

**PURGATORY VILLAGE LAND, LLC  
WETLAND MITIGATION AND MONITORING REPORT  
AT THE OPHIR FEN**

2022 Monitoring Report  
Permit No. 200175166

Mitigation Project ID: SPK-20017516



**Prepared for:**

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**Prepared by:**

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*In cooperation with Michigan Technological University*

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## Executive Summary

**Project Name and Corps Permit Number:** Purgatory Village Land, LLC - Wetland Mitigation and Monitoring Plan at the Chattanooga Fen and Ophir Pass Fen (permit #200175166).

**Name and Contact Information of Permittee and Consultant:** The permittee is: Purgatory Village Land, LLC (PVL), Mr. Gary Derck, 10 Town Plaza, #325, Durango, CO 81301, (970) 759-1524.

**Responsible Party for Monitoring and Date of Monitoring:** Mountain Studies Institute, on behalf of PVL, P.O. Box 426, Silverton, Colorado 81433, 970-387-5161. Monitoring and maintenance were conducted from June 16<sup>th</sup> through September 19<sup>th</sup> of 2022.

**Summary Project Information:** The Ophir Pass Fen project combined the use of heavy equipment and hand work to grade 0.32 acres of bare area, infill 200 linear feet of ditches, install three plywood dams, and transplant and seed 0.53 acres of native vegetation. Ultimately the project will restore the hydrologic regime (3.62 acres), reduce erosion and sedimentation into Mineral Creek, and revegetate 0.53 acres of exposed bare peat. Combined with the Chattanooga Fen restoration, PVL will restore 5.89 acres of fen wetlands (credit of 2:1 ratio).

**Location:** The Ophir Pass Fen's centroid location is at latitude 37° 50' 59" N and longitude 107° 46' 18" W. It is located 6.3 miles northwest of Silverton and 0.5 miles east of Ophir Pass in the Upper Animas River watershed within the San Juan National Forest Lands (Appendix A, Figure A-1).

**Directions to Mitigation Site:** From Silverton, Colorado, travel north on Highway 550 approximately 5.4 miles to Ophir Pass Road on the left. Follow the four-wheel drive road for 3.6 miles. The fen is situated downslope from the Ophir Pass Road intersection with the Opus Hut road.

**Mitigation Site Construction:** In 2012, construction occurred on September 4<sup>th</sup> - 5<sup>th</sup> and handwork activities occurred from July 12<sup>th</sup> to September 30<sup>th</sup>. The equipment graded 0.32 acres of non-vegetated area, infilled 60 linear feet (LF) of Ditch 5 and 140 LF of Ditch 6, installed three plywood dams within Ditch 6. Hand work installed five ditch plugs(dams), graded 0.2 acres of bare steep slope, installed 850 LF of sediment control wattles, placed over 6000 pounds of mulch, transplanted over 1000 vegetation plugs, and installed 14,400 square feet of erosion control jute matting. In 2017, in the bare area, 300 LF of wattles were replaced, erosion controls were dredged, and 500 greenhouse-propagated *Carex* plugs from local seed and 100 *Deschampsia cespitosa* and *Calamagrostis canadensis* (50 of each) were planted. No activities were performed in the Ditch 6 area. In 2018, 1,379 vegetation plugs were planted: *Calamagrostis canadensis*, *Carex aquatilis*, *Carex microptera*, and *Carex norvegica*. In 2019, 1,000 greenhouse propagated vegetation plugs of *Carex aquatilis* were planted, and one bale of excelsior was installed to improve erosion control and 300 LF of wattles were replaced. In 2020, 22 small mats of vegetation were transplanted and two one-meter-squared experimental plots were seeded with *Deschampsia cespitosa*. In 2021, approximately 350 greenhouse propagated vegetation plugs of *Carex aquatilis* were planted, one bale of excelsior was installed to improve erosion control and 240 linear feet of wattles were replaced, erosion control structures were maintained (dredged with hand tools), and 81 bog birch saplings were planted. In response to the September 16<sup>th</sup> wildfire, jute mesh was installed on the slope within the burned area on September 25, 2021. In 2022, an additional 54 bog birch were planted, approximately 180 sedge plugs were planted, and 12 pounds of seed were spread in the burned area of the fen. Excelsior "blankets" were installed over the seeded

area to protect the seed, and the jute mesh that was originally installed in 2021 was used to tack it down. An additional 200 linear feet of wattles were installed to replace those consumed in the 2021 fire, as well as 4 additional bales of excelsior. The baled excelsior was split apart and strategically staked down to address rills and erosion issues on the fen.

**Summary Statement of Status of Success of Mitigation Site:** The hydrologic success criteria were met. The vegetation cover expanded as transplanted *Carex spp.* plugs from previous years increased rhizome propagation. There was a greater than 50% survivor rate of the sedge and grass plugs planted in 2017 and 2018, and an 80% survivor rate of *Deschampsia cespitosa*. Survivorship of *Carex aquatilis* plugs planted in 2019 was approximately 50%. The vegetation criterion (75%) was met for plots associated with Ditch 6 mitigation (96.6%); the plots associated with the Ditch 2-5/bare area mitigation are increasing in vegetation although at a slower rate of growth (46.4%) Average vegetation coverage in plots across both areas was assessed to be 69.5%, a 1.5% increase from 2021.

**Dates of any Corrective Activities:** Replacement of erosion control materials that were consumed in the 2021 wildfire occurred on September 24, 2022.

**Specific recommendations for any additional corrective/remedial actions:** Continued assessment of wattles and dams. Continue to plant wetland plant seedlings and collect seed for propagation. Assessment of experimental *Deschampsia cespitosa* (tufted hairgrass) seeding plots that were established in 2020 were assessed in 2021. No successful establishment of *Deschampsia cespitosa* was observed. The San Juan National Forest provided approximately 200 bog birch (*Betula glandulosa*) shrubs were provided for planting in 2021. The success of these shrub plantings was assessed in 2022, and survivorship was over 50%. Additional bog birch plantings were done in 2022. The “Crystal” Wildfire burned approximately 0.3 acres within the fen on September 16, 2021, consuming the lowest six rows of wattles and destroying one groundwater monitoring well. In 2022, wet meadow/wetland restoration techniques were employed in the bare area affected by the “Crystal Fire” to help control erosion and water channelization. On June 28, 2022, the fen was visited by Dr. Rod Chimner of Michigan Technological University to assess the damage from the fire, the original author of the restoration plan for the Ophir Fen. He advised MSI staff to use dense seeding, covered with excelsior mulching and jute mesh. Seeding should be done in late fall, ahead of winter precipitation, to avoid summer seed predation by birds and rodents, as much as possible. MSI staff then made plans to implement these efforts during the National Public Lands Day event in late September. MSI staff sought advice on the seed mix from area seed expert and owner of Western Native Seed, Alex Tonneson. A mix of 4 species that occur in the fen was prepared, including: *Deschampsia cespitosa* (tufted hairgrass), *Calamagrostis canadensis* (bluejoint grass), *Carex aquatilis* (water sedge), and *Carex microptera* (smallwing sedge). Twelve pounds of seed were spread in the burned area. MSI also secured erosion control materials from Aspen Wood Products, which were transported to the site by Jim Hards. Excelsior “blankets” were installed over the seeded area to protect the seed, and the jute mesh that was originally installed in 2021 was used to tack it down. An additional 200 linear feet of wattles were installed to replace those consumed in the 2021 fire, as well as 4 additional bales of excelsior. The baled excelsior was split apart and strategically staked down to address rills and erosion issues on the fen. Ongoing and diligent efforts to reduce sediment transport

and restore sheet flow of water will need to be coupled with revegetation efforts in order for treatments to be effective in this area.

## **1.0 Project Overview of Durango Mountain Land - Wetland Mitigation and Monitoring Plan Permit #200175166- Ophir Pass Fen**

The report summarizes the eleventh year of monitoring following the restoration activities at the Ophir Pass Fen in the fall of 2012. The data and observations for this report were collected and compiled through the collaborative efforts of the Mountain Studies Institute (MSI) staff and partner Dr. Rod Chimner, restoration wetland ecologist at Michigan Technological University (MTU). MSI staff included: Anthony Culpepper and Amanda Kuenzi, Project Managers; and Jeremy May, Haley Farwell, and Carly Bonwell, Research Assistants.

The “Durango Mountain Land Wetland Mitigation and Monitoring Plan at the Chattanooga Fen and Ophir Pass Fen,” was originally approved by the U.S. Army Corp of Engineers (USACE) in 2008 (Sugnet and Moore 2008) and updated/approved in 2012. The primary objective is to ensure a “no net loss” of wetland functions within the Animas River watershed through the restoration of natural hydrology. A natural hydrologic regime will promote native wetland vegetation, thereby reducing sediment transport and slowing the erosion present before mitigation.

The Ophir Pass Fen restoration project involved grading bare slopes, infilling and/or damming ditches, and installing sediment controls of mulch, transplanted vegetation, and jute matting. During the summer of 2012, 0.2 acres of steep bare slopes were hand graded, check dams were built in three ditches, 850 feet of straw wattles were installed, and 13 excelsior bales (shredded aspen [*Populus tremuloides*]) were used for erosion control mulch on 0.52 acres of bare areas. Jute matting was used to cover 0.33 acres of steep slopes that was mulched (Map 5.1). Heavy equipment was used for two days to grade 0.32 acres of the large bare area, remove 280-300 cubic yards of material from the bare area and used to fill in 60 LF of Ditch 5 (Map 5.1) and 140 LF of Ditch 6 (Map 5.1). The heavy equipment was also used to install three plywood dams within Ditch 6 and replace vegetation that had been removed and stored prior to infilling the ditches.

Vegetation has been monitored for eleven years (2012-2022) and groundwater wells have been monitored for 14 years (2008, 2010-2022). The monitoring data includes wells installed during three different periods: 12 existing groundwater wells installed in 2007 (1-0 through 12-0), 3 groundwater wells associated with 2008 vegetation experiments (Plot 1-3, formerly R1-3), and 7 wells installed within the bare areas in 2012 (A1-A7). Two wells were selected as controls for documenting the hydrologic success criteria. Control wells were below the mitigated Ditch 4 (6-0) and Ditch 6 (12-0). Wells A-1 to A-7 covered the large bare area and wells below the ditches (7-0 and 8-0) are used to quantify how water table levels responded at the bottom of the restored wetland, Map 5.1. Wells 1-0 and 2-0 were chosen as reference wells for the entire site due to their presence in an undisturbed area, both pre and post mitigation, Map 5.1. Well 2-0 was seemingly destroyed in 2019 (we assume by sliding snow) and was replaced with a new well in the approximate same location using GPS coordinates in 2020. Well “Plot 3” was consumed in the fire in 2021, and has not been replaced.

In 2017, PVL, MSI, and USACE met to discuss the status of the Ophir fen mitigation area. At the onsite meetings, we reviewed the progress at the site associated with specific areas as the ditches and bare areas are progressing at differing rates and established subareas. The subareas of Ditch 6, Bare Areas, and reference areas are identified in Map 5.1. This report, data file, and appendices provide the monitoring results for hydrologic conditions and vegetation summarized in these subareas to evaluate the progress of each section individually and as a whole site. The subarea information will be useful in future maintenance and management decisions.

## 2.0 Requirements of Ophir Pass Fen Mitigation Project

The success criteria for Ophir Pass Fen were established within the “Durango Mountain Resort Wetland Mitigation and Monitoring Plan at the Chattanooga Fen and Ophir Pass Fen” report. Table 1 includes the requirements and fulfillment of the requirements for year five (full criteria found in Appendix F). This is now the eleventh year of monitoring the success criteria and no standards are defined for years after Year 5. We will reference the Year 5 success criteria standards as these are the ones that need to be met to fulfill the mitigation requirements. The complete monitoring data set has been submitted as an Excel file and additional maps, photos, and tables have been submitted as an appendix to accompany this report in the project record. Success criteria were met for Year 5 for hydrologic regime and invasive species for both the Ditch 2-5/bare areas and for Ditch 6. Vegetation cover is currently at 69.5% for all mitigation sites (increased from 68% in 2021), but in the Ditch 6 mitigation area cover meets or exceeds the 75% goal (including 100% desired species). Vegetation in the Bare Area continues to expand and increase; however, in 2022 cover was determined to be 46.4% (increased from 44.9% in 2021), which does not meet the Year 5 success criteria, though shows improvement. Vegetation for the Ditch 6 mitigation area meets the Year 5 goal at 96.6% cover (increased from 95% in 2021). At an altitude of 11,500 feet, the area is subjected to harsh conditions and a short growing period; therefore, slow revegetation is to be expected. As discussed in 2014-2021 reports, to speed the vegetation colonization, additional planting efforts through seeding and developing new methods for *Carex* plugs were recommended and have been implemented. These activities were performed in 2016, 2017, 2018, 2019, and to a lesser degree in 2020 and 2021. In 2022, revegetation using heavy seeding was employed for the first time, and we are hopeful this will increase vegetation in the burn scar area. See vegetation discussion for details.

**Table 1. Success criteria for Ophir Pass Fen\***

Standard	Remedial Measures if Standards Not Met
<b>Year 5</b>	<b>2022*</b>
<b>Hydrologic Regime:</b> Mitigation areas exhibit adequate wetland hydrology to support target species. Groundwater level should be within 2 standard deviations (+5 cm) of the mean of the reference sites within the Ophir Pass Fen.	Modify check dams, if necessary.

<b>Weeds:</b> Less than 10% cover of noxious plant species.	Increase maintenance operations as recommended by the restoration consultant.
<b>Vegetation:</b> 75% total ground cover within bare areas designated for revegetation; greater than 80% dominant/target species within revegetated areas (visual estimates). All other areas of the mitigation site will exhibit 80% dominance of target* species.	Additional seed or container plants as recommended by restoration consultant.

*\*2022 is Year 11 of monitoring. Since the success criteria are only defined to Year 5, the Year 5 criteria are referenced as the benchmark for analysis of 2022 (Year 11) metrics. Source: Durango Mountain Resort Wetland Mitigation and Monitoring Plan at the Chattanooga Fen and Ophir Pass Fen (Sugnet and Moore 2008).*

### 3.0 Summary Data

#### *Mitigation Work*

The goal of the Ophir Pass Fen Restoration Project was to restore the hydrologic and ecological function of the fen from historical mining and other disturbances. Specifically, the project aimed to: (1) restore hydrological and ecological function of the fen, (2) reduce metal loading from sediment eroding into Mineral Creek, and (3) advance the state of practice for fen/wetland restoration in mountain environments. The collaboration combined efforts of MSI, Michigan Technological University, PVL, National Forest Foundation, San Juan National Forest, Colorado Mountain Club, San Juan Citizens Alliance, and many volunteer partners and organizations.

Maintenance activities for 2022, Year 11, included: 1) inspecting past mitigation work and damages from the 2021 wildfire (i.e., erosional controls, ditch dams, ditch plugs, and transplanted vegetation), 2) dredging and replacing erosion controls, 3) planting approximately 180 greenhouse propagated vegetation plugs of *Carex aquatilis* and 54 bog birch saplings, 4) installing four bales of excelsior mulch and replacing 200 linear feet of wattles to improve erosion control, 5) dredging collected material from behind established erosion control structures with hand tools, 6) spreading 12 pounds of high elevation wetland seed mix (custom created for Ophir fen) in the burned area, and 7) installing excelsior blankets and jute mesh in the burned area. The sheep fencing was not installed in 2022 due to their absence from the allotment containing Ophir Fen. The bulk of the maintenance and planting work was done by 45 volunteers and 4 MSI staff during three fen restoration events. These volunteer events were funded, in part, by matching funds from the National Forest Foundation. All the 2022 maintenance activities occurred on and near the Ditch 2-5/bare areas. No mitigation activities occurred in or near Ditch 6.

After inspecting past mitigation work, the erosion controls outside of the burned area, ditch dams, transplanted vegetation, and greenhouse propagated plugs all appear to be effective. Erosion controls within the burned area that were compromised or consumed by the fire were not functioning to catch sediment and eliminate the development of runnels. However, the jute mesh that was installed in September 2021 as an emergency measure appeared to be holding some soil in place that would have otherwise washed downstream. Erosion controls were replaced with new material in 2022. Other dam and erosion control structures previously placed by PVL and MSI staff in 2016 were inspected. It was determined that these improvements were working and dredging was done with hand tools to improve their function, where needed.

We engaged five organizations to recruit volunteers to complete the maintenance and revegetation work:

- On June 21st, 2022, 14 members of the Wright Ingram Institute and 3 MSI staff members conducted fen restoration activities at Ophir Pass fen by planting bog birch. Dr. Rod Chimner, a wetland restoration specialist, also attended to teach a class on wetland restoration methods.
- On June 30th, 2022, 11 participants of Amigos International, and 4 MSI staff, distributed excelsior bales to the eroded burn site at Ophir Pass fen. Additionally, participants installed wattles to the burn area to further help erosion when sedges are planted in the area.
- On September 24th, 2022, MSI partnered with the high school program, Environmental Pathways (formerly called the Environment and Climate Institute), the Fort Lewis College Environmental Center, and a student-led Fort Lewis College organization called SEEDS, which endeavors to increase diversity and representation in the ecological fields. Participants, including MSI staff and 24 volunteers planted sedges and seeds to help restore the eroded section of the fen, installed erosion-control blankets, excelsior wattles, and other erosion controls.

Revegetation efforts are now being concentrated in the bare areas; with focus given to the steep section of the bare area. The goal is to have a viable and efficient option to speed up vegetation cover and enhance plant propagation. In 2018, to further improve the rate of revegetation, 50 plugs of *Deschampsia cespitosa* and 50 plugs of *Calamagrostis canadensis* were planted, which are both facultative species from the target species list (Appendix D). Survivorship of these plantings continues to be around 50%. Survivorship of the greenhouse propagated *Carex aquatilis* was approximately 50% in 2022. In 2019, it was assessed that *Deschampsia cespitosa* demonstrated a survivorship rate of over 80%. This species was selected as it may prove to be a faster spreading option than *Carex aquatilis* on the dryer bare slopes. This information drove the decision to install experimental 1-metered-squared seeding plots in 2020. The seed used for the experiment was acquired from Western Native Seed and was collected from Chaffee County at approximately 10,000 feet in elevation. Initially, MSI intended to install 8 of these plots, but the seed collection site also suffered from a lack of precipitation and only produced enough seed to cover 2 plots. These plots were inspected on August 25, 2021, but no plants had established in the plots. The reason for this is inconclusive, as the seed may not have been viable.

*Carex aquatilis* seedlings were purchased from a greenhouse in 2021. Unfortunately, most of the material was dead upon receiving it. MSI staff were able to salvage approximately 350 seedling plugs, which were planted on June 22 and August 14, 2021. MSI received a donation of an additional 180 *Carex aquatilis* plugs in 2022, and these were planted in the wetter regions at the top of the fen on September 24, 2022.

The San Juan National Forest planted about 25 willows (*Salix* sp.), cut from the fen, in August and September of 2017. These willow cuttings were planted in the wetter areas of the bare area located on the upper portion of the mitigation site. This was an attempt to see if willow propagation is possible on the site. In 2019, approximately 25% of the willow cuttings were surviving from 2017 plantings. However, in 2020, 0% of these willow cuttings were observed to survive. The 20



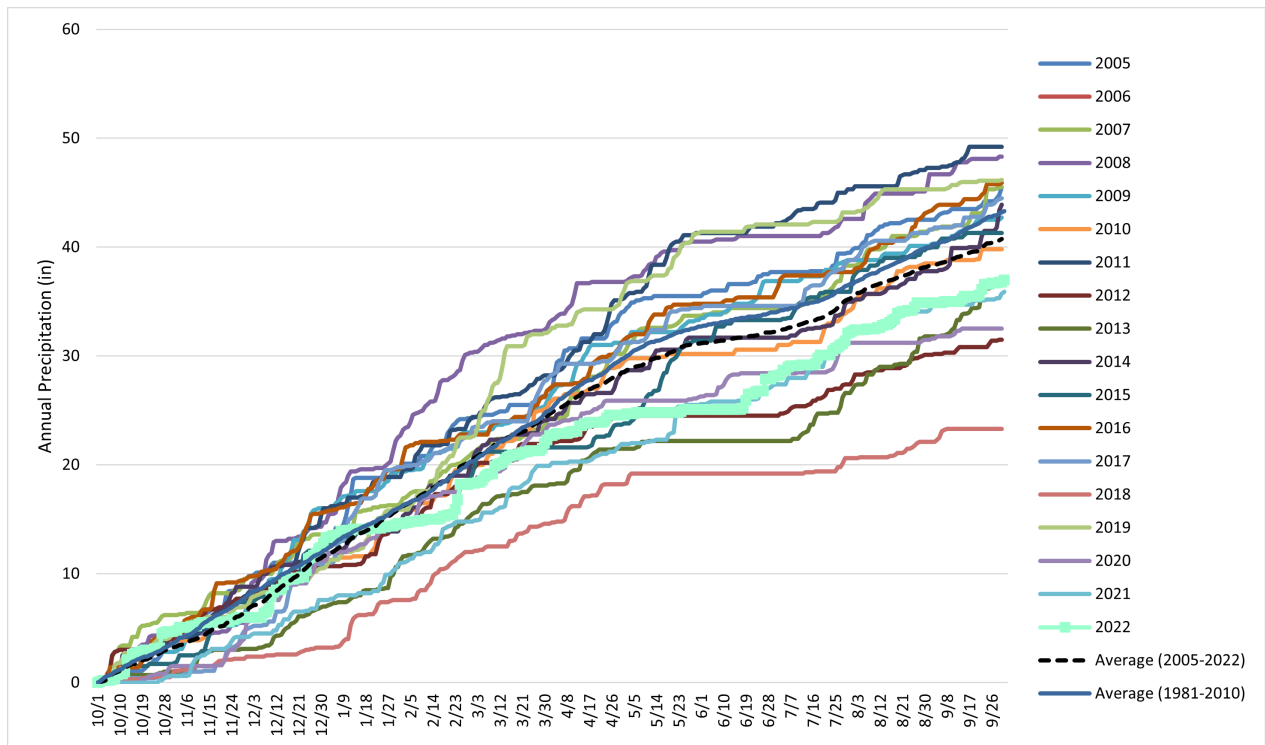
greenhouse-propagated willows that were planted in 2019, demonstrated about 50% survivorship in 2020 and 2021. Survivorship of the willows was reduced to 25% in 2022. The 81 bog birch planted in 2021 showed approximately 80% survivorship in 2022. If these plants continue to survive, it will be determined if greenhouse-propagated shrubs may be a better option for future revegetation efforts.

On September 16, 2021, the “Crystal” Wildfire burned approximately 0.3 acres of the Ophir Fen in short grass and peat habitat. The San Juan National Forest responded with full suppression efforts. The fire caused mortality of several trees, consumed the six lowest rows of straw wattles on the fen, and melted the groundwater monitoring well “Plot 3”. Official documentation of the wildfire from the San Juan National Forest is attached in Appendix G. Dr. Rod Chimmer assessed the burned area on June 28, 2022. His recommendation was to proceed with heavy seeding within the burn scar. Twelve pounds of seeds were spread on September 24, 2022.

### *Hydrologic Monitoring*

Accumulated precipitation in 2022’s water year (October 1st, 2021 – September 30th, 2022) was below average of the last 15 years (Figure 1), as reported at the nearest SNOTEL site 713- Red Mountain Pass (approximately 4.5 miles NNE of the Ophir site). Total accumulated precipitation for the 2022 water year totaled 37 inches, compared to an average of 40.9 inches from 2005-2021. Winter precipitation was slightly below average for the San Juan’s, but a warm and dry spring coupled with dust on snow events led the snowpack to completely melt off about three weeks before the average date of zero Snow Water Equivalent. A slightly above average monsoon season started in mid-June and delivered consistent and strong precipitation pulses through September, which helped to increase precipitation totals after the dramatic snow melt runoff in the spring. Peak flow in the Animas River also occurred about three weeks before the 1898 – 2021 median peak date and the peak flow was about 3,000 CFS in Durango in 2022. The Red Mountain Pass precipitation data are used to estimate the precipitation that may have fallen on site, with the understanding that due to high spatial variability in precipitation in the San Juan Mountains it serves as an approximation for the actual moisture at the Ophir site.

This monitoring report provides information on the eleventh growing season (Year 11) following restoration activities. The monitoring infrastructure at the site includes: 12 groundwater wells monitored consistently since 2008; three monitoring wells installed with 2008 experimental plots within the bare areas (wells Plot 1, Plot 2, and Plot 3; wells formerly known as R1, R2, and R3); and 7 wells installed within the previously large bare area transformed in 2012 (A1-A7, Map 1). Additionally, the gaps between each ditch dam (Dam 1, 2, and 3) were treated as wells because the height of the water table can be seen on the surface at each; monitoring these “wells” has been discontinued due to the degradation of the dams above ground (they have been gnawed on by rodents). In total, there are 22 groundwater wells installed at Ophir Pass Fen. However, well Plot 3 was destroyed in the 2021 “Crystal Fire” and has not been reinstalled. For 2022, hydrologic monitoring was conducted four times, June 16, August 1, August 30, and September 19.



**Figure 1. Accumulated precipitation from SNOTEL site 713, Red Mountain Pass**

*The figure shows the water years 2009-2022 with average accumulated precipitation calculated from 2005-2022*

Mitigation and reference wells were evaluated and reselected in 2014 to provide better representations of healthy and impacted fens. The reference wells that were selected, 1-O and 2-O, had no impact from the restoration construction, and were placed in a healthy section of fen. They were placed on the northeastern edge of the fen above the impacted Ditch 6 and away from the bare areas. In 2019, reference well 2-O could not be located, even with extensive searching using grid patterns and GPS coordinates by multiple staff during the 3 different site visits for groundwater well monitoring. (It was assumed the well was destroyed by sliding snow.) In 2020, a new PVC pipe was installed for reference well 2-O in the same location, based on GPS data. Previous reference wells, wells 7 and 8, were reconsidered in 2014 because their water levels could be impacted by mitigation activity. The mitigation wells, wells 6-O and 12-O, show the impact of the ditch plugs in Ditch 3 and ditch dams in Ditch 6, respectively. Well 11-O was removed as a mitigation well in 2014 due to its distance from Ditch 6 and the potential groundwater influence from areas other than Ditch 6. In 2014, wells 7-O and 8-O were no longer considered mitigation wells because they are in the graded steep bare area, which was regraded and altered during construction.

Using the Hydrologic Success Criteria, 100% of the mitigation wells were compliant in 2022 (Table 2, Figures 2A-2B, 3). Most wells showed a higher groundwater table (shallower depths) in 2022 than in 2021, especially in later in the season after the influence of the monsoon. This strong monsoon season produced large amounts of precipitation June – September, especially compared to recent years where the wells were dry (i.e. wells A5 and 8-0 in 2020). Reference well 2-0 was replaced in 2020, so the data only represents two water-years' worth of data. Using this hydrologic

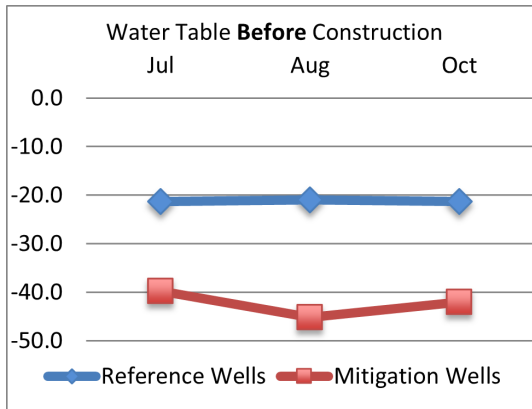
success level all wells meet the success criteria. The negative value of the difference between wells shows that the mitigation wells' average water table is higher than that of the reference wells (Figure 3 and Appendix B, Table B-1). Additionally, on two different occasions, large amounts of excelsior were distributed throughout the fen for water retention and erosion control. The "Crystal Fire" started at the base of the steepest part of the sloping fen on September 16<sup>th</sup>, 2021, and many of the excelsior bales were burned, jute mesh was installed across the slope on the volunteer event that had already been planned for September 25, 2021. The well known as "Plot 3" was destroyed in the fire. During this year's monsoon season, the jute mesh helped to minimize erosion. However, runnel formation and sediment/peat transportation was observed after large storm events. To prevent further erosion, excelsior bails and waddles were strategically placed throughout the slope and in channelized areas. Continued efforts to control erosion and promote revegetation will be needed to promote sheet flow and retention of water. In the coming years more data will indicate whether the sloping area of the fen is retaining water and promoting sedge growth. In its current state, the wells on the sloping part of the fen have not shown great improvement aside from normal monsoonal fluctuations of water table depth.

**Table 2. Groundwater measurements of reference and mitigation wells (cm)**

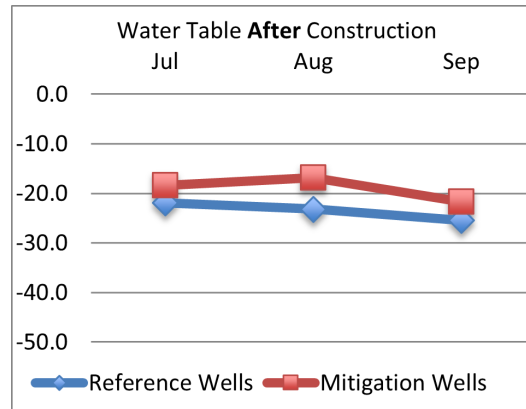
**2022 Hydrologic Success Table**

Well	June	July	Aug	Sept
<b>Reference Wells</b>				
1-O	-17.5	-6	-6.5	-14
2-O	-38	-19.3	-27.8	-37.3
Mean	-27.8	-12.7	-17.2	-25.7
Standard Deviation	14.5	9.4	15.1	16.5
Hydrologic Success Level (mean + 2 stdev + 5 cm)	-61.7	-36.5	-52.3	-63.6
<b>Mitigation Wells</b>				
6	-16.8	-16.5	-17	-17
% out of compliance	-267.5	-121.0	-207.5	-274.1
12	-18	-5.8	-10.5	-13
% out of compliance	-243.0	-528.6	-397.8	-389.2

*Note: Table 2 shows groundwater measurements (cm) at reference wells (1-0 and 2-0) and mitigation wells (6-0 and 12-0). The Hydrologic Success Criteria (Table 1) is set at the mean of the reference groundwater level plus twice their standard deviation plus 5 cm.*



**Figure 2A**

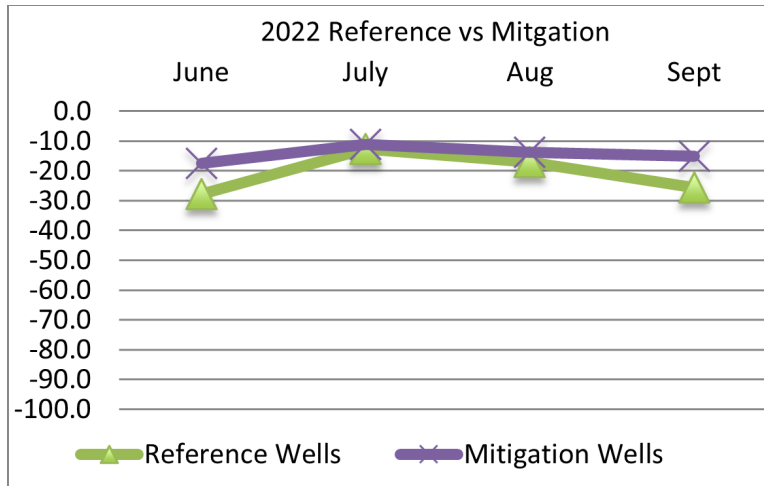


**Figure 2B**

**Figures 2A-2B. Comparison of average water table depths before and after construction**

*The graphs show the average water table depths (cm) for reference (1-0 and 2-0) and mitigation (6-0 and 12-0) wells for each month before and after construction. The points represent the average of all data from months during all the years of data before (2008-2012) or after construction (2012-2022).*

The large bare area’s hydrology is best measured with the A-1 to A-7 wells installed after construction in 2012 and the 7-0 and 8-0 wells directly below the large bare area. No wells existed within the large bare area prior to construction; hence, the water table data is interpreted to be at a level hospitable to wetland species (i.e., 30 cm below the surface or less) instead of levels prior to construction. The 2022 data show only two of the nine wells have an average water table below 30 cm (Appendix B, Table B-2). Dam 1, 2, and 3 were removed from Table B-2 as they have not been monitored since 2016 due to damage by rodents. We have observed that most of the wells, referenced here, have met or exceeded the 30 cm standard every year since 2012, with the exception of 2018 and 2020, which were very dry years. The 2022 data shows improvements in water depths, likely due to the precipitation during monsoon season, as shown by several wells that had greater water depths in 2022, but were dry in 2021 (Figure 3).



**Figure 3. Comparison of 2022 mitigation vs reference wells**

The graph shows the water table depths (cm) for reference (1-0 and 2-0) and mitigation (6-0 and 12-0) wells for each monthly monitoring event in 2022.

### Vegetation Monitoring

Visual inspections were conducted at the 15 vegetation monitoring plots established after site construction in 2012. The vegetation monitoring plots were established in areas that remained undisturbed and those impacted by mitigation efforts. These plots are grouped into two types (reference and mitigation areas, and three areas: 1) *reference areas* not impacted by mitigation (Plots A, B, L, and M), and 2) *mitigation areas*, divided as (a) *bare areas* that have been treated with restoration activities (Plots C, D, E, F, G, H, N, and O), and (b) *vegetated areas* whose hydrology may have changed after mitigation of Ditch 6 (referred to as Ditch 6 area, Plots I, J, and K), (Table 3 and Appendix E) (MSI 2012).

At each plot, cover estimates are visually estimated for each species within a one-meter quadrat (MSI 2012). Vegetation plots were surveyed on August 30, 2022 by Amanda Kuenzi and Anthony Culpepper, MSI botanists. Vegetation has continued to expand coverage across the mitigation areas. Averaged together, bare areas and Ditch 6 area have 69.5% cover (Table 3). When the mitigation areas are split into bare areas and the area below Ditch 6, the coverages differ substantially: bare areas at 46.4% (increased from 2021) and below Ditch 6 areas at 96.6% total cover (increased from 2021). The Ditch 6 area meets the success criteria for Year 5 of 75% (Table 1). While the bare areas have expanded, they remain well below the success criteria (Table 3 and Appendix F).

Visual inspections of vegetation planted in 2016-2021 showed moderate survivorship (~50%) including transplanted mats and plugs grown from local seed. Survivorship of nursery grown plugs was down from the previous year and this is likely due to the drought in 2020. Some vegetation was consumed in the 2021 wildfire, but showed recovery in 2022. The expansion of vegetation has accelerated near the perimeter of the bare areas and in areas that became saturated post-construction in 2012. Increased rhizome propagation from *Carex* spp. mats transplanted prior to 2015 was observed. Plugs planted in 2017 - 2019 are showing signs of rhizome propagation. In

addition to *Carex aquatilis* plugs, other species such as *Calamagrostis canadensis* are expanding naturally in these areas on the western side of the large bare area. Continued revegetation monitoring and experimentation with nursery grown plugs, and experimental seeding will be useful in guiding future revegetation efforts. As mentioned in previous reports, the rate of time required to reach this success criteria is likely unrealistic for a site that began barren, exists in harsh conditions, and has a short growing season. For reference, sedge plugs took five years before expanding rapidly at the lower elevation Chattanooga fen restoration area.

**Table 3. Comparison and change in total vegetation cover between years and plot types**

Year	Reference	Mitigation All	Mitigation Bare Area	Mitigation Ditch 6
	(%)	(%)	(%)	(%)
2012	100	31.8	0.4	70
2013	100	33.4	3.9	67.7
2014	100	34.8	4.6	71.7
2015	100	36.6	6.4	75
2016	100	41.5	9.3	88.3
2017	97.5	45.3	14.3	91.7
2018	100	52.7	24.6	97.6
2019	100	55.7	28.9	98.6
2020	91	61	41.8	93
2021	93	68	44.9	95
2022	94	69.5	46.4	96.6

All species were from the target list (Appendix D). The vegetation composition had few changes or shifts in plant species. Plots mostly show increases in *Carex aquatilis* and *Carex canescens*. Several plots show continued increases in *Calamagrostis canadensis*. In two plots (K and L) *Calamagrostis* seems to be in competition with *Carex aquatilis*, as its cover has decreased. Encroachment of spruce has been seen elsewhere on the site, particularly on the steep bare slope near the treed boundary. While trees were not included as a target species, and are neither a wetland obligate or facultative species, encroachment by forest/upland species may increase on drier portions of the site. Three new species were documented in 2018: *Juncus drumundii*, *Agrostis scabra*, and *Salix planifolia*. These species are considered either wetland obligate or facultative species by the US Army Corps of Engineers (USACE 2016) and are found in populations near the mitigation site. No new species were identified in 2021. The stake marking plot “N” was consumed in the 2021 wildfire, and was replaced using GPS coordinates in 2022.

The site was inspected for plants listed by the Colorado State listed invasive and noxious weeds on the USDA NRCS website (USDA 2012). No invasive species were observed in 2022.

## *Future Mitigation*

Future maintenance will focus on erosion control, revegetation, and assessment of and response to the area burned by the 2021 “Crystal” Wildfire. Erosion control wattles that were replaced in the area where the fire consumed them will be closely monitored to ensure that they have been installed effectively. The wattles upslope of the burned area will continue to be dredged and reset annually, in the bare areas, to prevent erosion until more vegetation cover is achieved. Replacement of wattles will continue as they further deteriorate. Activities that expand the spread of vegetation and mosses will also assist in meeting the vegetation criteria and minimizing erosion. It is recommended that continuing the practice of reduced foot traffic in the mitigation areas is needed for term success of the revegetation efforts. Revegetation focus should continue in areas that have seen slower growth and less success. The response of the vegetation on the lower slope in the burned area will be monitored. Heavy seeding had not been utilized prior to 2022, and we look forward to seeing the results. *Deschampsia cespitosa* has shown high survivorship in the past. Although the seeding experiment initiated in 2020 was unsuccessful, seeding experimentation should continue to find species that will germinate in wetter years. Additionally, methods for collection, germination, and propagation of these species and willow stakes should continue to be explored. Additional mulching in future years may be needed to maintain the proper growing conditions that are conducive to plant growth from seed.

## **4.0 Conclusions**

The eleventh year of visual inspections focused on improving erosion controls that had been compromised in the 2021 wildfire, dams impounding water, and moderate survivability of previous transplanted vegetation. Groundwater well monitoring revealed improvement in the water table from the previous year, with almost all wells showing conditions conducive to wetland vegetation.

Hydrologic conditions (Table 2) and vegetative cover continued to improve in 2022, though data for the reference wells was irregular. The vegetation criterion, 75% ground cover, was met in subareas of the site near Ditch 6 subarea, Table 4. Vegetation within the bare area’s expanded to 46.4% from 44.9% in 2021. *Carex* spp. seedlings that were planted in 2016, 2017, 2018, and 2019 have survived and are expanding. Transplanted vegetation mats planted in 2020 showed moderate survival. No invasive species were observed. Due to the volunteer day that was planned for September 25, 2021, MSI and our volunteers responded immediately to the September 16<sup>th</sup> wildfire by installing jute mesh to control erosion in the burned slope, which was somewhat effective. The erosion controls and seeding done on September 24, 2022 will greatly augment the restoration on the burned slope.

Monitoring of the nursery propagated plugs and bog birch planted in 2022, the seeding, as well as previous plantings, will improve our understanding and help to determine which of the past mitigation techniques have been the most effective. Specifically, maintenance of the erosion controls and continued revegetation efforts, in the bare areas, in the form of planting nursery-

propagated vegetation plugs, transplanting, seeding, and/or utilizing willow stakes and bog birch will contribute to the success of the restoration.

**Table 4: Comparison of success criteria of the Ditch 6 area and the Ditch 2-5/Bare Area**

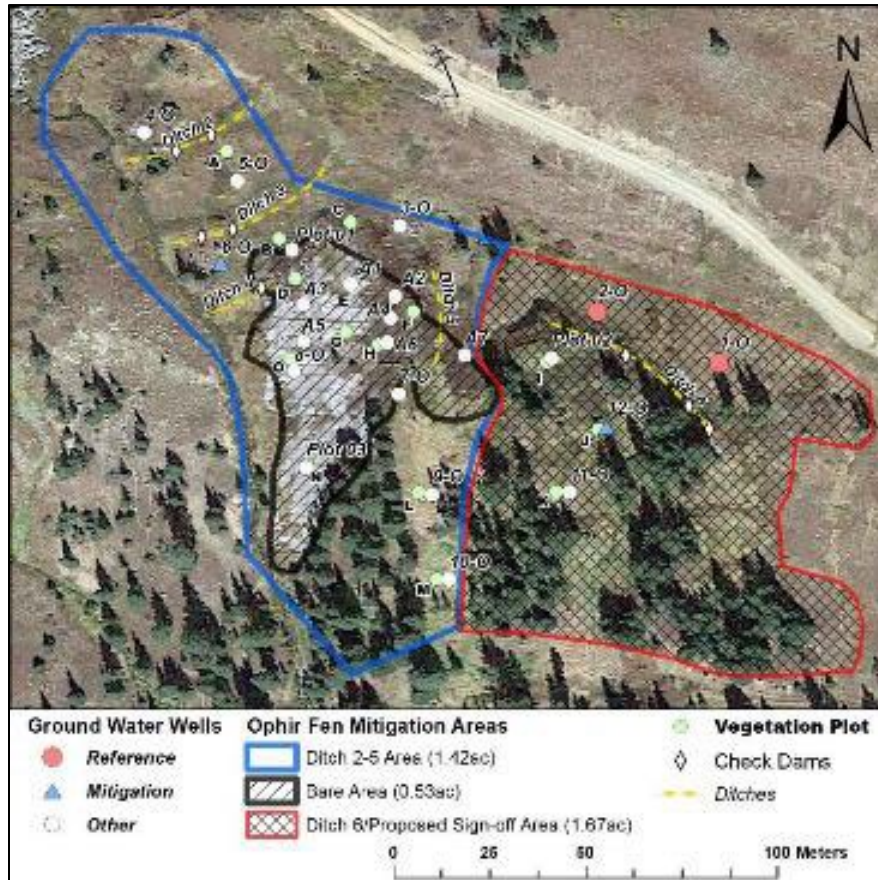
<b>Phase</b>	<b>Hydrologic Regime (Year Achieved)</b>	<b>Vegetation (Year Achieved)</b>	<b>Invasive species (Year Achieved)</b>
<b>Ditch 6 Mitigation Area</b>	Year 11 (100% compliant since 2013)	Year 11 (100% compliant since 2013)	Year 11 (100% compliant since 2013)
<b>Ditch 2-5 &amp; Bare Mitigation Area</b>	Year 11 (100% compliant since 2013)	Year 11 not in compliance at 46.4%	Year 11 (100% compliant since 2013)
<b>Overall (combined)</b>	Year 11 (100% compliant since 2013)	Year 11 not in compliance at 69.5%	Year 11 (100% compliant since 2013)



## 5.0 Project Map

**Map 5.1. Ophir Pass Fen perimeter and delineation of bare areas; well and vegetation plot locations**

*Note: Blue circles signify wells and red circles signify vegetation plots*



## 6.0 References

Mountain Studies Institute. 2012. "Durango Mountain Resort Wetland Mitigation and Monitoring Report at Ophir Fen. Permit 200175166, Mitigation Project ID: SPK-200175166." Submitted to U.S. ACE December 2012.

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Natural Resources Conservation Service (NRCS). 2012. United States Department of Agriculture Natural Resources Service Invasive Species Executive Order 12112. "Introduced, Invasive, and Noxious Plant List." Accessed December 1, 2012 at:  
<http://plants.usda.gov/java/noxious?rptType=State&statefips=08>.

Sugnet and Moore, 2008. "Durango Mountain Resort Wetland Mitigation and Monitoring Plan at the Chattanooga Fen and Ophir Pass Fen" Report to Army Corp of Engineers, submitted June 17, 2008. Approved by U.S. ACE, July 10, 2008.