BIG CANYON CREEK
REHABILITATION PROJECT

FEASIBILITY ANALYSIS

Prepared for:

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INTRODUCTION

Big Canyon Creek enters the Clearwater River 34 miles upstream from Lewiston, ID and drains the northwest corner of the Camas Prairie. The creek flows in a northerly direction through a canyon 200-600 feet wide at the bottom while the top of the canyon walls are typically 1000 to 1200 feet above the canyon bottom. Riparian vegetation in the canyon bottom is sparse but used for livestock grazing. Location of Big Canyon Creek is shown in Figure 1.

Fisheries utilization of Big Canyon Creek is significant. Biological inventories of Big Canyon Creek show substantial numbers of 0+ and 1+ rainbow/steelhead trout age classes. Evaluation of the habitat quality parameters showed Big Canyon Creek to have good quality habitat. Fisheries managers have determined Big Canyon Creek supports a population of A-Run Steelhead. These fish typically move into the smaller tributaries of the lower Clearwater River early in January or February and spawn in March or April with the alevins emerging out of the gravels in late May or June. This sequence corresponds to the period when flows are the largest in this type of watershed. It is believed that as the flows continue to decrease during the summer, the rearing fish move downstream into the Clearwater River where they reside until smolting.

A major flood occurred in Big Canyon Creek in January, 1965. This flood cut a new stream channel and had a detrimental effect on the canyons riparian vegetation.
FIGURE 1

Location map of Big Canyon Creek Rehabilitation Project.
Figure 67. Map of Big Canyon Creek indicating the two study areas sampled in 1983.
Big Canyon Creek flows through an alluvium filled canyon floor and over the years prior to the 1965 flood had sealed the alluvium with sediment to contain the flow in the stream channel. This seal was destroyed by the 1965 flood. As a result, sections of Big Canyon Creek lose all surface water flow during the summer low flow periods. This loss of water has had a severe impact on the fish utilization of Big Canyon Creek and on the riparian vegetation in the canyon bottom.

To determine the feasibility of completing a stream channel rehabilitation project on the sections of Big Canyon Creek which go dry during the summer, a site visit was completed on September 28, 1988 to the upper section and on September 30, 1988 to the lower section.

This report describes the existing conditions, the methodology used to develop a conceptual design of the rehabilitated stream channel shape, the rehabilitation alternatives, the equipment and materials needed for each alternative and the recommended alternative.
EXISTING CONDITIONS

Big Canyon Creek is approximately 30 miles long from the mouth near Peck, Idaho upstream to the headwaters near Mason Butte. The major tributaries entering Big Canyon Creek include Little Canyon Creek, Nichols Canyon, Sixmile Canyon and Posthole Canyon. It is estimated that 7 miles of Big Canyon Creek are dry annually in the ten-mile section of the creek which begins 2 1/2 miles upstream of Posthole Canyon and extends downstream to 1 mile downstream of Sixmile Canyon.

Existing channel features in the dry section of Big Canyon Creek have changed little since the 1965 flood. Width, depth and shape of the channel reflect the channel characteristics needed to carry a 2000-3000 cfs flood in this section of the creek. Vegetation and cut banks define the flood channel throughout the dry section.

In the flowing reach downstream of Sixmile Canyon, the toe of the canyon wall is very close to the edge of the stream. At several locations, bedrock outcrops form part of the stream bank. These outcrops occur regularly and indicate that the stream channel is controlled by the bedrock in the canyon bottom. Water flowing through this controlled reach has very little opportunity to disappear into the alluvium. Surface water in the stream channel is available to develop a vegetated riparian zone. Bed materials in the stream channel are similar in size in both the flowing and dry sections. The large materials that
dominate the channel are an indication that the flow velocity during the flood was very high and transported the smaller materials downstream. The wide channel width in the flowing section is a result of the flood. Riparian vegetation has begun to reestablish along the margins of the 1965 flood channel with the low flow and average flood channel occupying only a part of it. As a result, the channel is very wide and shallow during low flows. These features are shown in Photos 1 and 2.

In the dry reach upstream of Sixmile Canyon, the toe of the canyon walls are 200-300 feet away from the channel in both directions in numerous locations. Near the downstream end of the section, the canyon walls converge and narrow the width of the canyon floor. Just upstream of Fletcher Canyon, bedrock outcrops pinch the canyon width to 150 to 200 feet. Through this portion of the dry section, surface water flow reappears and continues downstream 300-400 feet before it disappears again. At the mouth of several side canyons, water is flowing out of the side canyons. This flow enters the Big Canyon stream channel and continues 100-150 feet downstream as surface water before it disappears into the cobble. Water is flowing through the dry section of Big Canyon Creek but it is subsurface flow. A riparian vegetation zone has not developed in the dry reach. Vegetation present in this reach consists mostly of small ponderosa pine and cottonwood trees with some grasses. Annual weeds are also present. Vegetation growth in this
section is limited by lack of water and soil. Subsurface flow through the alluvium puts the water out of the reach of plant roots resulting in very little annual growth on trees, brush and grasses. Lack of a soil layer also hinders plant growth. Once water has passed through the 1- to 2-inch soil layer, it flows through the alluvium unrestricted. Vegetation is slowly beginning to grow along the margins of the 1965 flood channel with most of the vegetation consisting of grasses and annual weeds. No trees or shrubs have sprouted in these areas. The shape of the channel through the dry section varies from a single confined channel along the toe of the canyon wall to a braided channel through the center of the canyon bottom. The course of the flow when the stream discharge is greater than the infiltration capacity of the alluvium is marked by the absence of vegetation and a whitish deposit left on the rocks when the water evaporated from the pools. These features are shown in Photos 3 through 6.
PHOTO 1 Bedrock outcrops along both banks confine the stream channel in the flowing reach of Big Canyon. Riparian vegetation has begun to grow on the gravel bars formed during the 1965 flood.

PHOTO 2 Channel width in the flowing reach is very wide due to the flood flows. Riparian vegetation is beginning to reestablish along the margins of the channel outside the current high flow channel. Summer low flows are very shallow in this wide channel.
**Photo 3** Surface flow reappears in the dry section just upstream of Fletcher Canyon. Bedrock outcrops narrow the canyon width forcing water to the surface but it disappears again 300-400 feet downstream.

**Photo 4** A single channel along the toe of the canyon wall. The flood channel extended from the canyon wall to the row of cottonwoods along the left edge of the picture. Without surface water flow in the channel, a riparian vegetation zone has not been established between the cottonwoods and the edge of the new high flow channel.
**PHOTO 5** A braided section of Big Canyon Creek in the dry reach. Annual runoff flows through most of the channel and disperses the water over a larger area to infiltrate into the alluvium. Only annual weeds grow in these sections of the creek.

**PHOTO 6** Location of the existing flow channel is defined by the absence of vegetation in the channel and the carbonate stains on the rocks left after the water evaporated out of the standing pools.
HYDROLOGIC ANALYSIS

Determining the feasibility of completing a channel rehabilitation project requires a hydrologic analysis to define the quantity of water in the stream during different periods of the year. This information will be used to determine the channel geometry needed to pass the annual runoff, confine the summer low flows, and to provide rearing habitat for juvenile steelhead.

The hydrologic analysis for Big Canyon Creek was completed to determine the average annual flow, the average flood flow, the seven-day average low flow, the average monthly minimum flow, the mean monthly flow and the average monthly maximum flow. This analysis was completed using a regional hydrologic model developed by analyzing USGS gaging station records for streams located in the Big Canyon region. Gaging records were analyzed for Lapwai Creek and Lawyer Creek on the Camas Prairie and Missouri Flat Creek, Paradise Creek, Union Flat Creek and the Palouse River on the Palouse Prairie. The analysis revealed that the runoff characteristic of the Palouse and Camas Prairies are significantly different. Therefore, only the records for Lawyer Creek and Lapwai Creek were used to estimate the flows for Big Canyon Creek.

The first step in developing the regional model is to determine the average annual flow for each of the gages. This value is divided by the drainage area to determine cfs/sq mi for average annual flow. The project site is
located in the upper section of Big Canyon so the drainage basin for the project area began downstream of Sixmile Canyon and extended upstream to the headwaters. For upper Big Canyon

Average Annual Flow (QAA) = 0.34 cfs/sq mi x Drainage Area
                           = 0.34 x 85
                           = 29 cfs

The seven-day average low flow and average flood flow were determined by calculating these values for each of the gaging stations, dividing the flows by the average annual flow for the gage, calculating the regional average and multiplying the average annual flow for the project site by the regional average. For upper Big Canyon:

Seven-Day Average Low Flow = 0.05 x QAA
                           = 0.05 x 29
                           = 1.45 cfs

and

Average Flood Flow = 14.2 x QAA
                    = 14.2 x QAA
                    = 412 cfs

The average monthly minimum, average monthly minimum and mean monthly flows are determined using the same procedures.

Flows are determined for each of the gaging stations and divided by the average annual flow for the gage. A regional average is calculated and multiplied by the average annual flow of the project site. The estimated monthly flows for upper Big Canyon are shown in Table 1 and plotted in Figure 2.
### TABLE 1  Estimated Average Monthly Minimum, Average Monthly Maximum and Mean Monthly Flow for Upper Big Canyon Creek

<table>
<thead>
<tr>
<th>Month</th>
<th>Average Minimum</th>
<th>Mean Monthly</th>
<th>Average Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>3.2</td>
<td>4.9</td>
<td>8.1</td>
</tr>
<tr>
<td>November</td>
<td>4.4</td>
<td>8.1</td>
<td>16.5</td>
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<tr>
<td>December</td>
<td>7.0</td>
<td>18.3</td>
<td>57.1</td>
</tr>
<tr>
<td>January</td>
<td>8.4</td>
<td>40.6</td>
<td>178.0</td>
</tr>
<tr>
<td>February</td>
<td>14.2</td>
<td>40.9</td>
<td>196.0</td>
</tr>
<tr>
<td>March</td>
<td>33.6</td>
<td>84.7</td>
<td>235.0</td>
</tr>
<tr>
<td>April</td>
<td>41.2</td>
<td>82.4</td>
<td>178.0</td>
</tr>
<tr>
<td>May</td>
<td>15.4</td>
<td>39.4</td>
<td>92.0</td>
</tr>
<tr>
<td>June</td>
<td>5.5</td>
<td>13.1</td>
<td>33.4</td>
</tr>
<tr>
<td>July</td>
<td>2.0</td>
<td>4.6</td>
<td>13.3</td>
</tr>
<tr>
<td>August</td>
<td>1.5</td>
<td>2.3</td>
<td>4.6</td>
</tr>
<tr>
<td>September</td>
<td>2.0</td>
<td>3.5</td>
<td>5.8</td>
</tr>
</tbody>
</table>
FIGURE 2

Annual Hydrograph showing Estimated Average Monthly Minimum, Average Monthly Maximum and Mean Monthly Flows for Big Canyon Creek.
CHANNEL GEOMETRY

The stream channel through the dry section of Big Canyon Creek must provide fish habitat at low flows and have the capacity to carry the average flood flows. From the Hydrologic Analysis, this channel will carry flows ranging from 1.5 to 412 cfs. It is recognized that extreme flow events can occur in Big Canyon but using these flows for design is impractical.

The channel shape that can be used to carry the range of flows estimated for the project area is a compound channel consisting of a low flow channel with floodplains along one or both banks. To provide bank stability, the low flow channel should have a trapezoidal shape with side slopes of 3H:1V. Channel width will be 10 feet with the floodplains 1.5 feet above the bottom of the low flow channel. By assuming uniform flow in the channel, Manning's equation can be used to calculate the discharge in the channel assuming a flow depth, roughness coefficient and channel slope. For a flow depth of 1.5 feet, a roughness coefficient of 0.035 and a channel slope of 1 percent:

\[
Q = 1.49 \frac{A}{n} R^{1/3} S^{1/3}
\]

where
- \( Q \) = discharge
- \( n \) = roughness coefficient
- \( A \) = flow area
- \( R \) = hydraulic radius
- \( S \) = channel slope

Substituting

\[
Q = 1.49 \times 21.75 \times \frac{21.75^{1/3} \times 0.01^{1/3}}{0.035 \times 19.48} = 100 \text{ cfs}
\]
Under these conditions, the low flow channel is flowing full with an average velocity of 4.6 feet per second.

With this channel shape, the low flow channel will carry over 85 percent of the flow regime estimated for the project area in Figure 2.

Width of the floodplains can be determined by assuming a depth of flow over the floodplain and using the average flood flow determined in the Hydrologic Analysis. It will also be assumed that the roughness coefficient and channel slope remain the same. For a flow depth of 1 foot over the floodplain:

\[
Q = \frac{1.49}{n} A R^{1/2} S^{1/2}
\]

Substituting

\[
412 = \frac{1.49}{0.035} A \times R^{1/3} \times 0.01^{1/3}
\]

or

\[
96.78 = A \times R^{1/3}
\]

Solving by trial and error for an assumed width, the floodplain/riparian zone on either side of the low flow channel is 20 feet wide.

Dimensions and descriptions of the channel features are shown in Figure 3.
FIGURE 3

Channel Dimensions and Features for the Rehabilitated Sections of Big Canyon Creek.
The shape and dimensions of the channel described are to be used as guidelines only when discussing channel rehabilitation plans for Big Canyon. Channel conditions within the project area are highly variable, and general application of this design to the entire project area is not appropriate. In several locations, the existing stream channel is at the toe of the canyon wall with a well developed low flow channel and sloping floodplain/riparian zone. These areas should be left alone as they create diverse habitat. Application of the channel design is recommended in those locations where the flood channel braided and left numerous channels for the average flows to pass through.

Reestablishment of a single flow channel for Big Canyon Creek through the project area would be a major step in improving water flows and ultimately fish habitat. Existing conditions allow the water to infiltrate into the alluvium over a large area as the multiple channels migrate through the canyon bottom. By confining the average flows into a single channel, the smaller bed load and suspended sediments would be deposited in the channel and begin to reseal the channel. As the channel bed seals, surface flow will be present during longer periods of the year. Ultimately, year round flows will be present in Big Canyon to provide rearing habitat for steelhead.

In conjunction with the reestablishment of a single channel in Big Canyon Creek, a revegetation project should
be completed. This work would accelerate bank stabilization, provide streamside cover and stream shading. Streamside riparian vegetation remains lush throughout the summer due to its access to water. As a result, livestock grazing can severely impact this vegetation and restrictions must be placed on the length of time livestock are allowed to graze in these areas. Without these restrictions, the riparian vegetation cannot thrive to develop stable banks and streamside cover.
CHANNEL REHABILITATION ALTERNATIVES

Three alternatives exist to complete the Big Canyon stream channel rehabilitation project. A benefit/cost analysis is not completed, because this report concentrates on the feasibility evaluation of completing the rehabilitation project.

The first alternative is to leave the existing stream channel conditions as they are and let natural processes mend the channel. Cost to implement this alternative would be zero. Estimating the length of time required before the channel naturally seals is impossible. It has been almost 25 years since the 1965 flood and very little evidence is present in the existing channel that would suggest year round surface water flow will occur soon. Steelhead continue to use the stream in the sections where surface water flow is present. When portions of the channel dry up the fish become trapped and, if they survive, must wait for higher discharges to move downstream. Overall production is limited by the lack of water in this section of the creek.

The second alternative is to cut a new channel using the channel shape and dimensions like those developed in the Channel Geometry Section. Once the new channel has been installed, natural processes would be used to seal the channel. Design of the project would require a site survey to define the existing channel locations, channel and bank elevations and identification of stable channel reaches. From this information, locations and elevations of the low
flow channel and floodplain could be determined. Implementation of the project would then be completed. Cost to implement this alternative would include the design and construction fees. Benefits of the project would depend on the time required to naturally seal the channel. Estimation of this time period is impossible. During the construction, any local sand or small gravels would be placed in the channel to help the sealing process.

The third alternative is the same as the second alternative with the addition of clays, sands and gravels being hauled into the project area to help seal the channel. Design and implementation of this alternative would be similar to the second alternative except for the placement of additional sealing materials in the channel. Cost to implement this alternative would include design and construction fees plus the cost of the materials and transportation to the site. Placement of the sand in the new channel is to fill the interstitial spaces between the large alluvium and keep the water in the channel. Some sedimentation of the stream bed may occur and be detrimental to fish but the water must be present before the fish will utilize the habitat. Benefits of the project would depend on the amount of time required for the channel to seal with the additional material placed in it.

Implementation of the second or third alternative will require an in-depth design to ensure habitat diversity is developed. This diversity requires pools, riffles and runs
with overhanging vegetation, stable stream banks and riparian vegetation. Locations where these features exist should not be changed. The proposed channel shape should be used as a guide and can be changed to accomplish the development of a particular habitat type. It is crucial to include the floodplain area in all channel designs to provide an area for the larger flows which results in less channel scour. These floodplain areas are also utilized as the riparian vegetation zone. Over time, high flows will deposit sands and silts on these areas which will encourage vegetation growth. Densely vegetated floodplains and riparian zones become very stable due to the plant roots and can resist erosion by the majority of flood flows.
EQUIPMENT AND MATERIALS

Implementation of the second or third alternatives will require the use of heavy equipment. Building the new channel, sloping banks and floodplains, and filling old channels cannot be done effectively using hand labor.

Two principal pieces of equipment will be used to complete the construction. A dozer with an articulating blade will be the primary piece of equipment used to build the new channels and slope the banks and floodplains. The size of the dozer needed will be a Caterpillar D3 or D4 or equivalent. The moveable front blade is needed to move material to one side or the other depending on the direction of movement. A rubber tire front end loader will be used to move surplus materials out of the channel construction area, haul bed sealing materials to the work areas and deliver materials to the fill areas. The size of the loader needed will be a Caterpillar 950 or equivalent. This size of machine will move over the rocky terrain easier due to the larger tires and carry a 2-3 cubic yard load.

Implementation of the third alternative will require the delivery of sand and small gravels to the project area. This material can be pit run sand and small gravel transported from a location in the canyon bottom or brought in from an off site location. This material could be placed in the system by dumping it along side the creek in the upper watershed and allowing the annual runoff to wash it into the creek.
Access to the project area for equipment and materials will be a crucial factor in deciding which alternative is chosen. A narrow road exists in Posthole Canyon that can be used to drive a vehicle, dozer or front end loader down to the project site. Large dump trucks or tractor-trailer units cannot drive down this road. A cultivated field exists between the county road and the beginning of the Posthole Canyon road restricting access during the majority of the year. Movement of off site materials to help seal the stream channel will be impossible using the Posthole Canyon road. Two alternatives exist for transporting the seal materials to the project area. One, a helicopter can be used to haul the materials from the staging area at the top of the canyon to the project sites or two, a logging yarder can be set up at the top of the canyon to move the materials to the project area in 1 cubic yard drop buckets. Daily movement of construction supervisors, equipment operators, fuel and lubricants, and project supplies to the project area on the Posthole Canyon road will be difficult due to the rough road. Condition of the road prevents moving travel trailers to the project site for on site living quarters requiring daily trips into and out of the project area.
RECOMMENDATIONS

Fisheries production in the Big Canyon watershed is currently limited by the section of stream that annually goes dry. Rehabilitating the dry section to speed up the return of year round flows would increase the production capability greatly. Any increase in fish production from Big Canyon Creek would improve the overall strength of the Clearwater River steelhead runs.

Implementation of the alternatives requiring construction will have an associated cost but will have a greatly improved chance to produce some benefits. Leaving the stream as is will have no cost but it will have very little chance to produce any benefits. Any decision must evaluate the long term value of a stream annually producing A-run steelhead against the short-term costs associated with implementing the project.

Knowing the production potential of Big Canyon Creek, the progress made thus far under natural conditions to reseal the channel, and the construction methodologies available to complete this type of project, a channel rehabilitation project should be considered for Big Canyon Creek. Alternative 2 would be the preferred alternative. Movement of additional material into the project area to place in the channel would be costly and difficult using a helicopter or logging yarder. Dumping the material along the creek would require access to the creek where enough flow exists during annual runoff to wash it into the stream.
and move it downstream to the project site. Using the dozer
and front end loader to complete the project would be a very
efficient method to reestablish a single channel throughout
the reach. Minor road improvements could be made to improve
access to the project area for equipment operators and
construction supervisors. Locations to be worked on would
be identified during the receding limb of the hydrograph to
determine how long the water remains in each section of the
channel. Areas which loose water the soonest and dry areas
downstream of the perennial flowing sections would be
concentrated on to prolong the surface flow period in each
of these sections. The entire project does not need to be
constructed at one time. Demonstration or test sections
could be built and evaluated to determine the effectiveness
of the project.

The success or failure of this project will depend on
the development of accurate design drawings showing the
location, elevation and shape of the new stream channel,
bank stabilization and habitat improvement structures.
Modifications to the plans after construction has begun is
to be expected and will occur due to the actual site
conditions.
Two Miles Upstream of Confluence of Big Canyon Creek and Nichols Canyon

<table>
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<tr>
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<th>2 yr</th>
<th>5 yr</th>
<th>10 yr</th>
<th>25 yr</th>
<th>50 yr</th>
<th>100 yr</th>
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<tr>
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<td>2350</td>
<td>3000</td>
<td>4420</td>
<td>5570</td>
<td>6400</td>
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<tr>
<td>50% Conservation Treatment</td>
<td>830</td>
<td>2010</td>
<td>2610</td>
<td>3920</td>
<td>5010</td>
<td>5800</td>
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<tr>
<td>Maximum Conservation Treatment</td>
<td>570</td>
<td>1550</td>
<td>2060</td>
<td>3220</td>
<td>4200</td>
<td>4900</td>
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Confluence of Big Canyon Creek and Little Canyon Creek

<table>
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<th>Land Treatment</th>
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<th>10 yr</th>
<th>25 yr</th>
<th>50 yr</th>
<th>100 yr</th>
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</thead>
<tbody>
<tr>
<td>Present Condition</td>
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<td>2970</td>
<td>3810</td>
<td>5630</td>
<td>7180</td>
<td>8200</td>
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<td>50% Conservation Treatment</td>
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<tr>
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<td>1880</td>
<td>2530</td>
<td>3990</td>
<td>5200</td>
<td>6140</td>
</tr>
</tbody>
</table>

The peak discharge values were obtained using the TR20 computer model by estimating acres of land use vs hydrologic condition for the three conditions; 1) Present, 2) 50% conservation treatment applied, and 3) Maximum conservation treatment applied. The rainfall amounts were taken from NOAA Atlas 2.

As conservation treatment is applied, the annual peak discharge and volume will be reduced from that which would occur under present conditions. This will reduce the sediment being delivered to the channel system, but the result will not be evident at the outlet for many years until the available sediment in the channel has moved through the system.

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