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TECHNICAL MEMORANDUM

TO: Mary Beth Marks – On-Scene Coordinator

FROM: Mark F. Pearson – Project Geologist
Mike Cormier – Project Manager

DATE: March 16, 2005 (*Revised December 2, 2005)*

RE: Sediment Characterization - Daisy and Fisher Creeks
New World Mining District Response and Restoration Project

INTRODUCTION

This technical memorandum presents sediment characterization activities that were conducted in the Daisy Creek and Fisher Creek drainages during September 2004. Sediment characterization involved mapping and sampling of fine-grained sediments present in the two stream courses to document the distribution of sediments and total metals concentrations present in fine-grained streambed sediments.

PREVIOUS INVESTIGATIONS

Two sediment studies have previously been conducted in the New World Mining District. The first study was completed for Crown Butte Mines, Inc. (CBMI) by Hydrometrics in 1993 (Hydrometrics, 1994). The study involved collecting sediment and bank/overbank samples from three locations in Daisy Creek, three locations on the Stillwater River, and three locations in the Stillwater Marsh. Surface water samples were collected at three locations, and a pH and specific conductance survey was performed at numerous locations in Daisy Creek and two locations in the Stillwater River. The second study was performed by Camp Dresser and McKee, Inc. (CDM) in 1996 (CDM, 1997). Sediment samples were collected at four locations in both Daisy Creek and Fisher Creek during two different flow regimes (August and October 1996).

For the Hydrometrics study, sediment samples were separated into two grain size ranges, mud (less than 60 microns) and sand (less than 2 millimeters and greater than 60 microns). The samples were analyzed for total metals and metal concentration in three sequential extractions. The sequential extractions were done to partition the metals into three fractions: exchangeable, reducible, and residual. A local background concentration was established during the study by analyzing the total metals data from bank/overbank deposit samples. Total metals concentrations measured in streambed sediments were determined to be generally higher than background for aluminum, copper, lead, and zinc. Using the fractional analysis of metals and grain size distribution, Hydrometrics concluded that metal concentrations in sediment originated from two different sources: metals that precipitated from surface water, and metals contained in sediment that enters the stream as a result of erosion (detrital sediments). The mud size fraction of sediment contained a higher proportion of precipitated metals while the sand fraction contained a higher proportion of detrital sediments. The mud size fraction also

generally contained higher concentrations of total metals than the sand size fraction. Hydrometrics also concluded in their report that reduction of acid rock drainage would be a necessary precursor to eventual improvement in stream sediment quality.

The focus of the CDM study was sediment mineralogy. Total concentrations of metals in sediment were determined using X-ray fluorescence, and copper and zinc concentrations were determined in four different soil:water solutions after tumbling for 48 hours. An electron microprobe technique was used to determine mineralogy. No analysis of the data or conclusions were presented in the CDM report.

METHODS

The Maxim Technologies (Maxim) scientists conducted the sediment characterization study in Daisy Creek and Fisher Creek in accordance with the methods and procedures outlined in the 2004/2005 Work Plan for the New World Mining District Response and Restoration Project (Maxim, 2004). Investigative activities included a longitudinal and measured traverse of each stream, collecting sediment samples, mapping stream deposits and channels, and analyzing samples for total metals. Methods and procedures used to accomplish these activities are described in the following subsections.

LONGITUDINAL AND MEASURED STREAM TRAVERSE

The longitudinal traverse of each stream was begun from a known point and distance was measured in feet along the traverse using an electronic distance meter or Hip-Chain. In Fisher Creek, a "U" or "D" was used to denote distance upstream (U) or downstream (D) from the known starting point, and in the lower section of the traverse, a "W" was used to distinguish the west channel of the creek from the east channel of the creek. In Daisy Creek, a "D" was used to denote downstream distance from the starting point. Orange flagging was used to mark every 100 feet of the stream traverse for mapping reference purposes and sample collection stations were also flagged. The traverse up or down the stream channel was generally made to one side. In steep terrain or terrain with abundant downfall or rock outcroppings, the traverse was made as close to the stream channel as possible.

SAMPLE COLLECTION

Sediment samples were collected at stations established every 1,000 feet of stream channel traversed. Samples were typically collected within 30 feet (upstream or downstream) of the measured sample station. Sediment was either collected from deposits below the existing water level of the stream (if present) or in deposits near the active stream channel. At each sample point, an effort was made to collect the finest fraction of sediment by field screening gravels from the sample.

Sediment samples were collected as grab samples from the streambed in accordance with the procedures described in the Site-Wide SAP (Maxim 1999). Samples were collected with a decontaminated stainless steel scoop and placed in a decontaminated stainless steel mixing bowl to be homogenized. A representative portion of the homogenized sample was placed in a 250 milliliter laboratory-grade, poly, wide-mouth jar with a waterproof, screw-seal lid.

DOCUMENTATION OF SAMPLING STATIONS

Sample collection stations were flagged, photographed using a digital camera, and located using a resource-grade global positioning system (GPS) instrument. Some stations could not be located by GPS due to intervening trees and topography; these stations were located by using the distance measured from the nearest GPS sample point.

STREAM CHANNEL MAPPING

Maxim scientists mapped the orientation of the stream, the areal extent of sediment deposits along the traverse, and any subsidiary channels. The width of active channels (water-filled at the time of mapping) and subsidiary channels was measured, general gradient changes were noted, and features such as waterfalls, pools, tributary locations, entrained wood, stream bank composition, rock outcrops, surface water monitoring stations, trails, and historic mining features (such as steel cables in Fisher Creek) were mapped. Mapping was done at a scale of one inch to 50 feet and relied upon measured placement of flagging at 100-foot intervals to input spatial aspects of the stream and channel(s).

LABORATORY ANALYSIS

Sediment samples were placed in iced coolers and refrigerated until shipment to Northern Analytical Laboratories, Inc., in Billings, Montana. Samples were analyzed for total arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc in accordance with laboratory methods presented in the Site-Wide Sampling and Analysis Plan (Maxim, 1999).

TRAVERSE OF DAISY CREEK

The longitudinal traverse of Daisy Creek was conducted between September 22 and 29, 2004. The traverse began at surface water monitoring station DCT-7 (denoted as 0) and proceeded down Daisy Creek and the Stillwater River into the upstream portion of the "Stillwater Marsh". The traverse was concluded at 15800, which is the intersection with a flagged crossection (T 11-9) that is part of Mr. Steve Cook's Stillwater Marsh Study (Montana State University Master's Thesis, In Progress).

TRAVERSE OF FISHER CREEK

The longitudinal traverse of Fisher Creek was conducted between September 13 and 17, 2004. The traverse was completed in two stages, beginning at the Fisher Creek bridge (FSC-0) and proceeding upstream to the Glengarry Mine (13280 U), followed by proceeding downstream from the Fisher Creek bridge to the confluence with the Clarks Fork of the Yellowstone River (7552 D and 7565 DW). At the upstream end of the traverse, a tributary channel, FCT-11, was also mapped from 12500 U to the Glengarry. Downstream of the bridge, two channels were mapped below 5500 D to the confluence with the Clarks Fork. These were identified as Fisher Creek and the West Channel of Fisher Creek; the Fisher Creek channel contained almost all of the streamflow.

RESULTS

This section presents a summary of the stream characteristics observed during mapping, and laboratory analytical results for sediment samples collected along each stream traverse. Location maps showing sample locations and selected total metals concentrations are presented in **Figures 1 and 2** in **Attachment A**. Detailed field maps of Daisy Creek and Fisher Creek are shown in **Attachment B**. Photographs from select sample stations are shown in **Attachment C**. Laboratory analytical reports are contained in **Attachment D**.

STREAM CHARACTERIZATION – DAISY CREEK

For the most part, the Daisy Creek stream channel is steep and narrow. The active channel is about 10 to 15 feet in width. The majority of the stream has a sand, gravel, and boulder streambed with pervasive iron staining. The intensity of iron staining on sediments decreases with increasing distance below the confluence of Daisy Creek and the Stillwater River. The longitudinal traverse began at surface water station DCT-7 at an approximate elevation of 9,380 feet above mean sea level. Daisy Creek descends approximately 910 feet in elevation over a distance of about two miles to its confluence with the Stillwater River. From this confluence, the traverse continued for approximately 0.8 mile downstream on the Stillwater River to the upstream portion of the "Stillwater Marsh".

Daisy Creek was divided into five segments (**Table 1**) based on similar gradient and stream channel characteristics. A description of each of these segments of Daisy Creek is presented below.

Table 1
Daisy Creek Stream Segments
New World Mining District Response and Restoration Project

Upstream Station	Station Elevation	Downstream Station	Station Elevation	Stream Distance	Vertical Drop	Gradient (%)
0	9,380	1,340	9,330	1,340	50	4%
1,340	9,330	3,400	9,120	2,060	210	10%
3,400	9,120	8,800	8,610	5,400	510	9%
8,800	8,610	11,400	8,510	2,600	100	4%
11,400	8,510	15,800	8,470	4,400	40	0.9%
Total				**15,800**	**910**	

Notes: All measurements in feet, unless otherwise indicated
Station elevations are approximate

Segment 0 to 1340 D

This segment is characterized by an overall 4% gradient through alpine meadow and scattered, small conifers. The channel is a riffle-run section or broad, shallow flow over angular silt, sand, and small gravel alluvial deposits. There are numerous springs in this segment, some of which have a white to yellow-brown precipitate (vicinity of 100 to 300 D; see Attachment B). There is also streamflow over

ferricrete between 700 to 1000 D. Gradient increases in the last 200 feet of this segment and stream bank slopes steepen.

Sediment accumulation appears minimal in this segment compared with further downstream segments. Sediment samples collected in this segment consisted of fine-grained sand and silt with "drapes" of mud.

Segment 1340 D to 3400 D

This Daisy Creek segment is characterized by an increase in gradient to 10% in a stream channel with steep slopes down to Daisy Creek in scattered forest and alpine meadow. The channel is a series of step pools created mainly by gravel/boulder accumulations. Boulders appear to have eroded from the stream channel slopes. There are several areas of mass wasting of stream banks (slumps) in this segment (Photograph 1, Attachment C). Boulder-sized rock along with silt, sand, and gravel exist as instream sediment and in high water channels adjacent to the active channel. Sediment samples collected in this segment consisted of fine to coarse-grained sand and silt with "drapes" of mud.

Segment 3400 D to 8800 D

This Daisy Creek segment is characterized by a relatively deeper and more incised valley with steep slopes down to Daisy Creek, flow over bedrock, and continuation of the relatively steep gradient (9%) through scattered forest and alpine meadow. Numerous step pools and waterfalls created by gravel/boulder accumulations, wood debris, and bedrock were observed this segment. Mass wasting of the stream banks was also observed. Boulder-sized rock along with silt, sand, and gravel exist as instream sediment and in high water channels (Photograph 2, Attachment C). Bedrock is exposed in the stream channel and stream banks between 3650 D to 4550 D and 7800 D to 8700 D (Photograph 3, Attachment C). Instream sediment occurs as sediment pockets in pools and riffle-run sections above the drop portions of the stream.

Sediment deposits, where dammed by rock and/or wood and in the riffle run sections, are larger in this segment than in the preceeding segment. Sediment samples collected in this segment consisted of fine to coarse-grained sand and silt/mud.

Segment 8800 D to 11400 D

This Daisy Creek segment is characterized by a decrease in gradient to 4% in a stream valley with more gentle slopes in scattered forest and alpine meadow. Station 11400 is the confluence of Daisy Creek and the Stillwater River. Between 8800 D and 10200 D, the channel is a step pool section created mainly by gravel/boulder accumulations (Photograph 4, Attachment C).

Between 10200 D and 11400 D, the channel is a riffle-run section that meanders between willow-vegetated banks (Photograph 5, Attachment C). Boulders/cobbles decrease in size to less than one-foot diameter. There is an increase of instream sediment accumulations and the size of sediment bars and point bars. These consist of silt, sand, and gravel. Pools created mainly by sand/gravel bars were observed. Sediment accumulations in this segment are estimated to be up to five feet or more in thickness. Sediment samples collected in this segment consisted of fine to coarse-grained sand and silt/mud.

Segment 11400 D to 15800 D

This segment is characterized by a meandering stream with relatively gentle gradient of 0.9%. This portion of the traverse contains the greatest accumulation of silt, sand, and gravel deposits as instream bars and point bars (Photographs 6, 7 and 8; Attachment C). The channel is a riffle-run section that meanders in a broad willow vegetated creek bottom of alluvial deposits. High water channels, either with alluvial deposits or vegetated, are present on either side of the active channel in this segment. Sediment accumulations are estimated to be up to ten feet thick and consist of gravel, and fine to coarse-grained sand with some silt and mud. Significant deposits of silt and mud appear to occur as "overbank" deposits (Photograph 8). Sediment samples collected in this segment consisted of primarily fine to coarse-grained sand with some silt and mud.

STREAM CHARACTERIZATION – FISHER CREEK

The Fisher Creek stream channel has relatively steep and narrow segments opening up into lower gradient segments. The active channel is about 8 to 15 feet in width. The majority of the stream has a sand, gravel, and boulder streambed with pervasive iron staining. The intensity of the iron staining on sediments decreases with increasing distance below the Fisher Creek bridge (Station 0). From the toe of the Glengarry mine dump (approximate elevation of 9,240 feet above mean sea level), Fisher Creek descends approximately 910 feet in elevation over a map distance of about 3.5 miles to its confluence with the Clarks Fork of the Yellowstone River.

Fisher Creek was divided into seven segments (**Table 2**) based on similar gradient and stream channel characteristics. In general, the greatest sediment accumulations are present in segments downstream of 6900 U. A description of each of these segments of Fisher Creek is presented below.

Table 2
Fisher Creek Stream Segments
New World Mining District Response and Restoration Project

Upstream Station	Station Elevation	Downstream Station	Station Elevation	Stream Distance	Vertical Drop	Gradient (%)
13,280	9,240	12,200	9,175	1,080	65	6%
12,200	9,175	10,300	9,130	1,900	45	2%
10,300	9,130	6,900	8,960	3,400	170	5%
6,900	8,960	0	8,775	6,900	185	3%
0	8,775	1,900	8,765	1,900	10	1%
1,900	8,765	5,500	8,360	3,600	405	11%
5,500	8,360	7,552	8,330	2,052	30	1%
Total				20,832	910	

Notes All measurements in feet, unless otherwise indicated
Station elevations are approximate

Segment 13280 U to 12200 U

This Fisher Creek segment begins at the toe of the Glengarry Mine dump (13280 U) and is characterized by an overall 6% gradient. The Fisher Creek channel was dry at the toe of the dump in September 2004, with streamflow originating at about 13000 U. The Fisher Creek channel below the Glengarry dump is characterized by pools and drops created by sand/gravel bars (Photograph 1, Attachment C) changing to pools and drops over fine-grained material with black-orange "algal growth" between 12800 and 12500 (Photograph 2, Attachment C). The Glengarry Mine adit discharge enters the Fisher Creek channel in tributary channel FCT-11 at about 12900 U in the form of a discharge from the second sediment pond at the mine; the flow from the pond was about 30 gallons per minute at the time of the traverse.

Most of the streamflow was observed in channel FCT-11. The FCT-11 channel is characterized by pools and drops created by ferricrete and bedrock ledges, gravel/boulder dams, and logs (Photograph 3, Attachment C). Sediment pockets are present in the pools as well as within the streambed sand and gravel materials in both the Fisher Creek and FCT-11 channels. Sediment samples collected in this segment consisted of primarily fine to coarse-grained sand with some silt and mud.

Segment 12200 U to 10300 U

This Fisher Creek segment is characterized by an overall 2% gradient in forest and meadow. The channel has riffle-run sections. Step pools are created mainly by wood debris but also by sand/gravel bars and ferricrete/bedrock (Photographs 4 and 5, Attachment C). Sediment pockets are present in the pools as well within the streambed sand and gravel materials. Sediment accumulations appear to be not more than two feet in thickness. Sediment samples collected in this segment consisted of primarily medium to coarse-grained sand with "drapes" of mud.

Segment 10300 U to 6900 U

This Fisher Creek segment is characterized by an increase in gradient to 5% in forest and meadow. The channel is a riffle-run section between 10300 U to 9700 U (Photograph 6, Attachment C), followed by step pools created mainly by gravel/boulder accumulations to just above the Gold Dust Mine road crossing (9200 U). Below this point, the channel is a riffle-run section with a decrease in step pools created by sand/gravel bars and wood debris. The channel widens and the volume of instream sand and gravel sediments increases below about 9200 U (Photographs 7 and 8, Attachment C). Sediment accumulations appear to be not more than three feet in thickness. Sediment samples collected in this segment consisted of primarily fine to coarse-grained sand with "drapes" of mud.

Segment 6900 U to 0

This Fisher Creek segment is characterized by a decrease in gradient from 5% in the previous segment to 3% in forest, meadow, and willow stands. The channel is a riffle-run section of greater width between 6900 U to 1000 U and has an increase of instream sediment accumulations and channel meanders (Photographs 9 and 10, Attachment C). Point bar and instream sediments consist of silt, sand, and gravel. Step pools created mainly by sand/gravel bars were observed. Based on observations of these step pools, sediment accumulations in this section could be up to five feet in thickness. Sediment samples collected in this portion of the segment consisted of primarily fine to coarse-grained sand with "drapes" of mud.

Between 1000 U and the bridge over Fisher Creek (FSC-0), the gradient increases and the stream flows over what appears to be a bedrock ledge. There is an abundance of boulders forming pools and drops in the stream (Photograph 11, Attachment C). Sand and gravel sediments are instream and as sediment pockets in pools and riffle-run sections above the drop portions of the stream. Sediment accumulations are less than the upstream section (above 1000 U), although individual sediment pockets were estimated to be up to several feet thick.

Segment 0 to 1900 D

This Fisher Creek segment is characterized by a decrease in gradient to 1% in forest, meadow, and willow stands. The channel is a meandering, riffle-run section (Photograph 12, Attachment C). Step pools are created from wood debris in the stream channel. Pools are also present in slack water sections and appear to have been created from high water events. Sediment accumulations are significant and occur as point bar and instream deposits. Sediment accumulations in this section were estimated to be up to seven feet thick. Sediment is similar in texture with the preceeding segment (gravel and fine to coarse-grained sand with mud "drapes" in some areas).

Segment 1900 D to 5500 D

This Fisher Creek segment is characterized by a significant increase in gradient to 11%. The stream channel is incised through bedrock to 4000 D. From 1900 D to 3000 D, streamflow occurs in a channel incised through bedrock and is dominantly pools and drops through gravel/boulder and bedrock ledges (Photographs 13 and 14, Attachment C). The steepest gradient of this segment is in the reach from 3000 D to 4000 D where the channel is a series of waterfalls in an inaccessible, bedrock canyon. There is less instream sediment accumulation between 1900 D and 4000 D than the next upstream segment.

Below 4000 D, the canyon opens up, gradient decreases, and there is significant sediment accumulation that is both instream and overbank (noted on the maps as *high water channels or HWC*). From 4000 D to 5500 D, there is braided streamflow through sand, gravel, and boulder deposits (Photograph 15, Attachment D). These sediments also form bars and along with wood debris, form step pools. The active and high water channels appear to be incised into older sediment deposits forming a narrow fan below the bedrock canyon. Sediment accumulations in this section could have accumulated up to ten feet in thickness. Sediment samples collected in this segment are similar to the above segments and consist primarily of fine to coarse-grained sand.

Segment 5500 D to 7552 D

This Fisher Creek segment is characterized by a decrease in gradient to 1% and the presence of several high water channels that meander through the forest. Fisher Creek splits into two primary channels from 5500 D to the confluence with the Clarks Fork. Surface water station CFY-2 is located in this reach (about 7000 D). At the time of the traverse, practically all streamflow was present in the main (or east) channel. The west channel of Fisher Creek was dry from its beginning to 6700 DW, with streamflow continuing from this point to the confluence of the Clarks Fork. Both west and east channels have riffle-run and step pool sections (Photographs 16, Attachment C). The step pools are created by the accumulation of wood debris and sand and gravel which result in instream sediment accumulations both upstream and downstream of these dams. Point bar and instream sediments consist of silt, sand, and gravel.

Overbank sediment deposits were also observed in this segment although these were assessed to be smaller and have decreased occurrence relative to the previous upstream segment. Subsidiary high water channels were also observed to depart from these two main channels, transitioning from instream and overbank sand and gravel deposits to vegetated channels continuing into the forest to either side. The occurrence and size of boulders in the channels decreases with increasing downstream distance from the previous segment. Based on observations of these step pools, sediment accumulations in this section could be up to eight feet thick. Sediment samples collected in this portion of the segment consisted of primarily fine to coarse-grained sand with "drapes" of mud.

LABORATORY ANALYTICAL RESULTS

Forty-three stream sediment samples were collected during the stream traverse, 25 on Fisher Creek, 11 on Daisy Creek, and seven along the Stillwater River. Sediment samples were dried and sieved through a 2.0 millimeter screen, and analyzed for total arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc. Analytical results are presented in **Table 3** and total metals are shown on **Figures 1 and 2** in **Attachment A** for arsenic, chromium, copper, lead, and zinc.

Table 3 shows sediment results listed in order from the furthest upstream station to the furthest downstream station. The average concentration for each traverse is shown at the bottom of the table, along with background concentrations for Daisy Creek (Hydrometrics, 1994) and national sediment guidelines (probable effects levels) recognized by the National Oceanic and Atmospheric Administration (NOAA) for sediment (NOAA SQUIRT, 1999).

Average sediment concentrations in both streams are lower than the NOAA probable effects levels (PEL) for cadmium, chromium, lead, mercury, silver, and zinc. In Daisy Creek, the average concentrations of arsenic and copper are above the PEL, while in Fisher Creek, only the average copper concentration is greater than the PEL. For both drainages, silver was not detected above the practical quantitation limit (PQL) in any of the sediment samples collected; mercury was detected in only one sample at a concentration slightly above the PQL; and cadmium was detected in sediment from only three stations (all in Fisher Creek) at concentrations equal to or just slightly above the PQL.

Sediment copper concentrations in Daisy Creek range from a high of 5,430 milligrams per kilogram (mg/kg) at station DSC-9000 to a low of 898 mg/kg at station DSC-3000. Streambed sediment copper concentrations in Daisy Creek are generally about five to 10 times higher than the PEL, and about two to four times higher than background concentrations. Arsenic concentrations in sediment from Daisy Creek range from a high of 32 mg/kg (about twice the PEL) to 11 mg/kg. Below station DSC-11430 (the Stillwater River portion of the traverse), sediment arsenic concentrations are less than or equal to the PEL of 17 mg/kg. Both lead and zinc concentrations exceeded the PEL at several sample sites in Daisy Creek and the Stillwater River. The highest zinc concentration and the second highest lead concentration were measured in sediment at station DSC-9000, which also had the highest copper concentration. Lead concentrations exceeded the PEL at only three stations above DSC-9000, while zinc concentrations exceeded the PEL of 315 mg/kg at six stations below DSC-9000.

Table 3
Total Metals Concentrations in Stream Sediment - Daisy Creek and Fisher Creek Traverse
New World Mining District Response and Restoration Project

Site ID			Date	Total Concentration (milligrams per kilogram)									
				As	Cd		Cr	Cu	Pb	Hg		Ag		Zn
DSC	1,000		9/22/04	19	2	<	17	1220	69	0.5	<	20	<	123
DSC	2,000		9/22/04	32	2	<	25	2440	76	0.5	<	20	<	152
DSC	3,000		9/22/04	21	2	<	20	898	121	0.5	<	20	<	150
DSC	4,000		9/22/04	23	2	<	23	1360	93	0.5	<	20	<	159
DSC	5,000		9/22/04	27	2	<	19	1240	78	0.5	<	20	<	140
DSC	6,000		9/27/04	16	2	<	15	1560	101	0.5	<	20	<	200
DSC	7,000		9/27/04	21	2	<	13	1400	77	0.5	<	20	<	256
DSC	8,000		9/27/04	11	2	<	14	1050	72	0.5	<	20	<	227
DSC	9,000		9/27/04	17	3		21	5430	111	0.5	<	20	<	672
DSC	10,000		9/27/04	13	2	<	14	1690	80	0.5	<	20	<	317
DSC	11,000		9/29/04	23	2		13	2060	86	0.5	<	20	<	404
DSC	11,430		9/29/04	14	2	<	14	1140	83	0.5	<	20	<	297
DSC	12,000		9/29/04	16	2		17	2030	76	0.5	<	20	<	401
DSC	13,000		9/29/04	13	2	<	15	1440	69	0.5	<	20	<	324
DSC	13,490		9/29/04	16	2	<	17	1110	88	0.5	<	20	<	287
DSC	14,000		9/29/04	14	2	<	18	1110	82	0.5	<	20	<	312
DSC	15,000		9/29/04	17	2	<	16	1180	64	0.5	<	20	<	320
DSC	15,675		9/29/04	14	2	<	16	1220	54	0.5	<	20	<	321
FCT	13,000	U	9/16/04	18	2	<	31	250	48	0.5	<	20	<	55
FSC	13,000	U	9/16/04	36	2	<	32	412	52	0.8	J	20	<	39
FSC	12,610	U	9/16/04	13	2	<	27	272	36	0.5	<	20	<	26
FSC	12,000	U	9/16/04	16	2	<	31	260	43	0.5	<	20	<	46
FSC	11,000	U	9/16/04	16	2	<	38	282	43	0.5	<	20	<	56
FSC	10,000	U	9/16/04	13	2	<	33	312	38	0.5	<	20	<	60
FSC	9,000	U	9/15/04	5	2	<	19	139	35	0.5	<	20	<	34
FSC	8,000	U	9/15/04	11	2	<	29	514	72	0.5	<	20	<	102
FSC	7,000	U	9/15/04	9	2	<	29	726	48	0.5	<	20	<	76
FSC	6,000	U	9/15/04	12	2	<	33	1750	59	0.5	<	20	<	105
FSC	5,000	U	9/15/04	15	2	<	32	870	78	0.5	<	20	<	99
FSC	4,000	U	9/15/04	9	2	<	24	883	45	0.5	<	20	<	84
FSC	3,000	U	9/15/04	9	2	<	35	841	51	0.5	<	20	<	94
FSC	2,000	U	9/13/04	7	2	<	30	1000	68	0.5	<	20	<	152
FSC	1,000	U	9/13/04	8	2	<	23	1160	54	0.5	<	20	<	134
FSC	0		9/13/04	5	2	<	22	1050	44	0.5	<	20	<	132
FSC	1,000	D	9/14/04	8	2	<	26	1270	55	0.5	<	20	<	148
FSC	2,000	D	9/14/04	8	2	<	26	1360	50	0.5	<	20	<	174
FSC	3,000	D	9/14/04	7	2	<	23	1210	46	0.5	<	20	<	144
FSC	4,000	D	9/14/04	8	2	<	21	1320	58	0.5	<	20	<	207
FSC	5,000	D	9/14/04	8	2	<	21	1130	42	0.5	<	20	<	180
FSC	6,000	DW	9/17/04	11	2	<	30	1360	70	0.5	<	20	<	201
FSC	6,000	D	9/14/04	11	2	<	31	1460	72	0.5	<	20	<	213
FSC	7,000	DW	9/17/04	10	2	<	27	1210	66	0.5	<	20	<	208
FSC	7,000	D	9/14/04	6	2	<	20	1060	80	0.5	<	20	<	195
DSC Average Concentration				18	2		17	1643	82	0.5	<	20	<	281
FSC Average Concentration				11	2	<	28	884	54	0.5	<	20	<	119
NOAA PEL				17	3.5		90	197	91	0.5		na		315
Background				na	2	<	na	462	96	na		na		215

Notes: DSC = Daisy Creek; FSC = Fisher Creek; FCT = Fisher trib; stations listed upstream (U) to downstream (D); W = west channel
As = arsenic; Cd = cadmium; Cr = chromium; Cu = copper; Pb = lead; Hg = mercury; Ag = silver; Zn = zinc
< = less than the Practical Quantitation Limit; J = estimated value
NOAA PEL = National Oceanic and Atmospheric Administration Probable Effects Levels for sediment
Background = average concentration of six Daisy Creek bank/overbank samples (Hydrometrics, 1994); na = not available

In Fisher Creek, copper exceeds the sediment PELs in all but one sample. The only other exceedences of the sediment PELs were arsenic and mercury concentrations at the uppermost sampling station on Fisher Creek (FSC-13000U) and arsenic in the Fisher Creek Tributary station (FCT-13000U). Sediment copper concentrations are lowest at the uppermost stations, and higher in the downstream portions of the traverse. The highest copper concentration in sediment was measured at station FSC-6000U.

SUMMARY

Based on gradient and stream channel characteristics, Daisy Creek (including the upper Stillwater River) was separated into five segments and Fisher Creek was divided into seven segments. In Daisy Creek, the lower two stream segments, which had stream gradients of 4% or less, were observed to have the greatest accumulations of sediment. In Fisher Creek, segments 6900 U to 0 (the Fisher Creek bridge), 0 to 1900 D, and 5500 D to 7552 D were observed to have the greatest accumulations of sediment.

Mapping indicated varying mixtures of gravel, fine to coarse-grained sand, and silt sediment accumulations along both stream traverses. Accumulations of fine-grained sediments (ie. fine-grained sand and silt/mud) observed in the furthest downstream segment of the Daisy Creek traverse (the Stillwater River) are inferred to result from high flows that deposited sediment above the active stream channel, and were commonly vegetated with willows. Fine-grained sediment accumulations in the lowest segment of Fisher Creek were of relatively minor occurrence and were commonly vegetated. These sediments were probably deposited during high flow events.

Analytical results for sediment samples collected during the traverse of each stream indicate that copper has the highest concentrations of the metals analyzed and exceeds the sediment PEL at all but one of the stations sampled. In Daisy Creek, copper exceeds the sediment PEL by five to ten times. In addition, arsenic, lead, and zinc exceed the respective PEL at some stations in Daisy Creek, and zinc exceeds the sediment PEL at the majority of stations in the Stillwater River portion of the traverse.

In Fisher Creek, only sediments at the uppermost station on Fisher Creek and the Fisher Creek tributary exceeded the PELs for metals other than copper. Copper and zinc concentrations generally are lowest at the uppermost portion of the stream and are higher at the downstream segments traversed. Copper concentrations in the lower segment of the stream exceed the sediment PEL by about six times.

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Maxim Technologies, Inc., 2004. 2004/2005 Work Plan, New World Mining District, Response and Restoration Project, Prepared for the USDA Forest Service Northern Region, June 2004.

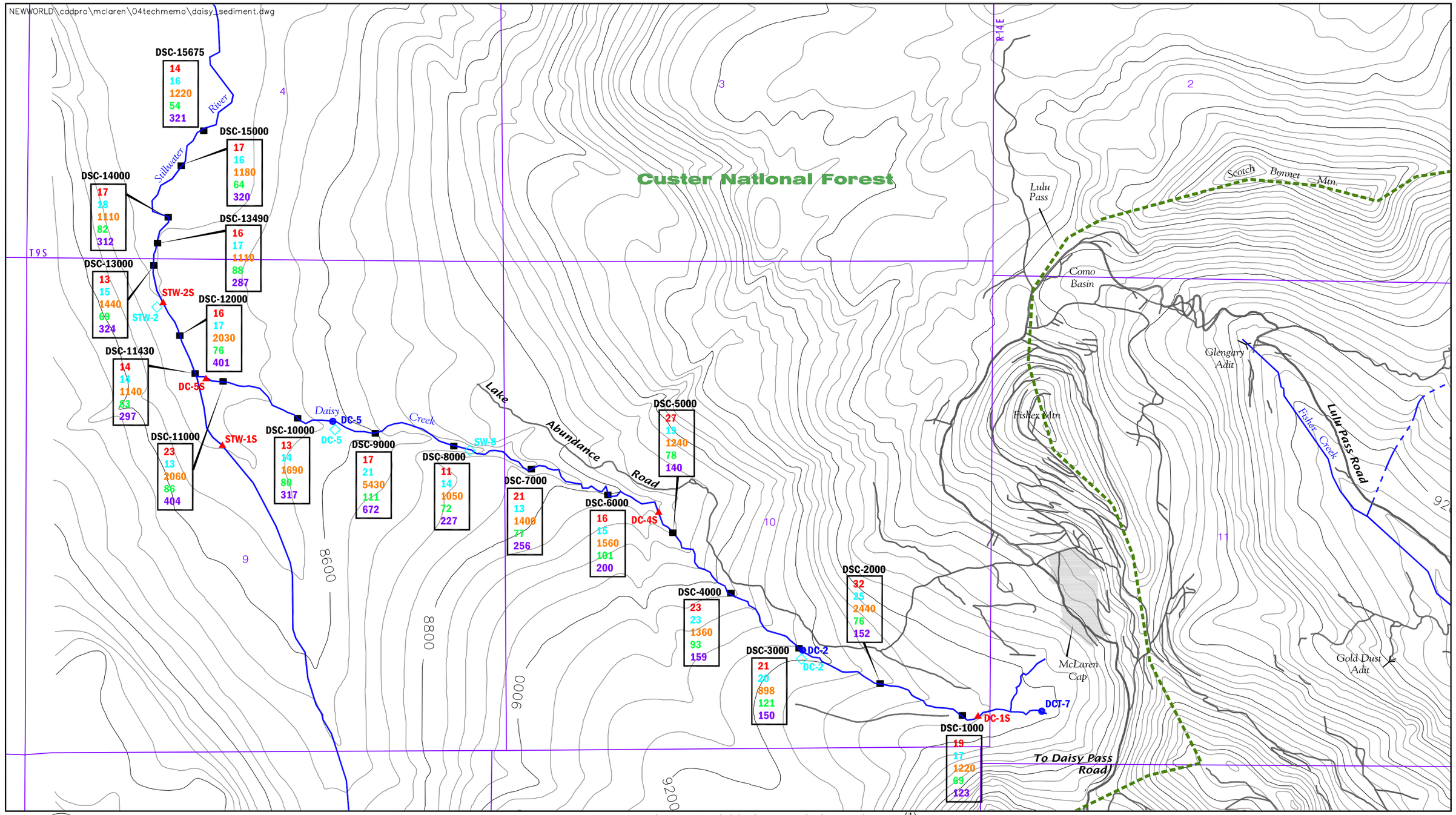
Maxim Technologies, Inc., 1999. Site-Wide Sampling and Analysis Plan. New World Mining District Response and Restoration Project. Appendix B of the Overall Project Work Plan. Final. Prepared for the USDA Forest Service, Northern Region, November 10.

NOAA SQUIRT, 1999. National Oceanic and Atmospheric Administration Sediment Quality Guidelines developed for the National Status and Trends Program.

ATTACHMENT A

FIGURES
CHARACTERIZATION OF SEDIMENT IN DAISY AND FISHER CREEKS
New World Mining District Response and Restoration Project

NEWWORLD\cadpro\mclaren\04techmemo\daisy_sediment.dwg



N

0 Feet 1000

Contour Interval 40 Feet

MAXIM TECHNOLOGIES 4560831-111

Cartographic feature files obtained from Montana State Library, Natural Resource Information System. 1:24000 Scale Data.

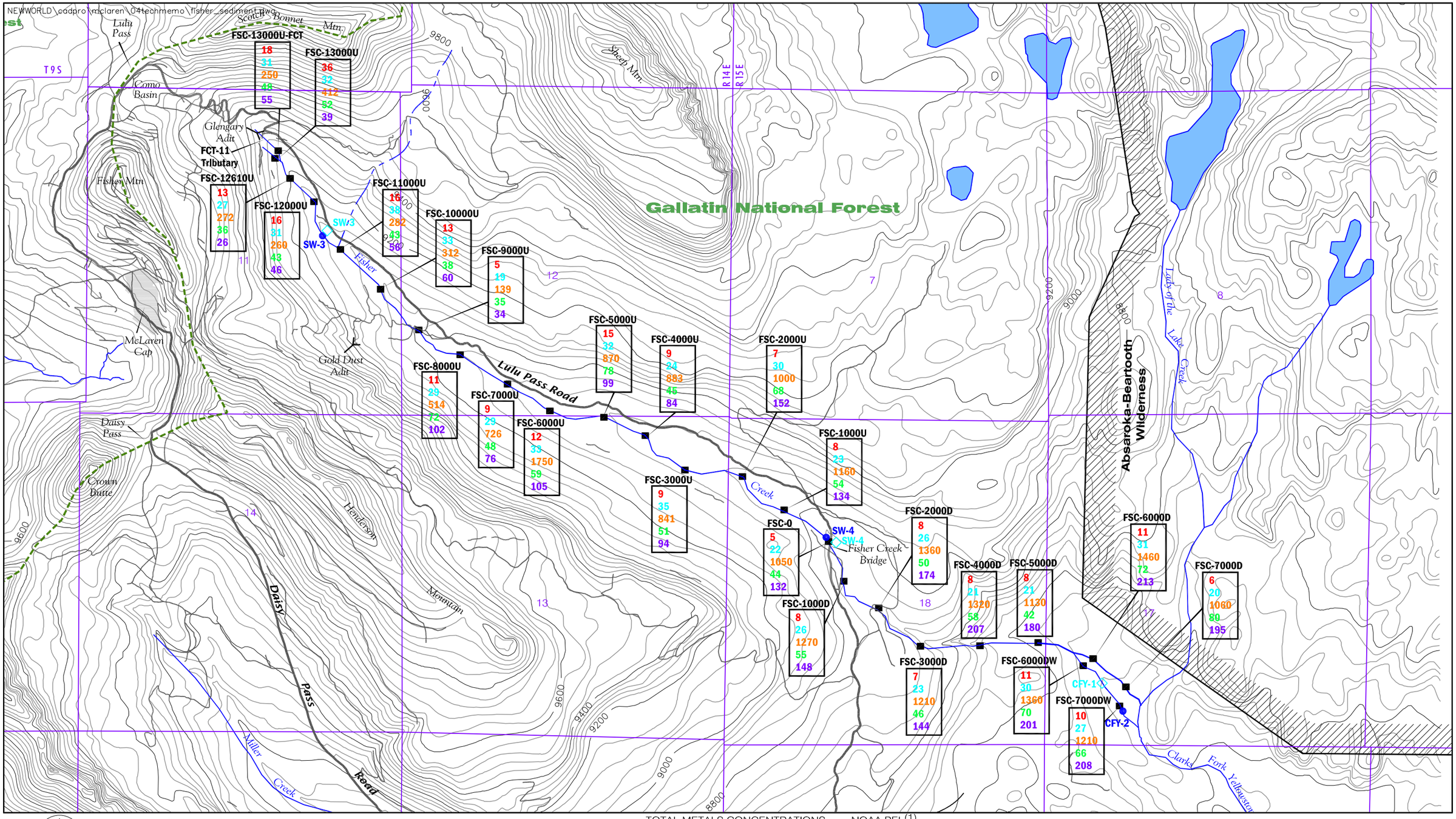
Sediment sample locations were located in the field using sub-meter accuracy GPS equipment if coverage available. If GPS coverage was not available, sample locations were estimated.

- County Road
- Unimproved Road
- National Forest Boundary
- Perennial Stream
- DC-2 ● Surface Water Station
- FSC-9000 ■ Sediment Sample Location
- DC-15 ▲ Hydrometrics (1994) Sediment Sample Location
- SW-8 ◇ CDM (1997) Sediment Sample Location

TOTAL METALS CONCENTRATIONS (milligrams/kilograms)		NOAA PEL[1] (milligrams/kilograms)	
21	Arsenic	17	Arsenic
20	Chromium	90	Chromium
898	Copper	197	Copper
121	Lead	91	Lead
150	Zinc	315	Zinc

(1) NOAA - National Oceanic and Atmospheric Administration Probable Effects Levels (PEL) for Sediment, NOAA, 1999 Sediment Quality Guidelines developed for the National Status and Trends Program.

Daisy Creek - 2004 Sediment Sample Results
New World Mining District
Response and Restoration Project
Cooke City, Montana
FIGURE 1



N

0 Feet 1500

Contour Interval 40 Feet

MAXIM TECHNOLOGIES 4560831-111

Cartographic feature files obtained from Montana State Library, Natural Resource Information System. 1:24000 Scale Data.

Sediment sample locations were located in the field using sub-meter accuracy GPS equipment if coverage available. If GPS coverage was not available, sample locations were estimated.

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(1) NOAA - National Oceanic and Atmospheric Administration Probable Effects Levels (PEL) for Sediment, NOAA, 1999 Sediment Quality Guidelines developed for the National Status and Trends Program.

Fisher Creek - 2004 Sediment Sample Results
New World Mining District
Response and Restoration Project
Cooke City, Montana
FIGURE 2

ATTACHMENT B

FIELD SKETCH MAPS
CHARACTERIZATION OF SEDIMENT IN DAISY AND FISHER CREEKS
New World Mining District Response and Restoration Project

ATTACHMENT C

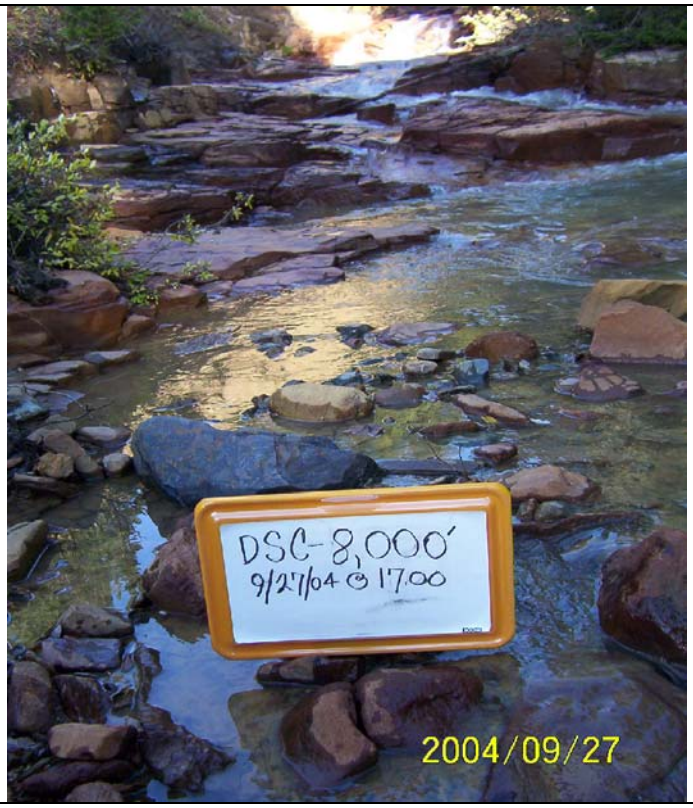
SELECTED SITE PHOTOGRAPHS
CHARACTERIZATION OF SEDIMENT IN DAISY AND FISHER CREEKS

New World Mining District Response and Restoration Project

NEW WORLD STREAM CHARACTERIZATION
DAISY CREEK DRAINAGE
Maxim Project #4560831

PHOTOGRAPH 1 Daisy Creek Station 3000 D

PHOTOGRAPH 2 Daisy Creek Station 6000 D



PHOTOGRAPH 3 Daisy Creek Station 8000 D

PHOTOGRAPH 4 Daisy Creek Station 9000 D

NEW WORLD STREAM CHARACTERIZATION
DAISY CREEK DRAINAGE
Maxim Project #4560831

PHOTOGRAPH 5 Daisy Creek Station 11000 D

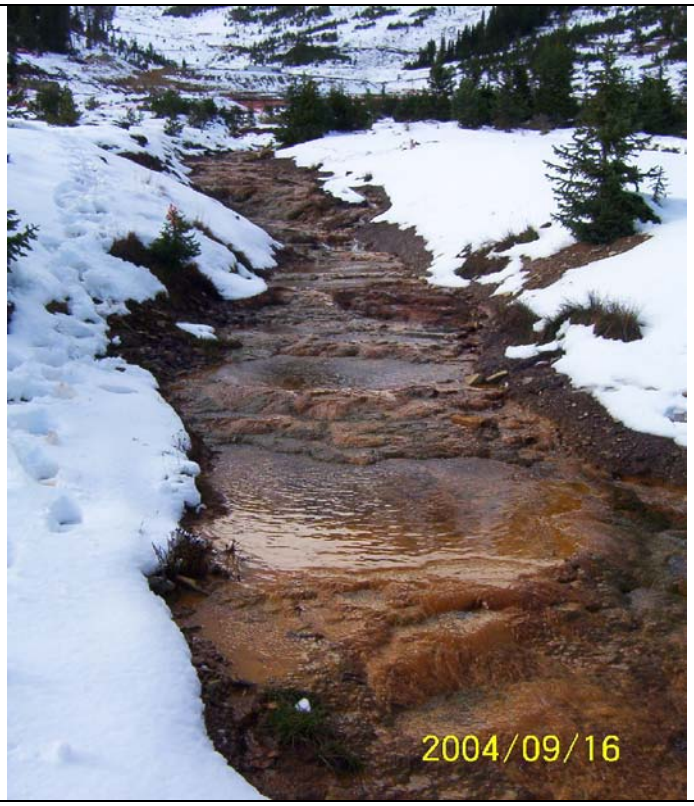
PHOTOGRAPH 6 Daisy Creek Station 11430 D

PHOTOGRAPH 7 Daisy Creek Station 13000 D

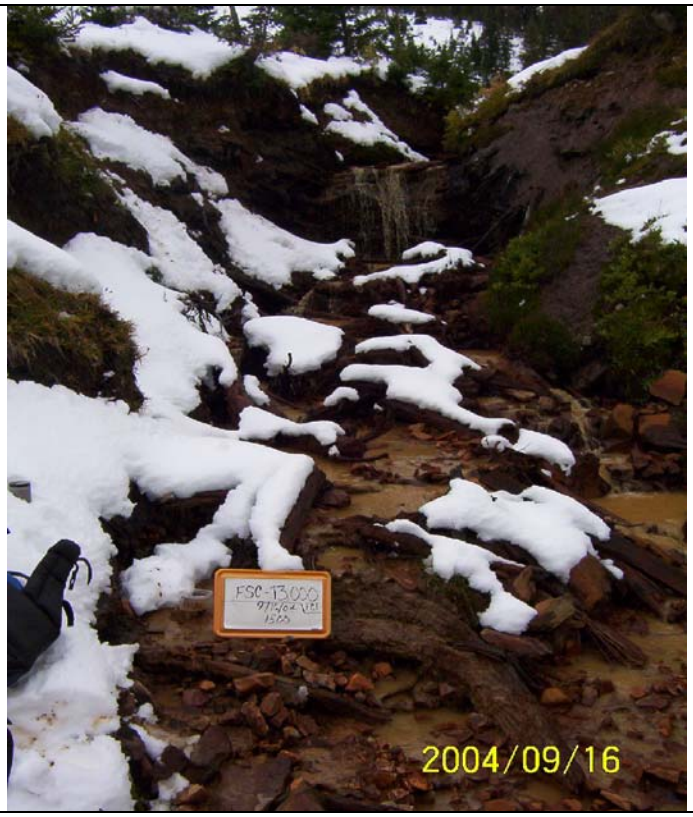
PHOTOGRAPH 8 Daisy Creek Station 15675 D

NEW WORLD STREAM CHARACTERIZATION
FISHER CREEK
Maxim Project #4560931

PHOTOGRAPH 1 Fisher Creek Station 13000 U



PHOTOGRAPH 2 Fisher Creek Station 12610 U



PHOTOGRAPH 3 Fisher Creek Station 13000 U-FCT, FCT–11 Stream Channel

PHOTOGRAPH 4 Fisher Creek Station 12000 U

NEW WORLD STREAM CHARACTERIZATION
FISHER CREEK
Maxim Project #4560931

PHOTOGRAPH 5 Fisher Creek Station 11000 U

PHOTOGRAPH 6 Fisher Creek Station 10000 U

PHOTOGRAPH 7 Fisher Creek Station 9000 U

PHOTOGRAPH 8 Fisher Creek Station 7000 U

NEW WORLD STREAM CHARACTERIZATION
FISHER CREEK
Maxim Project #4560931

PHOTOGRAPH 9 Fisher Creek Station 4000 U

PHOTOGRAPH 10 Fisher Creek Station 3000 U

PHOTOGRAPH 11 Fisher Creek Station 1000 U

PHOTOGRAPH 12 Fisher Creek Station 1000 D

NEW WORLD STREAM CHARACTERIZATION
FISHER CREEK
Maxim Project #4560931

PHOTOGRAPH 13 Fisher Creek Station 2000 D

PHOTOGRAPH 14 Fisher Creek Station 3000 D

PHOTOGRAPH 15 Looking Upstream of Fisher Creek Station 5000 D

PHOTOGRAPH 16 Fisher Creek Station 6000 D

ATTACHMENT D

LABORATORY ANALYTICAL REPORTS
CHARACTERIZATION OF SEDIMENT IN DAISY AND FISHER CREEKS

New World Mining District Response and Restoration Project