OPHIR PASS FEN RESTORATION PROJECT FINAL REPORT *Project Number OE PDA 12000000090*

Executive Summary

The goal of the Ophir Pass Fen Restoration Project was to restore the hydrologic and ecological functioning of the fen from historical mining and to engage the community in service-based education. More specifically, the project sought to (1) reduce metal loading from Ophir Pass Fen into Mineral Creek, (2) restore hydrological and ecological function of the area, (3) integrate meaningful service-based education on restoration ecology through volunteer and student participation, (4) enhance recreation experience, and (5) advance the state of practice for fen/wetland restoration in mountain environments. The collaborative effort combined efforts of Mountain Studies Institute, Michigan Technological University, San Juan National Forest, Durango Mountain Resort, Colorado Mountain Club, San Juan Citizens Alliance, and many volunteer partners. Funding was provided for this project by Colorado Water Conservation Board, National Forest Foundation, Durango Mountain Resort, Mountain Studies Institute, Colorado Mountain Club, and San Juan National Forest.

The Ophir Pass Fen restoration activities included the use of heavy equipment to grade 0.32 acres of bare fen, excavate 280-300 cubic yards of peat material to infill 200 linear feet of anthropogenic ditches, install three plywood check dams, and replace vegetation removed for construction. Hand restoration work involved installing five aspen Excelsior bale check dams, grading 0.2 acres of bare steep slope, installing 850 feet of sediment control wattles, placing over 6,000 pounds of mulch, transplanting over 1000 vegetation plugs, and laying 14,400 square feet of erosion control jute matting. In total, 12 partner organizations, 104 volunteers, and 790 volunteer hours were involved to complete the restoration. The extensive restoration efforts changed the topography, diverted groundwater into the fen, reduced erosion, revegetated bare areas, educated volunteers, and ultimately restored 0.52 acres of bare area enabling the rehabilitation of the fen's entire 3.62 acres through improved hydrologic connectivity beyond the site.

Number	Unit & Description	Number	Unit & Description
76	Number of volunteers	Over 1,000	Number of vegetation plugs planted
678	Number of volunteer hours	Over 6,000	Pounds of Excelsior mulch placed
12	Number of youth involved (under 18)	850	Feet of installed erosion control straw wattles
29,065	Number of people engaged through outreach: (estimated) 21,000- Durango Herald article 8,000- MSI/CMC/SJCA websites 65- Field tour visitors	14,400	Square feet of natural jute netting placed
12	Number of partners	0.52	Acres of slope graded
5	Number of people involved in monitoring	280-300	Cubic yards of deposited material excavated
28	Number of hours of monitoring	200	Linear feet of ditches infilled
7	Number of new wells installed	5	Number of Excelsior bale dams installed
22	Number of wells monitored	3	Number of plywood dams installed
14	Number of vegetation plots created	5	Number of man-made ditches altered
		0.52	Acres treated

Narrative Summary

Introduction to Project Goals, Work Accomplished and Significance

The goals for the restoration project, as presented in the Colorado Water Conservation Board (CWCB) proposal, included restoring natural hydrology, revegetating the existing bare areas, and installing erosion control while providing volunteer service opportunities. Specifically, the project sought to: (1) reduce sediment and metal loading from Ophir Pass Fen into Mineral Creek, (2) restore hydrological and ecological function of the area, (3) integrate meaningful service-based education on restoration ecology through volunteer and student participation, (4) enhance recreation experience, and (5) advance the state of practice for fen/wetland restoration in mountain environments.

Ophir Pass Fen is a unique alpine wetland characterized as an iron fen by its saturated acidic iron-laden soils and their ability to accumulate organic material known as peat. Being denuded and altered by mining activity, the fen is conspicuously located below a frequently traveled backcountry road linking the town of Silverton to Ophir and Telluride in southwest Colorado (Appendix A, site maps). It has been rapidly eroding and was listed as a high priority restoration project by the San Juan Fen Partnership assessment of fens (Chimner et al. 2010). Planning at the site began in 2007, formalizing a partnership between San Juan National Forest, Mountain Studies Institute, and Durango Mountain Resort. The work of this core group led to the restoration project that is the subject of this grant in the summer of 2012. Through the collaborative work of multiple partners and volunteer groups, 0.52 acres of fen restoration efforts were completed via handwork from June to October and heavy equipment construction in September. Erosion control treatments were installed, runnels and slopes were graded, mulch was placed, vegetation was added, man-made ditches were filled with excess material from the site, and ditch dams were installed in order to restore natural hydrology throughout the fen. In the spring of 2013, the partnership monitored the groundwater connectivity, watered vegetation plugs that were stressed by drought, and performed erosion control maintenance. The Ophir Pass Fen Report encompasses the goals, outcomes, community interaction, partner involvement, challenges, and conclusions regarding these restoration efforts.

Project Goals and Accomplishments

The five goals were addressed through a variety of restoration techniques and extensive collaboration with a myriad of twelve organizations. To reduce metal loading into Mineral Creek prior to construction and site disturbance, multiple erosion control treatments were conducted within the denuded areas of the fen. Excelsior bales (bales of aspen shavings) and straw wattles (cylindrical 9-inch diameter by 25-feet long erosion controls) were installed at the base of the steep eroded bare area (Appendix A) to collect any sediment before it entered the stream. Similarly, wattles were placed every 20-30 feet along the bare area and Excelsior bales were installed into existing runnels. The bare areas were graded and compacted to encourage groundwater and slow sheet flow instead of forming preferential flow paths that create runnels. A month after grading, installing erosion control, and mulching, no erosion features such as runnels and depressions were found. Minimal sediment had collected by the wattles or bales.

Eight months and one winter after the restoration activities, minimal erosion had occurred and some vegetation colonization had occurred from the plugs. Activities this summer included reinforcing erosion barriers, adding an additional Excelsior dam, mulching the site, and monitoring the groundwater wells.

It is premature to report conclusive results on hydrologic or ecologic functioning after only one year; however, initial observations indicate a change from prior conditions. Groundwater wells were monitored on three occasions post-construction in 2012 and four times in 2013. The wells showed a 6.3 centimeter (cm) average rise in the water table for wells below the restored areas as compared to a 1.4 cm average increase within reference wells. Moreover, prior to construction, the bare area's water table reached a maximum depth below the surface of 90 cm. After excavating and grading and with no measurable change in precipitation, the water was at or near the surface. The entire restoration area was then covered with mulch and jute matting (i.e., a natural netting placed to prevent mulch attrition and down slope creep). The higher groundwater levels in combination with mulching in the former bare areas should lessen temperature extremes, deter frost heaving, and encourage vegetation re-colonization (Chimner 2011). To further promote vegetative cover, seeds and vegetation plugs (i.e., small parcels of vegetation exhumed to the depth of the roots) were transplanted from healthy, dispersed locations to the denuded slopes.

Within two months, new growth emerged near the plugs and at the fringes of the restored area (Appendix B, Figures B-1 and B-2). Ditches 2-4, originally created to drain groundwater from the fen, were dammed in an effort to capture and redirect water towards the bare areas. Consequently, water visibly pooled behind the dams and flowed towards the lower reaches of the fen. Ditches 5 and 6 received plywood dams and were filled to create the same effect. Seven groundwater wells were added to the existing 15 wells and 14 vegetation plots were created, measuring the changes in cover and monitoring the fen's hydrologic and ecological function.

Ophir Pass Fen was restored with the collaborative efforts of several volunteer and student groups. The project introduced the groups to the unique ecosystem of a fen and provided service-based education on restoration ecology. Groups were exposed to the variety of restoration techniques that were implemented, including but not limited to: mulching, installing dams, installing erosion controls, and transplanting vegetation. In addition to learning restoration techniques, MSI staff guided volunteers through the formation of fens and their importance as a unique and rare ecosystem remnant from the last glacial period. The volunteers consisted of a variety of groups ranging from a youth camps (6-12 and 15-17 year olds) to college students and interns to Colorado Mountain Club and San Juan Citizens Alliance volunteers. Over 790 hours of volunteer work enabled the successful completion of the project.

The experience of recreationalists in the area was also enhanced both during the project and in years to come. Daily, visitors would stop and inquire about our efforts *("digging for gold or burying bones?"* they would ask*)*. Many of the volunteers reported that volunteering for restoration projects was recreation for them. In the future, we hope to fund permanent interpretive signs in this area discussing restoration ecology and fens. We also hope to enhance recreation in the area. Prior to restoration, 0.52 acres of barren land and five ditches were

incongruent with the surrounding natural landscape. This portion of land appeared bright orange, due to iron oxidation, and was noticeably eroding. As a result, the stark contrast and degraded environment was highly visible from the Ophir Pass Road and hiking trails above and below the fen. Although early in the revegetation process, the restoration will transition the area into its former natural state, thereby, providing recreationalists a chance to enjoy the improved visual resource.

Numerous methods were tested and implemented throughout the project, further advancing wetland restoration practices. Mulching and ditch plugs (i.e., Excelsior bale ditch dams) were tested in previous years by Dr. Chimner from Michigan Tech; these techniques were expanded and evolved in 2012. For example, Excelsior mulching had been placed and tested on small one meter squared plots, but it had never been tested in a large 0.52 acre application. The results over the next few years will show the efficacy and durability of the application. Ditch plug installation was improved via removing vegetation from the area before Excelsior bales were placed, and then using the vegetation and excavated soil to cover the dam (Appendix B, Figures B-3 and B-4). The result was an effective water barrier, less impact on the area's vegetation, and a more natural aesthetic. Construction was used to excavate deposited material mounds on the large bare areas to an in-situ layer of peat. As with the techniques of transplanting vegetation, grading slopes, mulching, and installing erosion controls, the method appears successful in restoring hydrologic/ecological functioning and could be used in future projects. However, these techniques must be monitored in the future to determine what was most effective and if the effectiveness continues over time.

Project Outcomes

The Ophir Pass Fen project included the use of heavy equipment to grade 0.32 acres of bare area, excavate 280-300 cubic yards of material, infill 60 linear feet of Ditch 5, infill 140 linear feet of Ditch 6, install three plywood dams within Ditch 6, and replace vegetation stockpiled during construction. Hand restoration work involved installing five aspen (Excelsior) bale dams, grading 0.2 acres of bare steep slope, installing 850 feet of sediment control wattles, placing over 6,000 pounds of mulch, transplanting over 1,000 vegetation plugs, and laying 14,400 square feet of erosion control jute netting. In total, 12 partner organizations, 104 volunteers, and 790 volunteer hours were involved to complete the restoration. The extensive construction changed the topography, diverted groundwater into the fen, reduced erosion, revegetated bare areas, educated several volunteers, and ultimately, restored 0.52 acres of bare area enabling the rehabilitation of the fen's entire 3.62 acres through improved hydrologic connectivity.

Intangible outcomes are difficult to predict in the first year following restoration, but the project's extent of outreach and construction are sure to have unquantifiable and potentially unanticipated impacts. For example, the precedence of the project and the lessons learned therein will influence future methods of wetland restoration. The restoration itself will undoubtedly alter the water regime and water quality in the area, which will impact unmonitored areas below and within the fen. Through the exposure and education of volunteers to restoration ecology processes, awareness of fens and other wetlands may spread to generate greater interest in proposed restoration projects. Three college interns spent a

combined total of over 860 hours working with the methods of this project and improving them as part of a pivotal experience in their career. With the complex system of a fen and the unpredictable influence of disseminated information, intangible outcomes will continue to arise.

Project Partners and Community Impact

The broad spectrum of partners involved in the Ophir Pass Fen project helped to generate interest in the project and impact numerous communities at multiple scales. Partners assisting in the restoration included Durango Mountain Resort (DMR), Michigan Technological University (MTU), Bureau of Land Management (BLM), San Juan National Forest (SJNF/USFS), AJ Construction, Colorado State University (CSU), SJNF Youth Ecology Camp, Colorado Mountain Club (CMC), San Juan Citizens Alliance (SJCA), Fort Lewis College, and United States Army Corps of Engineers. SJNF served as the official land owner and NEPA/permit compliance agent for the project. DMR provided matching funds, inkind construction expertise, and donated materials. MSI and MTU provided project management, grant tracking, monitoring and technical restoration expertise. Additionally, SJCA, CMC and MSI recruited and organized volunteer crews. AJ Construction operated the heavy equipment. BLM funded a fen internship. Army Corp of Engineers provided oversight. The multiple partners brought a diversity of volunteers from different Colorado communities (e.g., Silverton, Durango, Mancos, Telluride, Bayfield, Denver, and Golden). Moreover, the fen restoration and the education accompanying it reached a wide range of people like college students interning at the Mountain Studies Institute from across the United States, retirees assisting the CMC, DMR employees, SJNF's hydrology crew, students studying restoration ecology at CSU, children enjoying an ecology camp, staff friends, and many more. As a result, information about the project and fen ecosystems was dispersed throughout communities.

Media also assisted in the dissemination of information. Durango Herald, SJNF, SJCA, CMC and MSI covered the restoration through different means of media. On September 19, 2012 the Durango Herald posted the story on the front page of their newspaper (Appendix B, Figures B-5 and B-6) providing significant exposure to the Ophir project to 21,000 daily subscribers. SJCA and CMC included information on fens and their uniqueness as part of their volunteer recruiting tools, reaching over 8000 members electronically. MSI and BLM presented the results at the Animas River Stakeholders Group and county commission meetings. MTU presented the project at the International Peat Society conference in 2013. Additionally, MSI created a video overview of the project that is posted on their youtube.com channel and their Facebook page.

Project Challenges and Lessons Learned

The location of the Ophir Pass Fen provided the most challenges for restoration. The logistics of hauling materials, mobilizing construction equipment, and accommodating volunteers was innately difficult since the project was located four miles up a backcountry four wheel drive road at 11,500 feet. At that altitude in the mountains, the site was subject to variable weather conditions including intensive sun, lightning, high winds, hail, and heavy rain. Also the fen lies on a steep sloping hill dominated by undulating topography. These conditions slowed restoration work at times and also attributed to volunteer attrition throughout the day.

The extreme setting caused some difficulty in planning and implementing restoration techniques. For example, 0.2 acres of the bare area was too steep to grade using heavy equipment; therefore, hand work was used. Also, different erosion gullies and paths would emerge following heavy storms even after implementing different erosion control method. Adjustments were continually made until the slopes were secured. Consequently, staff adapted quickly and effectively to best address these and similar arising issues.

For similar future projects, a flexible approach must be taken to adapt to the variability of the landscape and weather. For the Ophir Fen project, we proposed an interpretive sign to educate recreationalists passing by the project. However, due to the demands of the logistics, the sign never came to fruition. In future projects, a sign would be extremely useful to engage the community and spark their interest for the restoration.

Conclusion

Through the collaborative efforts of partners and volunteers, the Ophir Pass Fen Collaborative Restoration Project effectively changed the dynamics of the fen to restore it to a more natural condition and reduce heavy metal laden sediment delivery to Mineral Creek. With a more natural water regime and vegetation colonization of the bare slopes, the future fen may resume carbon sequestration in the form of peat accumulation. Simultaneously, the project engaged surrounding communities, educated them about unique ecosystem in their neighboring mountains, and generated new collaborative partnerships through the process. We will continue to maintain this restoration site and continue to revegetate the area, which will likely take 5-10 years. We aspire to continue to engage the communities surrounding the fen in restoration activities and service-learning opportunities.

References

Chimner, R. A., D. J. Cooper, and J. M. Lemly. 2010. Mountain fen distribution, types and restoration priorities, San Juan Mountains, Colorado, USA. Wetlands 30:763-771.

Chimner, R.A. 2011. Restoring sedges and mosses into frost heaving iron fens, San Juan Mountains, Colorado. Mires and Peat 8: Art. 7. (Online: http://www.mires-and-peat.net/map08/map_08_07.htm).

Mountain Studies Institute. 2012. "Durango Mountain Resort Wetland Mitigation and Monitoring Plan at the Chattanooga Fen and Ophir Pass Fen. 2012 Monitoring Report, Permit Number 200175166, Mitigation Project ID: SPK-200175166." Submitted to U.S. Army Corps of Engineers November 2012.

Appendix A Project Maps: Project Location and Construction Plans

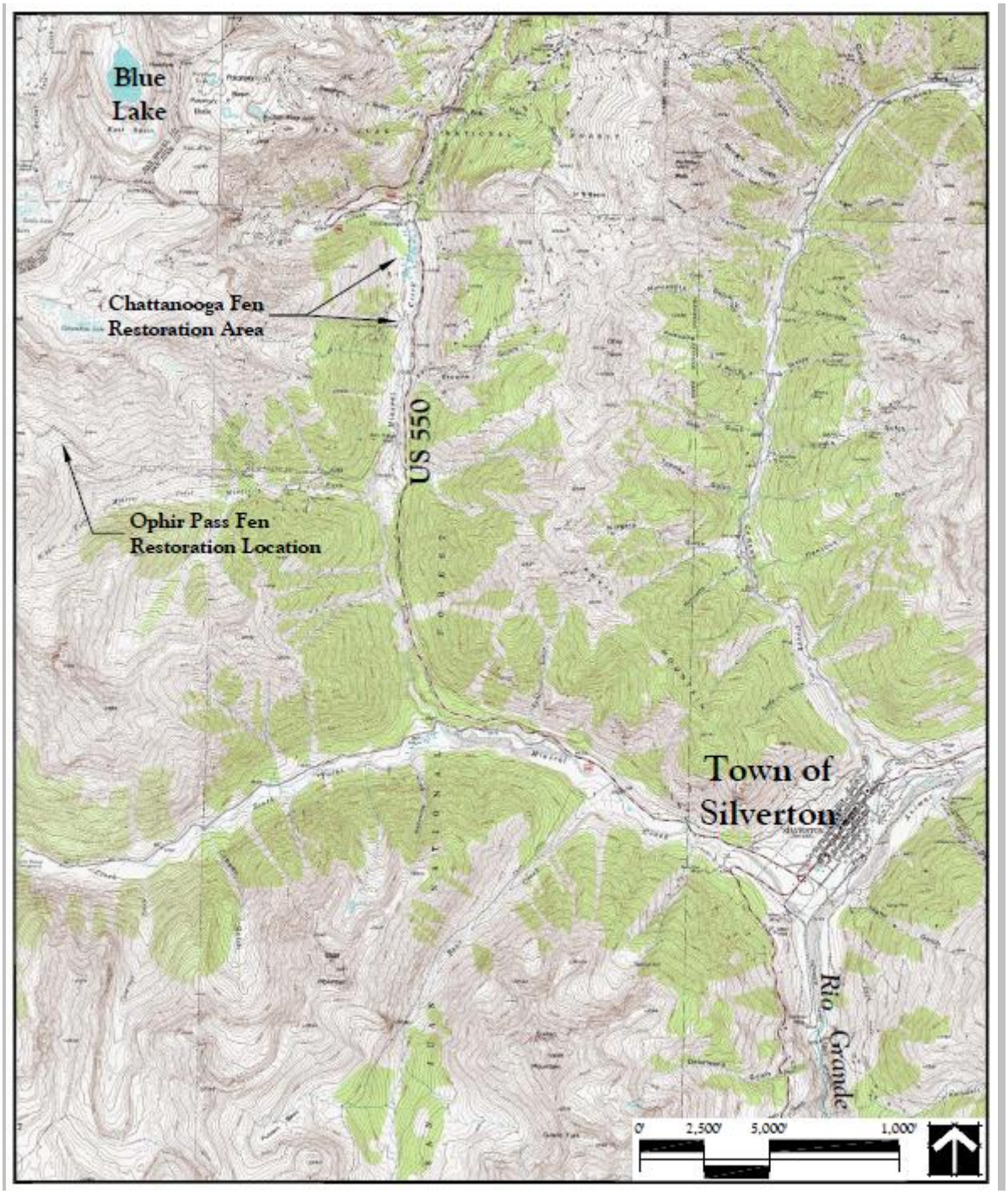

Figure A-1: Project location map
Source: original figure from Sugnet and Moore 2008 Mitigation Plan

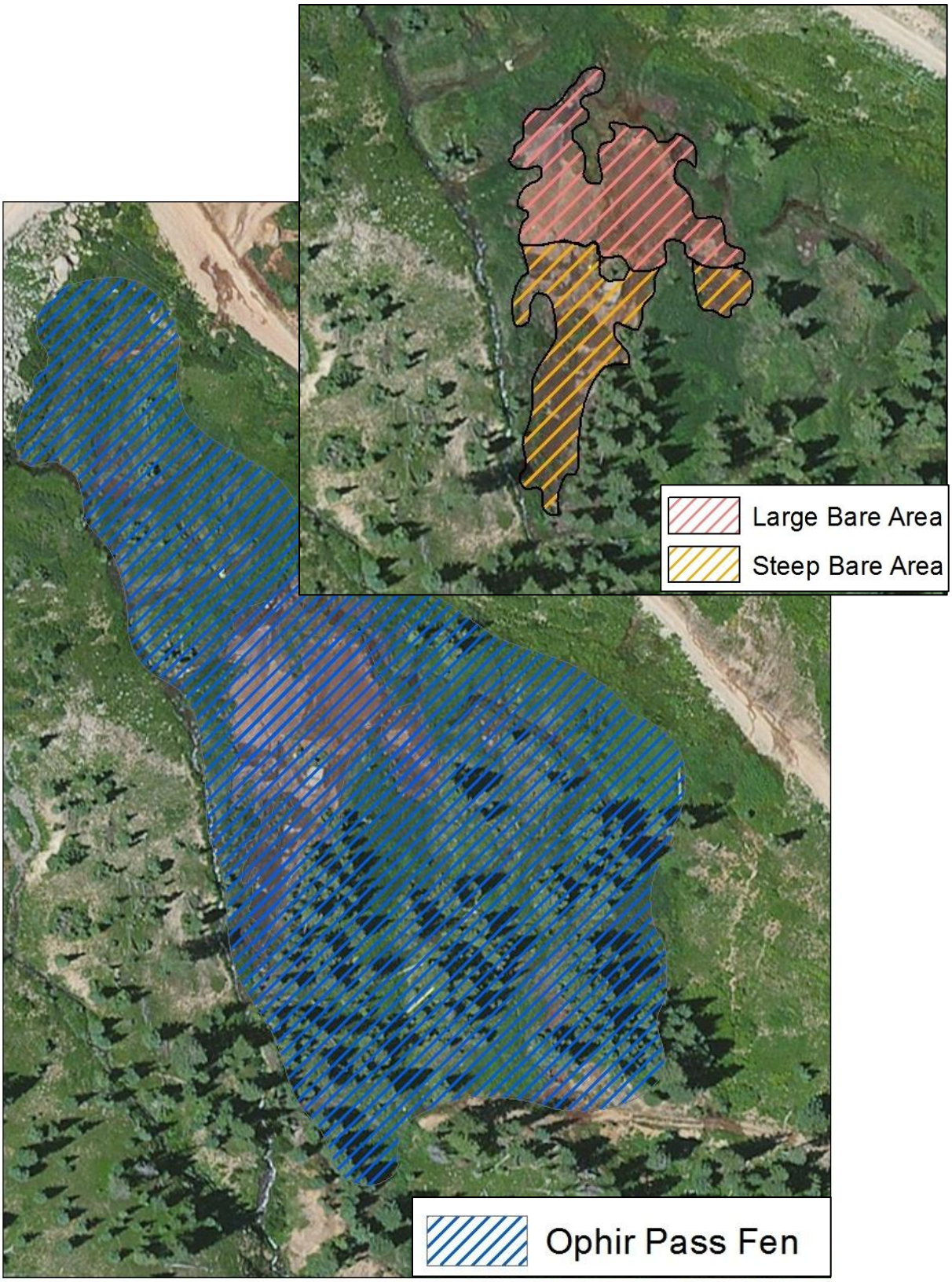

Figure A-2: Ophir Pass Fen perimeter and delineation of bare areas

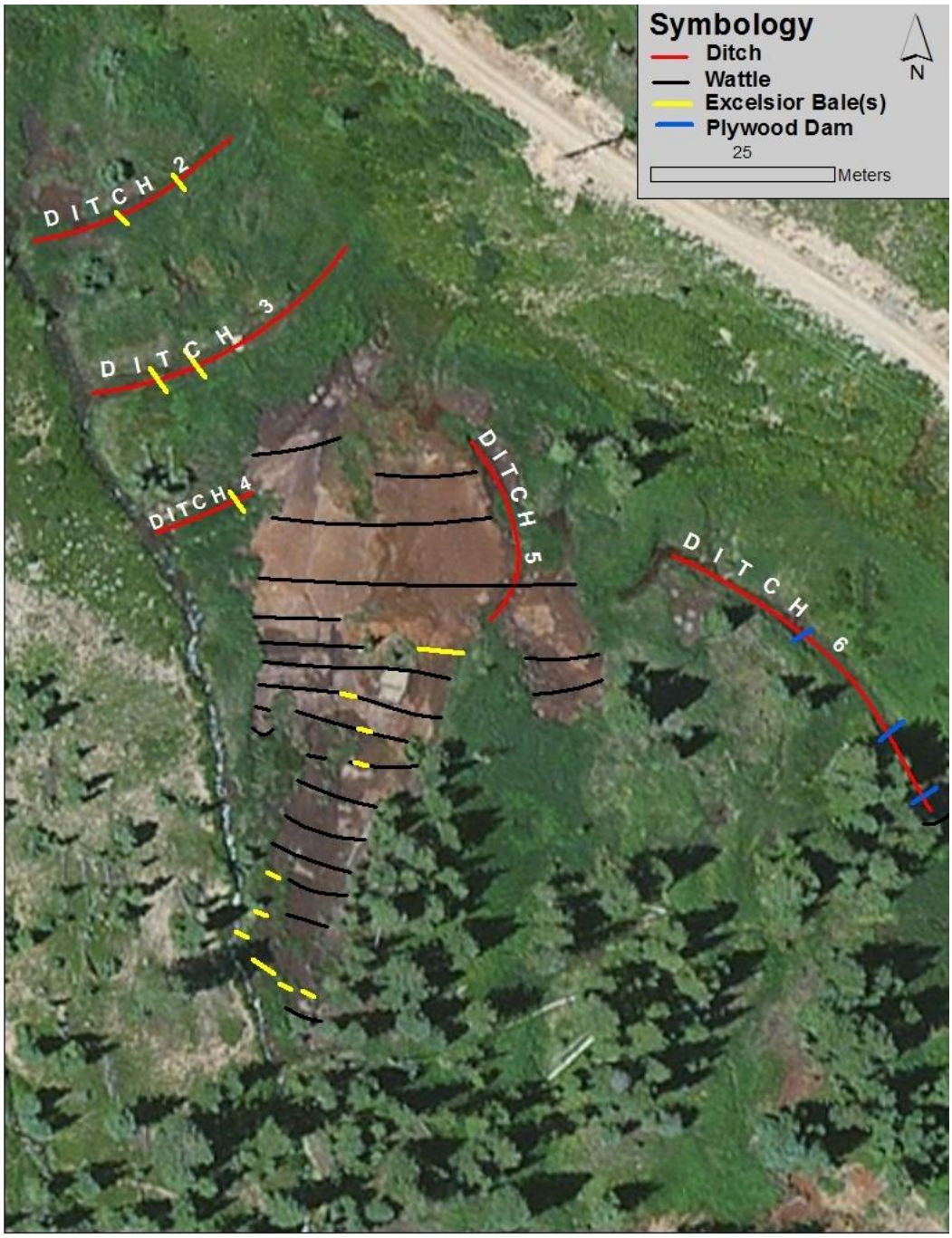

Figure A-2: construction plan

Appendix B: 2012 Pictures of Monitoring, Restoration Activities, and Media

FigureB-1: new moss growth below the mulch on the steep bare area (September 18, 2012)

Figure B-2: new sedge growth sprouting through the jute netting on the steep bare area (October 4, 2012)

Figure B-3: ditch 3 looking west (May 30, 2012)

Figure B-4: installation of a Ditch 3 Excelsior bale dam (July 20, 2012)

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'I just hope we got here in time'

Work starts to save rare peat basin eroding into Animas feeder creek

BY DALE RODEBAUGH
HERALD STAFF WRITER

OPHIR PASS – Indiscriminate, heavy-handed mining of an iron-rich peatland here at 11,500-feet elevation dried up a millennia-old mountain slope, leaving bare land and triggering erosion that carries debris into the middle fork of Mineral Creek. The creek joins the Animas River at Silverton.

"We don't know really when or why this occurred, but the site could have been exploited for peat or for its iron pigment," said Rod Chimner, a professor of wetlands-restoration ecology at Michigan Technological University, who is working with a team to restore the battered terrain." It could have occurred around the turn of the (20th) century, but it was definitely pre-1950."

The team of professionals and volunteers, with machinery and manual labor, is restoring the fen, a groundwater-sustained basin of peat that was formed 8,000 to 10,000 years ago as glaciers retreated at the end of the Ice Age.

"The peat – organic material such as leaves, flowers, grass and wood – accumulated over time," said Marcie Demmy Bidwell, executive director of Mountain Studies Institute. "The material doesn't degrade as long as it remains in an anaerobic state.

"Fens are important because they store clean water and they sequester carbon," Bidwell said. "If a fen dries up, it releases greenhouse gases."

The strata revealed by a 2-meter-deep assessment pit dug by team members chronicles how the peat basin developed over

See BASIN, 8A

JERRY MCBRIDE/Durango Herald photos

Rory Cowie, right, with Mountain Studies Institute, and Tim Cutter, an intern with the institute, work on erosion control at a peat basin on top of Ophir Pass.

To help

Mountain Studies Institute is looking for volunteers to plant sedge on a rehabilitated fen on Ophir Pass on Saturday and Sunday. Call 382-6908 for information.

A portion of the fen on a steep slope near the top of Ophir Pass has been restored.

Figure B-5 : Durango Herald's September 19, 2012 coverage of the restoration project

Additional outreach materials, including a time-lapse video of the project can be found through MSI's Youtube channel or our website, at www.mountainstudies.org.

Basin: Degraded peat releases greenhouse gas

Continued from 1A

thousands of years, Bidwell said.

As a trackhoe moved and smoothed dirt, Bidwell pointed to where patches of bare earth had been exposed and where ditches used by peatland exploiters carved channels that encouraged erosion.

After the area is prepared, volunteers place wattles of wood shavings to slow runoff of precipitation. Next will come insulating mulch, and then plugs of Carex aquatilis sedge, a tufted grasslike plant, will be placed at intervals.

The fen project is funded by grants from the Colorado Water Conservation Board, the U.S. Forest Service, Purgatory at Durango Mountain Resort and the National Forest Foundation. Volunteers are from the Mountain Studies Institute, Colorado Mountain Club and San Juan Citizens Alliance.

"This project is notable for several reasons," Bidwell said. "It's an iron fen, it's at high elevation and it's steep terrain."

An iron fen is one where the predominant mineral is iron, Bidwell said. The water in most fens is mineral-neutral, she said.

JERRY MCBRIDE/Durango Herald

Marcie Demmy Bidwell, director of Mountain Studies Institute, plants plugs of grass from another part of the fen into the restored area near Ophir Pass.

"Iron fens are rare in the world," Bidwell said. "There are 13 iron fens in the United States and five are in the San Juan Mountains."

Team members will return next summer when the snow is gone to plant moss, Chimner said. He expects touch-up revegetation will go on for several years.

"Fen restoration is a hot topic in Canada, Indonesia and Scandinavia in relation to climate change," Chimner said. "When peat degrades, it releases greenhouse gases."

The U.S. Army Corps of Engineers requires five years of monitoring conditions in fen restorations, he said.

Climatologists are particularly interested in fens because they're storehouses of climatological data, Chimner said.

Peat holds evidence of climate change just as rocks, sediment, ice sheets, tree rings and coral do, Chimner said.

"Peat can contain diatoms, seeds and pollen that recreate past climate," Chimner said.

Peat dries out and degrades when it's outside its anaerobic universe, Bidwell said.

"I just hope we got here in time to save it," Bidwell said.

Figure B-6: Continuation of the Durango Herald's September 19th, 2012 coverage of the restoration project

Figure B-7: ditch 3 looking west (May 30, 2012)

Figure B-8: installation of a Ditch 3 Excelsior bale dam (July 20, 2012)

Figure B-9: Ditch 3 Excelsior bale hams holding water (August 2012)

Figure B-10: looking north and upslope at the erosion of the steep bare area (May 2012)

Figure B-11: looking south and downslope at the erosion of the steep bare area (July 2012)

Figure B-12: looking north and upslope at the steep bare area after grading occurred and wattles and partial mulch were laid (August 9, 2012)

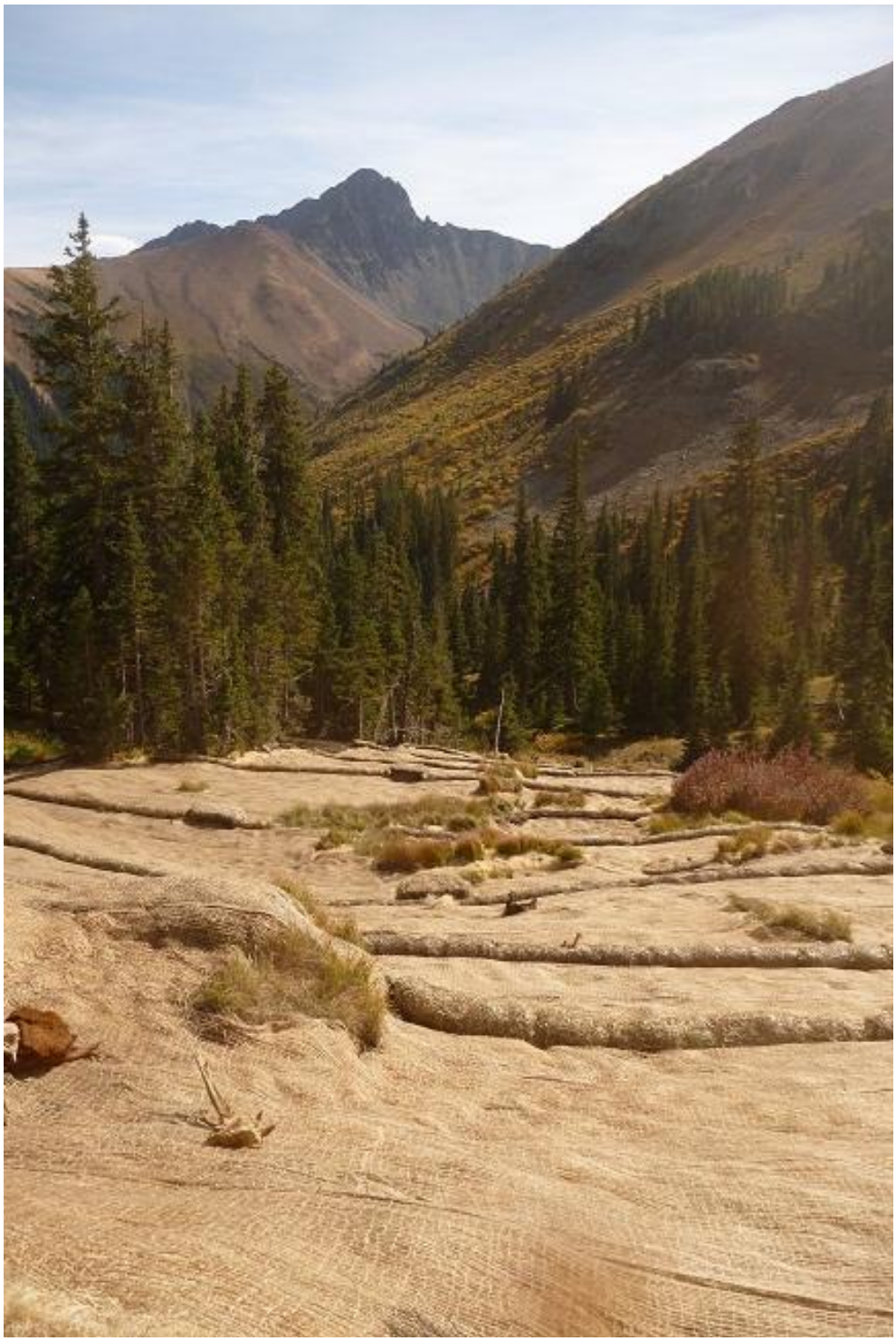

Figure B-13: looking south and downslope after all the steep bare area mitigation was completed (August 9, 2012)

Figure B-14: looking north and upslope at the western mineralized mound on the large bare area (background). The bales in foreground are the erosion control installed to catch sediment from heavy equipment construction (August 1, 2012)

Figure B-15: looking south and downslope at the western mineralized mound being excavated by AJ Construction (September 4, 2012)

Figure B-16: looking west across the newly graded large bare area after construction (September 5, 2012)

Figure B-17: pond created within Ditch 5 (September 7, 2012)

Figure B-18: AJ Construction removing vegetation as construction on Ditch 6 begins (September 4, 2012)

Figure B-19: AJ Construction filling Ditch 6 with material from the large bare area (September 4, 2012)

Figure B-20: AJ Construction installing a plywood dam and excelsior bales in Ditch 6 (September 5, 2012)

Figure B-21: Ditch 6 after infilling, installing plywood dams, and revegetating (September 5, 2012)

Figure B-22: installing Excelsior bale erosion controls with MSI staff, interns and a visually impaired student volunteer from University of Colorado (July 11, 2012)

Figure B-23: Gretchen Fitzgerald's and Silverton Ecology Camp mulching the steep bare area (August 7, 2012)

Figure B-24: MSI staff and Colorado Mountain Club volunteers mulching the steep bare area (August 18, 2012)

Figure B-25: Marcie Bidwell, Executive Director of MSI, congratulating Fort Lewis College and Colorado Mountain Club volunteers on a job well done (September 22, 2012)

Figure B-26: Ophir Pass Fen under the first blanket of snow (October, 2012)

Figure B-27: Ophir Pass Fen after spring melt (June 14, 2013)