a small portion of the burned area includes Idaho fescue dominated sites.

Forest communities on the driest sites are dominated by Ponderosa with snowberry, spiraea, pinegrass and bunchgrasses in the understory. More moderate forested stringer communities vary from Douglas-fir dominated stands to Ponderosa pine dominated stands, to mixtures of these two species. Understory layers are dominated by pinegrass, ninebark, mosaics of these two species, and numerous other shrubs including snowberry, rose, oceanspray, shiny leaf spiraea, and serviceberry. Only a small portion of the burned area includes Grand fir dominated sites.

Arrangement of plant communities across the landscape is strongly controlled by the steep topography of this deeply dissected basalt plateau area. Cooler north-facing slopes support forest communities (mainly Douglas-fir/ninebark and pinegrass) while exposed ridges and east, south and west-facing slopes typically support bunchgrass communities. This preference of plant communities to specific sites results in a pattern of forest stringers alternating with grassy slopes. Moderate and heavy fuels, more common in forested communities, are therefore discontinuous across the dissected slopes. More continuous forest stands may occur along major stream courses (Swamp and Davis Creeks) within the cooler reaches of the canyon or at the heads of forest stringers where draws tend to merge. Grazing along Swamp creek in particular has eliminated much of the shrubby forest species and coupled with natural meadows has created a mosaic of fuel types.

FIRE ECOLOGY:

Fire History:

It is well documented that fire has been an important environmental factor in all floristic ecosystems of the Pacific Northwest (Volland and Dell 1981). Individual plants and plant communities within the burned area appear well adapted to fire. Local data and numerous literature sources indicate that the fire return interval for the most common forest type (Douglas-Fir/ninebark) is between 7 and 19 years in the Rocky Mountains (Arno 1976), and for Ponderosa pine in the Blue Mountains around 10 years (Hall 1976, 1980). The most typical stand condition of Douglas-fir/ninebark communities on the Wallowa-Whitman National Forest is even-aged and reflects the importance of stand-replacement fires in the past (Johnson and Simon, 1986). Drier forest types have shorter fire return intervals while moister sites have longer return intervals; stand replacement fires are probably not as frequent in these communities. Fire return intervals of 3-10 years are documented for natural grasslands (Vogl, 1974). Thousands of years of selective pressure under such fire regimes has resulted in numerous plant and plant community adaptations.

Adaptations to fire:

The most common fire resistant adaptations found amoung plants in the Joseph Creek fire area include: thick bark to resist underburns (Ponderosa Pine, Douglas-fir, Western Larch), ability to resprout from rhizomes, deep underground stems, and stem and root buds protected beneath the soil surface (ninebark, snowberry, serviceberry, rose, pinegrass, elksedge, balsamroot, Bluebunch wheatgrass, Sandberg's bluegrass), seeds that require heat scarification for germination (red-stemmed ceanothus, most legumes,e.g.lupine, locoweed), and seed dispersal mechanisms (lightweight seed easily blown into the area, e.g. scoulers willow, thistle, fireweed, or heavy-sticky and heavy-edible seed which cling to animal hair or are eaten and dropped as the animal traverses the burned area, e.g. chokecherry, stickseed, bedstraw). Some plant communities within this area such as Douglas-fir - Ponderosa pine/pinegrass would not even exist in their present condition without the periodic influence of fire.

Effect of fire on plants:

Many factors will effect the ability of a plant to withstand fire. Each species and growth stage has is own heat tolerance and fire resistance characteristics but most of these values are unknown to us at this time (Volland and Dell 1981). Furthermore, fire return intervals for the Joseph Creek plant communities have been interrupted following decades of effective fire control programs. As a result, fuel levels in some areas probably exceed those found in forest stands under natural fire frequencies. It is apparent that time of season, amount and type of fuels will effect intensity of burns. Therefore, a larger area effected by hot burns can be expected although it is unlikely that fire resistant adaptations have been exceeded on most of these sites. These factors along with information available on species adaptations to burning were used to assess the degree of damage to plants and plant communities in the Joseph Creek fire complex.

Bunchgrass communities - observations:

Many of the bunchgrasses on the hot,dry sites in the fire area were burned during a period of partial or nearly complete plant dormancy. By mid to late summer, these grass plants have produced seed and are dry. Food reserves during this period are high in below ground root structures and therefore removal of aerial portions of the plant will normally not result in complete death. In fact, most research indicates that bluebunch wheatgrass will respond favorably to moderate burns in late summer and may show significant increases in forage production in comparison to pre-burn conditions (Uresk, Cline and Rickard 1976, Conrad and Poulton 196?) Similar responces are expected for Sandberg's bluegrass. On the other hand, growth areas for Idaho fescue are more exposed and this species will normally decline following moderate or severe burning.

Complete death of bluebunch wheatgrass, Sandberg's bluegrass, or Idaho fescue will not often occur unless the accumulation of dead material at the base of plants is great enough to carry a hot burn. It is likely that exclusion of fire in areas not used by animals will promote high levels of litter accumulation. This condition is very uncommon in the Joseph Creek fire area. Periodic grazing by both wild and domestic ungulates has removed enough plant material yearly and has substantially reduced the probability of high fire intensities. In this situation, grazing has replaced the natural role of fire. The typical widely-spaced arrangement of bunchgrasses on the most xeric sites has further reduced risk of catastrophic fires. Many of these communities do not even have enough fuel to carry a fire.

None of the bunchgrass communities were mapped as having more than moderate burn intensities. The most common situation observed was that of patchy light to moderate burns within unburned areas. Continuous burns were also common although they too never exceeded moderate severity. Inspection of individual plants on sample areas showed that most grasses were still very firmly rooted and had numerous live roots below the soil surface. Some plants still had green above-ground material.

Bunchgrass communities - recommendations:

No treatment is recommended in bunchgrass communities although a period of rest or reduced use by domestic livestock may be necessary in order for plants to fully recover. Following this period of rest, it is expected that forage amounts will exceed those of pre-fire conditions by as much as 25%.

Some pockets of reduced forage production can be expected in communities in poor range condition where already weakened grasses may have been killed by the fire. Areas of heavy animal concentrations along ridgetop bedding areas probably fall into this category. Annuals will dominate these sites until the communities progress through early to mid successional stages. These areas are relatively small and may not be economically feasible to treat.

Forested communities - observations:

Burn intensity in forested communities was highly variable. In general, hottest fires occurred in upper portions of forest stringers. In these situations, crown fires have completely killed overstory and removed most if not all of the above-ground portions of understory plants. Moderately burned areas include isolated pockets of similar hot burns. The vast majority of trees in these areas are still alive and understories are at most only scorched. Light burned areas were essentially underburns and many of these were interspersed with completely un-burned areas.

Although all trees were killed in hot burned stands, ground observations revealed that many understory species remained viable below the soil surface. Few extremely hot areas were observed where all litter had been consumed and even those areas showed evidence of live root systems below the insulating soil surface. It was common to find exposed burned remnants of shrubs that, when excavated, showed extensive deep live roots. Other finer live roots were also common. It is believed that many of these roots are from ninebark, and pinegrass plants, both of which have proven very resistant to such fire effects.

Some resprouting of ninebark, snowberry, rose, Oregon grape, and pinegrass can be expected even in the hot-burned areas. Moderately burned areas and expecially those areas where underburning was most typical may resprout vigorously and create some future problems for tree regeneration. Most of those areas, however, are currently under moderate to heavy timber and cover of all understory plants can be expected to decline as tree canopies continue to develop and provide greater shading.

The most extensive hot-burned areas may be slow to recover fully because of lack of sufficient seed source for Douglas-fir and Ponderosa pine. Considering pre-fire stand conditions in many of these areas, however, there is a good possibility that given an adequate seed source and timely cone crop, tree regeneration may be very prolific. It is common to find dense, even-aged stem arrangements especially at the upper ends of Douglas-fir/ninebark communities. This is evidence of past stand replacement fires and subsequent successful regeneration of the stands. Because of the patchy nature of the burn, most stands appear to have enough live trees in unburned sections to supply adequate seed. The next several seed years will be critical. If good seed crops do not occur, shrubs may dominate these sites for many years.

Forested communities - recommendations:

It is our opinion that recovery of forested sites in the Joseph Canyon fire complex will occur without treatment. However, rate of recovery may be enhanced and losses to site potential minimized if some sort of erosion control measures are initiated.

Seeding annual grasses (cereal grains) on only hot burned areas may be the most effective treatment for the following reasons: 1) they will supply immediate protection to steep slopes with highly erodible soils, 2) they will not introduce a long-term non-native species that may compete with more adapted native species, 3) they will not compete heavily with future tree regeneration, and 4) they are inexpensive. Exclusion of livestock from treated areas is recommended for 2 years to increase probability of successful erosion control.

Seeding more long-term perennials in combination with annuals may be more appropriate if management requires a greater probability of treatment success and more rapid stabilization of soils, but some reduction in successful future tree regeneration must be accepted. In addition, seeding of perennials on hot as well as moderately burned areas within the southern half of the fire area may be more acceptable from a range management standpoint. In other words, the recommendation to exclude livestock from allotments for 2 years to insure soil stability on the steep slopes and vigor in grassland communities may be easier to accept if significant short-term forage amounts can also be enhanced through the seeding of perennials on a larger number of forested sites.

In summary, it is recommended that a mix of annual and perennial grasses be seeded on forested slopes on hot and moderate-burn areas at the south end of the fire (Swamp and Davis creeks) and a mixture of annuals with fewer perennials be seeded on only the hot-burn forested sites on the remainder of the fire (Brushy, Rush, and Joseph creeks). See seed mix for specifics.

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E. WILDLIFE

The Joseph Canyon/Starvation Ridge Fire has impacted both winter and summer range for elk and deer as well as habitat for other key wildlife species. Approximately 29,000 acres of winter range and 9,500 acres of summer range used by a minimum of 1,000 elk was burned at varying degrees of intensity.

Timbered winter and summer range areas appear to be the most critical features lost to the fire. High intensity burn areas comprised the bulk of the best thermal and hiding cover used on both summer and winter ranges. Calving areas in the upper Peavine Creek/Lupine, Rush Creek and Brushy Creek appear to be seriously compromised.

Losses of hiding and thermal cover in upper Swamp Creek and Davis Creek may push elk and deer onto private lands.

Deer are distributed throughout the burned area, probably in lesser numbers than elk. Losses of habitat opportunity will be similar, particularly regarding cover needs.

In the short term (less than one year), thee will be some forage losses for both species. Fall rains should provide relief in the form of green-up on perennial grasses and some shrubs. This fire should provide increased forage opportunities in the future provided livestock management that complements plant needs for regrowth and re-establishment is implemented.

Cavity nesting birds and snag dependent wildlife species will have been essentially eliminated from all high intensity burn areas (3085 degrees). No assessment of snag candidates has been made at this point, but it appears that potential recruits in high intensity burn areas are minimal. Snag habitat was also lost in the moderate burn areas (10,157 acres), but some recruits may have been created, as well. As much as 50 percent of the standing snags in the moderate burn areas were lost. Snag losses in light burn areas don't appear to be heavy at this time.

Prime black bear habitat in the north-end creeks (Peavine, Brushy, Rush, etc.) was severely impacted. Brush draws and wild timber stands were impacted as were forage resources available in standing dead trees, and downed logs consumed by fire. Similar impacts occurred in Swamp and Davis Creeks, as with deer and wlk, extensive cover was lost.

Upland game bird habitat was adversely impacted, primarily on ridge-top edges with timber, and in brush draws. It does appear, however, that because of the green condition of brush species along the creeks, these forage and cover areas were not too severely impacted.

Secondary impacts will occur to other species, particularly raptors and mammalian predators that will have to accommodate shifts in prey species availability.

In the short-term, losses of forage, cover and snags will be detrimental to terrestrial and avian wildlife resources, particularly in the moderate to high intensity burn areas. If fall rains do not occur, forage resources for ungulates (deer and elk) on winter range areas of this fire will probably not recover sufficiently to meet their needs. These animals willmove to adjacent ranges.

In the long-term, perennial grasses have the potential to recover (and improve in quality) with protection and judicious management of livestock. Response to fall and winter rains should produce abundant forage opportunities for next year's use by wildlife. Woody plant species (browse and cover) will recover and produce excellent habitat for upland game birds, bears, deer, etc.

Hiding and thermal cover will require decades to recover. Production of big game could be seriously hampered by losses of calving/fawning areas, for many years to come. The limited summer range areas involved will be impared to decades.

2,025 acres of old-growth habitat were burned (losses not calculated at this time). That which was involved in "high intensity" burning was lost. "Modeately intensity" burn areas will have to be evaluated in more detail.

Five 1-acre wildlife exclosures were destroyed by this fire.

Habitat for bighorn sheep (proposed reintroduction) will be improved by this fire by improving forage quality and quantity of grasses and forbs.

F. RANGE

The Joseph Canyon Fire burned over portions of 5 separate allotments. These allotments are Swamp Creek C&H, Buck Creek C&H, Table Mountain C&H, Joseph Creek C&H and Hunting Camp C&H.

It is recommended that all treated area on the south end of the fire not be grazed for a period of 2 full seasons. An assessment should then be made to determine if there is a minimum of 75 percent ground cover on moderately burned areas and 50 percent ground cover on hot burned areas.

The north end of the fire will have 2 full growing seasons of rest from livestock grazing. Then if the hot burn areas have a minimum of 50 percent ground cover, livestock grazing will continue on treated areas.

The is the potential of 10,987 AMs of non-use on this fire and several others in the area.

The following is a summary of burn conditions by allotment.

1. Swamp Creek C&H Allotment

AMS	Acres	Acres Burned	% Burned
6,612	29,260	13,437	46%

The area that was burned is the entire spring and early summer range the allotment will have 998 head of cattle (cow/calf) from 4/16-5/16 turn ons until 7/15 each year. This would amount to 2,452 AMs of forage.

Birkmaier Ranch Inc.		
Term	154	4/16 - 10/31
Dawson, Jeff, Gaynor, Margaret		
Term	130	4/16 - 10/31
Term	197	5/16 - 10/31
McClaran Ranch, Inc.		
Term	300	5/16 - 10/31
Singer, Charles Sr.		
Term	127	4/16 - 10/31
Simmons		
High Valley	90	
Total	998	

2. Joseph Creek C&H Allotment

AMS	Acres	Acres Burned	% Burned
175	1,405	1,343	95%

This is a small on-off allotment and it has been nearly completely burned.

Amos and Stella Evans
On/Off permit
Term 30 Off 20 4/1 - 5/15 and 11/1 - 12/31

3. Table Mountain C&H Allotment

AMS	Acres	Acres Burned	% Burned
2,850	14,203	10,662	75%

The area that was burned is summer range plus approximately 3/4 of spring and winter range.

George Darneille

Term	276	3/16 - 12/31
Private Land Permit	24	3/16 - 12/31

4. Hunting Camp C&H Allotment

AMS	Acres	Acres Burned	% Burned
1,346	9,614	3,621	38%

The Hunting Camp Allotment has had portions of both the early-late unit and summer unit burned.

Wallane Corporation

Term	109	6/1 - 11/30

5. Buck Creek C&H Allotment

AMS	Acres	Acres Burned	% Burned
2,720	23,623	2,414	10%
AMS	Acres	Acres Burned	% Burned
6,612	29,260	13,437	46%

This area which has burned is approximately 10 percent of the allotment but there has been nearly all of 2 of the spring turn-on pastures burned. This amounts to approximately 210 AMs.

Proudfoot Ranch Inc.

Term	140	4/16 - 5/31

<u>Noxious Weeds</u>

It is estimated that 25 percent of the hot burned area will be infested with noxious wees, primarily Russion knapweed. These areas will require treatment for four years.

Years	1	2	3	4	5	6	7	8	9	10
Weed Control Costs prior to fire	0	0	0	0	0	0	0	0	0	0
With Project	0	0	0	0	0	0	0	0	0	0
Without Project	30102	30102	30102	30102	0	0	0	0	0	0

PNV 30102 x 4 years = 106,883

G. SILVICULTURE

The majority of timbered areas that burned within the fire lines were a mixture of ponderosa pine, Douglas-fir and some western larch. These stands have a history of fire and many older ponderosa pine have large, multiple fire scars. Since timber stands occured mainly in draws on north slopes and in stream bottoms rather than in large continous stands, the pattern of fire was spotty or discontinous. Much of the fire was only moderately burned with some spots of very hot burn found within. Smaller second growth trees were often lost in such instances yet enough overstory trees remain to function as seed sources.

Since prescriptions for the Swamp Creek Resale which was within the fire were primarily overstory removals and this sale was within the fire much of the understory that has expected may be destroyed. Sale units should be examined to see if prescriptions can still be met.

Only small amounts of current year cones were observed, so little natural regeneration of trees is expected the first year but north slopes should regenerate within 5-7 years. It is essential that those areas of the fire where seed sources at tops of draws were destroyed be monitored every year. Ninebark is a component of many stands and could prove to be a major tree competitor. The majority of the hot burned areas do have a seed source above them and natural regeneration should be given a chance to succeed. The seed mixes proposed by the rehabilitation team were designed to stabilized slopes and to protect site productivity yet minimize competition with tree seedlings. The most critical concern in regard to regeneration is to protect current seed sources that were not destroyed in the hot and moderate burned areas and to monitor those sites for seedlings establishment and survival.

H. LOGGING

Although the Joseph Canyon/Starvation Ridge firelines include some 41,000 acres, salvage logging opportunities are limited.

The majority of forested areas affected by fire burned lightly or moderately. In these areas, tree mortality is limited to smaller (less than 10" DBH) trees and occasional larger individuals. Some of these larger trees have burned off at the base. A high percentage of sawtimber-sized trees possessing reasonable fire resistance (larch, Douglas-fir and ponderosa pine) as well as some of the larger grand fir have survived in these moderate- to light-burned areas.

In the hot-burned areas, fire usually raced through crowns of saplings and pole-sized timber. This occurred in many north-slope "stringers" in steep side drainages of all major streamcourses in the fire. These trees definitely died; however, few sawtimber-sized trees were growing in the midst of these thickets. Most of the larger trees occurred at the tops or sides of these "stringers". Many of these trees will also survive.

In short, we do not believe there was a catastrophic loss of merchantable timber in this fire. The most likely place for salvage is on Table Mountain and the gentler ground to the east in the upper portions of the Peavine and Lupine Creek drainages. Fortunately, little of this area was significantly affected by the fire. What burning occurred there appeared to be light affecting mature trees little. It is likely that what mortality did occur could be picked up during normal salvage operations over the next year or so. **(This was written before the effects of the 8/25 burning on Table Mountain could be evaluated. There may be more to do there than was previously thought.)**

The scattered single-tree mortality and patchy nature of "hot burn" areas in "stringers" combine to make logging costs extremely high per unit volume regardless of logging systems considered. Very little of the affected area, particularly on steep ground, is accessible by road and conventional ground-based or cable logging systems. This makes helicopter yarding the system of choice in these areas. In our opinion, based on limited analysis, the scattered nature of volume and flight distances involved will effectively prohibit its use.

We were unable to make even an educated guess as to the amount of merchantable volume the fire may have killed in the "stringers". The obviously dead trees are scattered so that a per-acre estimate is impossible; and questionable trees, likewise scattered, need on-the-ground evaluation. However, we can make some general observations and recommendations.

First, it is likely that simply finding merchantable dead trees in the steep burned "stringers" and preparing them for sale will cost more than double the worth of material. There is also a significant risk of not finding enough volume in a concentrated area to make a viable helicopter sale. Unfortunately, this won't be known until a majority of the area is intensively inventoried and a great deal of sale prep money spent.

Second, particularly in ponderosa pine, there will be a tendency to select trees that aren't dead for removal, thereby removing a future seed source.

Third, **not** logging the area could result in many positive resource benefits:

1. Replacement dead and defective tree habitat for those snags consumed in the fire.
2. Large woody debris, either in streams already as a result of the fire or stored as current D & DTH for future input.
3. Dead shade for hot-burned areas as they regenerate.
4. No added risk of soil disturbance as a result of felling, bucking, and yarding activities.
5. No logging-related disturbance of erosion control-seedings or naturally-regenerated vegetation on the area.

Therefore we recommend limiting salvage logging to gentle terrain in the Table Mountain-Lupine Creek-Peavine Creek area and letting nature take its course on the remainder. The most likely opportunities for salvage logging on steep hot-burned areas appear to be in the north end of the fire. We were unable to observe these areas on-the-ground, but the burn-intensity map shows substantial hot burns in the following areas:

1. North and east of Table Mountain

2. The north- and east-facing slopes into Peavine and Lupine Creeks,

3. The head of an unnamed drainage in the West half of Section 22 north of Horsepasture Ridge,

4. The head of Brushy Gulch north of Horsepasture Ridge.

5. Upper Rush Creek drainage.

Several of these areas appear suited to cable logging except anchoring problems could be severe.

We realize this inventory is only cursory. We expect the Forest and District to do a more detailed analysis. We trust this will be done in an interdiscliplinary team environment with specialists in silviculture, forest ecology, forest hydrology, soils, fish biology, non-game wildlife biology, and logging systems present. If, after due deliberation, salvage of "stringers" is planned, we recommend waiting until the end of next year's growing season before marking. This will allow marginal trees to either die or recover. Value losses to bluestain and saprot caused by waiting will not make up for loss of seed trees marked by accident when timber will likely be sold at base rates. Waiting will also allow some of soil stabilization measures to be effective. We observed that simply walking on some slopes will initiate soil displacement. Felling, bucking and hooking activities before the soil is stabilized will likewise cause problems.

APPENDICES

APPENDIX A

TREATMENT ALTERNATIVES CONSIDERED

1. Seed all severely burned areas with recommended mix.
2. Seed all hot and moderately burned areas with recommended mix.
3. Seed all hot and moderately burned areas within Swamp and Davis Creek Drainages with recommended mix. Seed only severely burned areas in remainder of fire.
4. Combination of seed and fertilize.
5. Fertilize only.
6. No treatment.
7. Seed recommended mix in Swamp and Davis Creek Drainages on hot and moderately burned sites. Seed a mixture heavty to annuals on remaining hot and moderately burned sites.
8. Same as 7 but seed heavy annual mixture only on hot burned sites.

APPENDIX B

MONITORING OPPORTUNITIES

The Wallowa-Whitman National Forest will develop an overall plan that will address opportunities for monitoring effects of fire on individual plant communities for the entire Forest. No attempt will be made here to indicate specific objectives or techniques for monitoring effects of the Joseph Creek Fire complex. However, the following opportunities for monitoring exist on this fire and it is hoped that this information will be useful in developing the overall W-W monitoring plan. A brief review of the input by members of the Emergency Fire Rehabilitation team may also prove useful in determining burn intensities and the various interpretations of burn severity.

1. Paired plot locations are available for comparing hot, moderate, and light burn intensities within Douglas-fir/ninebark, Douglas-fir/pinegrass and mosaics of both communities.

2. Paired plot locations are available for comparing different burn intensities in forest stands where heavy accumulations of logging slash (helicopter logging) are present. Different degrees of logging slash may be hard to determine but no slash vs. slash can be compared.

3. Effects of seeding treatments can be determined, e.g., the time it takes to get the desired ground cover, germination success, percent cover by year by native vs. introduced species.

4. If stands are tagged now for nontreatment, then a comparison of recovery of sites can be made between seded vs. nonseeded stands.

5. Effects (rate of recovery) of seeding in hot-burns can be compared with effects in moderate-burns (hot and moderate burns will be seeded only in the southern portion of the fire).

6. A comparison can be made between two seeding mixes in hot-burned areas (the north end of the fire will be seeded to less perennial and more annual species).

7. Comparison of rates of recovery in light vs. moderate burns vs. no burns in bunchgrass communities (AGSP-POSA3, FEID-AGSP/LUSE, FEID-AGSP/BASA, FEID-KOCR mounds, etc.).

8. Comparison of pre-burn to post-burn conditions where permanent long-term ecology monitoring plots exist (I think there are quite a few in this area).

   Monitoring effects of fire in this area will not only enhance our ability to properly manage these plant communities but will provide future rehabilitation teams better data from which to make recommendations. The most important questions which need to be answered are:

a. What plant cover can be expected on vrious communities under various fire intensities?

b. What is the rate of recovery without treatment, i.e., what cover from native species can be expected?

c. What species tend to be most successful at stablizing sites, at adapting to different sites, and at competing less with native species and tree seedlings?

d. What is the actual increase in stream sedimentation following burning during the first year, during the first 5 years?

e. How much soil loss can be expected for fine-textured soils on steep slopes (50%+).

f. How much are animals attracted to seeded areas?

g. During the five 5 years following treatment?

A special request from members of the rehab. team to be informed of the results of monitoring efforts has been made. Although this information will presumably be made public and easily acquired by most anyone, mailing the findings to rehab. members would be very much appreciated.

SEED MIXTURES

Four seed mixtures were discussed for use in treating hot burned areas on the Joseph creek fire complex. It is believed that all mixes will provide adequate erosion control. Benefits to wildlife and range resources and the probability of success may vary. Adaptability, suitability for erosion control, palatability of species and degree of expected competition with tree seedlings were considered in determining the following seed mixtures.

Mix 1 (highest wildlife benefits)

Species	Adj.* lbs/ac	$/lb	total cost
Orchard grass	2.7	0.70	$1.89
Smooth brome	1.3	1.75	2.28
Winter wheat	5.0	0.14	0.70
Small burnet	2.0	1.35	2.70
Alfalfa	2.3	2.50	5.75
	13.0		13.32

Mix 2 (highest erosion control benefits)

Inter. Wheatgrass	3.7	1.23	4.55
Winter wheat	8.0	0.14	1.12
White dutch clover	2.2	1.75	3.85
Yellow bl.sw.clover	2.2	0.65	1.43
	16.0		10.95

* adjusted rate when germination and purity are considered (not rounded)

Mix 3 (recommended moderate perennial mix)

Species	#seeds/sq.ft. per lb	lbs/ac *	total seeds/sq.ft.	$/lb	total cost
Cereal grain	1	10	10	.14	1.40
Orchard grass	12	3	36	.70	2.10
Yellow bl.sw.clover	6	2	12	.65	1.30
Alfalfa	5	2	10	2.50	5.00
		----	----		-----
		17	68		9.80
				application	5.00
				overhead	1.48

					$16.28

Mix 4 (recommended light perennial mix)

Species	#seeds/sq.ft. per lb	lbs/ac *	total seeds/sq.ft.	$/lb	total cost
Cereal grain	1	15	15	.14	2.10
Orchard grass	12	2	24	.70	1.40
Yellow bl.sw.clover	6	2	12	.65	1.30
		----	----		-----
		19	51		4.80
				application	5.00
				overhead	.98

					$10.78

* adjusted rate when germination and purity are considered (rounded)

APPENDIX

COMPLETED FORM FS-2500-8

USDA-FOREST SERVICE

Date of Report: 8/13/86

BURNED AREA REPORT
(Reference FSH 2509.13, Report FS-2500-A)

PART I - TYPE OF REQUEST

1. Type of Report

   [X] A. Funding (Request for estimated FFF funds)
   [ ] B. Accomplishment Report

2. Type of Action

   [X] A. Initial (estimated funding is first requested)
   [ ] B. Interim

      [ ] Updating the initial funding request.
      [ ] Supplying information for accomplishments to date on emergency work underway.

   [ ] C. Final

      [ ] Best estimate for funds needed to complete eligible rehabilitation measure.
      [ ] Following completion of funded work.

PART II - FIRE LOCATION

1. Fire Name (from Form FS-5100-29):JOSEPH CANYON/STARVATION RIDGE
2. Forest Supervisor's Fire No. (from Form FS-5100-29):763164
3. State:ORE
4. County:WALLOWA
5. Region:6
6. Forest:WALLOWA WHITMAN
7. Ranger District:WALLOWA VALLEY
8. Date Fire Started:8/10/86
9. Date Fire Controlled: NOT CONTROLLED AS OF 8/28/86 (CONTAINED 8/22)
10. Estimated Suppression Costs: $ 3,827,390
11. Fire Suppression Damages Repaired with FFF 102 Funds:

    14 miles (firelines waterbarred)
    35 acres (firelines seeded)
    ______ Other (identify)

12. Fire Intensity: 57 % (low) 33 % (medium) 10 % (high)

PART III - NATIONAL FOREST SYSTEM PROBLEM INVENTORY

1. Watershed No.:1706010602
2. NFS Acres Burned:30615
3. Water Repellant Soil: 15 % of NFS acres burned

4. Vegetation Types: BUNCHGRASSES: (65%)

Bluebunch wheatgrass-Sandberg's bluegrass	- 40%
Idaho fescue-Bluebunch wheatgrass	- 15%
Other (Idaho fescue-Prairie junegrass, scablands)	- 10%

FOREST TYPES: (35%)

Douglas fir/ninebark + snowberry	- 15%
Douglas fir/pinegrass	- 10%
Grand fir communities (ninebark,twinflower big huck)	- 10%

5. Geologic Types: COLUMBIA RIVER BASALT FLOWS - DISSECTED PLATEAU THIN MANTLE OF VOLCANIC ASH AND LOESS

6. Soil Erosion Hazard Rating:

___20 % (low) _____0% (medium) ___80 % (high)

7. Erosion Potential: ______3210______ cu. yds/sq. miles
8. Miles of Stream Channels by Regional Order or Classes:
36.8 SMU CLASS I
2.3 SMU CLASS II
17.3 SMU CLASS III

9. Miles of Forest Service Trails: NONE
10. Miles of Forest Service Roads by Maintenance Levels:

_____0 miles (Level I) ____0 miles (Level II)
____0 miles (Levels III, IV, V)

PART IV - CALCULATED RISK AND CLIMATIC EVALUATION

1. Estimated Vegetative Recovery Period: _2 years.
2. Chance of Success Desired by Management: _80 percent.
3. Equivalent Design Recurrence Period: 2 years.
4. Related Design Storm Duration: 30 MIN.
5. Related Design Storm Magnitude: 0.3 inches.
6. Related Design Flow 7.5_ cfsm. (25 YR. RETURN FLOW EVENT)
7. Estimated Reduction in Infiltration: _10 percent.
8. Adjusted Related Design Flow: __ 8.3cfsm.

PART V - SUMMARY OF SURVEY AND ANALYSIS

1. Skills Represented on Burned Area Survey Team ("x" appropriate boxes):

[X] Hydrology [X] Soils [ ] Geology [X] Range
[X] Timber [X] Wildlife [ ] Fire Mgmt. [ ] Engineering
[ ] Contracting [ ] Local Mgmt. [ ] Research [X] Other (ECOLOGY, SILVICULTURE)

2. Describe Emergency:
40,000 ACRE FIRE IMPACTING 30,615 ACRES OF NFS LANDS. MAJOR FISERIES AND WATER QUALITY CONSIDERATIONS APPROXIMATELY 13,000 ACRES IN HOT AND MODERATE BURNED CATEGORIES.

3. Emergency Rehabilitation Objective:
STABILIZE SOIL AND RESTORE HYDORLOGIC FUNCTION TO PRE-FIRE CONDITIONS TO PROVIDE FOR MAXIMUM POTENTIAL GROUND COVER WITHIN TWO YEARS. MINIMIZE LOSS OF FISH PRODUCTIVITY. NO SEDIMENT INCREASES IN SWAMP AND DAVIS CREEKS.

4. Probability of Completing Treatment Prior to First Major Damage Producing Storm:

Land __100 % Channel _____ % Roads _____ % Other _____ %

5. Net Environmental Quality Benefit Index:

[X] Significant [ ] Not Significant

6. Net Social Well Being Benefit Index:

[ ] Significant [X] Not Significant

7. Benefit/Cost Ratio: 2.9/1
8. Net Benefits: $ __314,941 ($43/ACRE)
9. Cost Effectiveness Index: [ ] I. [X] II. [ ] III. [ ] IV.

PART VI - ELIGIBLE EMERGENCY REHABILITATION MEASURES OR TREATMENTS AND SOURCE OF FUNDS

NOTE: Emergency rehabilitation is work done promptly following a wildfire and is not to solve watershed problems that existed prior to the wildfire.

			NFS Lands			Other Lands			All Lands
Line Items (1)	Units (2)	Unit Cost (3)	No. of Units (4)	FFF 092 $ (5)	Other $ ident. (6)	No. of Units (7)	Federal $ ident. (8)	Non-Federal $ identify (9)	Total $
A. LAND									
a. Seeding	Acres	$11	1901	20,492					20,493
b.	ACRES	$16	15430	88,400					80,400
c.			(INCLUDES OVERHEAD)						
d.									
e.									
B. CHANNELS									
a. Opening water courses	Miles								
b. Stabilizing streambanks	Miles								
c.									
d.									
e.									
C. ROADS AND TRAILS									
a.									
b.									
c.									
D. MAJOR STRUCTURES									
a. Preplanned - from Forest Plans									
E. TOTAL				108,893	$		$	$	$108,893

PART VII - APPROVALS

Frank Olson (Wallowa Valley district ranger)
/S/
Forest Supervisor (Signature) Date

/S/
Regional Forester (Signature) Date

Soil Erosion Calculations
Joseph Canyon/Starvation Ridge Fire
August 26, 1986

Procedure used is from Guidelines for Computing Soil Erosion Hazard and On-Site Soil Erosion by David A. Anderson, October 1969.

BER = 0.32 (mod. deep, med. tex., mod. perm.)
Soil component of EH = Moderate (detachability)
2 year - 30 min. prescription = 0.3 inches

Erosion Hazard (EH)

20% slopes; 0.043 in/yr   70% slopes; 0.12 in/yr

Percent Ground Cover & Coefficients

(Assumptions: Non-Burned and low intensity burned areas will not produce significant amount of sediment - only moderate and high intensity analyzed; 0-44% good ground cover curved used for yr. 0 and no treatment, 75-100% curve used for treatment).

	Moderate Severity				High Severity			
Yr	% w/o treat.	C	% w. treat.	C	% w/o treat.	C	% w. treat.	C
0	55	0.098	55	0.098	20	0.43	20	0.43
1	60	0.076	70	0.013	25	0.36	45	0.07
2	65	0.061	80	0.007	30	0.28	60	0.025
3	70	0.049	85	0.005	35	0.23	70	0.013
4	75	0.040	90	0.004	40	0.18	80	0.007
5	80	0.032	95	0.003	50	0.12	90	0.004

Erosion (in/yr) = EH x C

20% slopes (EH = 0.43					70% slopes (EH = 0.12)			
Moderate Sever.		High Sever.			Moderate Sever.		High Sever.	
w/o treat.	with treat.	w/o treat.	with treat.	Yr.	w/o treat.	with treat.	w/o treat.	with treat.
.00421	.00421	.01849	.01849	0	.01176	.01176	.0516	.0516
.00327	.00056	.01548	.00301	1	.00912	.00156	.0432	.0084
.00262	.00030	.01204	.00108	2	.00732	.00084	.0336	.0030
.00211	.00022	.00989	.00056	3	.00588	.00060	0.276	.00156
.00172	.00017	.00774	.00030	4	.00480	.00048	0.216	.00084
.00138	.00013	.00516	.00017	5	.00384	.00036	0.144	.00048

Cubic Yds = E (in/yr) ÷ 12 x 43560 ÷ 27 x Acres

464 Ac		73 Ac		Yr	9693 Ac		3012 Ac	
263	263	181	181	0	15325	15325	20895	20895
204	35	152	30	1	11885	2033	17494	3402
163	19	118	11	2	9539	1095	13606	1215
132	14	97	5	3	7663	782	11177	632
107	11	76	3	4	6255	626	8746	340
86	8	51	2	5	5004	469	5831	194

Sediment production = 30% of above values

TOTALS - Cubic Yrds of Sediment/Yr.

Yr.	Without Treatment		With Treatment
0	11,000		11,000
1	8,921		1,651
2	7,028		703
3	5,721		431
4	4,556		294
5	3,291		202
Total	40,517	+35%	24,281

Block 7 Erosion Potential

Cubic Yards Sediment - from Soil Erosion Calculations

Gentle Slopes (20%)		(Steep Slopes (70%)	
Mod. Sev.	High Sev.	Mod. Sev.	High Sev.
263	181	15,325	20,895
204	152	11,885	17,494

Total: 66,399 cu. yds/13,242 ac[1]/ 2 yrs

66,399 ÷ 13,242 = 5.01 cu. yds./ac/2 yrs
x 640 ac
3,210 cu. yds./2 yrs