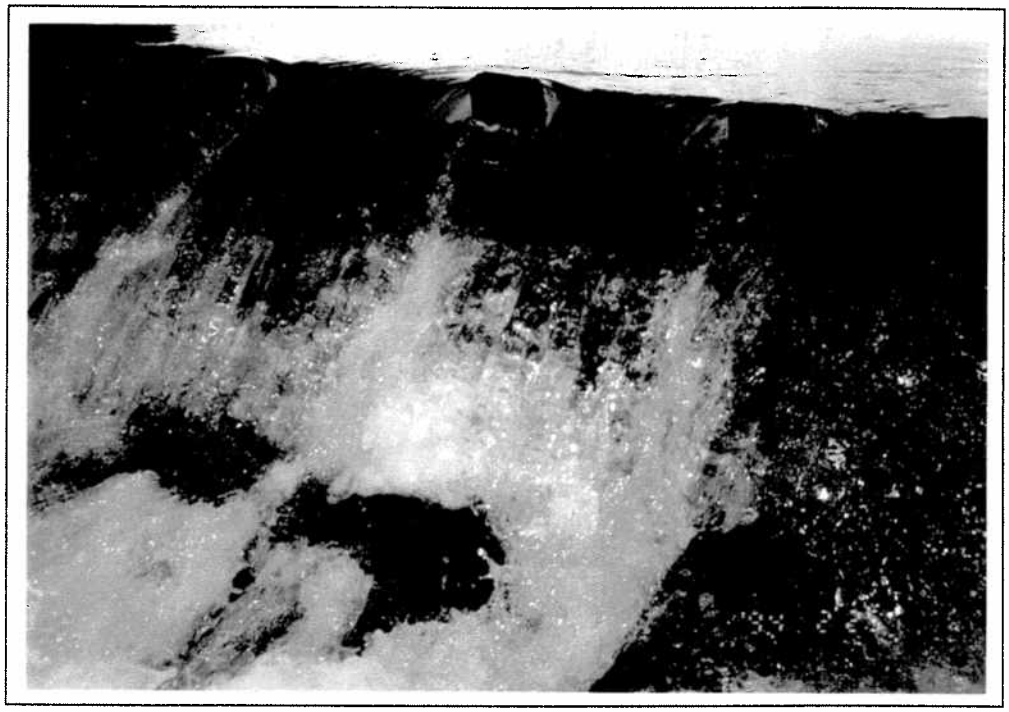
FISH BARRIER FEASIBILITY REPORT



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1120 Cedar Street • P.O. Box 8254 • Missoula, Montana 59807 • Tel (406) 721-0354
E-mail info@landandwater.net • Fax (406) 721-0355

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E-mail info@landandwater.net • Fax (406) 721-0355

August 19, 1999

Lewis and Clark National Forest
Attention: Mr. Mike Enk
P.O. Box 869
Great Falls, MT 59403

RE: Fish Barrier Report

Dear Mike,

Enclosed is the feasibility report on the fish barrier sites we visited. The discussion of the engineering considerations is somewhat cursory since survey and design was not included in this contract. If you would like more details on any of the potential sites, please feel free to call.

Sincerely,

Paul Callahan
Hydrologist

Cc: Ken McDonald, FWP

Fish Barrier Feasibility Report

August 1999

Prepared For:

MONTANA DEPARTMENT OF FISH WILDLIFE AND PARKS
1420 East Sixth Avenue
Helena, Montana 59620

And

LEWIS AND CLARK NATIONAL FOREST
P.O. Box 869
Great Falls, Montana 59403

Prepared By:

LAND & WATER CONSULTING, INC.
P.O. Box 8254
Missoula, Montana 59807-8254

LAND & WATER

This report provides some preliminary considerations for the construction of fish barriers at eight locations (seven in the Little Belts and one in the Highwoods). The following descriptions were derived from brief site visits in May of 1999. Survey and design for these sites was out of the scope of the contract.

CHAMBERLAIN CREEK #1

This site is located near the confluence of Chamberlain Creek and Jefferson Creek (Figure 1). There is an existing bridge at this location (Photo 1). In recent years, a fish barrier was constructed within the bridge cross-section. This barrier is a spring-loaded check structure that was intended to collapse under the pressure of high flows, thus allowing floods to pass unimpeded under the bridge. According to Mike Enk, the springs collapse under even low to moderate flows and the structure is most likely not an effective barrier to fish passage.

This bridge is slated for replacement within five years. It was the consensus of the group that visited this site that the most feasible option was to perch a set of culverts and construct a rock splash basin to eliminate the scour pool at the outlet.
Bridge is 16'x16'
The 100-year flow was calculated as 1049 cfs which would require three 84" squash culverts. These would cost approximately $1,700 per pipe.

This is a popular dispersed camping area and the threat of illegal introductions would be serious after completion of this barrier.

CHAMBERLAIN CREEK #2

The second site is upstream of Chamberlain #1 (Figure 1). There is no road access to the site and some removal of trees would be required if heavy equipment were to be used to construct a barrier. There is a bedrock outcrop on the right side of the creek (Photo 2) which constricts the flow and would allow for a firm anchor of any barrier structure. The stream is somewhat entrenched and the flow could be checked up slightly without high risk of the creek scouring a new channel during high water. The slope of the channel is approximately 3%.

This is far enough off the road that the threat of illegal introductions upstream of a constructed barrier is relatively small.

MEMORIAL FALLS

At this location, there is approximately 6 feet of drop over a stream length of 100 feet. This provides a fundamental element of a drop-type fish barrier. The general approach is to construct a drop structure with a floor or splash basin that precludes the formation of a scour pool. The valley is confined and the structure could possibly be built without the threat of failure in a large flood. The cost of construction of a drop structure at this site would likely be in the $30,000 to $50,000 range. The costliness, along with the easy public access throughout most of the drainage above this location, makes this an unlikely candidate at this time for construction of a barrier.

HARLEY CREEK

Bridge 1 and Bridge 2

There are two bridges that span Harley Creek. Bridge 1 (Photo 4) is the downstream bridge and Bridge 2 (Photo 5) is the upstream bridge. Bridge 1 has a flow cross-section of 56" x 23' wide and Bridge 2 has a cross-section of 50" high by 24' wide. The channel slope at both of these bridges was estimated to be 2.5%. With this steepness, perched pipes with rock splash basins may be the most cost-effective method of constructing a passage barrier.

To determine what size culverts would be needed to pass the same flow of the bridge cross-sections, a hydraulic model was run. Appendix A contains the output of this model. Essentially, when the discharge just fills the cross-section it should be approximately equal to 1,452 cubic feet per second for Bridge 1 and 1,301 cfs for Bridge 2. I also used USGS regression equations to determine the 100-year flood discharge at these sites. The upper and lower sites had 100-year floods of 1,222 and 1,333 cfs, respectively. These numbers correspond well to the modeled maximum flows.

To pass this flow with culverts, one could install four 84" squash culverts. At approximately $2,000 per pipe, the total project cost for each bridge would likely exceed $20,000.

Mouth

There is a pair of old bridge abutments near the mouth of Harley Creek (Photo 3). These structures constrict the flow of Harley Creek and provide some unfavorable hydraulics for fish passage. By reconstructing these abutments with a drop structure and rock splash basin, this location could be made into a barrier. Of all the sites on Harley Creek, it appears to be the most feasible technically.

There is some indication of gully erosion in the floodplain. This most likely occurs as a result of the flow constriction during high water. This potential problem would require careful consideration when designing a new structure.

Public access and cabin sites upstream of this location make the threat of illegal introductions high. Another complicating factor with this site is the fact that it lies on private land. The easement question should be resolved before moving forward with a project here.

BIG COULEE

This site, in the Highwoods (Figure 2), was chosen as a project that we could move ahead on. There is a bedrock constriction that currently provides some hydraulics, which are unfavorable for fish passage. We have applied for Future Fisheries money and are moving ahead with the plan to place boulders from nearby the project site, into the stream to increase the strength of the right-angle flow vectors. Mike Enk first pointed out that effective natural barriers often display this hydraulic characteristic.

PILGRIM CREEK

Because of the roadless nature of the Pilgrim Creek drainage, this appears to be the most feasible barrier project from the biological perspective. In addition, there are some favorable site characteristics which make this a technically appealing project.

There is currently a bedrock constriction just above a 20 foot long smooth rock chute. As it is, this outcrop presents a serious challenge for fish passage. With some additional rock and/or concrete work, this would almost certainly be an effective barrier.

Heavy equipment access to the site would be very difficult and therefore, the use of large rocks to create a more effective hydraulic barrier would be difficult. This, however, seems to be the best option. With the use of some low-tech devices such as come-alongs, I believe that an effective barrier can be formed at this location.

The other apparent option, concrete (or gunnite) could be effective in the short-term. The erosive action of ice and flowing water (the 100-year flood at this location was modeled at 2,286 cfs), however, is likely to destroy this structure within a year or two.

Appendix A

MODEL OUTPUT

Fish Passage Barrier Feasibility Report

LAND & WATER

Harvey Creek Bridge 1 Full Cross-section
Worksheet for Rectangular Channel

Project Description	
Project File	\\paul\projects99\h99-220 barriers\harvey.fm2
Worksheet	Harvey Creek Bridge 1
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.025000	ft/ft
Depth	4.70	ft
Bottom Width	21.00	ft

Results		
Discharge	1,452.70	cfs
Flow Area	98.70	ft^2
Wetted Perimeter	30.40	ft
Top Width	21.00	ft
Critical Depth	5.30	ft
Critical Slope	0.017654	ft/ft
Velocity	14.72	ft/s
Velocity Head	3.37	ft
Specific Energy	8.07	ft
Froude Number	0.00	

LAND & WATER

Harvey Creek Bridge 2 Full Cross-section
Worksheet for Rectangular Channel

Project Description	
Project File	\\paul\projects99\h99-220 barriers\harvey.fm2
Worksheet	Harvey Creek Bridge 1
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.025000	ft/ft
Depth	4.20	ft
Bottom Width	22.00	ft

Results		
Discharge	1,301.47	cfs
Flow Area	92.40	ft²
Wetted Perimeter	30.40	ft
Top Width	22.00	ft
Critical Depth	4.77	ft
Critical Slope	0.017143	ft/ft
Velocity	14.09	ft/s
Velocity Head	3.08	ft
Specific Energy	7.28	ft
Froude Number	0.00	

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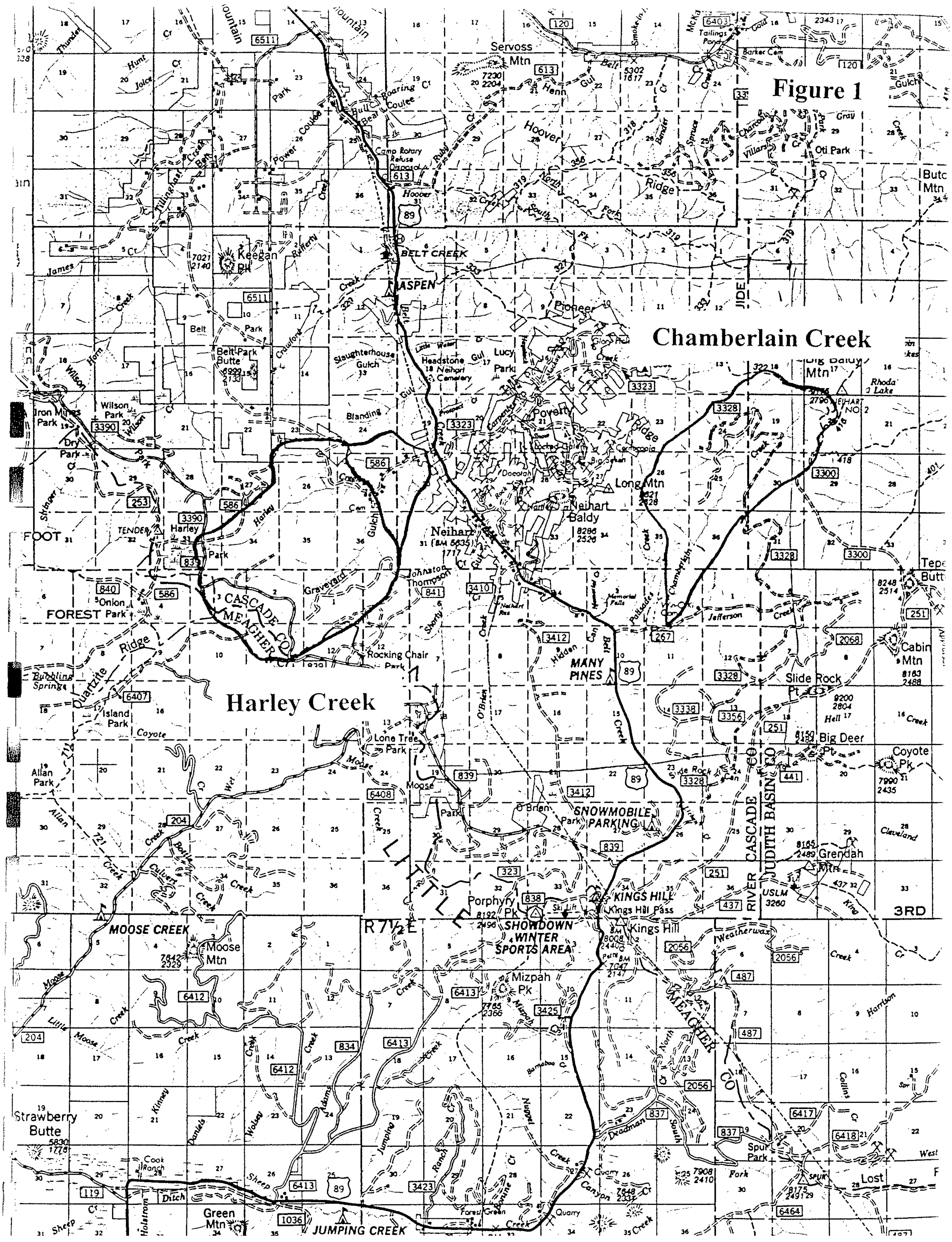
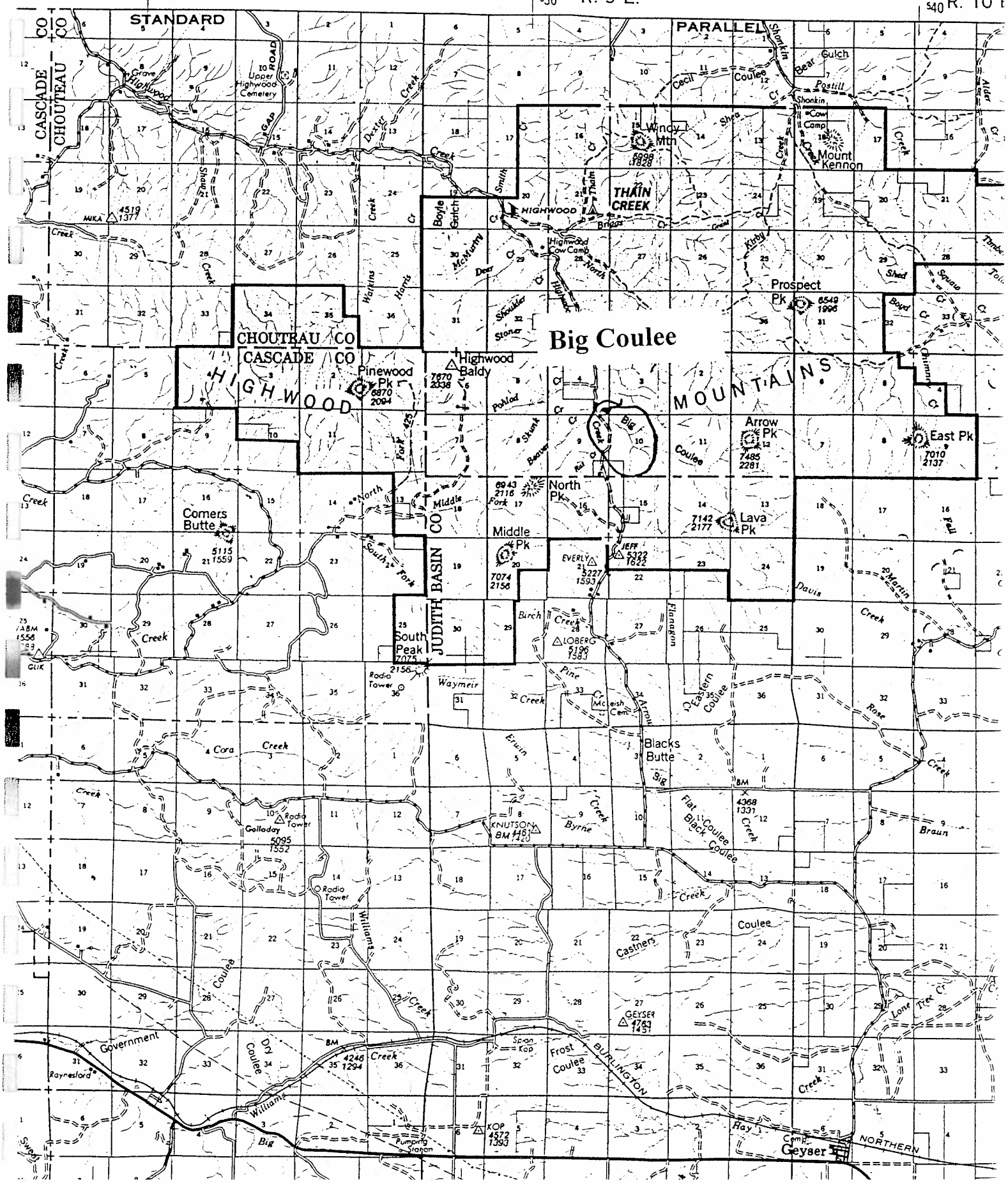


Figure 1
Chamberlain Creek
Harley Creek
Neihart
Belt Creek
Aspen
Kings Hill
Kings Hill Pass
Showdown Winter Sports Area
Snowmobile Parking
Many Pines
Moose Creek
Jumping Creek
Big Baldy Mtn
Long Mtn
Neihart Baldy
Porphyry Pk
Mizpah Pk
Moose Mtn
Green Mtn
Strawberry Butte
Keegan Pk
Servoss Mtn
Hoover Ridge
Slide Rock Pt
Big Deer Pt
Coyote Pk
Cabin Mtn
Grendah Mtn
Spur Park
Harley Park
Belt Park
Belt Park Butte
Iron Mines Park
Island Park
Allan Park
Onion Park
Lone Tree Park
Rocking Chair Park
Moose Park
O'Brien Park
Cascade Co
Meagher Co
Judith Basin Co
R 7 1/2 E
Little Belt

Figure 2


520
R. 8 E.
530
R. 9 E.
540
R. 10 E
STANDARD
PARALLEL
CASCADE CO
CHOUTEAU CO
Big Coulee
HIGHWOOD MOUNTAINS
JUDITH BASIN CO
Highwood Baldy
Pinewood Pk
Windy Mtn
Mount Kennon
THAIN CREEK
Prospect Pk
East Pk
Arrow Pk
North Pk
Middle Pk
Lava Pk
South Peak
Comers Butte
Blacks Butte
Big Coulee
Eastern Coulee
Flat Coulee
Black Coulee
Dry Coulee
Frost Coulee
Geyser
BURLINGTON NORTHERN

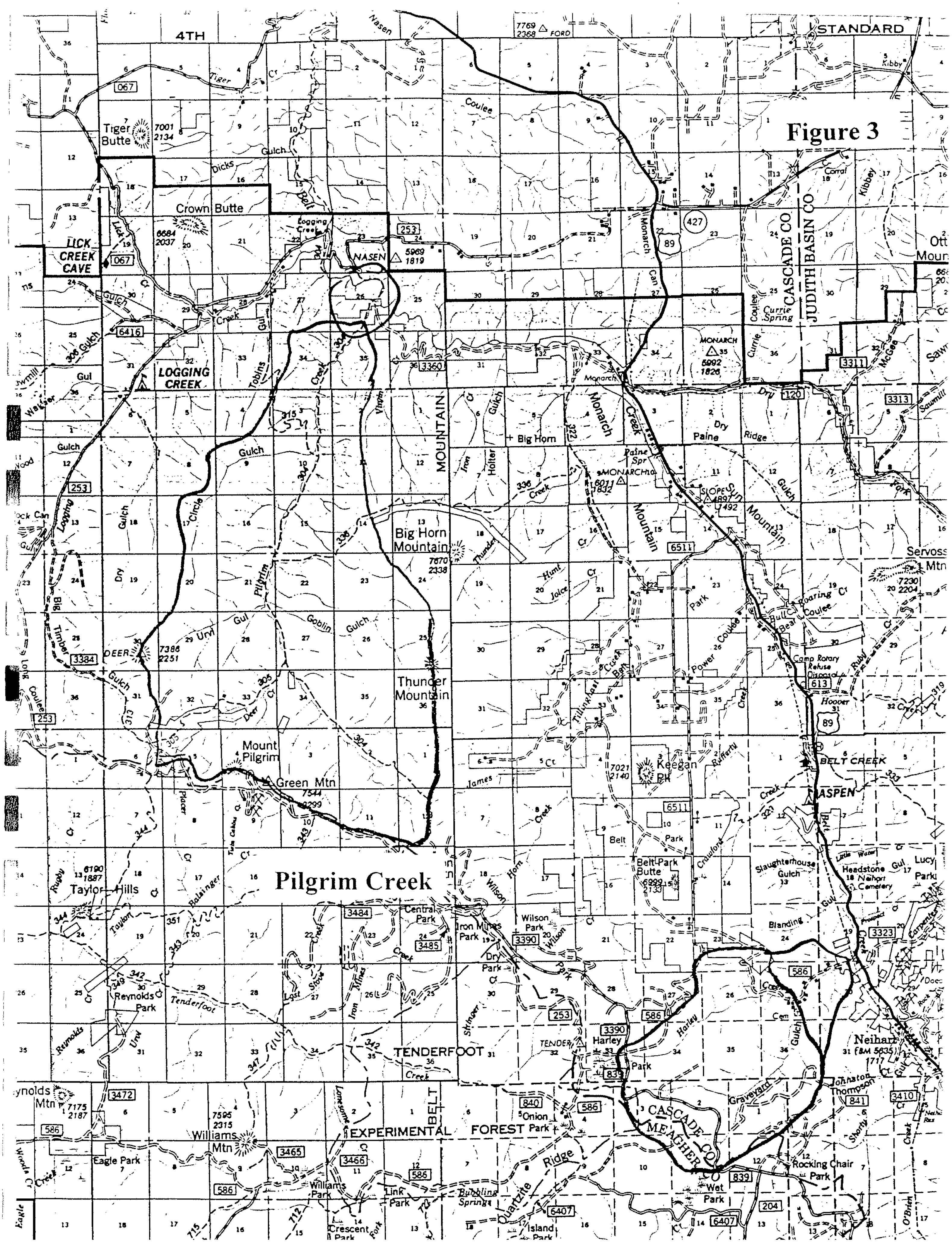
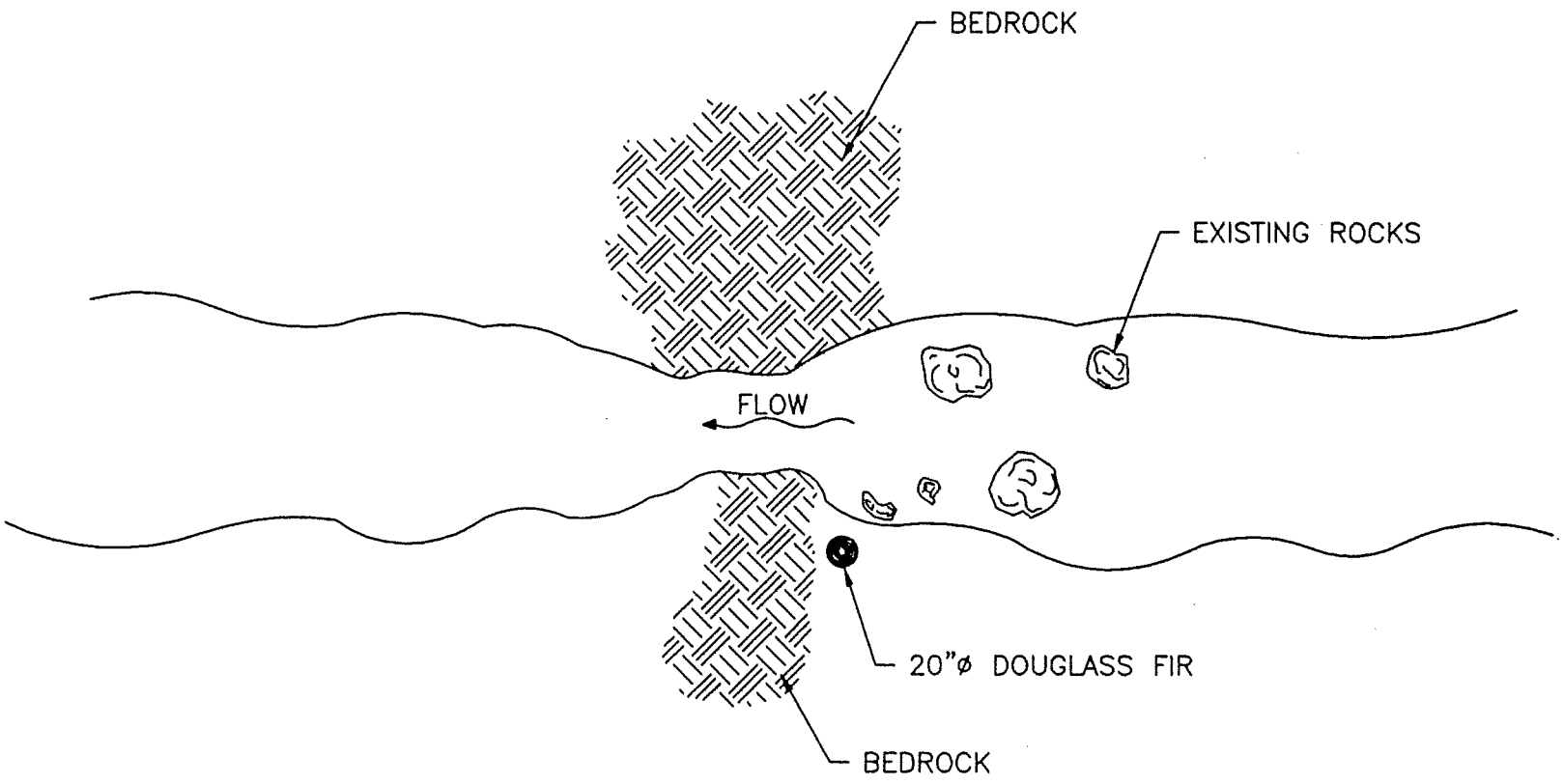


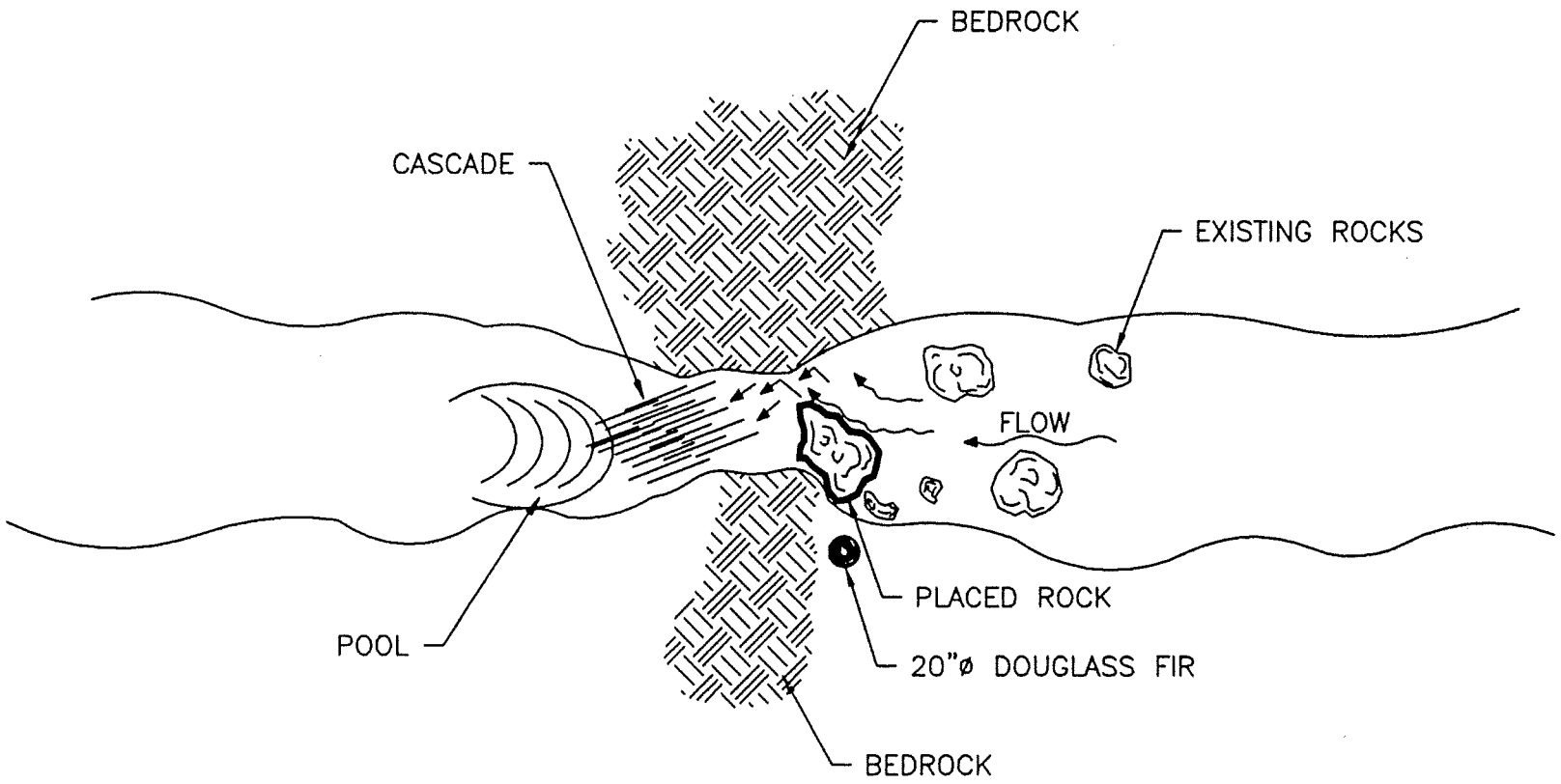
Figure 3
Pilgrim Creek
STANDARD
Tiger Butte
Crown Butte
LICK CREEK CAVE
LOGGING CREEK
NASEN
MONARCH
Big Horn Mountain
Thunder Mountain
Mount Pilgrim
Green Mtn
MOUNTAIN
Sun Mountain
Monarch Creek
Keegan Pk
Belt Park Butte
Taylor Hills
Reynolds Park
TENDERFOOT
Williams Mtn
EXPERIMENTAL FOREST
BELT
Harley Park
Neihart
BELT CREEK
ASPEN
CASCADE CO
JUDITH BASIN CO
CASCADE
MEAGHER CO
Servoss Mtn
Slaughterhouse Gulch
Rocking Chair Park
Wet Park
Eagle Park
Crescent Park
Quartzite Ridge



PLAN VIEW OF EXISTING CHANNEL

Figure 4a

LAND & WATER CONSULTING, INC. P.O. BOX 8254 Missoula, MT 59807	PROJ NO: H99-220	FILE NAME: fish_barrier	FIGURE: 1	PROJECT NAME FISH BARRIER FEASIBILITY STUDY	SH 1 OF 3
	PROJ MGR: PC	DRAWN: SPM	SCALE: ~1"=10'		
	DESIGNED:	CHECKED:	DATE: 6/16/99	DRAWING TITLE EXISTING CHANNEL	REV -
	LOCATION: NIEHART	APPVD:			



PLAN VIEW OF MODIFIED CHANNEL

Figure 4b

LAND & WATER CONSULTING, INC. P.O. BOX 8254 Missoula, MT 59807	PROJ NO: H99-220	FILE NAME: fish_barrier	FIGURE: 2	PROJECT NAME: FISH BARRIER FEASIBILITY STUDY	SH 2 OF 3
	PROJ MGR: PC	DRAWN: SPM	SCALE: ~1"=10'		
	DESIGNED:	CHECKED:	DATE: 6/16/99	DRAWING TITLE: MODIFIED CHANNEL	REV -
	LOCATION: NIEHART	APPVD:			

Photo 1. Bridge with barrier insert on Chamberlain Creek

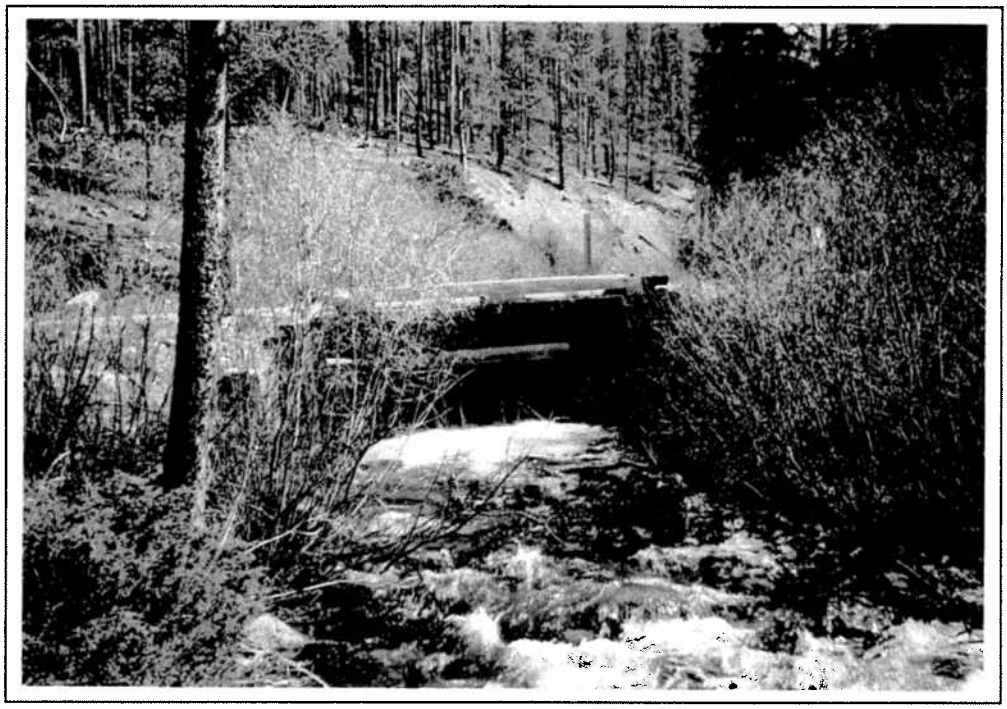
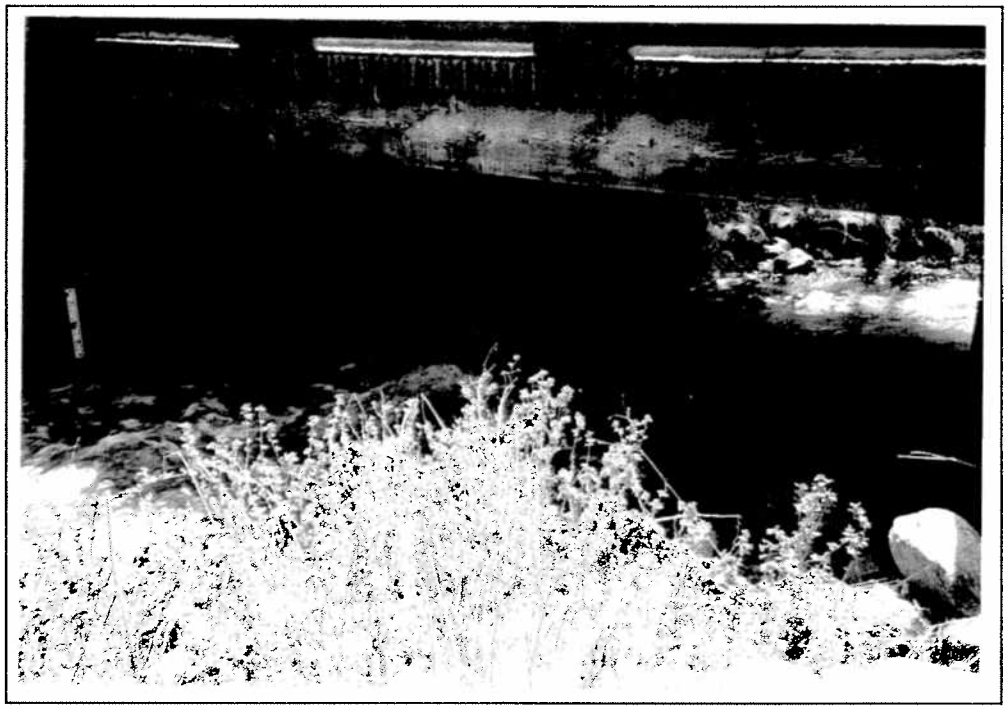


Photo 2. Chamberlain Creek upper potential barrier site with rock outcrop to left of photo.

Photo 3. Near the mouth of Harley Creek. Concrete abutment to left of photo.

Photo 4. Harley Creek looking upstream at Bridge #1.

Photo 5. Harley Creek, Bridge #2.



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October 1, 1999

Lewis and Clark National Forest
Attention: Mr. Mike Enk
P.O. Box 869
Great Falls, MT 59403

RE: Additional Requested Fish Barrier Information

Dear Mike,

To follow up on my feasibility report I have completed drawings for two of the potential sites, Pilgrim Creek and Harley Creek mouth. Figures 1 and 2 shown the site at the mouth of Harley Creek. The floor dam design is similar to the one which I believe was installed at White's Gulch. It's a standard NRCS irrigation diversion design and should be relatively simple to engineer. The biggest challenge with this site is working out access with the private landowner.

Figures 3 and 4 and Photos 1 through 4 depict the Pilgrim Creek site. During our visit with Mark Lere and Anne Tews, we all agreed that the site had great potential in terms of maintaining a pure population of cutthroat above the barrier and in terms of hydraulics at the site. I apologize for the rough, hand drawings but I think my concept is sound.

The idea is very similar to the Big Coulee approach. If we can get some larger rocks to wedge into the tongues of water which are shooting down the narrow gap (see photos and Figure 2), we can enhance the natural features which exist (3 to 5 feet of drop and high velocity flows) into a more effective barrier.

Due to access, the boulders would have to be moved by hand, and/or mules. Some rebar pins drilled into the bedrock on both sides of the chutes will help hold the boulders in place. I do not see concrete working very well for these applications since the joint between the concrete and the bedrock will be very susceptible to freeze-thaw degradation.

I hope this provides the information that you needed. Please give me a call if you have questions.

Sincerely,

Paul Callahan
Hydrologist

Cc: Ken McDonald, FWP

Photo 1. Pilgrim Creek Barrier Site (looking upstream)

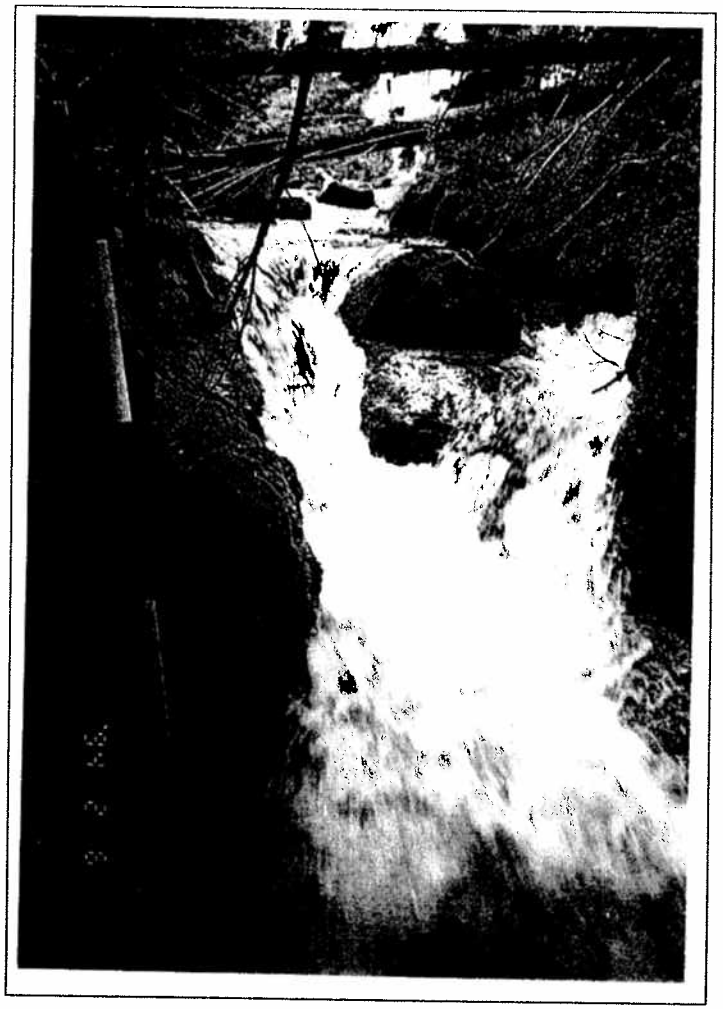

Photo 2. Pilgrim Creek Barrier Site (looking upstream)

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Photo 3. Pilgrim Creek barrier site (looking upstream)

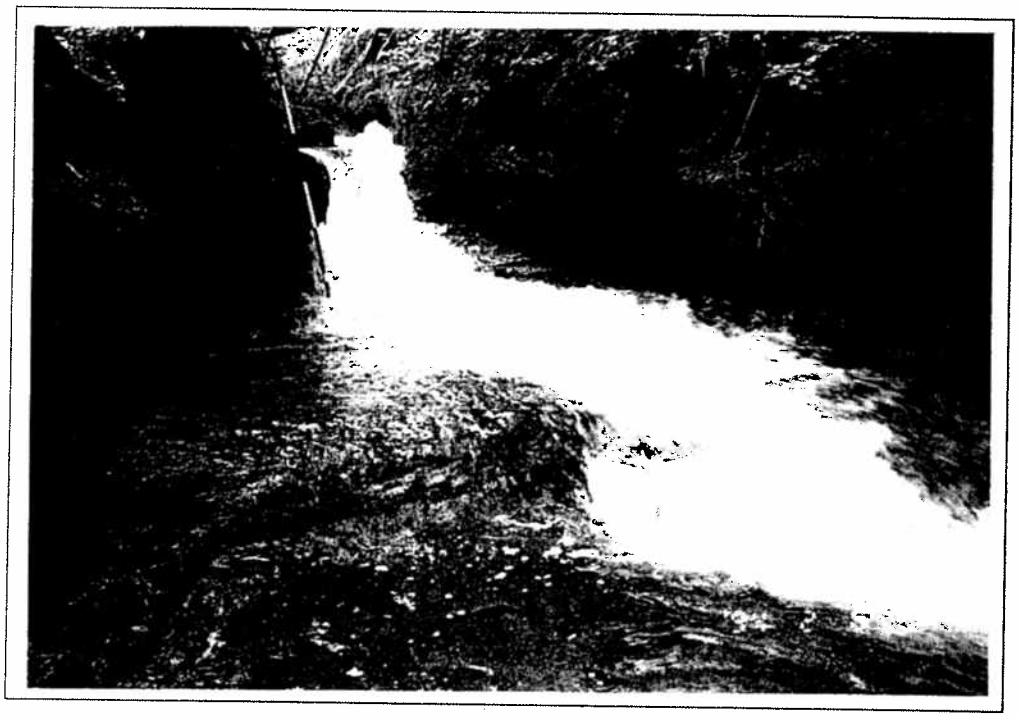
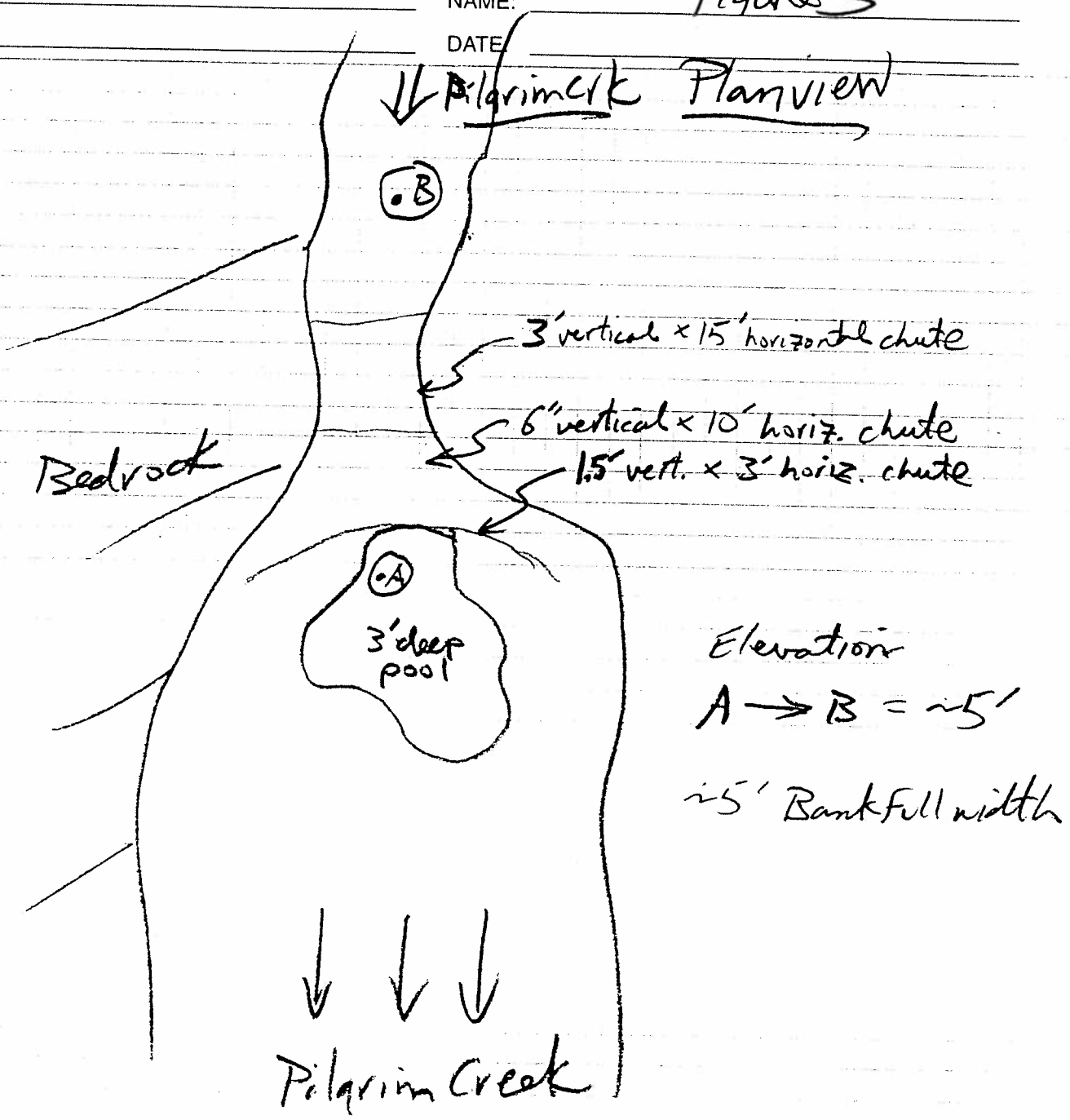


Photo 4. Pilgrim Creek barrier site (looking downstream)

PROJECT #: _____ NAME: _____ Figure 3

TITLE: _____ DATE: _____



Elevation

A → B = ~5'

~5' Bankfull width

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E-mail: info@landandwaterconsult.com

PROJECT #: _____ NAME: _____

TITLE: _____ DATE: _____

Figure 4

Pilgrim Creek

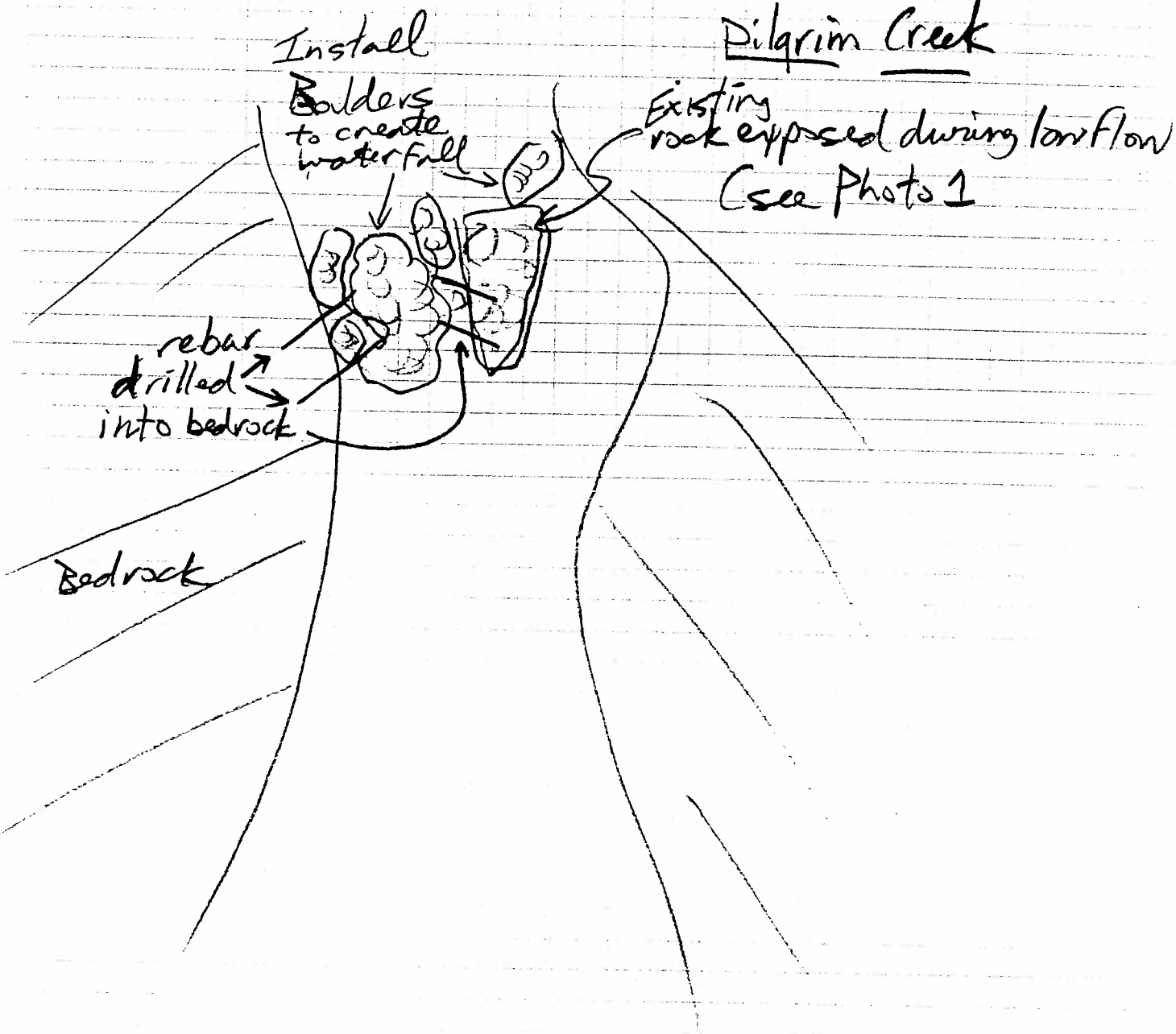

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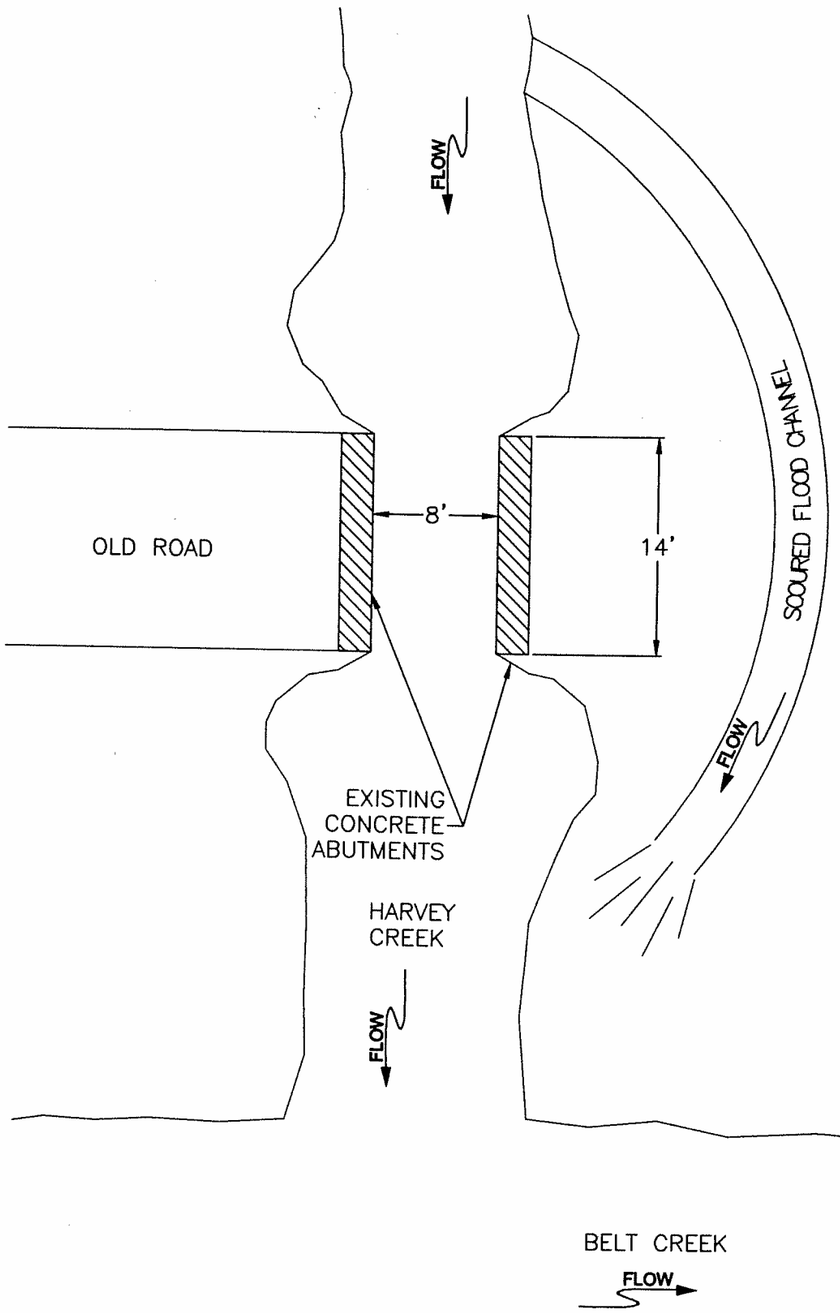
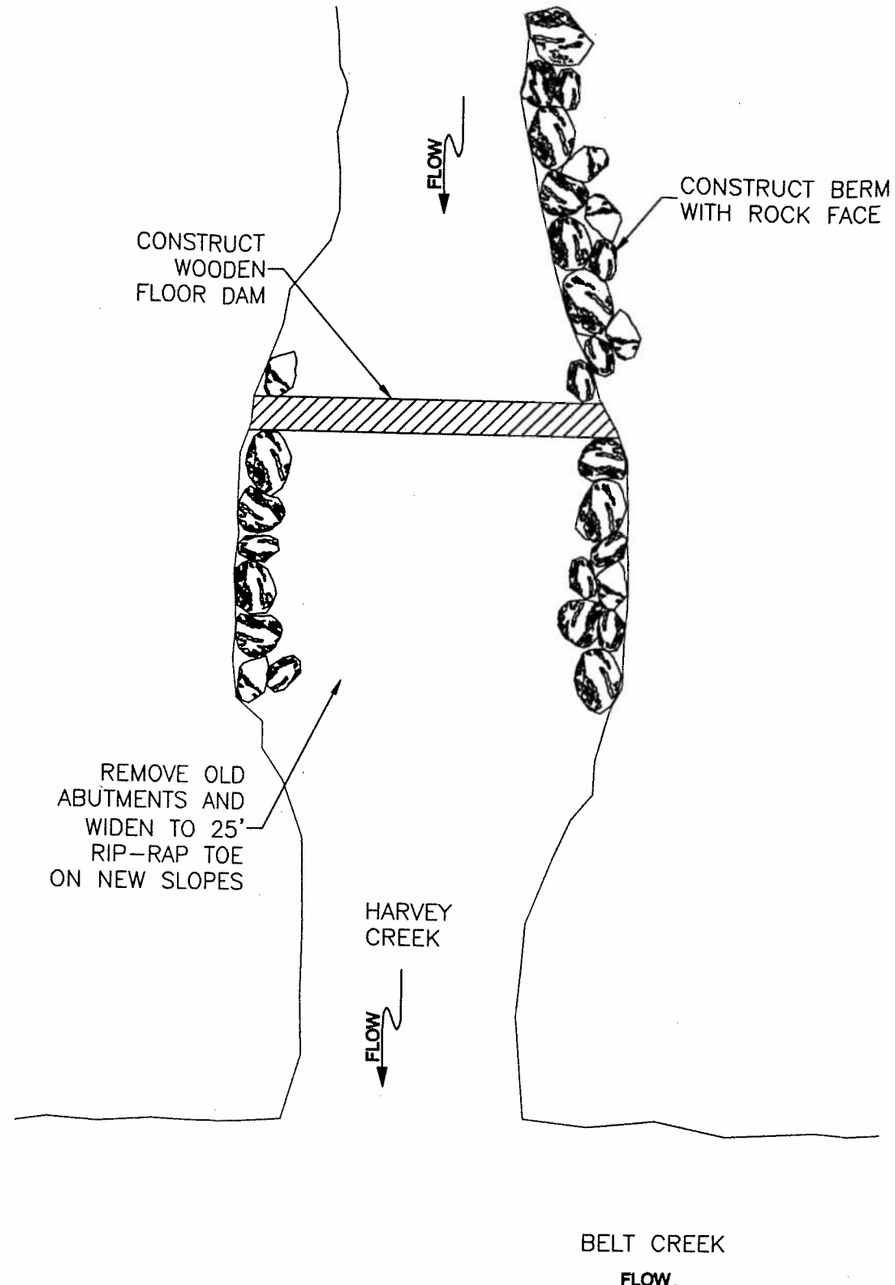
FIGURE 1



PLAN VIEW – EXISTING



PLAN VIEW – PROPOSED

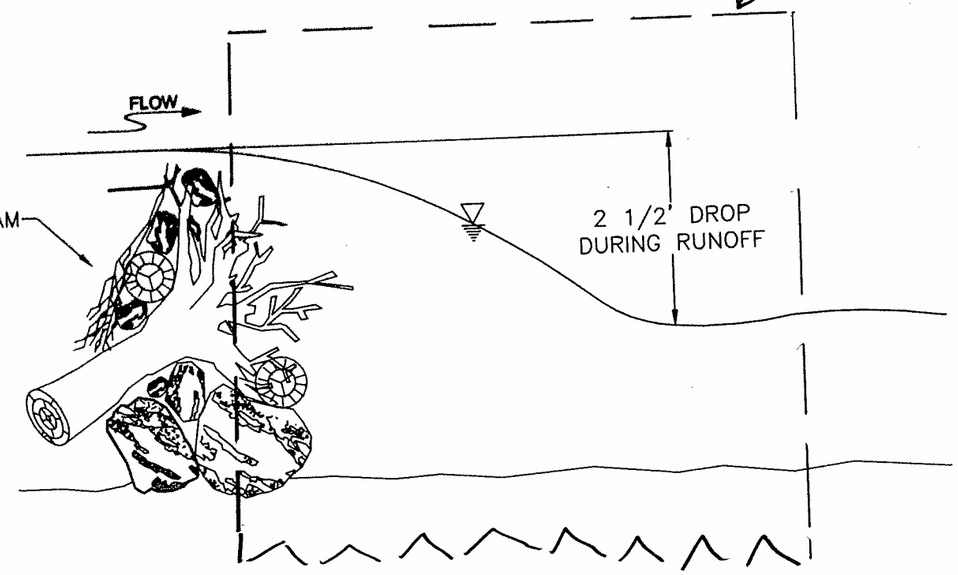
10 0 5 10

1 inch = 10'

FILE NAME: harvey_creek | FIGURE: 1 | PROJECT NAME | PROJ NO: 192220 | DESCRIPTION | REV/DATE

FIGURE 2

cross-section of bridge abutment



CROSS SECTION – EXISTING

CROSS SECTION – PROPOSED

2 0 1 2

1 inch = 2'

PROJECT NAME
FISH BARRIER FEASIBILITY STUDY
DRAWING TITLE
PROPOSED FISH BARRIER

FILE NAME: harvey_creek	FIGURE: 1
DRAWN: SPM	SCALE: NOTED
CHECKED:	DATE: 9/21/99

REV/DATE	DESCRIPTION

PROJ NO: 199220
PROJ MGR: PC
DESIGNED:

LAND & WATER CONSULTING, INC.
P.O. BOX 6254