

**APPENDIX L**  
**RIPARIAN RECLAMATION SUMMARY REPORT**

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**EMERALD CREEK GARNET  
RIPARIAN RECLAMATION SUMMARY REPORT  
1994 THROUGH 2002**

Prepared For:  
ENVIRONMENTAL PROTECTION AGENCY  
1435 North Orchard St.  
Boise, Idaho 83706

Prepared By:  
EMERALD CREEK GARNET, LTD  
PO Box 190  
Fernwood, Idaho 83830

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## 1.0 INTRODUCTION

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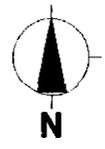
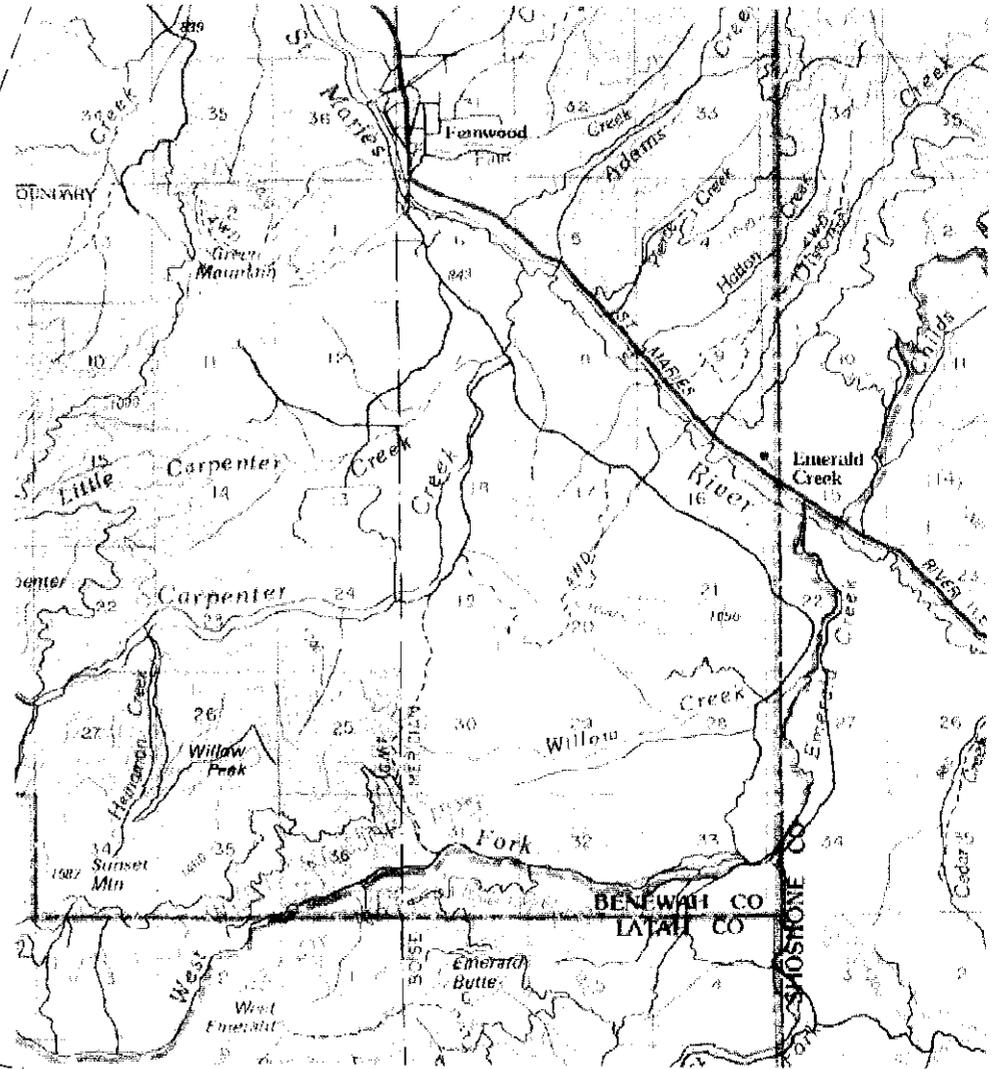
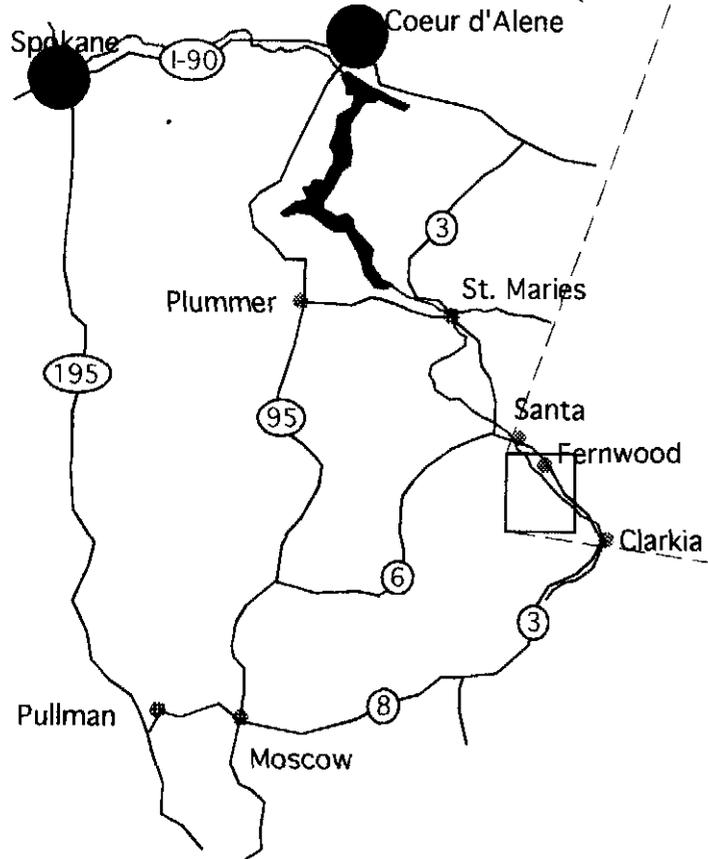
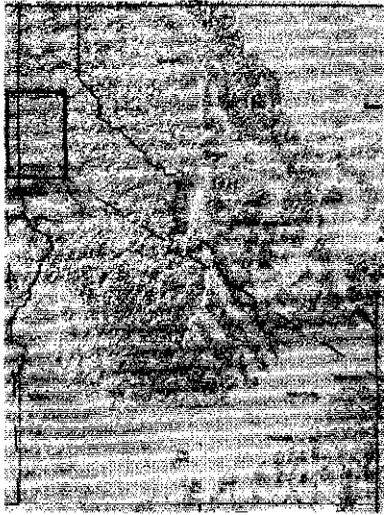
This Riparian Reclamation Summary Report 1994 Through 2002 has been completed by Emerald Creek Garnet, LTD (ECG) at the request of the US Environmental Protection Agency (EPA). EPA personnel have requested a written review of ECG's reclamation activities as a means of assessing ECG's potential to complete proposed reclamation activities in new permit areas currently under permit review. This report summarizes ECG's reclamation activities in four mining areas, Section 31, Parcel 46, Permit 288, and Permit 296. This report is a compilation of annual reclamation progress reports that have been submitted to the US Army Corps of Engineers (COE) and Idaho Department of Lands (IDL).

Emerald Creek Garnet Milling Company was acquired by Western Garnet International, LTD in 1991. A new management team started operation as Emerald Creek Garnet, LTD in 1992. ECG continued mining existing permit areas in Emerald and Carpenter basins through 1992, 1993, and 1994. Riparian reclamation designs, including wetlands and stream channels, were completed in 1993 with COE approval and implemented in existing mining areas in 1994. These mining areas include, Section 31, Parcel 46, and Permit 296. See Figure 1 for a vicinity map.

ECG received a COE 404 permit in 1994 to mine additional wetlands in Emerald and Carpenter basins, including Dredge Mining Permit (DMP) 288, among others. The 404 permit authorized reclamation design specifications for wetlands, floodplains, and stream channels. These are outlined in Section 2.0.

The four mining areas discussed in sections 4 through 7 (Figure 2) have been selected for discussion in this report because they typify the diversity of reclamation ECG is completing, and because they represent the oldest reclamation and, thus, the longest period of reclamation monitoring. Other mining areas have been reclaimed. They are not discussed in this report for the sake of conciseness and brevity, and because the information they provide would be redundant.

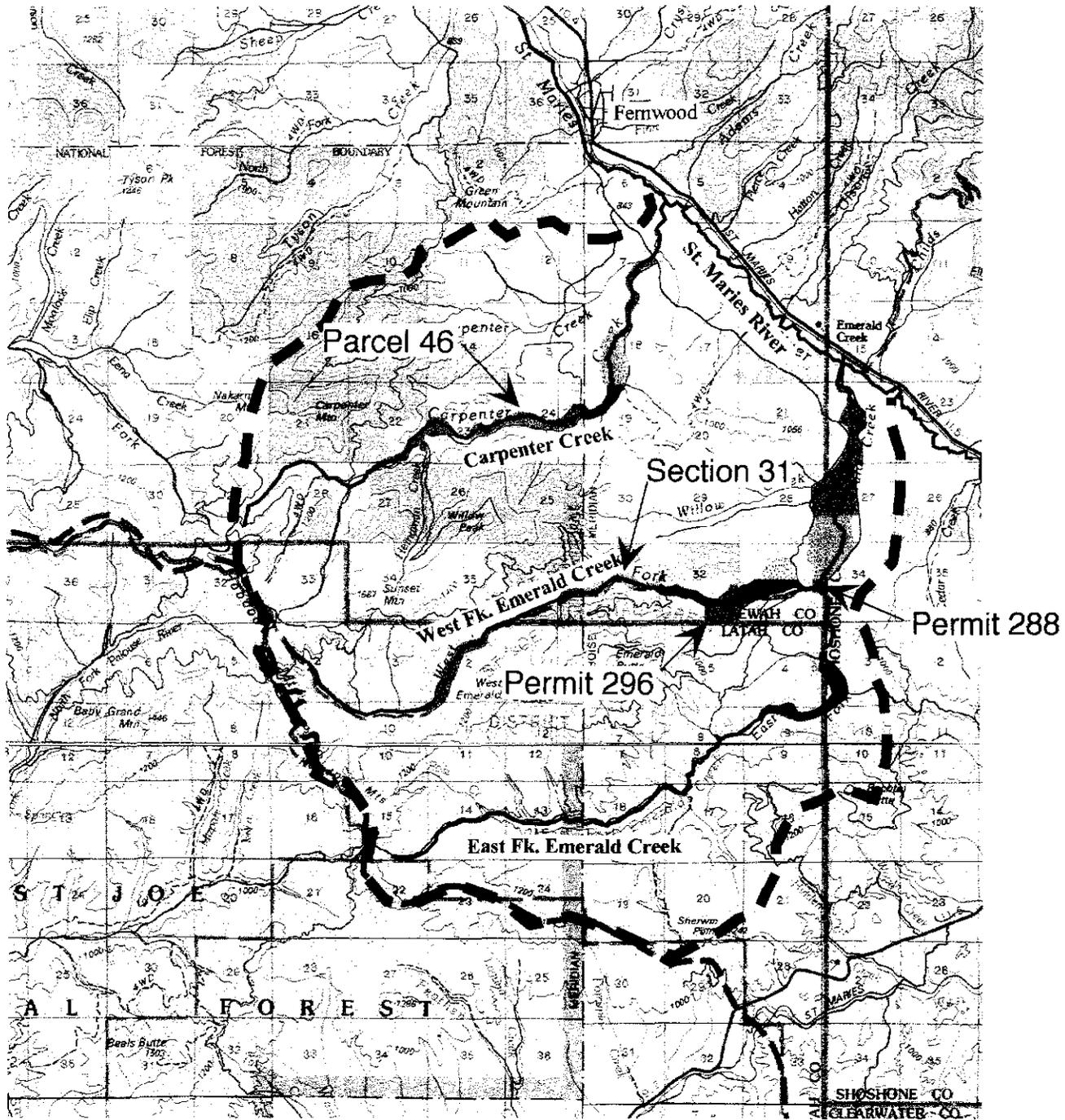
This report documents that the reclamation ECG has completed has been successful in full measure. All performance standards established as a means of evaluating success have been satisfied over a brief monitoring period. In fact, ECG has received three mining reclamation awards since acquiring the property. The awards were given in for "excellence in final reclamation" by US Forest Service, US Bureau of Land Management, Idaho Department of Lands, Idaho Department of Water Resources, and Idaho Fish and Game. The awards were for Parcel 46 in 1995, Section 31 in 1996, and Permit 288 in 1998.



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**FIGURE 1: VICINITY MAP  
RECLAMATION SUMMARY REPORT  
EMERALD CREEK GARNET, LTD**

-  Historic Mining Areas Completed By Other Companies Before 1992
-  Mining Areas Started By Other Companies; Completed By Emerald Creek Garnet Since 1992
-  Current Mining Areas, Permitted By Emerald Creek Garnet in 1994



SCALE: 1 inch = 10,560 feet



**FIGURE 2: MINING AREAS  
RECLAMATION SUMMARY REPORT  
EMERALD CREEK GARNET, LTD.**

## **2.0 RECLAMATION DESIGN SPECIFICATIONS AND PERFORMANCE STANDARDS**

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Reclamation design specifications used by ECG are detailed in Section 6.2 of Environmental Assessment For Section 404 Permit Application Within Emerald And Carpenter Basins (April 4, 1994) (EA). Design specifications are used as guidelines for all reclamation activities, including those mining areas acquired by ECG at the time of purchase, prior to the 1994 COE permit.

### **2.1 Design Specifications**

In a nutshell, design specifications pertain to floodplain regrading, stream channel construction, and revegetation using seed mixes, nursery stock, and transplanted stock. The aim of the design specifications is to create a restored channel suitable as cutthroat trout habitat, and create a diverse "blueprint" from which a complex riparian corridor will quickly re-establish and function in conjunction with on-going basin-wide logging and road building activities.

#### **2.1.1 Floodplain Regrading**

Pre-mining cross sections of the floodplain were surveyed as a basis for post-mining floodplain restoration. The floodplain is regraded to pre-mining elevations and extent, except where additional wetlands are created. In this case the post-mining floodplain has a greater extent. The floodplain gradient is the same as the pre-mined state. The floodplain is designed in conjunction with new channel depth so that a 2-year flood event will overtop the bank and inundate portions of the floodplain. Overtopping with a 2+ year event provides the necessary hydrology for wetland development. Side channels are occasionally excavated in floodplains to convey water to wide expanses of floodplain. The side channels also provide wetland hydrology along their saturated fringe and when they are overtopped by 2+ year flood events.

#### **2.1.2 Stream Channel Construction**

During COE permitting, all channels were assessed to determine their gradient, sinuosity, length, and pool:riffle:glide ratios. Channels are restored to a specific gradient, length, and sinuosity, providing a new channel that is similar to the pre-mined channel in some areas. In other areas, new channels have a reduced length, less sinuosity, and a steeper gradient than the pre-mined channel. This improves the pool:riffle:glide ratios, and provides better quality habitat for cutthroat trout.

Once a floodplain is restored and seeded, a new channel centerline is located and surveyed. A channel excavation plan is completed based on channel dimensions specified in the EA. Based on basin modeling, the new channel cross section is sized to provide a 3 inch depth of water at base flow, and to overtop the bank at a 2+ year flow. The channel is excavated in a trapezoidal fashion with a constant bottom width, constant bank slopes, constant top width, and variable depth. Control structures are placed in the channel bottom for every foot of elevation gain, and 5 to 7 pieces of large woody debris per 100 feet of channel are anchored into the bank for in-stream habitat structure. Water is flow ramped into the new channel over a 24-hour period during base flow periods.

The trapezoidal channel is immature until channel forming flood events occur. These events create local scour and deposition, and the new channel develops habitat types, including pools, riffles, glides, scour holes, side bars, point bars, and side channels. Channel forming events are crucial to the maturation of the restored channel.

### **2.1.3 Revegetation**

The EA calls for 3 types of revegetation, seed mixes, planted woody stock, and transplanted woody stock. Three seed mixes are used, a wetland top-of-bank mix, a wetland pasture mix, and an upland pasture/erosion control mix. These mixes all provide rapid establishment of groundcover to minimize surface erosion. They also provide a variety of native and endemic species that are found in wetlands and floodplains, and that provide forage for cattle.

Woody stock is used to stabilize new stream channels, to restore scrub-shrub habitats, and to provide wildlife corridors across riparian areas. Transplanted stock, primarily alder, is placed at the water's edge once restored channels have been wetted. Willow slips, and 10 and 20 cubic inch nursery stock are planted in top-of-bank positions and across the floodplain.

## **2.2 Performance Standards**

Performance standards are evaluated for a 5-year or longer period following the completion of reclamation in a permit area, or a portion of the permit area. Unique performance standards were developed in the EA for wetland hydrologic support, wetland planting, and stream channel re-establishment.

### **2.2.1 Wetland Hydrologic Support Standards**

The following performance standards were developed in the EA as a means of assessing hydrology of the shrub, emergent, and pasture wetlands.

- Direct observation of surface inundation and/or saturated soils during May and November monitoring for the 5 year monitoring period;
- Observation of indicators of soil saturation and inundation during all monitoring for the 5 year period.

### **2.2.2 Wetland Planting Standards**

The following performance standards were developed in the EA for monitoring shrub-emergent and pasture wetlands.

- Establish at least 80 percent aerial cover in all layers at the end of 5 years;
- Establish at least 3 shrub species and 5 ground layer species in the wetland at the end of 5 years;
- Maintain at least 50 percent survival of planted trees where wildlife corridors are designated at the end of 5 years; and
- Allow natural recruitment of desirable wetland species to be included as cover and as species diversity during long-term monitoring.

### 2.2.3 Stream Channel Re-establishment Standards

The following performance standards were developed in the EA for monitoring the re-establishment, stabilization, and habitat components of the restored stream channels.

- Vegetation between toe of bank and top of bank shows increases in percent cover, and shall have at least 80 percent aerial cover, composed of 90 percent grasses and 10 percent shrubs;
- Bank stability shows increases in stability due to root mass development on 90 percent of the bank, bank erosion on less than 10 percent of the bank, and sloughing on less than 5 percent of the bank.
- Habitat types within the restored channel shall occur with a similar frequency as the pre-mining condition, or a decrease in the pool:riffle ratio toward 1:1 to improve fish habitat;
- Spawning gravels within the channel are accessible during spring for cutthroat trout spawning;
- Pools within the restored channel shall maintain a 12 to 36 inch depth;
- Substrate within the restored channel segregates into size classes typically associated with each habitat type;
- Instream cover, i.e., large woody debris, overhanging bank vegetation, and large boulders show incremental increases in creating microhabitat features within the habitat types;
- Quantity of stream flow shall remain constant over entire length of the restored channel;
- Restored channel establishes a dynamic equilibrium between erosion and deposition within the channel;
- Overall channel gradient would be similar to or modified slightly to improve fish habitat when compared to pre-mining conditions; and
- Restored channel length would be similar to the pre-mined condition. Reduced stream lengths may occur when steep gradients are required for preferred fish habitat types, or for the creation of buffer zones between roads and channel meanders.

Performance standards are assessed annually at permanent data plots. Vegetative data plots for wetland and riparian plant communities are 0.01-acre circular plots. Plants within the data plots are identified and aerial cover is determined for each species by ocular estimate. Photographs are taken at all vegetative data plots. Data plots for stream habitat are 200-foot long reaches. Each reach is paced in the stream, each habitat type is identified and numerous measurements taken to determine pool:riffle:glide ratios and cover availability.

### 3.0 HYDROLOGIC EVENTS 1995 THROUGH 2002

High flow periods are essential elements for the formation of reclaimed wetlands, and for in-channel habitat development. High flow events exceeding a 2-year flow overtop stream banks and provide long-term inundation to accessible floodplain areas. High flow periods exceeding a 10-year flow create scour and deposition in the reclaimed channels, leading to the development of pool, riffle, and glide habitat as well as scour holes and bars. High flow periods occurring over time are essential for the maturation of wetland habitats and stream channel diversification.

As shown in Table 2, the following annual high flow events have occurred in the St. Maries River basin since reclamation started. Graphs for these events are found in Appendix A. Scientific Applications International Corporation (SAIC) modeled the St. Maries River gage near Santa to determine flows for 2-year to 100-year events.

**Table 2: High Flow Events 1995 Through 2002**

Year	Flood Flow	Flood Event
1995	approximately 4,300 cfs	> 2-year, < 5-year
1996	approximately 12,200 cfs	> 50-year, < 100-year
1997	approximately 5,700 cfs	> 5-year, < 10-year
1998	approximately 1,750 cfs	< 2-year
1999	approximately 4,000 cfs	> 2-year, < 5-year
2000	approximately 3,700 cfs	> 2-year, < 5-year
2001	approximately 2,000 cfs	< 2-year
2002	approximately 7,400 cfs	> 10-year, < 25-year

Although the tributaries associated with the reclaimed areas have lower flows than those recorded at the gage on the St. Maries River near Santa, they experienced the same general flood event, approximately 12 hours sooner.

Thus, the reclaimed areas accessible to a 2-year flood flow experienced wetland hydrology in all years except 1998 and 2001. The reclaimed stream channels had channel forming flood events in 1996 and 2002.

#### 4.0 SECTION 31 RECLAMATION

This section looks in detail at the reclamation efforts on Section 31, in West Fork Emerald Basin. Baseline information, design specifications, reclamation chronology, reclamation monitoring review, and the post-mining landscape are all examined.

##### 4.1 Pre-mining Baseline

Section 31 is a 37-acre riparian area that was mined prior to ECG's acquisition of the property. This area was "high-graded", leaving garnet reserves in the ground and leaving the West Fork Emerald Creek in a man-made channel along the left toe-of-slope. Aerial photographs from 1955 suggest most of the mined area was a scrub-shrub riparian corridor. Existing riparian shrub communities upstream are either 1) hydrophytic dominated by alder, sedge, and canarygrass, or 2) non-hydrophytic dominated by snowberry, thimbleberry, canarygrass, and redtop. Community 2 was probably forested prior to logging between 1910 and 1925.

The extent of wetlands prior to mining is not known. Similar landscape positions in this and other drainages have riparian corridors varying in wetland extent from 30 percent to 70 percent. Based on the valley bottom gradient and Rosgen typing, the pre-mining stream channel varied from level and sinuous to moderately steep and relatively narrow. The channel was dominated by a cobble/gravel substrate and was heavily shaded.

Section 31 was divided into 5 areas for mining and reclamation purposes. Areas A, B, and C had the remaining reserves mined, and a new stream channel/floodplain corridor was constructed. Areas D and E did not have sufficient reserves left to pay for mining. These two areas remain in their pre-purchase condition.

##### 4.2 Design Specifications

A new stream channel was designed and constructed in Areas A, B and C. The West Fork has a 7-day low flow (Q7L2) of 1.8 cfs, and an average flood flow (Q1F2) of 120 cfs. Based on these flows a channel cross section of 1.65 feet deep, 5.5 feet bottom width, and 3:1 sideslopes was constructed. The bottom width allows a minimum of 3 inches of water depth during low flow. The channel depth allows a 2-year flood flow to overtop the bank and provide wetland hydrology to the floodplain. Areas A and C were constructed with a sinuosity of 1.4 and a gradient of 2.0%. Area B was constructed with a sinuosity of 1.2 and a gradient of 2.4%.

The floodplain was regraded to be accessible to a 2+ year flood flow. The floodplain was reconstructed to occupy approximately 50 percent of the mined area. Once the channel was constructed and wetted, the top-of-bank and adjacent floodplains were seeded with the wetland top-of-bank seed mix. The seed mix is composed of the following plants.

**Table 3: Top-of-bank Seed Mix**

Common Name	Scientific Name	% of mix
tufted hairgrass	<i>Deschampsia caespitosa</i>	20%
timothy	<i>Phleum pratense</i>	15%
Alsike clover	<i>Trifolium hybridum</i>	10%
red clover	<i>Trifolium pratense</i>	5%
redtop bentgrass	<i>Agrostis stolonifera</i>	50%

The seed mix was applied at a rate of 24-30 pounds per acre. Shrubs from the abandoned channel were then transplanted along the new top-of-bank. River alder is the dominate transplant; red-osier dogwood, willow, and mountain ash were also transplanted. Nursery stock was hand planted at a later date.

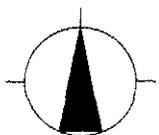
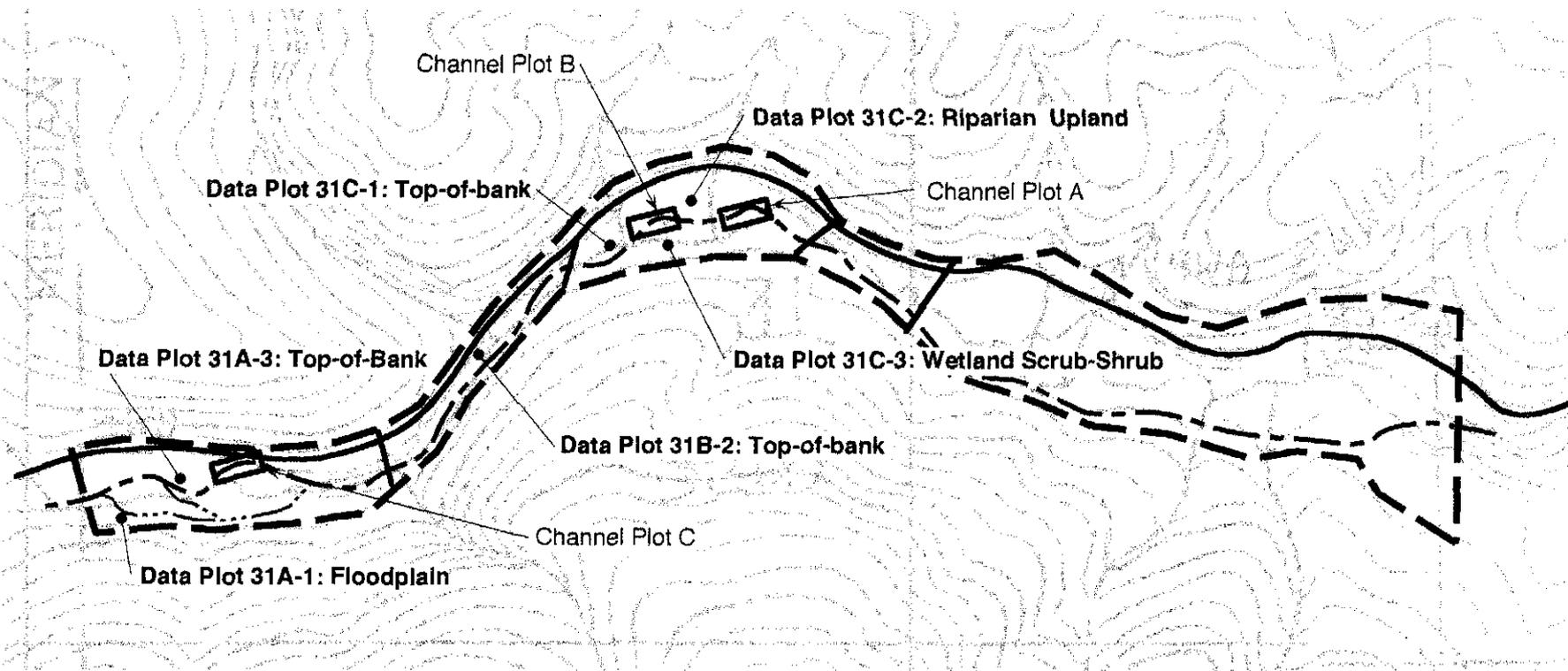
### **4.3 Chronology of Reclamation Activities**

Reclamation proceeded in the following sequence in Section 31. See Figure 3 for locations of these areas.

Area A channel constructed and wetted in 1994  
Left side Area A mined and reclaimed in 1995  
Area B channel constructed and wetted in 1994  
Area C channel constructed and wetted in 1995  
50-plus year flood event in January in 1996  
Left side Area C mined in 1996  
Bank slump in Area E stabilized in 1999  
10-plus year flood event in April 2002

### **4.4 Reclamation Monitoring Review**

A review of reclamation success is provided by looking in detail at data plots established for long-term monitoring. Monitoring of six vegetative data plots and three stream channel plots is discussed below. See Figure 3 for data plot locations within this mining area. The vegetative data plots provide information on reclamation of floodplain, channel top-of-bank, riparian upland, wetland scrub-shrub, and in-stream habitat areas.



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**FIGURE 3: SECTION 31 DATA PLOTS  
RECLAMATION SUMMARY REPORT  
EMERALD CREEK GARNET LTD**

4.4.1 Floodplain Reclamation: Data Plot A1



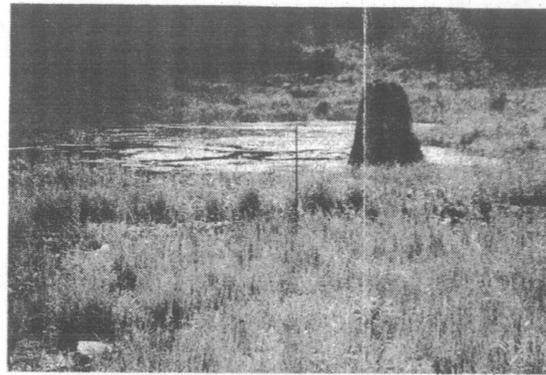
Data Plot A1 - 1996



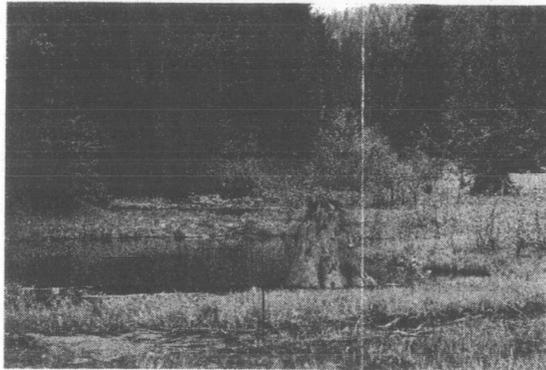
Data Plot A1 - 1997

This data plot is on the upper left (looking upstream) floodplain of the West Fork Emerald Creek in Area A, Section 31. A new channel was constructed and wetted in 1994. The left floodplain was mined and reclaimed in 1995. A 50 plus year flood event occurred in January 1996. This data plot was established in October 1996.

All photos show a high flow side channel in the foreground. This channel was created during the '96 flood where channel overtopping occurred. Most of the area represented by this data plot is saturated every spring. As seen in the 2000 photo, the area is also inundated when 2 plus year flood events occur. The "pond" in the middle of the photos is permanently inundated. The following tables summarize the establishment of hydrophytic vegetation following regrading. This area was seeded with the wetland top-of-bank seed mix.



Data Plot A1 - 1999



Data Plot A1 - 2000



Data Plot A1 - 2002

1996 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	1	Trace	2 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species		bulrush (60%), mangrass (5%), hairy willow herb (5%), speedwell, rush, white clover, water sedge. Bare ground (30%).	
<b>total groundcover</b>		<b>70 percent</b>	

1997 Data Plot

Common Name	Numbers	Cover %	Leader Length
none			
<b>total shrub cover</b>		<b>0 percent</b>	
groundcover species		bulrush (15%), mangrass (5%), hairy willow herb, speedwell, rush, white clover, water sedge.	
<b>total groundcover</b>		<b>20 percent</b>	

1999 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	1	Trace	2 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species		dagger-leaf rush (25%), mangrass (15%), bulrush (15%), bluejoint (10%), clover (15%), redbot (5%). Bare ground (15%).	
<b>total groundcover</b>		<b>85 percent</b>	

2000 Data Plot

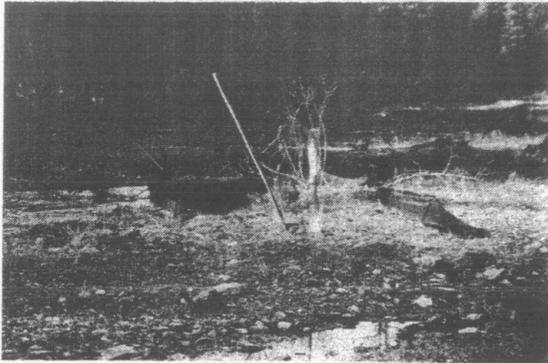
Common Name	Numbers	Cover %	Leader Length
river alder	3	T	2 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species		dagger-leaf rush (20%), mangrass (10%), bulrush (20%), bluejoint (5%), clover (15%), redbot (5%). Bare ground (25%).	
<b>total groundcover</b>		<b>75 percent</b>	

2002 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	2	T	3 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species		Bulrush (50%), horsetail (5%), buttercup (5%), sedge (15%), dagger-leaf rush (15%), avens, clover, mangrass. Bare ground (10%).	
<b>total groundcover</b>		<b>90 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers and at least 5 ground layer species for an area that is dominated by emergent hydrophytes.

4.4.2 Top-of-bank Reclamation: Data Plot A3



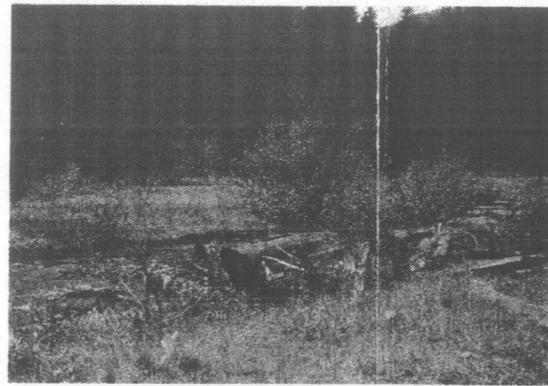
Data Plot A3 - 1995



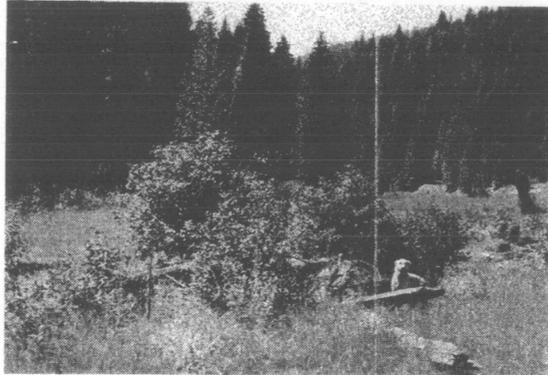
Data Plot A3- 1998

This data plot is on the upper right (looking upstream) top-of-bank of the West Fork Emerald Creek in Area A, Section 31. The new channel was constructed and wetted in 1994. Alders were transplanted, nursery stock planted, and the area seeded in 1994. This data plot was established in July 1995. A 50 plus year flood event occurred in January 1996.

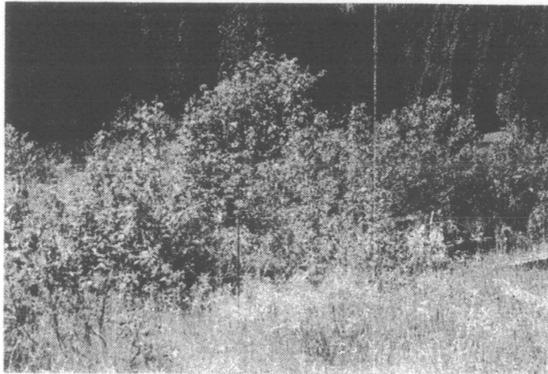
This plot is included in this report to show the establishment pattern of vegetation at a typical top-of-bank position. Alder and dogwood were transplanted and planted as nursery stock. The photo sequence shows how much shrub bio-mass is present by the sixth growing season (2000). Alder transplants are by far the most successful. They may show crown mortality soon after planting, but the root masses armor the stream bank and re-sprout with many new plants 2 to 3 years after transplanting.



Data Plot A3 - 2000



Data Plot A3 - 2001



Data Plot A3 - 2002

1995 Data Plot

Common Name	Numbers	Cover %	Leader Length
red-osier dogwood	7	5%	2-5 inches
river alder	5	Trace	6 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	clover (20%), water sedge (5%), lady fern (5%), redtop (3%), toad rush (2%), perennial rye, soft rush, ox-eye, buttercup, hellebore, timothy.		
<b>total groundcover</b>		<b>35 percent</b>	

1998 Data Plot

Common Name	Numbers	Cover %	Leader Length
red-osier dogwood	2	Trace	1 inch
river alder	6	Trace	2 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species	clover (40%), meadow foxtail (15%), sedge (10%), redtop (5%), rush (5%), cow parsnip, bulrush. Bare ground (25%).		
<b>total groundcover</b>		<b>75 percent</b>	

2000 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	10	Trace	2 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species	clover (20%), meadow foxtail (15%), sedge (15%), redtop (10%), soft rush (15%), cow parsnip (5%), bulrush (15%). Bare ground (5%).		
<b>total groundcover</b>		<b>95 percent</b>	

2001 Data Plot

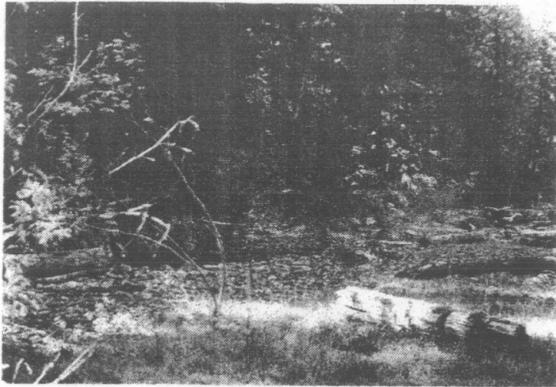
Common Name	Numbers	Cover %	Leader Length
river alder	13	10%	2 inches
<b>total shrub cover</b>		<b>10 percent</b>	
groundcover species	dagger-leaf rush (20%), mannagrass (10%), bulrush (20%), bluejoint (5%), clover (15%), redtop (5%). Bare ground (25%).		
<b>total groundcover</b>		<b>75 percent</b>	

2002 Data Plot

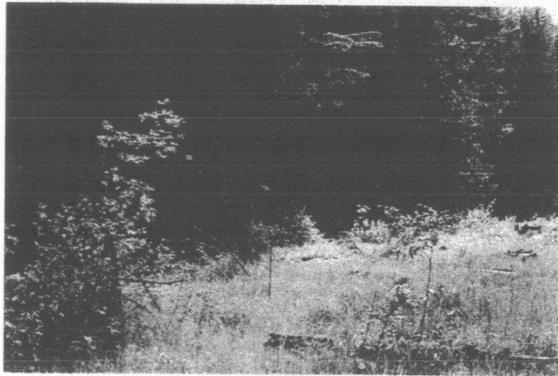
Common Name	Numbers	Cover %	Leader Length
none	13	30%	5 inches
<b>total shrub cover</b>		<b>30 percent</b>	
groundcover species	bulrush (35%), redtop (15%), timothy (15%), hellebore (5%), sedge (5%), orchardgrass (5%), horsetail (5%), ox-eye.		
<b>total groundcover</b>		<b>85 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by emergent hydrophytes. Three shrub species are present throughout the floodplain. They are not reflected in the data plot due to the clumped nature of shrubs and the small plot size relative to shrub size.

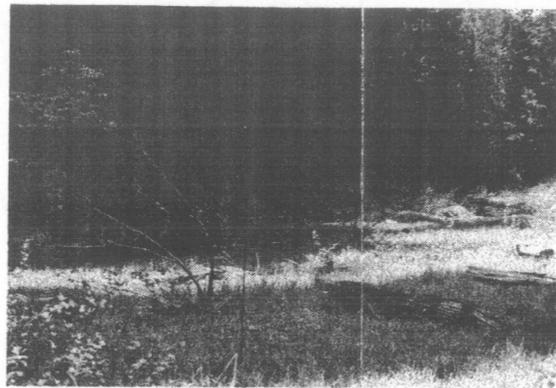
4.4.3 Top-of-bank Reclamation: Data Plot B2



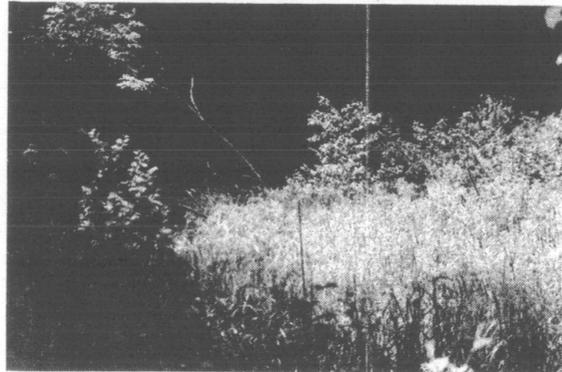
Data Plot B2 - 1996



Data Plot B2 - 1999



Data Plot B2 - 2000



Data Plot 2 - 2002

This data plot is on the mid right (looking upstream) top-of-bank of the West Fork Emerald Creek in Area B, Section 31. The new channel was constructed and wetted in 1994. Alders were transplanted, nursery stock planted, and the area seeded in 1994. A 50 plus year flood event occurred in January 1996. This data plot was established in October 1996, after the earlier flood destroyed previous data plots.

As seen in the first photo, the '96 flood created large gravel bars, and straightened the channel in several areas of Area B. The photo sequence shows the rapid establishment of groundcover, including cover on the gravel bar. This plot is in a narrow corridor and receives flood-borne sediments frequently.

**1996 Data Plot**

Common Name	Numbers	Cover %	Leader Length
red-osier dogwood	2	Trace	6 inches
river alder	2	Trace	2-5 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	clover (45%), redtop (20%), bulrush (15%), soft rush (5%), hairgrass, mannagrass.		
<b>total groundcover</b>		<b>85 percent</b>	

**1999 Data Plot**

Common Name	Numbers	Cover %	Leader Length
river alder	2	Trace	2 inches
mountain ash	1	Trace	3 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species	redtop (30%), bulrush (30%), mannagrass (5%), timothy (35%), orchardgrass.		
<b>total groundcover</b>		<b>100 percent</b>	

**2000 Data Plot**

Common Name	Numbers	Cover %	Leader Length
mountain ash	1	Trace	dead
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species	redtop (60%), timothy (15%), fescue (5%), Bare ground (20%)		
<b>total groundcover</b>		<b>100 percent</b>	

**2002 Data Plot**

Common Name	Numbers	Cover %	Leader Length
mountain ash	1	dead	
river alder	3	T	2 inches
red-osier dogwood	1	T	2 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species	clover (5%), horsetail (5%), bulrush (100%), buttercup, orchardgrass.		
<b>total groundcover</b>		<b>110 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by emergent hydrophytes. Three shrub species are present throughout the floodplain. They are not reflected in the data plot due to the clumped nature of shrubs and the small plot size relative to shrub size. The shrub layer may not dominate at this plot.

#### 4.4.4 Top-of-bank Reclamation: Data Plot C1



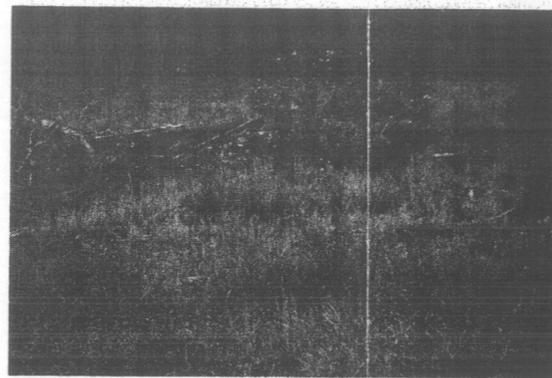
Data Plot C1- 1996



Data Plot C1 - 1997

This data plot is on the upper right (looking upstream) top-of-bank of the West Fork Emerald Creek in Area C, Section 31. The new channel was constructed and wetted in 1995. Alders were transplanted, and the area seeded in 1995. A 50 plus year flood event occurred in January 1996. This data plot was established in October 1996.

As seen in the foreground of the 1996 photo, the '96 flood created a side channel. The 1997 photo shows spring run-off in the side channel. By 1999, the area of the data plot is heavily vegetated with hydrophytes and the side channel is reduced in size. By the spring of 2000, the side channel area has been deposited with fresh sands. The flood event of April 2002 has created a new low flow side channel on this plot. The photos also show moderate development of shrub cover in an area that changes dramatically from year to year depending on the volume of run-off.



Data Plot C1 - 1999



Data Plot C1 - 2000



Data Plot C1 - 2002

#### 1996 Data Plot

Common Name	Numbers	Cover %	Leader Length
red-osier dogwood	1	Trace	6 inches
river alder	1	Trace	4 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	clover (10%), redtop, bulrush (5%), soft rush, lady fern. Bare ground (85%).		
<b>total groundcover</b>		<b>15 percent</b>	

#### 1997 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	1	Trace	6 inches
red-osier dogwood	1	Trace	3 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species	clover (15%), soft rush (15%), redtop (10%), bulrush (5%), timothy (5%). Bare ground (50%).		
<b>total groundcover</b>		<b>50 percent</b>	

#### 1999 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	4	5%	2 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	soft rush (15%), redtop (40%), timothy (15%), red fescue (10%), manna grass (5%), clover (5%). Bare ground (10%).		
<b>total groundcover</b>		<b>90 percent</b>	

#### 2000 Data Plot

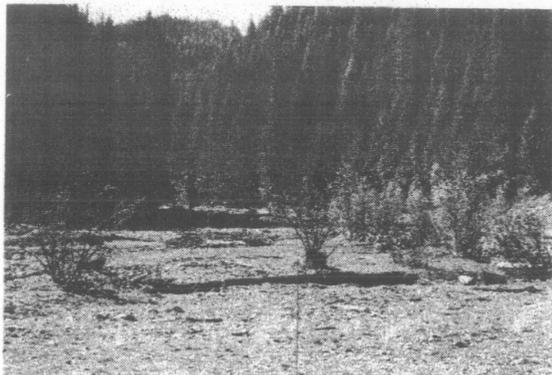
Common Name	Numbers	Cover %	Leader Length
river alder	5	10%	3 inches
<b>total shrub cover</b>		<b>10 percent</b>	
groundcover species	bulrush (5%), timothy (15%), horsetail (5%). recent sand deposit (75%).		
<b>total groundcover</b>		<b>25 percent</b>	

#### 2002 Data Plot

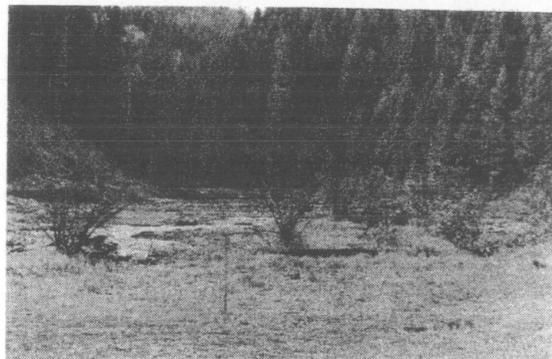
Common Name	Numbers	Cover %	Leader Length
river alder	7	20%	4 inches
<b>total shrub cover</b>		<b>20 percent</b>	
groundcover species	bulrush (10%). Wetted channel (60%).		
<b>total groundcover</b>		<b>10 percent</b>	

The portion of this data plot that is not an active channel satisfies the performance standards. The area that the vegetated portion of this data plot represents (background in photos) satisfies the performance standards. Much of this plot will probably remain an active channel.

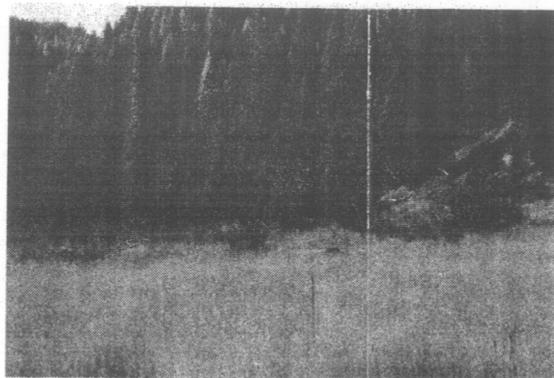
4.4.5 Riparian Upland Reclamation: Data Plot C2



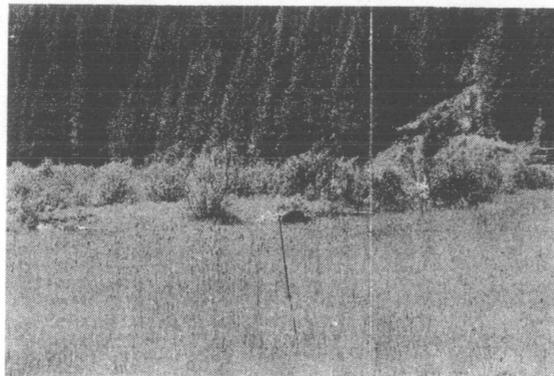
Data Plot C2- 1996



Data Plot C2 - 1997



Data Plot C1 - 1999



Data Plot C1 - 2002

This data plot is on the mid right (looking upstream) portion of Area C, near the new West Fork Emerald Creek channel in Section 31. This area was regraded and seeded to a wetland pasture mix when the new channel was constructed in 1995. This data plot was established in October 1996.

The photo sequence shows the development of groundcover in an area that is rarely flooded. Two year flood events do not provide hydrology to this data plot. The plot was inundated during the 1996 fifty plus year event, and the 2002 ten plus year event.

**1996 Data Plot**

Common Name	Numbers	Cover %	Leader Length
<b>total shrub cover</b>		<b>none</b>	
groundcover species		clover (15%), redtop, hairgrass. Bare ground (85%).	
<b>total groundcover</b>		<b>15 percent</b>	

**1997 Data Plot**

Common Name	Numbers	Cover %	Leader Length
<b>total shrub cover</b>		<b>none</b>	
groundcover species		clover (35%), redtop (15%). Bare ground (50%).	
<b>total groundcover</b>		<b>50 percent</b>	

**1999 Data Plot**

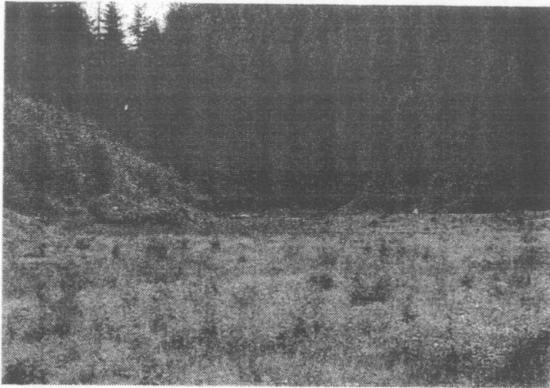
Common Name	Numbers	Cover %	Leader Length
<b>total shrub cover</b>		<b>none</b>	
groundcover species		redtop (80%), timothy (5%), fescue. Bare ground (15%).	
<b>total groundcover</b>		<b>85 percent</b>	

**2002 Data Plot**

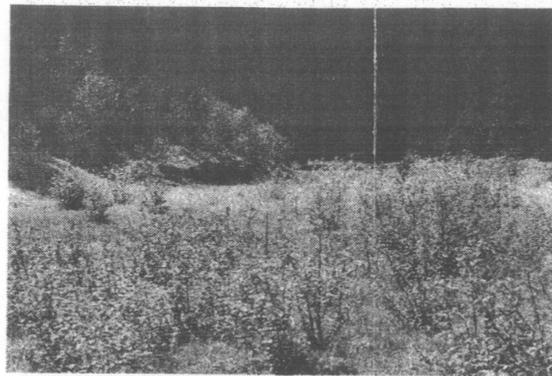
Common Name	Numbers	Cover %	Leader Length
<b>total shrub cover</b>		<b>0 percent</b>	
groundcover species		timothy (60%), redtop (20%), sedge (5%), foxtail, clover, ox-eye. Bare ground (15%).	
<b>total groundcover</b>		<b>85 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by ground layer vegetation

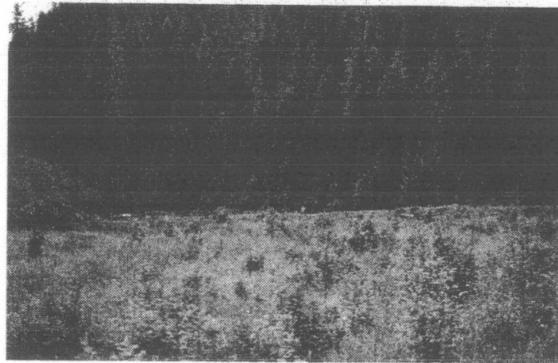
4.4.6 Wetland Scrub-Shrub Reclamation: Data Plot C3



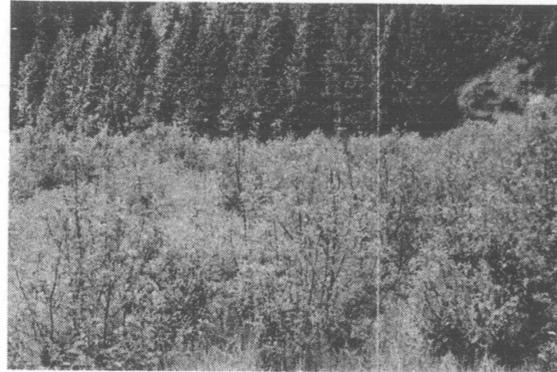
Data Plot C3- 1998



Data Plot C3 - 2001



Data Plot C3 - 1999



Data Plot C3 - 2002

This data plot is on the mid left (looking upstream) portion of Area C, near the new West Fork Emerald Creek channel in Section 31. This area was regraded and seeded to a wetland mix in 1996. This data plot was established in 1998, the second growing season after reclamation was finished.

The photo sequence shows the development of an alder thicket in a saturated soil that has groundwater discharge during the spring and early summer. By 2002, the plot center could not be located or photographed due to the dense shrub layer.

1998 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	21	20%	1-3 inches
<b>total shrub cover</b>		<b>20 percent</b>	
groundcover species	dagger-leaf rush (30%), clover (60%), soft rush, sedge. Bare ground (15%).		
<b>total groundcover</b>		<b>15 percent</b>	

1999 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	25	30%	2-4 inches
<b>total shrub cover</b>		<b>30 percent</b>	
groundcover species	dagger-leaf rush (25%), soft rush (5%), redbud (45%), timothy (10%), clover (15%), bulrush.		
<b>total groundcover</b>		<b>100 percent</b>	

2001 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	25	80%	5 inches
<b>total shrub cover</b>		<b>80 percent</b>	
groundcover species	dagger-leaf rush (10%), soft rush (5%), redbud (20%), timothy (20%), clover (10%), bulrush.		
<b>total groundcover</b>		<b>65 percent</b>	

2002 Data Plot			
Common Name	Numbers	Cover %	Leader Length
alder thicket		80+ percent	
<b>total shrub cover</b>		<b>80+ percent</b>	
groundcover species	Not recorded because plot center was not located.		
<b>total groundcover</b>			

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by emergent hydrophytes. Three shrub species are present throughout the floodplain. They are not reflected in the data plot due to the clumped nature of shrubs and the small plot size relative to shrub size.

#### 4.4.7 Stream Channel Habitat Reclamation



Area A - 1998



Area A - 1999

Stream channels were restored in Section 31 in 1994 and 1995. Design specifications for the construction are outlined in Section 4.2.

The 1998 photo was taken in early summer, looking downstream from the upper right corner of Area A. The photo shows the designed main channel at the left of the view, and two side channels to the center and right of the view. The side channels were formed by the 1996 flood flow.

The 1999 photo was taken in early fall, looking downstream from the upper right corner of Area A. The photo shows the designed main channel in the center of the view, and one side channel to the right of the view. The photo sequence also shows how rapidly top-of-bank shrubs increase over 2 growing seasons, once they are established.

Data plots in the stream channel were established in 2000 to determine the development of in-stream physical habitat for fisheries. Data was collected in 3 reaches, each approximately 200 feet in length. Data is found in Appendix B. The following tables summarize the in-stream habitat data.

**In-stream Habitat Data Summary - Reach A**

	Pools	Riffles	Glides
Percent of Reach	61	27	12
Dominant Substrate			
Percent Fines	45	10	27
Percent Gravels	37	40	47
Percent Cobbles	16	47	25
Dominant Cover			
LOD (sq ft/100 ft)	10.4	2.4	5.6
Vegetation (sq ft/100 ft)	0	0	0
Bank (sq ft/100 ft)	0	0	0
Substrate (sq ft/100 ft)	0	0	0
	Avg length	Avg width	Avg max depth
Pools	23.8 ft	9.63 ft	1.75 ft
Riffles	38.5 ft	10.5 ft	0.6 ft
Glides	16.5 ft	11.5 ft	0.75 ft

**In-stream Habitat Data Summary - Reach B**

	Pools	Riffles	Glides
Percent of Reach	40	48	12
Dominant Substrate			
Percent Fines	80	12	40
Percent Gravels	10	47	60
Percent Cobbles	5	30	0
Dominant Cover			
LOD (sq ft/100 ft)	3.1	1.0	7.9
Vegetation (sq ft/100 ft)	0	0	0
Bank (sq ft/100 ft)	0	0	0
Substrate (sq ft/100 ft)	1.0	0	0
	Avg length	Avg width	Avg max depth
Pools	22.0 ft	18.8 ft	1.67 ft
Riffles	54.8 ft	20.8 ft	0.35 ft
Glides	54.0 ft	21.0 ft	0.50 ft

**In-stream Habitat Data Summary - Reach C**

	Pools	Riffles	Glides
Percent of Reach	42	33	25
Dominant Substrate			
Percent Fines	21	22	15
Percent Gravels	65	45	43
Percent Cobbles	14	29	8
Dominant Cover			
LOD (sq ft/100 ft)	6.7	3.4	3.3
Vegetation (sq ft/100 ft)	0	0	0.8
Bank (sq ft/100 ft)	0	0	0
Substrate (sq ft/100 ft)	0	0	0
	Avg length	Avg width	Avg max depth
Pools	12.9 ft	10.1 ft	1.45 ft
Riffles	18.3 ft	8.75 ft	0.40 ft
Glides	20.3 ft	10.5 ft	0.50 ft

Channel forming flood flows have altered the trapezoidal channel (as constructed) over time, providing dynamically stable channels with pool:riffle:glide ratios appropriate for cutthroat trout, eastern brook trout, and bull trout. Pools and scour holes were created by LOD in the channel. LOD is the primary cover mechanism in these systems. Bank undercut begins to provide cover when the channel is approximately 5 years old. The banks are stabilized by vegetation by the end of the third growing season after construction. Vegetation overhang begins to provide cover when the channel is 5 to 7 years old. These restored stream systems typically meet the performance standards in Section 2.2.3 the fourth year after construction.

## 5.0 PARCEL 46 RECLAMATION

This section looks in detail at the reclamation efforts on Parcel 46, in Carpenter Basin. Baseline information, design specifications, reclamation chronology, reclamation monitoring review, and the post-mining landscape are all examined.

### 5.1 Pre-mining Baseline

Parcel 46 is a forested and riparian area that was mined prior to ECG's acquisition of the property. This area was "high-graded", leaving garnet reserves in the ground and leaving Carpenter Creek in a man-made channel. Aerial photographs from 1955 suggest 50% of the mined area was a scrub-shrub riparian corridor. Existing riparian shrub communities upstream are either 1) hydrophytic dominated by alder, sedge, and canarygrass, or 2) non-hydrophytic dominated by snowberry, thimbleberry, canarygrass, and redtop. Community 2 was probably forested prior to logging between 1910 and 1925.

The extent of wetlands prior to mining is not known. Similar landscape positions in this and other drainages have riparian corridors varying in wetland extent from 30 percent to 70 percent. Based on the valley bottom gradient and Rosgen typing, the pre-mining stream channel was moderately low gradient with low sinuosity and numerous side channels. The channel was dominated by a cobble/gravel substrate and was heavily shaded.

### 5.2 Design Specifications

A new stream channel was designed and constructed over a 2-year period. This reach of Carpenter Creek has a 7-day low flow (Q7L2) of 1.64 cfs, and an average flood flow (Q1F2) of 111 cfs. Based on these flows a channel cross section of 1.9 feet deep, 4.0 feet bottom width, and 3:1 sideslopes was constructed. The bottom width allows a minimum of 3 inches of water depth during low flow. The channel depth allows a 2-year flood flow to overtop the bank and provide wetland hydrology to the floodplain. The channel was constructed with a sinuosity of 1.2 and a gradient of 2.2%.

The floodplain was regraded to be accessible to a 2+ year flood flow. The floodplain was reconstructed to occupy approximately 30 percent of the mined area. Once the channel was constructed and wetted, the top-of-bank was seeded with the wetland top-of-bank seed mix (Table 3). The floodplain areas were seeded with the wetland pasture mix. This seed mix is composed of the following plants.

Table 4: Wetland Pasture Seed Mix

Common Name	Scientific Name	% of mix
orchard grass	<i>Dactylis glomerata</i>	25
tall fescue	<i>Festuca arundinacea</i>	20
Alsike clover	<i>Trifolium hybridum</i>	15
red clover	<i>Trifolium pratense</i>	10
timothy	<i>Phleum pratense</i>	10
perennial rye	<i>Lolium perenne</i>	10
annual rye	<i>Lolium sp.</i>	5
New Zealand white clover	<i>Trifolium sp.</i>	5

The seed mixes were applied at a rate of 24-30 pounds per acre. Shrubs from the abandoned channel were then transplanted along the new top-of-bank. River alder is the dominate transplant; red-osier dogwood, willow, and mountain ash were also transplanted. Nursery stock was hand planted at a later date.

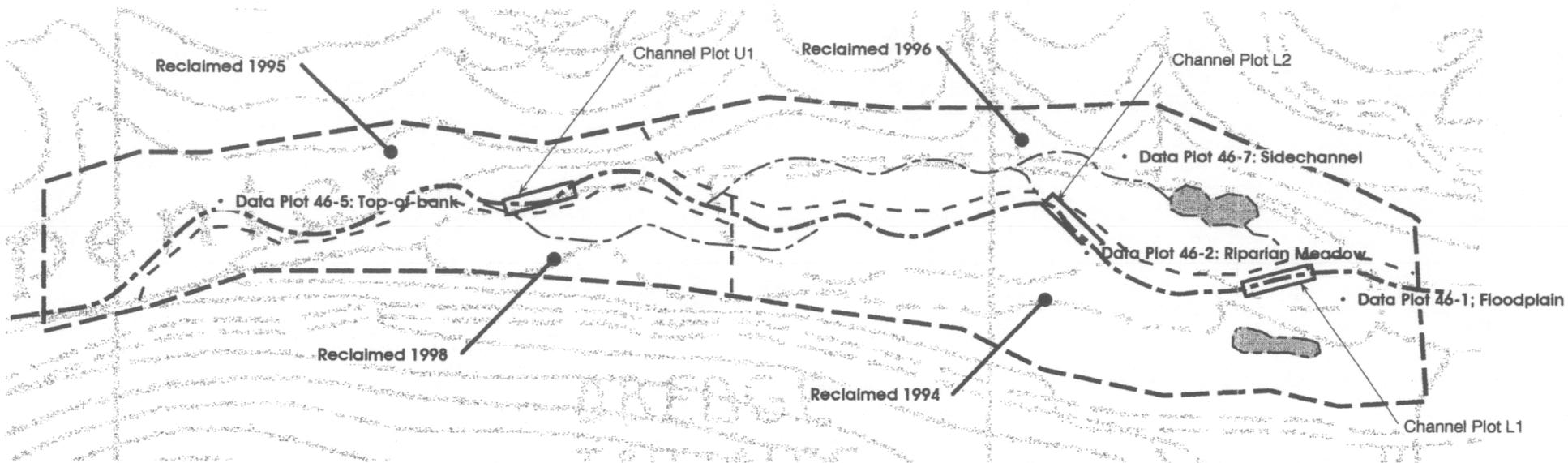
### 5.3 Chronology of Reclamation Activities

Channel in lower half of Parcel constructed and wetted in 1994  
Channel in upper half of Parcel constructed and wetted in 1995  
Lower right area mined and reclaimed in 1995  
50-plus year flood event in January in 1996

Side channel excavated in lower right area in 1996  
Upper left area mined in 1996 and reclaimed in 1997  
Side channel excavated in upper left area in 1998  
10-plus year flood event in April 2002

#### **5.4 Reclamation Monitoring Review**

A review of reclamation success is provided by looking in detail at data plots established for long-term monitoring. Monitoring of four vegetative data plots and three stream channel plots is discussed below. See Figure 4 for data plot locations within this mining area. The vegetative data plots provide information on reclamation of floodplain, channel top-of-bank, riparian meadow, side channel, and in-stream habitat areas.

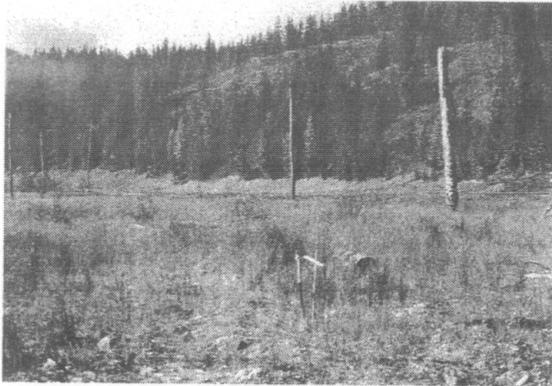


N

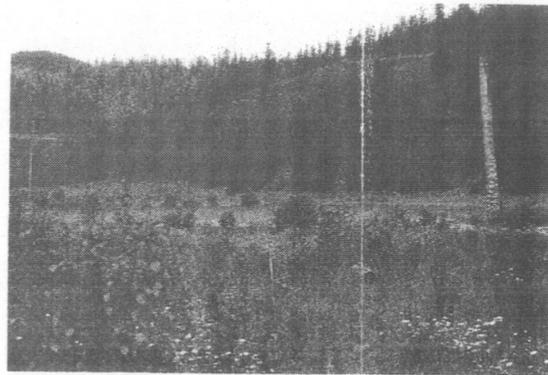
NOT TO SCALE

**FIGURE 4: PARCEL 46 DATA PLOTS  
RECLAMATION SUMMARY REPORT  
EMERALD CREEK GARNET LTD**

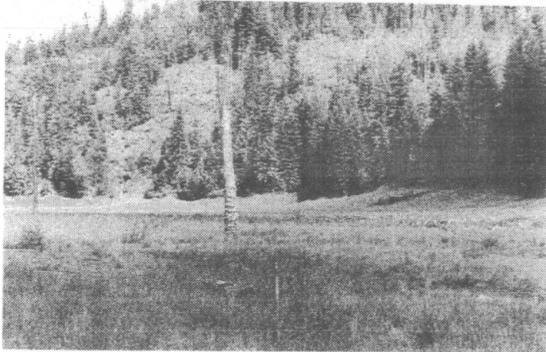
5.4.1 Floodplain Reclamation: Data Plot 1



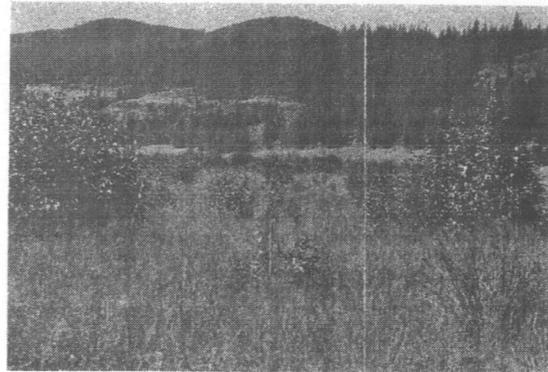
Data Plot 1 - 1995



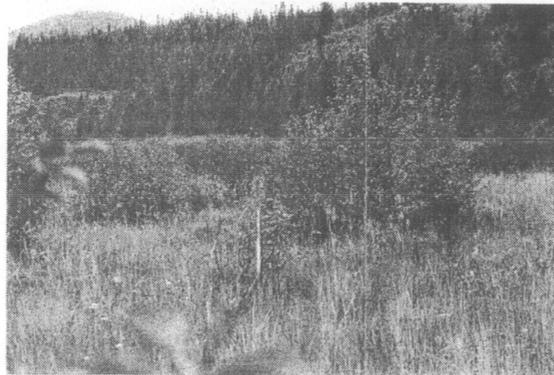
Data Plot 1 - 1999



Data Plot 1 - 1997



Data Plot 1 - 2001



Data Plot 1 - 2002

This data plot is on the lower left (looking upstream) floodplain of Carpenter Creek in Parcel 46. A new channel was constructed, planted, and wetted in the lower half of this parcel in 1994. A 50 plus year flood event occurred in January 1996. This data plot was established in July 1995 in the designed floodplain about 50 feet from the new channel.

The area represented by this plot receives hydrology every year from upstream overtopping of the channel bank. This area was seeded with the wetland top-of-bank seed mix. The photo sequence shows rapid establishment of groundlayer and shrub vegetation. By 1999, the dominant emergent hydrophytes were established by natural regeneration, not by seeding or planting. The following tables summarize the establishment of hydrophytic vegetation following regrading.

1995 Data Plot

Common Name	Numbers	Cover %	Leader Length
willow	2	Trace	3-6 inches
<b>total shrub cover</b>		<b>Trace</b>	
groundcover species	soft rush (10%), clover (5%), redtop (5%), hairgrass (5%), toad rush (5%), foxtail (5%), mannagrass, sedge, tarweed, buttercup, timothy, dagger-leaf rush (+10% for all traces).		
<b>total groundcover</b>		<b>45 percent</b>	

1997 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	2	Trace	4 inches
willow	1	Trace	5 inches
<b>total shrub cover</b>		<b>0 percent</b>	
groundcover species	soft rush (70%), redtop bentgrass (35%), small-fruited bulrush (5%), white clover, fowl mannagrass, buttercup, cattail, tufted hairgrass, timothy, horsetail.		
<b>total groundcover</b>		<b>110 percent</b>	

1999 Data Plot

Common Name	Numbers	Cover %	Leader Length
willow	2	Trace	1 inch
river alder	3	5%	3 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	soft rush (70%), ox-eye (5%), sedge (5%), bulrush (10%), foxtail (5%), horsetail (5%), mannagrass, redtop, buttercup, avens.		
<b>total groundcover</b>		<b>100 percent</b>	

2001 Data Plot

Common Name	Numbers	Cover %	Leader Length
willow	1	Trace	5 inches
river alder	4	10%	6 inches
<b>total shrub cover</b>		<b>10 percent</b>	
groundcover species	soft rush (35%), redtop (30%), timothy (10%), foxtail (25%), manna grass (5%), bulrush (10%).		
<b>total groundcover</b>		<b>115 percent</b>	

2002 Data Plot

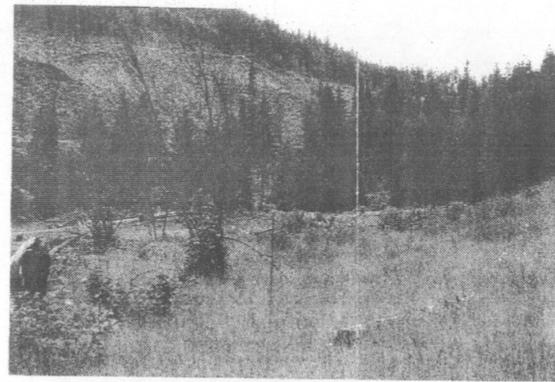
Common Name	Numbers	Cover %	Leader Length
willow	1	Trace	7 inches
river alder	3	10%	4 inches
<b>total shrub cover</b>		<b>10 percent</b>	
groundcover species	clover (20%), foxtail (30%), redtop (20%), sedge (5%), soft rush (25%), bulrush (5%), avens, ox-eye.		
<b>total groundcover</b>		<b>105 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by emergent hydrophytes. Three shrub species are present throughout the floodplain. They are not reflected in the data plot due to the clumped nature of shrubs and the small plot size relative to shrub size. Alder will eventually dominate this plot.

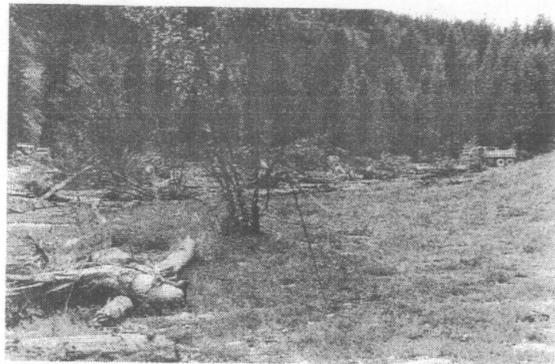
5.4.2 Top-of-bank Reclamation: Data Plot 5



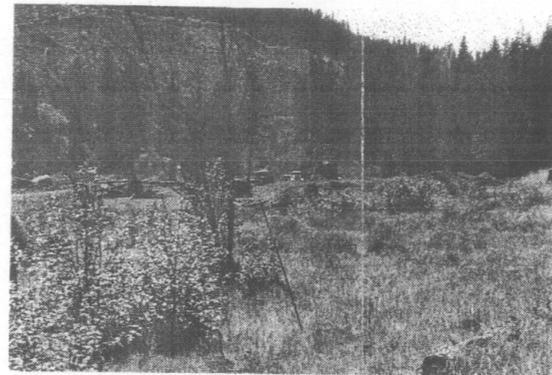
Data Plot 5 - 1996



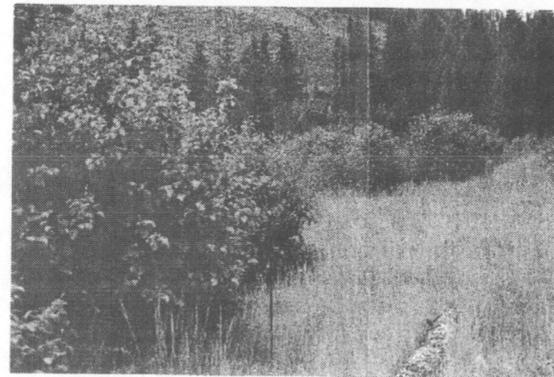
Data Plot 5 - 1999



Data Plot 5 - 1997



Data Plot 5 - 2000



Data Plot 5 - 2002

This data plot is on an upper right (looking upstream) top-of-bank position next to Carpenter Creek in Parcel 46. A new channel was constructed, planted, and wetted in the upper half of this parcel in 1995. A 50 plus year flood event occurred in January 1996. This data plot was established in June 1996.

The area represented by this plot receives hydrology when 2 plus year flood events occur. This area was seeded with the wetland top-of-bank seed mix. The photo sequence shows a sand bar immediately after the '96 flood, followed by rapid establishment of groundlayer and shrub vegetation. The transplanted alder typically die back and appear dead as seen in the early photos. The root mass remains alive, and by year 3-4, sends up many new shoots, creating an alder thicket. In the interim, the root mass is armoring the bank. The following tables summarize the establishment of hydrophytic vegetation following regrading. The alders in the data plots are all volunteer from natural seed source.

1996 Data Plot			
Common Name	Numbers	Cover %	Leader Length
none			
<b>total shrub cover</b>		<b>0 percent</b>	
groundcover species		clover (10%), redtop, bulrush. Bare ground (90%).	
<b>total groundcover</b>		<b>10 percent</b>	

1997 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	13	Trace	2-5 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species		clover (35%), meadow foxtail (20%). Bare ground (45%).	
<b>total groundcover</b>		<b>55 percent</b>	

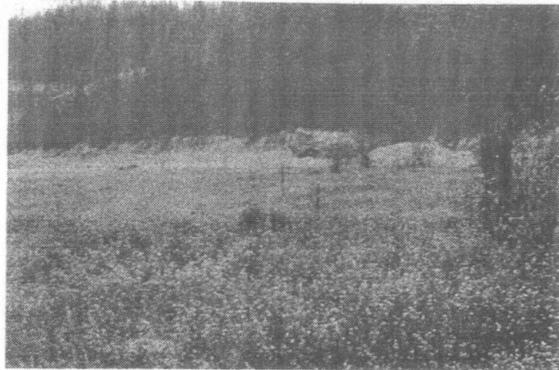
1999 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	11	15%	2-6 inches
<b>total shrub cover</b>		<b>15 percent</b>	
groundcover species		redtop (30%), timothy (45%), clover (15%), orchardgrass (5%), foxtail (5%).	
<b>total groundcover</b>		<b>100 percent</b>	

2000 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	10	15%	6 inches
<b>total shrub cover</b>		<b>15 percent</b>	
groundcover species		timothy (30%), redtop (70%), bulrush (10%).	
<b>total groundcover</b>		<b>110 percent</b>	

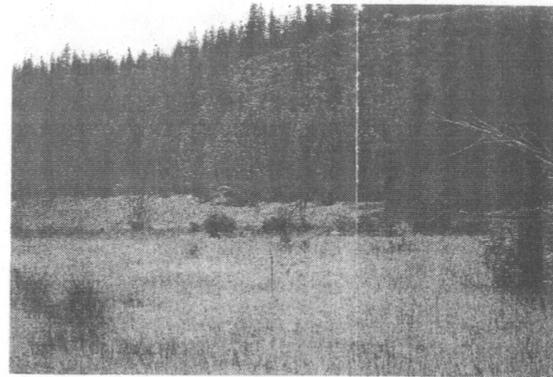
2002 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	13	45%	4 - 7 inches
<b>total shrub cover</b>		<b>45 percent</b>	
groundcover species		orchardgrass (10%), redtop (20%), timothy (25%), clover (10%), annual forb (10%), ox-eye, hawkweed.	
<b>total groundcover</b>		<b>75 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by emergent hydrophytes. Three shrub species are present throughout the floodplain. They are not reflected in the data plot due to the clumped nature of shrubs and the small plot size relative to shrub size. Alder will eventually dominate this site.

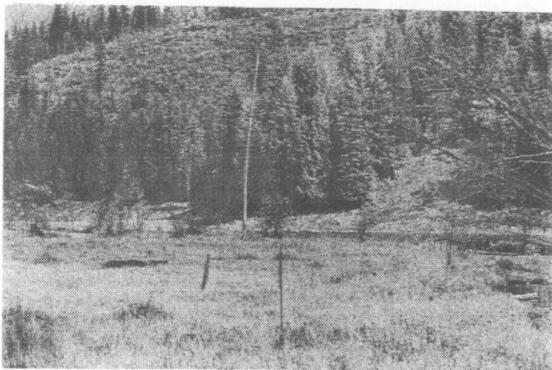
5.4.3 Riparian Meadow Reclamation: Data Plot 2



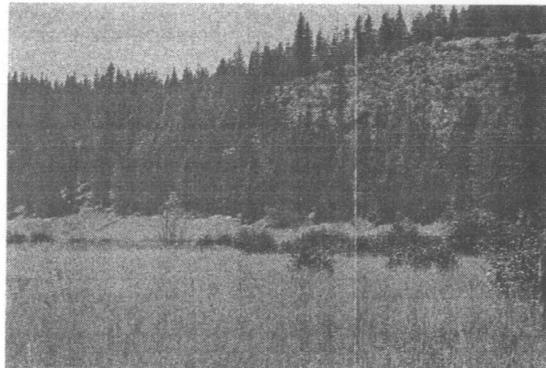
Data Plot 2 - 1995



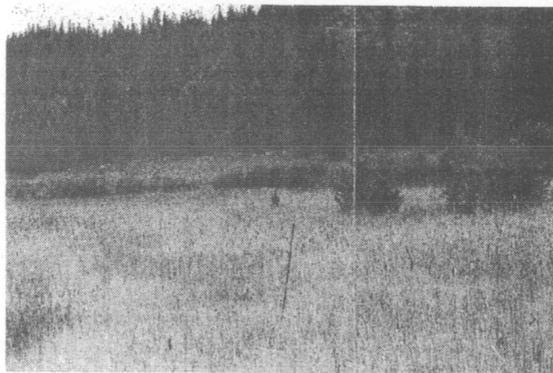
Data Plot 2 - 1999



Data Plot 2 - 1997



Data Plot 2 - 2001



Data Plot 2 - 2002

This data plot is on a lower left (looking upstream) floodplain position next to Carpenter Creek in Parcel 46. A new channel was constructed, planted, and wetted in the lower half of this parcel in 1994. This data plot was established in July 1995. A 50 plus year flood event occurred in January 1996.

The area represented by this plot does not receive hydrology when 2 plus year flood event occurs. This area was seeded with the wetland top-of-bank seed mix. The photo sequence shows maturation of vegetation over time, but little establishment of wetter species or shrubs. The photo sequence also shows how clover, about 10% of the seed mix, dominates the first few years, then declines. An upper left side channel, created in 1998, is now providing more spring hydrology to this area. This plot may eventually reflect a change in vegetation as a result of the new side channel. The following tables summarize the establishment of vegetation following regrading.

1995 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	1	5%	2-3 inches
red-osier dogwood	2	T	2 inches
willow	4	T	1-6 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	clover (85%), redtop (5%), timothy (5%), ryegrass, sedge, mannagrass, slender wheatgrass.		
<b>total groundcover</b>		<b>95 percent</b>	

1997 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	1	5%	6-9 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	white clover (45%), redtop (20%), timothy (35%), soft rush.		
<b>total groundcover</b>		<b>100 percent</b>	

1999 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	1	5%	2-5 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	timothy (50%), clover (10%), orchardgrass (15%), foxtail (10%), soft rush. Bare ground (15%).		
<b>total groundcover</b>		<b>85 percent</b>	

2001 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	1	5%	5 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	redtop (30%), foxtail (55%), soft rush (10%), clover (15%).		
<b>total groundcover</b>		<b>110 percent</b>	

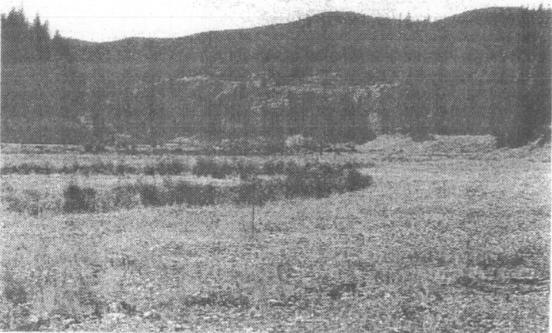
2002 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	1	5%	3 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species	foxtail (65%), clover (30%), bulrush (10%), redtop (20%), bluegrass, orchardgrass.		
<b>total groundcover</b>		<b>125 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 species for an area that is dominated by ground layer vegetation.

5.4.4 Sidechannel Reclamation: Data Plot 7



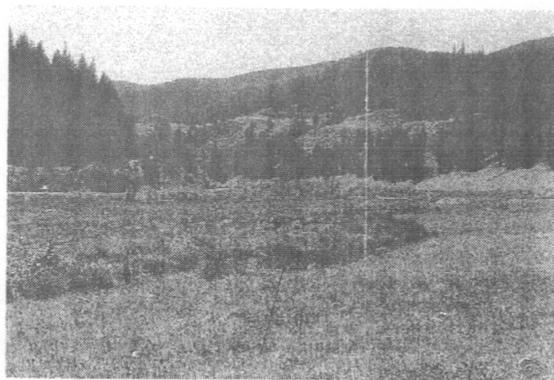
Data Plot 7 - 1997



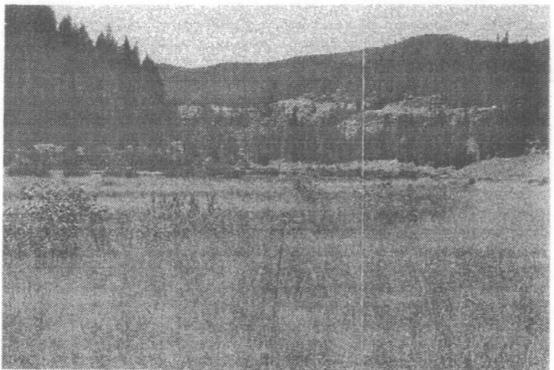
Data Plot 7 - 1998

This data plot is on a lower right (looking upstream) floodplain position next to a side channel of Carpenter Creek in Parcel 46. A new channel was constructed, planted, and wetted in the lower half of this parcel in 1994. A 50 plus year flood event occurred in January 1996. The side channel was excavated and seeded in 1996. This data plot was established in May 1997.

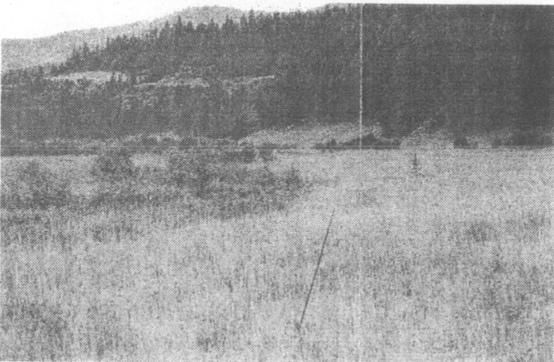
The area adjacent to the side channel receives hydrology when a 2 plus year flood event occurs. This area was seeded with the wetland top-of-bank seed mix. The photo sequence shows maturation of vegetation over time, with large soft rush along the side channel bank in '98, and volunteer alder established by 2000. The photo sequence also shows how clover, about 10% of the seed mix, dominates the first few years, then declines. The following tables summarize the establishment of vegetation following regrading.



Data Plot 7 - 2000



Data Plot 7 - 2001



Data Plot 7 - 2002

1997 Data Plot

Common Name	Numbers	Cover %	Leader Length
total shrub cover		none	
groundcover species		clover, non-specific grasses. Bare ground (95%).	
total groundcover		5 percent	

1998 Data Plot

Common Name	Numbers	Cover %	Leader Length
total shrub cover		none	
groundcover species		clover (35%), timothy. Bare ground (65%).	
total groundcover		35 percent	

2000 Data Plot

Common Name	Numbers	Cover %	Leader Length
total shrub cover		none	
groundcover species		redtop (35%), timothy (30%), foxtail (5%). Bare ground (30%).	
total groundcover		70 percent	

2001 Data Plot

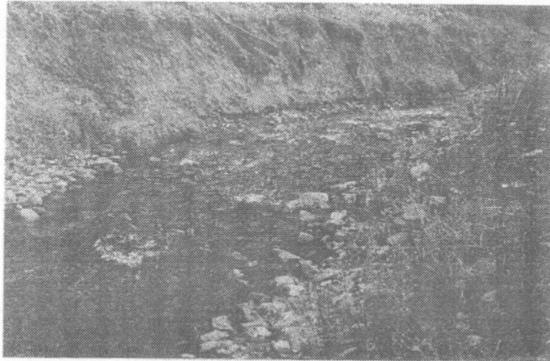
Common Name	Numbers	Cover %	Leader Length
river alder	1	T	3 inches
total shrub cover		trace	
groundcover species		redtop (25%), timothy (20%), foxtail (25%), soft rush. Bare ground (30%).	
total groundcover		70 percent	

2002 Data Plot

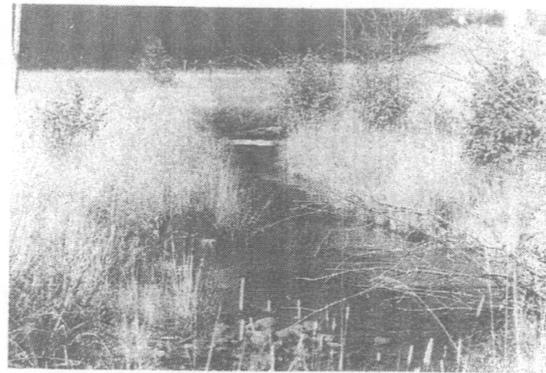
Common Name	Numbers	Cover %	Leader Length
river alder	1	T	4 inches
total shrub cover		trace	
groundcover species		foxtail (45%), clover (10%), redtop (5%), timothy (5%), annual forb (40%).	
total groundcover		105 percent	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by emergent hydrophytes. Three shrub species are present throughout the floodplain. They are not reflected in the data plot due to the clumped nature of shrubs and the small plot size relative to shrub size. Alder will eventually dominate the side channel margin. Most of this plot will probably remain as meadow vegetation.

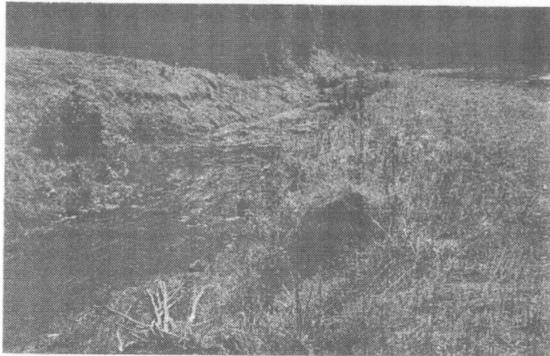
#### 5.4.5 Stream Channel Habitat Reclamation



Pre-mining Channel - 1994



Reclaimed Channel - 1999



Pre-mining Channel - 1994



Reclaimed Channel - 1999

Stream channels were restored in Parcel 46 in 1994 and 1995. Design specifications for the construction is outlined in Section 5.2.

The photo sequence shows Carpenter Creek before reclamation was initiated, and shows the lower portion of Carpenter Creek during the fifth growing season following construction. The top-of-bank canopy density in 2002 (photo not available) is about 70%, with overhanging vegetation beginning to provide significant cover habitat.

Data plots in the stream channel were established in 2000 to determine the development of in-stream physical habitat for fisheries. Data was collected in 3 reaches, each approximately 200 feet in length. Data is found in Appendix C. The following tables summarize the in-stream habitat data.

In-stream Habitat Data Summary - Reach L1

	Pools	Riffles	Glides
Percent of Reach	18	59	23
Dominant Substrate			
Percent Fines	25	0	8
Percent Gravels	40	57	47
Percent Cobbles	35	37	45
Dominant Cover			
LOD (sq ft/100 ft)	3.1	0	1.6
Vegetation (sq ft/100 ft)	0.7	0	0
Bank (sq ft/100 ft)	2.9	0.2	1.1
Substrate (sq ft/100 ft)	0	0	0
Avg length			
Pools	20.5 ft	9.85 ft	1.8 ft
Riffles	36.5 ft	8.0 ft	0.4 ft
Glides	37.8 ft	6.75 ft	0.7 ft

In-stream Habitat Data Summary - Reach L2

	Pools	Riffles	Glides
Percent of Reach	15	43	42
Dominant Substrate			
Percent Fines	25	7	18
Percent Gravels	33	72	60
Percent Cobbles	27	18	22
Dominant Cover			
LOD (sq ft/100 ft)	4.3	0	7.1
Vegetation (sq ft/100 ft)	1.1	0	.02
Bank (sq ft/100 ft)	0	0	0
Substrate (sq ft/100 ft)	3.8	0	0
Avg length			
Pools	23.3 ft	10.0 ft	1.5 ft
Riffles	26.0 ft	11.7 ft	0.3 ft
Glides	24.3 ft	12.5 ft	0.5 ft

In-stream Habitat Data Summary - Reach U1

	Pools	Riffles	Glides
Percent of Reach	72	26	2
Dominant Substrate			
Percent Fines	33	8	5
Percent Gravels	27	45	20
Percent Cobbles	30	45	75
Dominant Cover			
LOD (sq ft/100 ft)	7.1	3.6	0
Vegetation (sq ft/100 ft)	0	0	0.8
Bank (sq ft/100 ft)	0	0	0
Substrate (sq ft/100 ft)	0	0	0
Avg length			
Pools	38.7 ft	11.2 ft	1.6 ft
Riffles	43.5 ft	8.0 ft	0.45 ft
Glides	8.0 ft	10.0 ft	0.60 ft

Channel forming flood flows have altered the trapezoidal channel (as constructed) over time, providing dynamically stable channels with pool:riffle:glide ratios appropriate for cutthroat trout, eastern brook trout, and bull trout. Pools and scour holes were created by LOD in the channel. LOD is the primary cover mechanism in these systems. Bank undercut begins to provide cover when the channel is approximately 5 years old. The banks are stabilized by vegetation by the end of the third growing season after construction. Vegetation overhang begins to provide cover when the channel is 5 to 7 years old. These restored stream systems typically meet the performance standards in Section 2.2.3 the fourth year after construction.

## **6.0 PERMIT 288 RECLAMATION**

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This section looks in detail at the reclamation efforts on Permit 288, located at the confluence of the east and west forks of Emerald Creek. Baseline information, design specifications, reclamation chronology, reclamation monitoring review, and the post-mining landscape are all examined.

### **6.1 Pre-mining Baseline**

Permit 288 is a 20-acre area. The West Fork and the East Fork join in the center of this permit area, forming the main stem of Emerald Creek. The West Fork has a sinuosity of 1.2 and a gradient of 0.4 percent, the East Fork has a sinuosity of 1.3 and a gradient of 0.5 percent; Emerald Creek has a sinuosity of 1.4 and a gradient of 0.4 percent. The permit area has 7.5 acres of wetland, primarily in the floodplain and adjacent to the three channels.

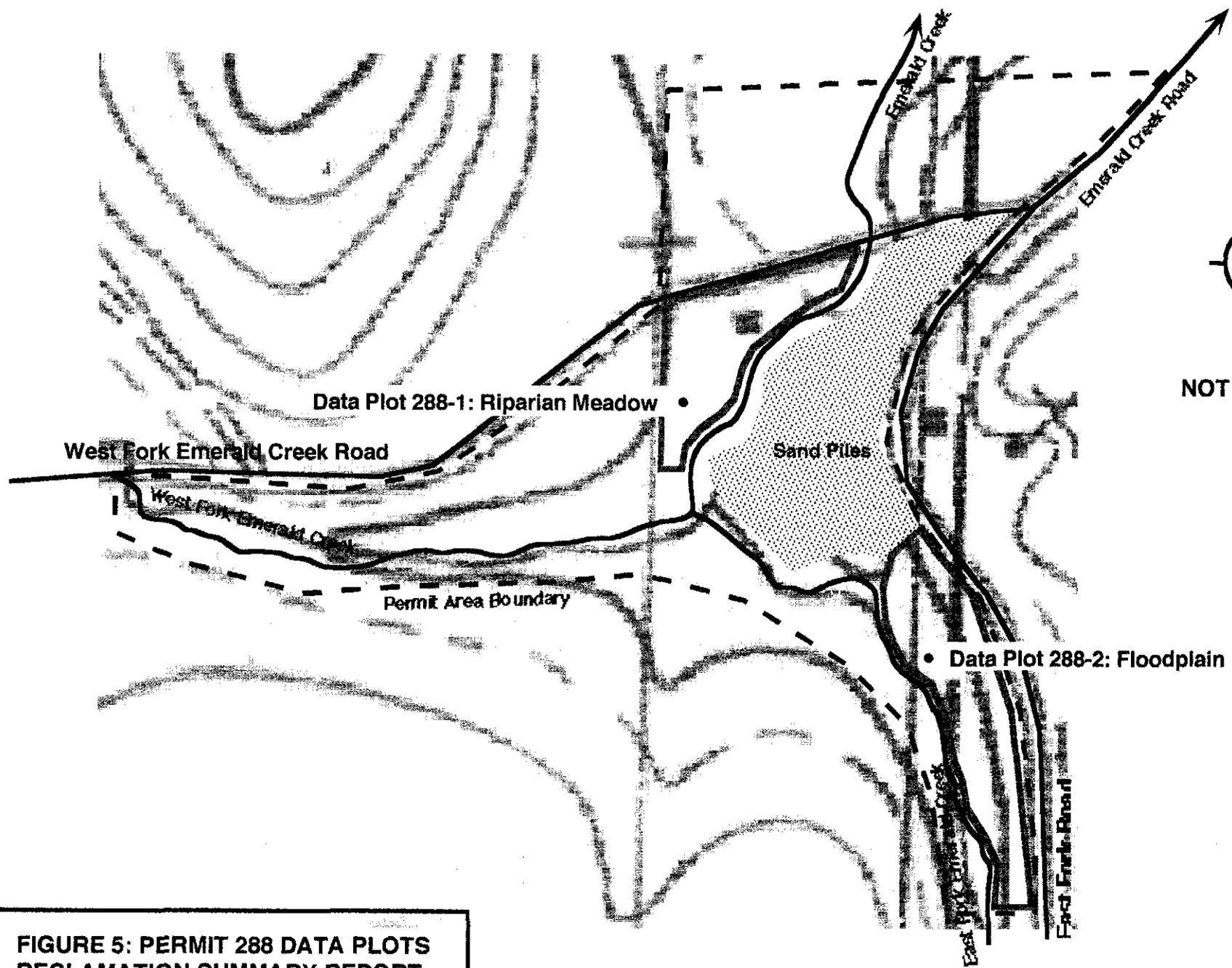
Initial permitting authorized mining the entire permit area and constructing new stream channels. Once mining started, it was apparent that sufficient garnet was not present to warrant mining all 20 acres and rebuilding stream channels. As a result, only the left bank of the West Fork and the right bank of Emerald Creek were mined. Additionally, a large area of sand piles from historic mining was reclaimed with most of the sand removed and used for reclamation in other mining areas. Stream channels were not relocated.

### **6.2 Chronology of Reclamation Activities**

This permit area was mined in 1995, and reclaimed in late 1995 and 1996. Removal of sand piles continued through 1998.

### **6.3 Reclamation Monitoring Review**

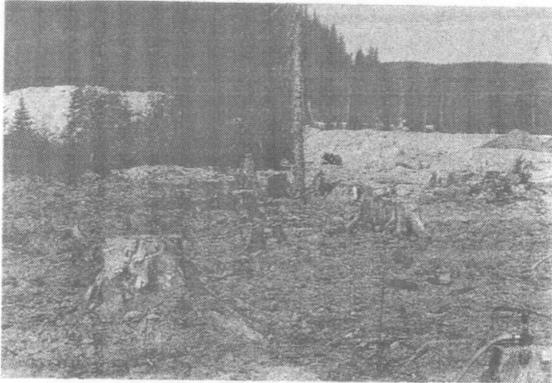
A review of reclamation success is provided by looking in detail at data plots established for long-term monitoring. Monitoring of two vegetative data plots is discussed below. See Figure 5 for data plot locations within this mining area. These data plots provide information on reclamation of floodplain, and riparian meadow areas.



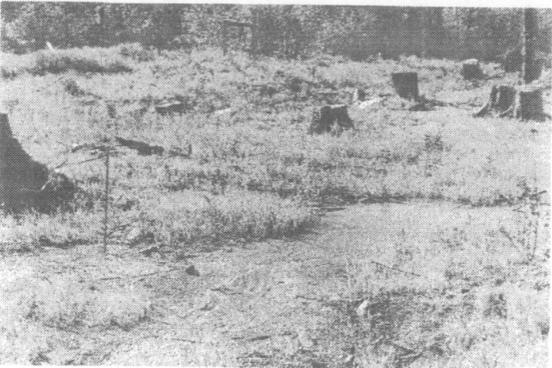
NOT TO SCALE

**FIGURE 5: PERMIT 288 DATA PLOTS  
RECLAMATION SUMMARY REPORT  
EMERALD CREEK GARNET LTD**

6.3.1 Riparian Corridor/Floodplain Reclamation: Data Plot 2



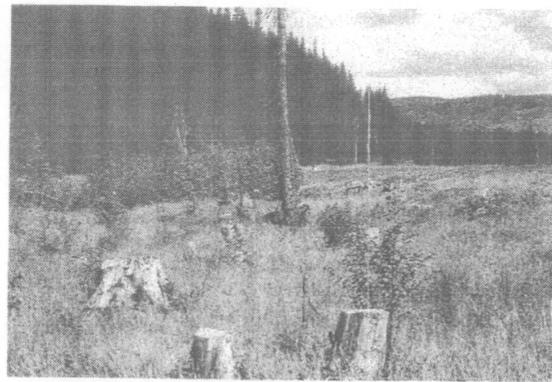
Data Plot 2 - 1996



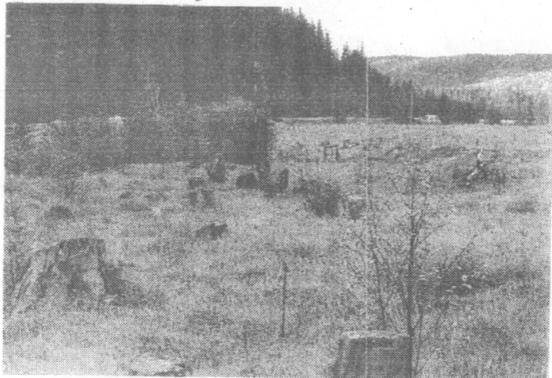
Data Plot 2 - 1997

This data plot is on the left (looking upstream) floodplain of the East Fork Emerald Creek in Permit 288. This area was mined in 1995, and reclaimed and seeded in 1996. This data plot was established in October 1996.

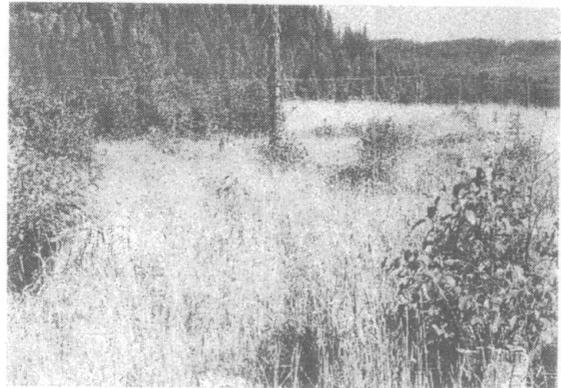
This area was seeded with the wetland top-of-bank seed mix and planted with small alder transplants in 1997. The stumps were placed after regrading and before planting. The photo sequence shows rapid establishment of groundlayer and shrub vegetation. The 1997 photo shows spring hydrology. The following tables summarize the establishment of hydrophytic vegetation following regrading.



Data Plot 2 - 1999



Data Plot 2 - 2001



Data Plot 2 - 2002

1996 Data Plot

Common Name	Numbers	Cover %	Leader Length
none			
<b>total shrub cover</b>		<b>none</b>	
groundcover species		herbaceous layer (T) Bare ground (100%)	
<b>total groundcover</b>		<b>0 percent</b>	

1997 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	3	Trace	6 inches
<b>total shrub cover</b>		<b>0 percent</b>	
groundcover species		meadow foxtail (55%), dagger leaf rush (10%), clover (10%), redtop (T), hairgrass (T), toad rush (T), bulrush (T), cattail (T), soft rush (T), willow herb (T).	
<b>total groundcover</b>		<b>75 percent</b>	

1999 Data Plot

Common Name	Numbers	Cover %	Leader Length
river alder	3	5%	5 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species		soft rush (15%), redtop (50%), foxtail (5%), timothy (10%), clover (30%).	
<b>total groundcover</b>		<b>110 percent</b>	

2001 Data Plot

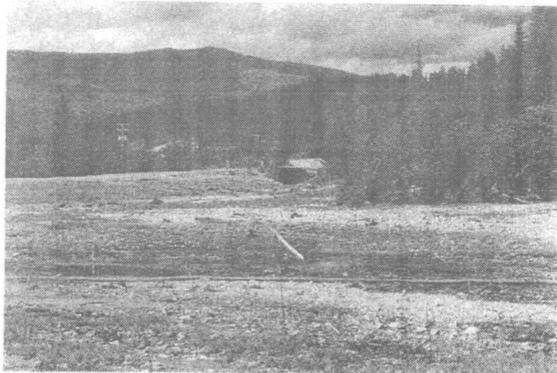
Common Name	Numbers	Cover %	Leader Length
river alder	3	5%	3 inches
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species		soft rush (5%), foxtail (35%), clover (25%), redtop (35%), dagger-leaf rush, horsetail, bulrush.	
<b>total groundcover</b>		<b>100 percent</b>	

2002 Data Plot

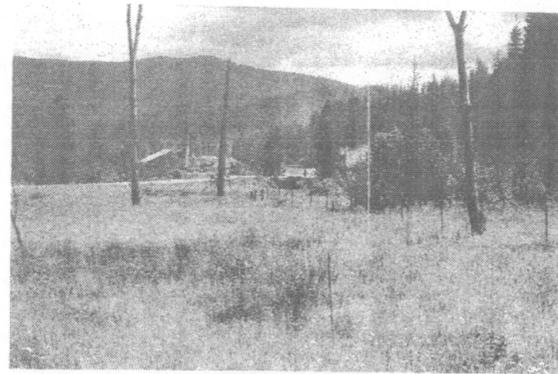
Common Name	Numbers	Cover %	Leader Length
river alder	3	5%	1 inch
<b>total shrub cover</b>		<b>5 percent</b>	
groundcover species		timothy (45%), redtop (10%), foxtail (25%), soft rush (15%), orchardgrass (5%), plantain, penstemon, ox-eye.	
<b>total groundcover</b>		<b>100 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by emergent hydrophytes. Three shrub species are present throughout the floodplain. They are not reflected in the data plot due to the clumped nature of shrubs and the small plot size relative to shrub size. Alder will eventually dominate this plot.

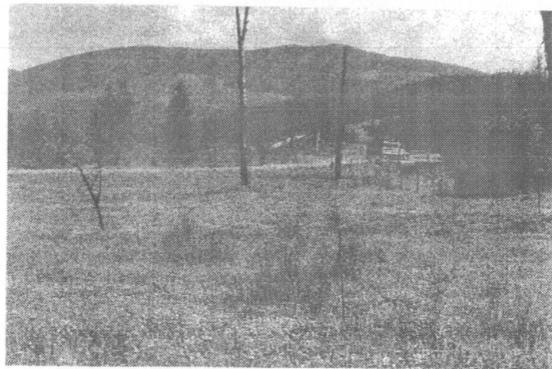
6.3.2 Riparian Meadow Reclamation: Data Plot 1



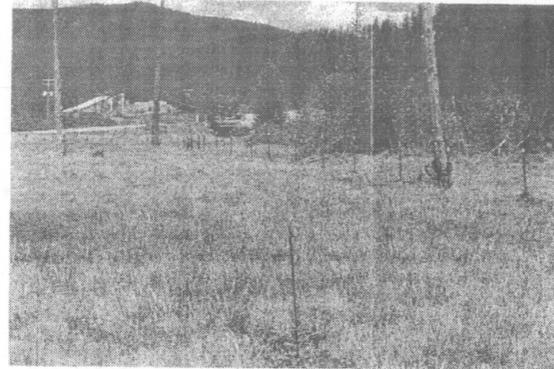
Data Plot 1 - 1996



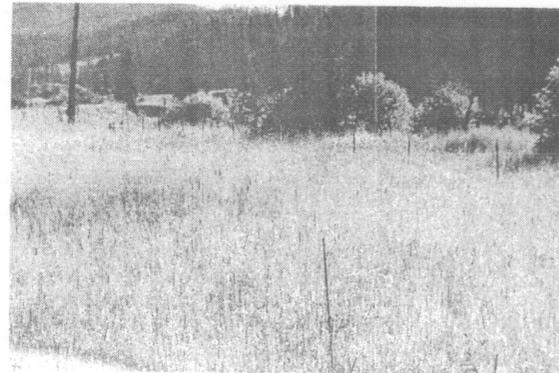
Data Plot 1 - 1999



Data Plot 1 - 1998



Data Plot 1 - 2001



Data Plot 1 - 2002

This data plot is on the right (looking upstream) floodplain of Emerald Creek in Permit 288. This area was mined in 1995, and reclaimed and seeded in 1995. This data plot was established in June 1996.

This area was seeded with the wetland pasture seed mix. The photo sequence shows rapid establishment of groundlayer vegetation. The 2002 flood event inundated much of this area. If additional bank scour makes this area accessible to flooding, wetlands may develop. The following tables summarize the establishment of vegetation following regrading.

1996 Data Plot			
Common Name	Numbers	Cover %	Leader Length
none			
<b>total shrub cover</b>		<b>none</b>	
groundcover species	clover (7%), redtop (3%). Bare ground (90%).		
<b>total groundcover</b>		<b>10 percent</b>	

1997 Data Plot			
Common Name	Numbers	Cover %	Leader Length
none			
<b>total shrub cover</b>		<b>none</b>	
groundcover species	clover (40%), redtop (10%), timothy (5%), soft rush (T), bulrush (T).		
<b>total groundcover</b>		<b>55 percent</b>	

1999 Data Plot			
Common Name	Numbers	Cover %	Leader Length
none			
<b>total shrub cover</b>		<b>none</b>	
groundcover species	clover (15%), redtop (40%), timothy (45%), orchardgrass (10%), foxtail (10%), ox-eye, soft rush, canarygrass.		
<b>total groundcover</b>		<b>120 percent</b>	

2001 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	1	T	3 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	clover (15%), redtop (40%), timothy (45%), canarygrass.		
<b>total groundcover</b>		<b>100 percent</b>	

2002 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	1	T	2 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	timothy (30%), redtop (20%), clover (15%), bluegrass (25%), ox-eye (5%), hawkweed (5%), horsetail, canarygrass, soft rush, bulrush.		
<b>total groundcover</b>		<b>100 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by meadow vegetation.

## **7.0 PERMIT 296 RECLAMATION**

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### **7.1 Pre-mining Baseline**

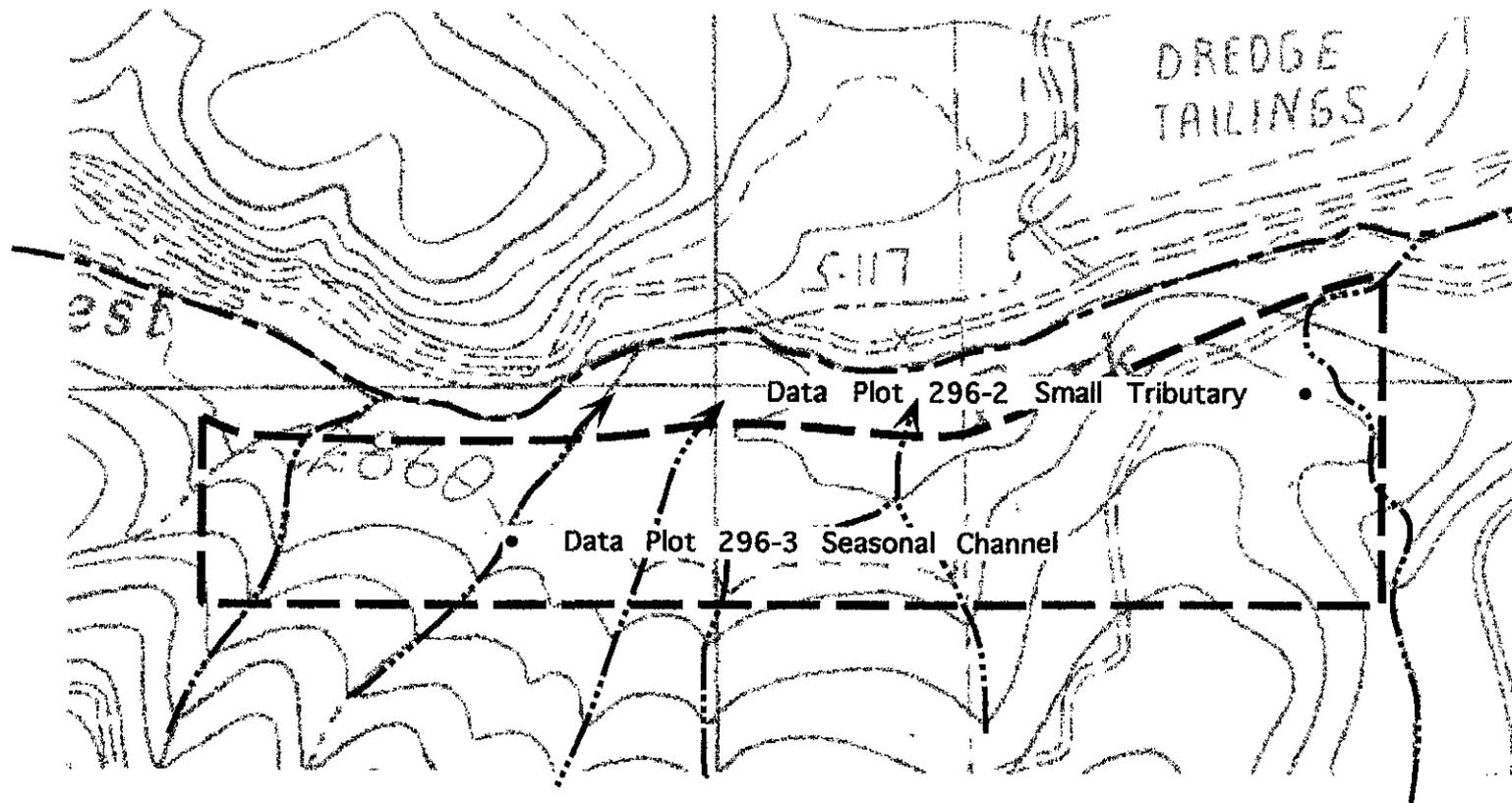
Permit 296 is an area on the south perimeter of old Permit 50 in the West Fork Emerald Creek basin that had been mined and partially reclaimed before ECG acquired the property. Permit 296 had approximately 0.87 acres of wetland in seasonal swales and 1.63 acres of wetland along a small perennial stream. Permit 296 was authorized to be mined, and have the seasonal and permanent channels reclaimed.

### **7.2 Chronology of Reclamation Activities**

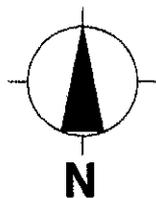
The eastern portion, along the small tributary was mined in 1994 and 1995 and reclaimed in 1995 and 1996. The body of Permit 296, including 3 seasonal swales, was mined in 1994, 1995, and 1996 with reclamation finished in 1998.

### **7.3 Reclamation Monitoring Review**

A review of reclamation success is provided by looking in detail at data plots established for long-term monitoring. Monitoring of two data plots is discussed below. See Figure 6 for data plot locations within this mining area. These data plots provide information on reclamation of small tributary and seasonal channels.

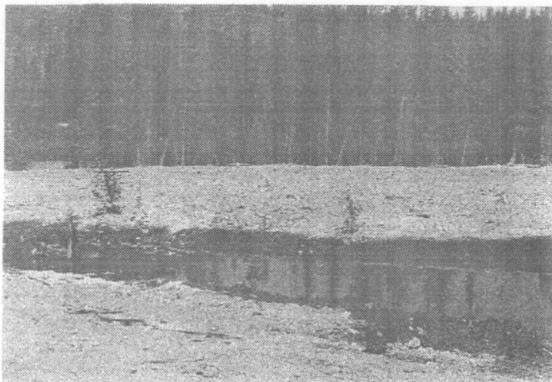


NOT TO SCALE

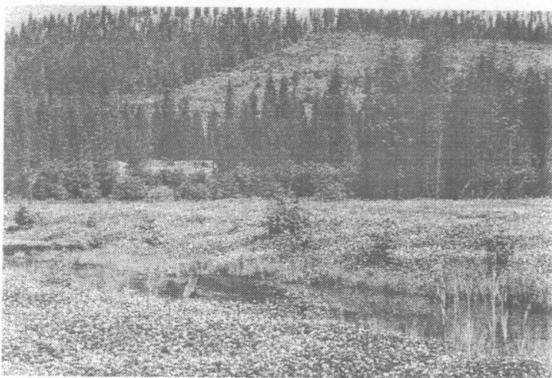


**FIGURE 6: PERMIT 296 DATA PLOTS  
RECLAMATION SUMMARY REPORT  
EMERALD CREEK GARNET LTD**

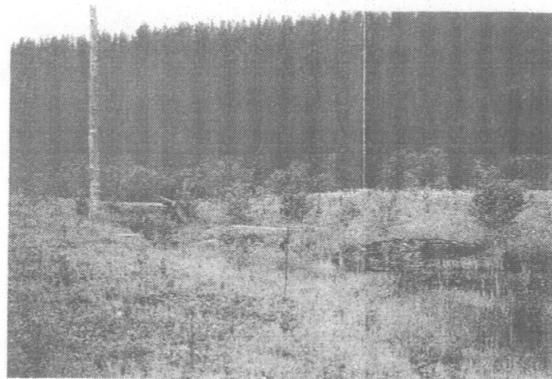
7.3.1 Small Tributary Reclamation: Data Plot 2



Data Plot 2 - 1996



Data Plot 2 - 1998



Data Plot 2 - 1999



Data Plot 2 - 2000

This data plot is in the eastern portion of Permit 296 next to a very small tributary of the West Fork Emerald Creek. This area was mined in 1995, and reclaimed and seeded in 1996. This data plot was established in October 1996.

This area near the tributary was seeded with the wetland top-of-bank seed mix in 1996 and planted with small alder transplants in 1996. The photo sequence shows rapid establishment of hydrophytic vegetation. The 1999 photo readily shows small conifers that were planted to shade this riparian system. The photo sequence again shows the initial heavy cover of clover, and its decline as grasses dominate after several years. The following tables summarize the establishment of hydrophytic vegetation following regrading.

1996 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	2	T	4-7 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	Bare ground (100%).		
<b>total groundcover</b>		<b>0 percent</b>	

1998 Data Plot			
Common Name	Numbers	Cover %	Leader Length
conifers	6	T	0 inches
river alder	2	T	1-3 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	clover (85%), soft rush (5%), cattail. Bare ground (10%).		
<b>total groundcover</b>		<b>90 percent</b>	

1999 Data Plot			
Common Name	Numbers	Cover %	Leader Length
conifers	5	T	0 inches
river alder	2	T	1-3 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	clover (55%), fescue (20%), redtop (5%), foxtail (5%), orchardgrass (5%). Bare ground (10%).		
<b>total groundcover</b>		<b>90 percent</b>	

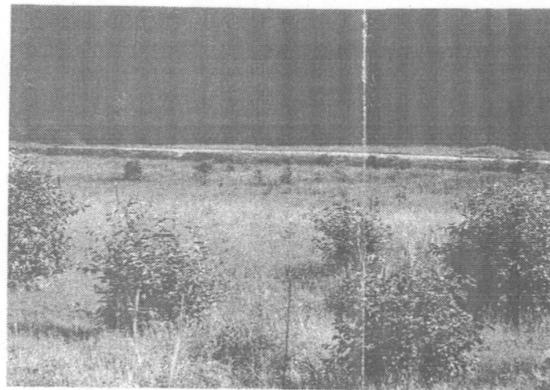
2000 Data Plot			
Common Name	Numbers	Cover %	Leader Length
conifers	5	T	2 inches
river alder	8	T	3 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	timothy (10%), redtop (80%), clover (30%).		
<b>total groundcover</b>		<b>120 percent</b>	

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 species for an area that is dominated by ground layer vegetation. Three shrub species are present throughout the floodplain. They are not reflected in the data plot due to the clumped nature of shrubs and the small plot size relative to shrub size. This data plot will eventually become a coniferous forest.

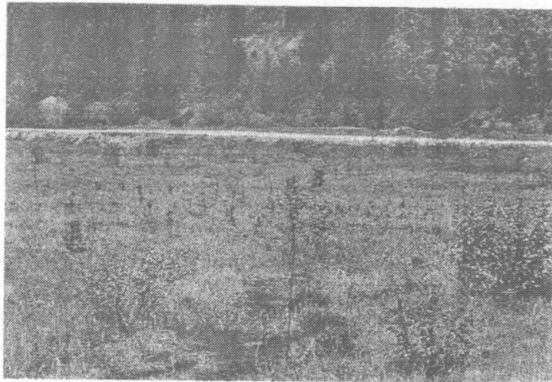
7.3.2 Seasonal Channel Reclamation: Data Plot 3



Data Plot 3 - 1997



Data Plot 3 - 2001



Data Plot 3 - 2000



Data Plot 3 - 2002

This data plot is in the central portion of Permit 296, near the West Fork Emerald Creek. This area was mined, reclaimed, planted, and seeded in 1995. The area was fenced in 1996. This data plot was established in May 1996.

This area was seeded with the wetland top-of-bank seed mix and planted with small alder transplants and willow slips. The photo sequence shows rapid establishment of groundlayer and shrub vegetation. The following tables summarize the establishment of hydrophytic vegetation following reclamation.

1997 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder	3	T	2-3 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	clover (40%), redtop (20%), hairgrass (10%), dagger-leaf rush. Bare ground (30%).		
<b>total groundcover</b>		<b>70 percent</b>	

2000 Data Plot			
Common Name	Numbers	Cover %	Leader Length
conifers	10	T	3-6 inches
river alder	2	T	5 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	soft rush (40%), redtop (15%), clover (20%), sedge (25%), foxtail, cattail.		
<b>total groundcover</b>		<b>100 percent</b>	

2001 Data Plot			
Common Name	Numbers	Cover %	Leader Length
conifers	9	T	3-6 inches
river alder	2	T	5 inches
<b>total shrub cover</b>		<b>trace</b>	
groundcover species	soft rush (45%), redtop (15%), clover (25%), sedge (20%), foxtail, cattail.		
<b>total groundcover</b>		<b>105 percent</b>	

2002 Data Plot			
Common Name	Numbers	Cover %	Leader Length
river alder			
<b>total shrub cover</b>		<b>20+ percent</b>	
groundcover species	Not recorded because plot center was not located.		
<b>total groundcover</b>			

This data plot satisfies the performance standards of 80% aerial cover in all layers, and at least 5 ground layer species for an area that is dominated by emergent hydrophytes. Alder and willow are present along the riparian corridor. This area will eventually become a thicket.

## 8.0 RECLAMATION SUMMARY

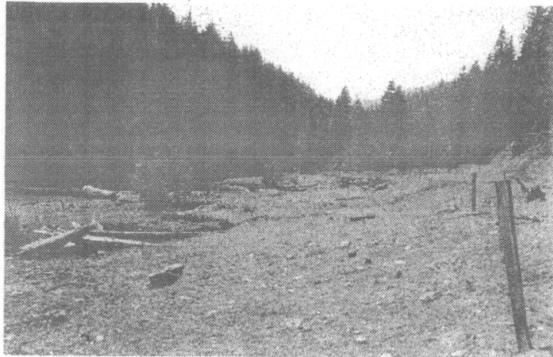
As stated in the PDEIS, April 2002 version, ECG has reclaimed nearly 450 acres of mined ground in 16 mining areas since acquiring the property in 1992. See Table 1-5 of PDEIS for details. ECG has reclaimed approximately 25 more acres than they have mined. Included in this reclamation total are both upland and wetland areas. Wetland areas include stream channels, emergent habitats, open water habitats, and scrub-shrub habitats.

ECG is currently monitoring nearly 245 acres of reclaimed property at 48 data plots, an average of 1 data plot for each 5 acres of reclaimed ground. Although this summary report documents only 14 of these data plots, the trends indicated here hold true for all data plots. Annual reports for all reclaimed areas have been submitted to the Corps and IDL, and are available for review. The following sections highlight these reclamation trends.

### 8.1 Vegetation Development

In essence, performance standards for vegetation require establishment of at least 80% aerial cover of shrubs and ground cover, at least 3 species of shrubs, and at least 5 species of groundcover. Aerial extent standards have been satisfied in all wetland plots by the fourth or fifth growing season. The two photos below show typical cover establishment, over 7 years in this case. Large shrub transplants frequently die back and resprout as a thicket. Volunteer shrubs can not be distinguished from small planted stock after 3 growing seasons.

Data plots do not reflect the presence of at least three shrub species. They are present, although river alder is clearly the dominant shrub and is transplanted and planted heavily because of its successful re-establishment. Red-osier dogwood is also present and dominant in small areas. Drummond willow and sandbar willow are also dominant in small patches.



Section 31 Looking Upstream - 1996



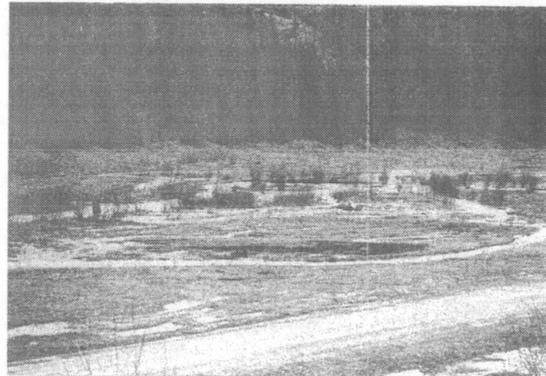
Section 31 Looking Upstream - 2002

Ground cover species also establish quickly. Clover provides rapid initial cover, soon followed by dominance of meadow foxtail, timothy, and redtop in floodplain and top-of-bank positions. These plants remain dominant in most seasonally saturated locations. In wetter topographic positions, soft rush, cattails, mangrass, creeping foxtail, bulrush, spikerush, dagger-leaf rush, big leaf sedge, and water sedge succeed the seed mix species and become dominant.

All wetland data plots satisfy the established performance standards.

### 8.2 Hydrologic Support

The key to vegetative success is establishment of a frequent period of saturation and/or inundation. ECG as elected to accomplish this in both Corps permitted areas and areas mined prior to the 1994 Corps permit by creating an expensive 2-year floodplain and a restored channel that has a channel capacity less than the 2-year flood flow. This combination provides frequent flooding leading to sufficient inundation and saturation to promote the development of jurisdictional wetlands.



Mid Parcel 46, 2-year Flood Flow - 2002



Lower Parcel 46, 2-year Flood Flow - 2002

The Parcel 46 photo sequence shows the extent of a 2-year flood flow on the reclaimed floodplain along Carpenter Creek. The main channel and all side channels are at bankful stage. The banks are overtopped in many areas, providing wetland hydrology to nearly one third of the designed floodplain. This has occurred with 2 channel-forming events in 8 high flow periods. Wetland reclamation, with this approach, is on-going, as future channel-forming events are anticipated to create additional overtopped banks and more floodplain inundation.

Hydrologic support from frequent flooding is extensive enough and has sufficient periodicity to create the desired extent of wetlands.

### 8.3 Channel Habitat Reclamation

In conjunction with wetland reclamation, ECG has restored over 3.5 miles of stream channel. The channels are dynamic, they are accessible to the reclaimed floodplains, they are stabilized by dense top-of-bank vegetation, and they have suitable in-stream habitat for fisheries.

All restored stream channels that have experienced a channel-forming flood flow, satisfy the channel performance standards.

### 8.4 Conclusions

ECG's reclamation designs and implementation have proven successful in all respects. This success is supported by long-term monitoring and by 3 interagency reclamation awards. The reclamation effort and subsequent monitoring have produced the following observations that have modified ECG's approach to implementation.

1) Channels that have been excavated on ground that has been reclaimed and seeded for several years have proven to be the most stable over time. ECG initially excavated new channels immediately after the floodplain was regraded and before reseeding. The decision to wait 1 to 3 years before channel excavation has minimized channel entrenchment and has reduced sediment loads eroding from the floodplain. This change has slowed ECG's reclamation schedule, but has provided higher quality final reclamation.

2) ECG no longer uses nursery stock for revegetation because natural regeneration of endemic shrubs is so successful. ECG continues to transplant stock and plant willow slips in channel top-of-bank positions.

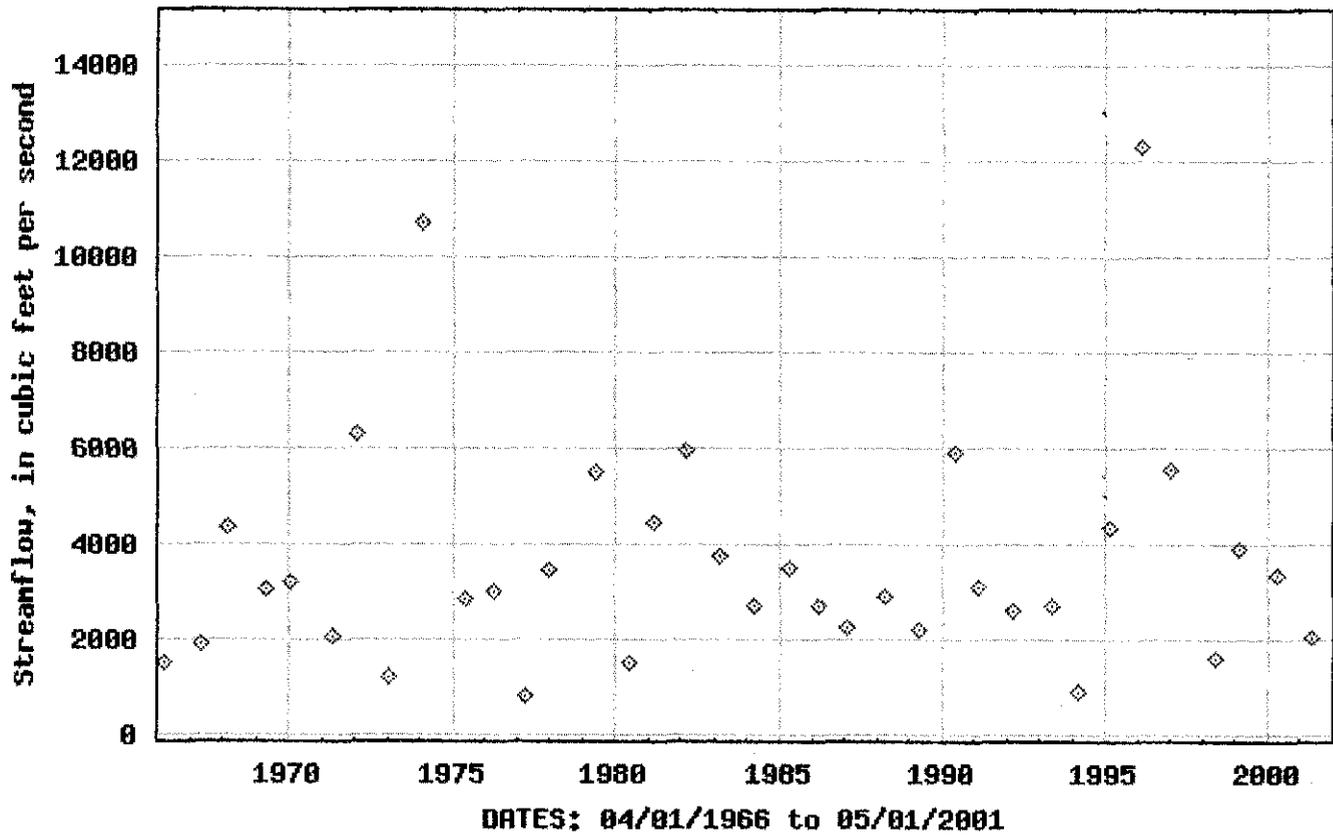
**APPENDIX A**

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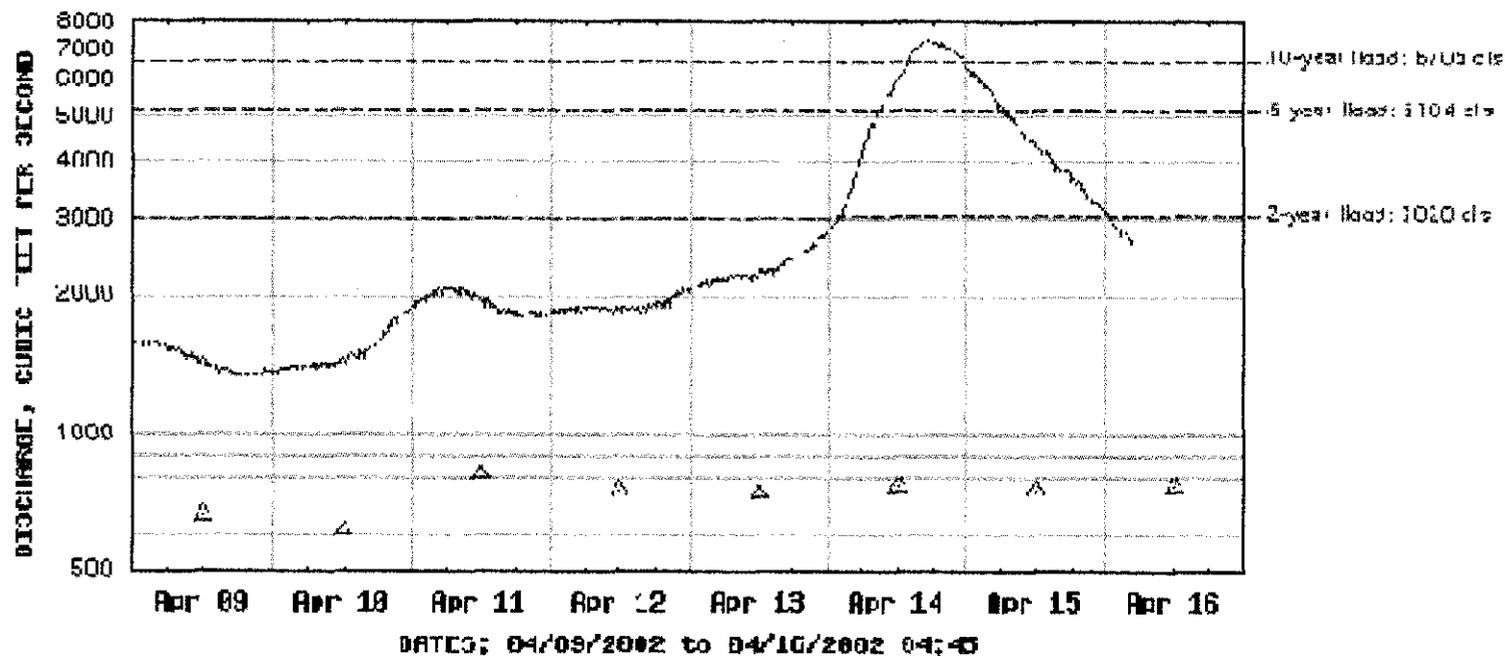
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### USGS 12414900 ST MARIES RIVER NR SANTA ID



USGS 124149AA ST MARTES RTUFR NR SANTA TN



EXPLANATION

— DISCHARGE

△ MEDIAN DAILY STREAMFLOW BASED ON 36 YEARS OF RECORD

2+ YEAR FLOOD DURATION APPROXIMATELY 47 HOURS AT MASHBURN GAGE.

PEAK FLOW 7370 cfs AT 17:15 APRIL 14, 2002 AT MASHBURN GAGE. PEAK OBSERVED AT EMERALD CREEK AT 14:00.

2-, 5-, AND 10-YEAR FLOWS MODELED BY SAIC FOR ECG IN 1999.

**APPENDIX B**

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
1	West Fork Emerald Creek Reach C															
2	Hab	Avg Max				SUBSTRATE%					COVER (ft2)					
3	Type	Length	Width	Dept	Dept	T-out	Depth	Fine	Grvls	Cobl	Boldr	Bedr	LOD	Veg	Bank	Sub
4	P1	9	6.2	1	1.25	0.75	10	75	15				0.7			
5	R1	6	7	0.5	0.75		20	10	60	10			27			
6	P2	8	11	1.2	1.5	0.5	80	20								
7	G1	25	10	0.5	0.75								2	5		
8	R2	26	8.3	0.2	0.6		30	70								
9	G2	12	11.5	0.4	1.25		30	70								
10	P3	17.5	11	1.8	2.3	1.2	15	60	25				40			
11	G3	24	10	0.7	1.8		15	60	25				18			
12	R3	9	10.2	0.5	1.2		40		55	5						
13	P4	6	15	0.7	1.1	0.7		100					22			
14	R4	32	9.5	0.5	0.7			100								
15	P5	24	7.5	0.7	1.1	0.6		70	30				4			
16	TOTAL	199	117	8.7	14.3		240	635	210	15	0	114	5	0	0	0
17																
18	POOLS															
19	P1	9	6.2	1	1.25	0.75	10	75	15				0.7			
20	P2	8	11	1.2	1.5	0.5	80	20								
21	P3	17.5	11	1.8	2.3	1.2	15	60	25				40			
22	P4	6	15	0.7	1.1	0.7		100					22			
23	P5	24	7.5	0.7	1.1	0.6		70	30				4			
24	TOTAL POOLS	64.5	50.7	5.4	7.25	3.75	105	325	70	0	0	66.7	0	0	0	0
25	AVERAGE	12.9	10.1	1.08	1.45	0.75	21	65	14	0	0	13.3	0	0	0	0
26	TOTAL POOL SURFACE AREA				3270											
27																
28	RIFFLE															
29	R1	6	7	0.5	0.75		20	10	60	10			27			
30	R2	26	8.3	0.2	0.6		30	70								
31	R3	9	10.2	0.5	1.2		40		55	5						
32	R4	32	9.5	0.5	0.7			100								
33	TOTAL RIFFLE	73	35	1.7	3.25	0	90	180	115	15	0	27	0	0	0	0
34	AVERAGE	18.3	8.75	4e-1	8.1e-1	0	22.5	45	28.8	3.75	0	6.75	0	0	0	0
35	TOTAL RIFFLE SURFACE AREA				2555											
36																
37	GLIDE															
38	G1	25	10	0.5	0.75								2	5		
39	G2	12	11.5	0.4	1.25		30	70								
40	G3	24	10	0.7	1.8		15	60	25				18			
41	TOTAL GLIDE	61	31.5	1.6	3.8	0	45	130	25	0	0	20	5	0	0	0
42	AVERAGE	20.3	10.5	5e-1	1.267	0	15	43.33	8.33	0	0	6.67	1.67	0	0	0
43	TOTAL GLIDE SURFACE AREA				1922											
44																
45	TOTAL POOL RIFFLE & GLIDE AREA					7746.65										
46	TOTAL POOL AREA					42.21%										
47	TOTAL RIFFLE AREA					32.98%										
48	TOTAL GLIDE AREA					24.80%										
49																

**APPENDIX C**

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
1	<b>Carpenter Creek Area 46-U1</b>															
2	Hab	Avg Max				SUBSTRATE%					COVER (ft2)					
3	Type	Length	Width	Dept	Dept	T-out	Depth	Fine	Grvls	Cobl	Boldr	Bedr	LOD	Veg	Bank	Sub
4	R1	24	7.5	0.4	0.1			5	55	35	5		24			
5	P1	37	10.5	1.2	1.6		0.6	20	25	35	20		1.6			
6	G1	8	10	0.6	0.8			5	20	75						
7	P2	10	11.5	0.75	1		0.7	20	55	20	5		3			
8	R2	63	8.5	0.5	0.8			10	35	55			2.5			
9	P3	69	11.5	1.5	2.2		0.2	60		35	5		40			
10																
11	TOTAL	211	59.5	4.95	6.5		1.5	120	190	255	35	0	71.1	0	0	0
12																
13	<b>POOLS</b>															
14	P1	37	10.5	1.2	1.6		0.6	20	25	35	20		1.6			
15	P2	10	11.5	0.75	1		0.7	20	55	20	5		3			
16	P3	69	11.5	1.5	2.2		0.2	60		35	5		40			
17																
18	TOTAL POOLS	116	33.5	3.45	4.8		1.5	100	80	90	30	0	44.6	0	0	0
19	AVERAGE	38.7	11.2	1.15	1.6		0.5	33.3	26.67	30	10	0	14.9	0	0	0
20	TOTAL POOL SURFACE AREA				3886											
21																
22	<b>RIFFLE</b>															
23	R1	24	7.5	0.4	0.1			5	55	35	5		24			
24	R2	63	8.5	0.5	0.8			10	35	55			2.5			
25																
26	TOTAL RIFFLE	87	16	0.9	0.9		0	15	90	90	5	0	26.5	0	0	0
27	AVERAGE	43.5	8	0.45	0.45		0	7.5	45	45	2.5	0	13.3	0	0	0
28	TOTAL RIFFLE SURFACE AREA				1392											
29																
30	<b>GLIDE</b>															
31	G1	8	10	0.6	0.8			5	20	75						
32																
33	TOTAL GLIDE	8	10	0.6	0.8		0	5	20	75	0	0	0	0	0	0
34	AVERAGE	8	10	0.6	0.8		0	5	20	75	0	0	0	0	0	0
35	TOTAL GLIDE SURFACE AREA				80											
36																
37	TOTAL POOL RIFFLE & GLIDE AREA						5358									
38	TOTAL POOL AREA						72.53%									
39	TOTAL RIFFLE AREA						25.98%									
40	TOTAL GLIDE AREA						1.49%									