Tarryall Meadows Ranch Landscape Reclamation and Habitat Enhancement Project

2014 Update Report

Prepared for Colorado Open Lands
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Introduction

This is a report on the effectiveness of treatments completed on the Tarryall Meadows Ranch near Como, CO in 2011 and 2012 as part of the Colorado Open Lands "Landscape Reclamation and Habitat Enhancement Project" which was funded by Tarryall Ranches, LLC in partnership with the Colorado Water Conservation Board and implemented by EcoMetrics. There was not a formal monitoring plan associated with the project, so quantitative data and a detailed analysis are lacking. But we did, however, spend a great deal of time and effort following the response to treatments, and we have an organized set of photos that were taken from set photopoints several times a year to document change. This report discusses some of the main changes made on the property, particularly the present and future performance of treatments, and the relative success of the project in meeting six stated goals.

History

Tarryall Creek and its associated riparian area were severely modified by dredge mining in the early to mid 1900s. Large sections of the valley were completely stripped of topsoil, inundated behind temporary dams, and completely worked by dredge boats mining for gold (Figures 1 and 2).

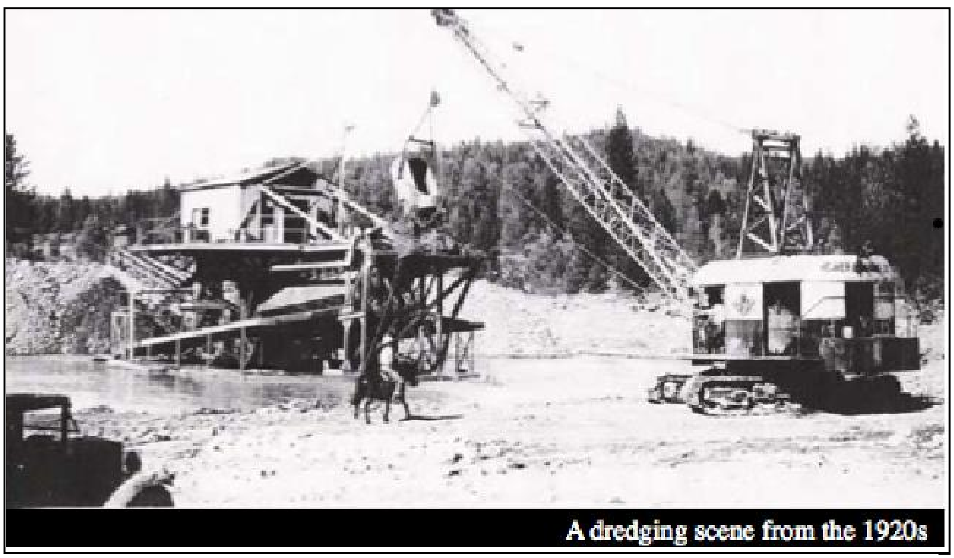

Figure 1: Dredge mining was popular in the 1920s. It was an extremely intensive process where entire streams and riparian areas were often excavated and worked.

When the dredges completed their work, they quickly moved on. The dams were breached, and the worked alluvial dredge material was left behind in waste piles; acres of bare rock spanning what used to be a riparian area. The stream was confined to a straight, entrenched, artificial channel that running in and around the dredge. Essentially no remediation work was done at that time.

Figure 2: The dredge that operated near Fairplay until the early 1950s was a huge machine. The ones used on Tarryall were probably slightly smaller versions. Dredging in riparian areas required the removal of all soil and inundation of the area behind large dams so that the dredge boats could float along, excavating, working, and then re-depositing deep alluvial material.

The condition of the site in 2011 was more or less the same as the miners left it 80 years prior, though it had partially "naturalized." A thin band of willows established along the stream edges, and free from herbivory the shrubs grew to large proportions eventually enveloping the entire stream channel in some places. In the absence of physical disturbance, there was very little age-class diversity among these shrubs. Stable channel banks were mostly colonized by mosses, but a herbaceous layer was conspicuously absent. Beyond the thin strip of riparian area that formed, the tailings were still mostly devoid of vegetation, though a few willows existed in troughs between tailings piles where groundwater was accessible. Except for these low troughs, most of the tailings area was inhospitable to all but the most xeric plants. Any precipitation or moisture in the soil rapidly drained through the loose dredge material to leave a rough, dry surface.

The channelized creek was an artificially stable threshold channel that was effectively isolated from nearby ponds, wetlands, and upland meadows. The bed and banks are composed of material that is generally too large for this small stream to move, so erosion rates have been extremely low, leaving no opportunity for channel migration or adjustment. Energetically speaking, the straight alignment was very efficient, with a very uniform distribution of energy and a homogenous plane-bed form that did not provide the variation in scour, deposition or disturbance that is needed to create and maintain physical habitat diversity. There was no effective floodplain, and in this condition peak flows would be routed efficiently through the reach, with little to no natural water storage.

Interestingly, while this channelized stream generally exhibited severely impaired morphological conditions, it also supported a healthy summertime population of brown trout. This is attributed to overhead willow cover, numerous water pockets created by in-stream boulders, high levels of aquatic insect production, and downstream beaver ponds that provide overwintering habitat for the population.

Natural references for this reach exist both upstream and downstream from the ranch. It is a wide riparian wetland area with diverse vegetation in heterogeneous patches. The reference creek is an anastomosed system of anabranching channels and numerous beaver ponds that is intimately associated with the adjacent wetlands on the floodplain and a wide, deep riparian aquifer. The reference system is very dynamic, with beaver dams regularly being built and then breaching at different locations through time. Following this pattern, ponds remain filled for some time and then drain when dams fail, leaving bare areas of accumulated sediment ripe for colonization that "re-boots" the vegetation succession process, maintaining species and age class diversity along with habitat heterogeneity. Between the ponds and the channels, the amount of physical aquatic habitat variety is great and ever-changing.

Fluvial geomorphologists have short-hand language to describe the type of transformation that took place when the dredge miners altered this system. Using Cluer and Thorne's latest adaptation of the stream evolution model (SEM), the reference condition is stage 0, and the condition after mining is a stable 3s stage system. In the Rosgen classification, the transformation is defined as D_B (or D_A) to G[1]. A detailed geomorphologic analysis of the reach is not necessary for our purposes, but the conditions described above represent the conversion from a floodplain-connected system to an entrenched and confined channel. This conversion is one of the most extreme changes in stream type possible, and the impacts to stream and riparian functioning is profound. Undoing these impacts is terribly difficult. Restoration of entrenched systems like this is described by Rosgen using three priorities: Priority 1 is to raise the stream back to its historic

[1] The Rosgen classification does not actually include a class for D_B. D_B is a class we use to describe the multi-channel, anabranching streams with no entrenchment, variable width-depth ratios, and slope less than 2% that are maintained by beavers. The closest thing to this in the Rosgen classification is the D_A anastomosed stream type.

floodplain, priority 2 is to construct a new floodplain at the level of the stream, and level 3 is to simply enhance the existing entrenched stream to the best condition possible.

Guiding Image

It was the desire of all project stakeholders to restore as much natural stream and riparian function to this reach as possible, knowing that a full scale restoration project on the property would probably be impossible or prohibitively expensive. We considered several options for restoring the native stage 0 (D_B) stream type including the associated functional floodplain and riparian wetlands it would support. We knew it was impossible to reconstruct this system in place using materials on site (priority 2), but it seemed possible to relocate the creek to a separate area of the valley which had not been dredged (priority 1). Ultimately, the costs and water rights issues that would be involved to make this happen were deemed insurmountable.

This project we ultimately completed is a priority 3 reclamation effort which aimed to enhance the stream as a stable stage 2, B-type stream. We did not attempt to alleviate all the impacts to the riparian area and stream channel, nor to restore the native stream type and its functioning. The intent of this project was to improve some areas of function in place, to increase the ability of the system to regain additional function over time by increasing its ability to move and adjust, and to improve certain values such as aesthetics, fish and wildlife habitat, and support of more diverse native vegetation. (Refer to Attachment A:*TMR Project Concept Paper* for further details on the scope of the project.)

Goals

Primary goals of the project were:

1. Improve overall landscape quality and create new upland habitat by shaping the tailings piles, spreading and mulching an overburden soil cap, and reestablishing native vegetation on the old dredge tailings;
2. Increase effective width and function of the riparian edge community along sections of the creek presently confined by dredge tailings;
3. Increase aquatic habitat diversity in the long riffle sections;
4. Encourage beaver colonization within the corridor;

5. Establish a network of interconnecting paths that provide human and wildlife access to enhanced aquatic and riparian resources; and
6. Generally create an attractive, functional and accessible corridor for fishing, hunting and wildlife viewing along 4,000 feet of Tarryall Creek.

Actions

To accomplish these goals, we proposed seven modes of action, including:

1. Reshaping and grading old dredge tailings in selected areas;
2. Spreading overburden material(fines) over the graded tailings area to create a thin soil layer (cap);
3. Re-vegetating treated upland and riparian habitats;
4. Physical streambed and bank treatments;
5. Construction of "beaver starts" at several cross sections of the creek;
6. Selective thinning and clearing of senesced willows along the channel; and
7. Constructing paths through the reclaimed tailings, from the tailings down to the stream, and from the tailings south to the grassy meadow.

These actions began in 2011 with the initial phase of tailings re-shaping on the upper portion of the property, and the rest of the work was accomplished in the summer of 2012.

Conditions during the monitoring period

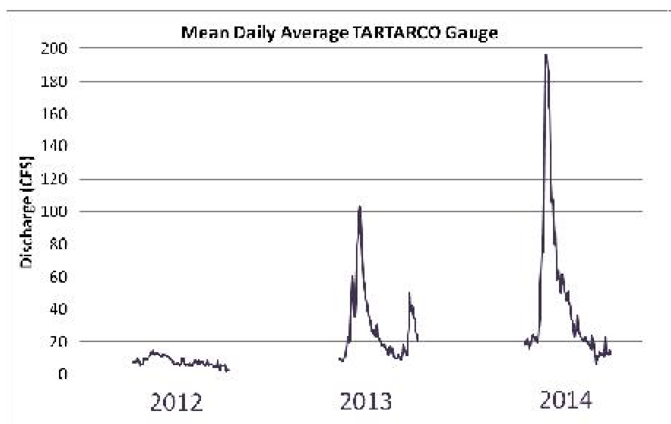

Figure 3: Mean daily average flows for Tarryall Creek at the TARTARCO Gauge which is just upstream of the ranch show the wide range of flow conditions during the monitoring period.

The monitoring period spanned three seasons, counting the season of construction, offering the full range of conditions. In terms of summer moisture and temperature, 2012 was exceptionally dry and warm; 2013 was exceptionally wet and cool; and 2014 was average. Peak flows also represented a wide range (Figures 3 and 4), including extremes at both ends of the scale with 2012 having one of the lowest peak flow discharge levels on record (16 cfs) and 2014 the highest (estimated 250 cfs). 2013 had an average peak flow discharge (118 cfs), but there were actually two peaks that season with the traditional runoff peak in early summer and a secondary peak (about 60 cfs) in fall caused by a very wet monsoon season. For comparison, bankfull discharge on the reach is between 90-110 cfs. Figure 2 is the hydrograph for the 2014 season. Discharge that season peaked at or above bankfull on about 20 days.

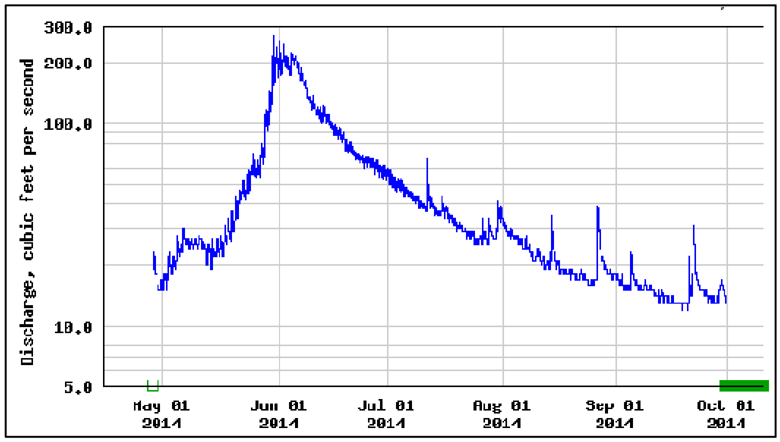

Figure 4: In 2014, discharge was more than twice the estimated bankfull for about 18 days.

Discussion and Results of Project Goals

> ***Goal 1:*** *Improve overall landscape quality and create new upland habitat by shaping the tailings piles, spreading and mulching an overburden soil cap, and reestablishing native vegetation on the old dredge tailings.*

Dramatic improvements were made to 6.7 acres of tailings and 1.7 acres of overburden for a total of 8.4 acres of improved upland habitat. What was a series of un-vegetated tailings piles composed of discarded alluvial material in piles 8-15 feet high has been converted to a smooth undulating surface that has a more natural pattern of elevation fluctuations. The overburden piles located along the edge of the tailings were even higher mounds, approximately 20-25 feet tall, with steep side- slopes. These piles consisted of finer material that had been cleared from the site prior to dredging, but vegetation coverage was still sparse due to the steep angle of the slopes. The height of overburden piles was lowered significantly, and the fine material was spread over the smoothed tailings area to create a surface suitable for vegetation. The smoothed topography creates greater connectivity between the adjacent creek and meadow habitats.

All of the treated areas were then seeded using a xeric high-elevation upland grass mix. About 5 acres of the seeded area was hydro-mulched, about 2 acres was mulched using willow chips, and the remainder was not mulched. Vegetation on the hydro-mulched area has responded very well with approximately 40-90%

ground cover in summer of 2014, comprised primarily of the grasses that were planted as seed mix.

Figure 5: This time series starts in 2012 before treatment (top) and concludes with a photo from 2014 (bottom). This series illustrates the landscape level changes that were made on the property and the successful re-vegetation of the treated area.

We expect herbaceous cover to continue to improve as these grasses begin to form a sod. The areas that were mulched with willow chips also re-vegetated well, but not to the extent of the soil-capped area. Grass cover on these areas tends to be about 20-40%. Any tailings areas that were seeded but not mulched have the lowest percentage of vegetation cover (0-15%), but even some localized patches in these areas have become colonized with native grass.

Figure 6: Two examples of re-vegetation in progress. The top photo is a shaped overburden pile that was seeded. The bottom photo is of a remediated tailings area that was capped with soil, seeded, and hydro-mulched.

There is notable shrub cover on the reclaimed area as well. The shrubs and trees that are present in 2014 are those that were already present in troughs between the tailings piles, which we saved during the reclamation. We do not expect much further willow recruitment or an expansion of shrub cover on this area in the future, however, since the reclaimed area is stable and perched too high above the local groundwater table.

Figures 5, 6, and 7 illustrate examples of the extensive transformation that occurred on the landscape.

Figure 7: This before-after comparison is of the 2011 treatment area. While still not a fully-functional riparian area by a long shot, the landscape has been remediated from a post-industrial mine site to a much more natural, aesthetic, and functional condition.

Goal 2: *Increase effective width and function of the riparian edge community along sections of the creek presently confined by dredge tailings.*

As we described in introductory sections of this report, the reach is severely incised and channelized, and that restoring a floodplain connected river-riparian system is far beyond the scope of this project. However, working within and adjacent to the entrenched channel area, we aimed to improve increase the size of the functional floodplain and riparian area by creating bankfull benches. We also aimed to preserve the few existing high-flow hydrologic connections between the creek and adjacent aquatic habitats.

During the high flows in 2013 and 2014, all of the newly constructed riparian bench features were inundated (Figure 8), and pre-existing high flow connections were active (Figure 9). As expected, even the record high flows in 2014 did not approach an elevation anywhere near high enough to escape the entrenched area. The treated tailings areas were still 1.0 to 2.5 feet above the water surface even during the highest discharge rates.

Figure 8: This photo shows the reach during runoff in 2014. The streamside bankfull benches are obviously inundated at 160 cfs, but the reclaimed tailings area in the background is still inaccessible to high flows, being about two feet higher than the benches.

Figure 9: This photo shows a side channel with water flowing in 2014. Again, most of the surrounding tailings remediation areas are still much higher than flood water levels.

Figure 10: An example of a stream reach with a newly created riparian flood plain bench. The area closest to the stream has well developed vegetation that is expected to expand over time.

Figure 11: This time series shows the dramatic change in streamside condition. Large tailings piles were removed from the stream edge to construct a riparian bench. The root systems of existing willows were undisturbed. These plants survived and are beginning to spread.

Figure 12: View of a well vegetated riparian bench in section G of the project. The width of vegetated area is expected to expand over time creating a larger and larger riparian area next to the creek.

The project was successful in creating a narrow floodplain along significant portions of the 4000 feet of channel in the project area (Figure 10). The width of the constructed floodplain bench varies from 5 feet to greater than 20 feet, with the average being between 8 and 12 feet. This often involved the removal of enormous volumes of tailings from areas next to the stream (Figure 11) to create room for a riparian edge community.

Bankfull benches are recovering with predominately hydrophytic vegetation (Figure 12). In some areas we observed deposition of fines, suggesting that the added floodplain area is functioning to create slower water velocities near the edges where suspended sediment can be deposited. These deposited fines will promote continued vegetation establishment by adding much needed nutrients and fine materials amongst the cobble tailings.

Goal 3: *Create diversity in the available aquatic habitat by breaking up long riffle sections with areas of pocket water.*

In its channelized state, Tarryall Creek was essentially one long riffle with very limited pool area, velocity refuge, or in-stream cover. With this goal we aimed to increase aquatic habitat diversity that would benefit fish, water birds, insects, and small mammals. We accomplished this chiefly by creating in-stream structures using boulders harvested on site. The rock features were primarily designed to affect habitat conditions at all flows by breaking up the homogenous riffle habitat. At low flows, the structures were intended to provide small areas of deeper low-velocity water (pocket water) as holding areas for fish, and to meander the thalweg so that there would be some small amount of sinuosity during low flow as well as added diversity in patterns of scour and deposition. The structures also provide much needed velocity refuge for fish within the otherwise long reaches of extremely fast water during high flows. The structures were also intended to promote lateral erosion and scour that would hopefully induce meandering and the creation of scour pool habitat. The thought was that if we could induce lateral instability in this otherwise hyper-stable system, then the system may naturally regain the hydrodynamic variability that should be present over time.

Aquatic habitat diversity was significantly increased. The number and size of holding areas (pockets) are significantly increased during low flows, and during high flows there is now at least some velocity refuge (Figures 13, 14,and 15). Inducing lateral instability via increased bank scour and erosion is proving to be a more difficult objective. The extreme high flows of the 2014 runoff were an excellent test of this function. When the waters receded, we observed very minimal mobility of the structures (they were stable) and were surprised to find very little lateral erosion. By and large, this channel is proving to be even more resistant than we had expected.

The one factor that we still hope may act to induce real morphological change is beavers. Expanded beaver activity may have the potential of introducing disturbance at a level that is sufficient to disrupt the hyper-stable channel condition in the long term.

Figure 13: Examples of the creek after structures were built. The purpose of these structures is to create pocket water, a meandering thalweg, and areas of slow water.

Figure 14: Before-after photos showing a typical rock structure treatment. The rock structures break up the homogenous riffle gradient creating pockets of slow water and a sinuous.

Figure 15: Before-after photos showing a typical rock structure treatment.

Goal 4: *Encourage Beaver Colonization: Encourage beaver colonization within the corridor.*

Prior to the project, the reach did not lend itself to perennial beaver dams due to the artificially high stream gradients and the very tall banks in especially entrenched areas. We reasoned that some segments of the reach could, however, become centers of beaver activity where the gradient is less steep and where bankfull benches were built to reduce bank heights. The riparian edge treatments and in-stream structures described previously were designed to create segments with sufficiently low gradient and low banks. We suspected that beavers may eventually colonize these areas on their own, but we tried to speed the process by luring them there with "beaver starts." The beaver starts we constructed on the reach were low-profile boulder structures that were piled with willow slash to create a sort of human-made woody beaver dam.

We constructed beaver starts at five locations using the following strategy:

- Identifying suitable cross sections based on multiple criteria;
- Using cut or fallen trees (with branches intact) as foundational materials; and
- Stockpiling green aspen or willow cuttings to attract beaver to these sites.

The structures worked as expected in that they impounded water and acted as a small beaver dam on their own (Figure 16). The water impounded behind these structures was deep enough to provide a cooperative beaver with cover should one want to build upon the structure. The locations were chosen in areas where there was potential for a future dam creating large pond to spread water and dispersing high flow forces.

After implementation, we observed beaver activity at several locations in the project area (Figure 17). In fall of 2012, there were two active beaver families on the reach, and in 2013 there were 4-5 active groups. The increase in beaver activity was very promising, but the locations that beavers selected to build their dams was a bit of a surprise. While we did see some beaver activity on a few of our beaver starts, the majority of activity was at locations of the beavers' own choice, which was generally not where we had been prepared for them. Of six full-scale dams on the reach in 2013, none were located on beaver start structures.

The main area of beaver activity has been at the site of 6 foot-tall dam in the middle of the project area. This dam was present in 2011 when we began the project, and the beavers remained present until 2013. They responded to our removal of adjacent tailings by building the height of the dam ever higher until water was effectively flooding onto the remediated tailings area (Figure 18). The dam became so high, in fact, that the beavers had diverted most of the channel flow through a side channel and pond area, mimicking the behavior of reference systems. Unfortunately, the system did not persist very long as the dam was overwhelmed by high flows in 2014 (Figure 19).

Figure 16: Examples of beaver start kits which were constructed at several locations within the project area. The structures were successful in impounding water and mimicking small beaver dams, but beavers tended to build their own dams in other locations. None of the large persistent dams that they built on the project site were on start structures.

The 2014 runoff apparently proved to be too much for all the beavers on the reach since all of the dams were wholly or partially destroyed. In summer of 2014, we saw very little beaver sign, indicating that the displaced beavers had likely emigrated. By fall, the start of several dams was again observed on the reach, so we are hopeful that beavers will continue to use the reach.

Figure 17: Examples of two locations where beavers built dams on the ranch in 2013.

Figure 18: This series of photos are of the main beaver pond that was present from 2011-2014. In the "before" picture (top) the creek/pond is barely visible behind the tailings at the edge. After the tailings were moved from the edge of the pond, the beavers raised the dam about one foot, increasing the size of the pond and bringing water near the elevation of the reclaimed tailings.

Figure 19: This view shows the main beaver dam when the dam was at full height in 2012 (top) and in 2014 (bottom) after the dam failed. Even with this major disturbance, there was very little erosion or change in channel morphology, giving us little hope for any major natural recovery of the reference riparian condition.

Goal 5: *Establish a network of interconnecting paths that provide human and wildlife access to enhanced aquatic and riparian resources.*

Establishing human and wildlife access was an intended byproduct of tailings remediation (Figure 20) that we capitalized upon further by creating sections of interconnecting trails. The long term expectation is that there will be relatively easy walking access in the upland for many years to come. The plant communities in these areas are coming in as upland grasses with patches of willow shrubs that makes for easy walking. Access points to the stream were created by opening up gaps in the dense strips of willows and by clearing areas of the over-topping decadent willow canopy. The trimmed willows are responding with exceptionally fast re-growth rates, which means that the access points are closing in quickly. Stream access will become problematic again soon unless these points are constantly maintained.

In addition to pathways on land, several bridges were constructed across the creek (Figures 21 and 22). These bridges are part of the cleared path network that connects various portions of the property. Made from materials collected on the property, these bridges weathered the high flows of the 2014 runoff and are expected to continue to function for the foreseeable future. Access and aesthetics both also benefited from selective clearing (Figures 23, 24, and 25).

Figure 20: View of open, trail area that was created from tailings piles.

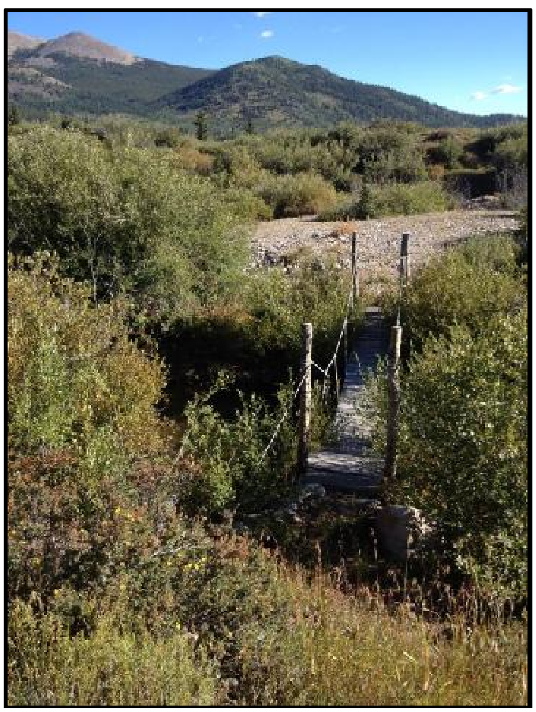

Figure 22: Suspension bridge on the upper portion of the property.

Figure 21: One of two bridges installed on the ranch to connect a trail network. This photo is from June, just prior to the peak of 200+cfs.

Figure 23: Before the project (top) the stream was completely enveloped within a canopy of decadent willows and bordered by steep tailings piles After selective willow cutting and strategic removal of the tailings to build bankfull benches, the creek has a much more natural look and better access.

Figure 24: Access points have been appreciated by anglers and other recreationists.

Figure 25: Before treatment (above) the tailings made access to this beaver pond difficult. The goal of these treatments was to make the area more suitable for vegetation establishment and more accessible for both people and wildlife.

__Goal 6:__ Generally create an attractive, functional and accessible corridor for fishing, hunting and wildlife viewing along 4,000 feet of Tarryall Creek

The landscape along the creek had been so extensively altered by dredge mining that it had very limited attraction and extremely challenging accessibility. The reach was essentially an industrial mining site that was abandoned without any reclamation efforts, and it showed. By restoring some of the natural parts and pieces of a functioning stream, riparian, and upland system, the accessibility and appeal of the property has been greatly improved. We are hopeful that the system will continue to positively adjust in the future, particularly if vegetation treatments continue to perform, if the land continues to be managed in a positive way, and especially if beavers occupy the area successfully for a long enough time to begin inducing larger-scale geomorphic disturbance.

Conclusions

The project has largely been successful in meeting the stated goals. The property is a more natural and aesthetically pleasing area with better access for both wildlife and people. Overall, the impression of the landscape was completely transformed with the remediation of tailings to create a much more natural appearance and functional condition. It now looks a lot more like a natural area and a lot less like an industrial mining site.

The stream and riparian areas are by no means restored to anything like the pristine condition, and ecological function is still much impaired due to the past impacts of dredge mining. However, the enhanced in-stream structure, improved riparian edge habitat, and functioning bankfull benches are a great improvement compared to the condition of the resource before the project.

Looking to the future, the most influential factor in the system's continued recovery will be beaver activity. The increase in beaver activity on the property through 2013 was encouraging, as was the return of beavers following the destruction of all their dams during runoff in 2014. The stream is remarkably stable and resistant to change, however, so one must be cautiously optimistic about any large-scale systemic recovery. Any major change will be slow in coming. In the meantime, the property is much improved over its past condition and appearance (Figure 26).

Figure 26: This time series starts in 2011 (top) showing pre-project conditions and follows the progression of the tailings, beaver pond, and creek to 2014.

CONCEPT PAPER

Tarryall Meadows Ranch

2012 Landscape Reclamation and Habitat Enhancement Project

Mark Beardsley, M.S.

January 26, 2012

Overview

The 240-acre Tarryall Meadow Ranch (TMR) is situated immediately upstream of the 1640-acre Cline Ranch State Wildlife Area (SWA) near Como. Both properties are now held in a perpetual conservation easement by Colorado Open Lands. Focal resources on TMR include numerous beaver ponds, extensive riparian and meadow wetlands, upland meadows, and approximately 6,000 linear feet (1.14 miles) of Tarryall Creek. Of the total stream distance on TMR, only about one-third (2,000 feet) is currently accessible, including 400 feet on the upper (west) end and 1600 feet of stream on the lower (east) end of the property.

In contrast, the majority of this stream corridor (4,000 linear feet) is virtually inaccessible and nearly impossible to walk through. Here the stream and associated riparian areas have been modified by dredge mining and channelization. Steep tailings define the banks and a dense willow canopy now envelops the high gradient channel. For much of its length, the creek is an artificially straightened, entrenched channel that is effectively isolated from nearby ponds, wetlands, and upland meadows. In the approximately 80 years since mining ceased, the creek has attained an artificially stable condition. This is largely owing to the fact that the banks and bed are comprised of boulders and cobbles. At the same time, long segments of the creek are now completely overtopped by a senesced willow community. While this channelized stream generally exhibits impaired morphological conditions, it also supports a large population of brown trout during the open water months. This is attributed to overhead willow cover, numerous water pockets created by in-stream boulders, high levels of aquatic insect production, and downstream beaver ponds that provide trout overwintering habitat.

Considering the broad scale of mining impacts, restoring the historic natural condition of this area is impractical if not impossible. There is, however, a tremendous opportunity to 1) increase connectivity between the stream and other habitats, 2) increase the size of seasonally flooded wetlands, 3) enhance aquatic and riparian communities, 4) increase bird, fish and wildlife populations, and 5) generally increase corridor function and appeal in a manner that is both practical and responsible. By working with and building on the unusual conditions of this site, a more effective and engaging riverine complex will be created. Moreover, reclamation of the dredge tailings will reconnect existing upland meadows with enhanced riparian and aquatic habitats. Ultimately the property will operate as a more natural system and support more native vegetation and wildlife.

While the corridor may not be very attractive or functional in its present condition, the tailings, stream, and riparian areas represent a unique reclamation project opportunity. Costs associated with enhancing this property may be viewed as an investment in raising its impaired resource values to a condition that more closely approximates surrounding “reference” habitats.

The tailings reclamation, vegetation, and trail improvement work accomplished in 2011 demonstrate the effectiveness of designs, scoping costs, and restoration techniques employed at TMR (Appendix A). We are encouraged by the success of these efforts and believe that expanding treatments to include broad scale re-vegetation, channel modifications, riparian enhancements, and beaver colonization will significantly increase the property’s intrinsic value.

Primary goals of the project proposed herein include the following:

1. Improve overall landscape quality and create new upland habitat by shaping the tailings piles, spreading and mulching an overburden soil cap, and re-establishing native vegetation on the old dredge tailings (Appendix B);
2. Increase effective width and function of the riparian edge community along sections of the creek presently confined by dredge tailings (Appendix C);
3. Increase aquatic habitat diversity in the long riffle sections (Appendix D);
4. Encourage beaver colonization within the corridor (Appendix E);
5. Establish a network of interconnecting paths that provide human and wildlife access to enhanced aquatic and riparian resources; and
6. Generally create an attractive, functional and accessible corridor for fishing, hunting and wildlife viewing along 4,000 feet of Tarryall Creek.

To accomplish these goals, we propose six modes of action, including:

1. Reshaping and grading old dredge tailings in selected areas;
2. Spreading overburden material (fines) over the graded tailings area to create a thin soil layer (cap);
3. Re-vegetating treated upland and riparian habitats;
4. Physical streambed and bank treatments;
5. Construction of “beaver starts” at several cross sections of the creek;
6. Selective thinning and clearing of senesced willows along the channel; and
7. Constructing paths through the reclaimed tailings, from the tailings down to the stream, and from the tailings south to the grassy meadow.

Goal 1: Tailings Reclamation and Upland Habitat Improvements

In addition to channelizing the stream, dredge mining created acres of bare tailings and overburden piles on the property. Tailings are comprised of discarded alluvial material in piles ranging from 8 to 16 feet in height. They consist primarily of cobble-sized rock with some fines, gravel and boulders. In contrast, overburden piles consist of finer (soil) material and range from a few feet to more than 16 feet high.

The tailings reclamation work accomplished in 2011 revealed the potential for additional, cost-effective resource improvements. Approximately 2.1 acres of tailings were reclaimed in 2011, along with about 0.6 acres of overburden (Appendix A). This work completely altered the landscape in a positive way. We propose expanding these efforts to encompass an additional 4.6 acres of tailings and 1.1 acres of overburden reclamation in 2012. Specific plans for earthwork and grading are detailed in Appendix B. With a few notable exceptions, we recommend using the same tailings reclamation approach used in 2011:

- Some areas (up to 2 acres) proposed for treatment in 2012 manifest considerable vegetative cover. In these areas, we will selectively grade tailings while retaining viable plants.
- We will spend less effort creating an even grade on reclaimed tailings than we did in 2011. In fact, we will make a concerted effort to create rolling hills and swales throughout the treated area to lend a more natural look and greater habitat diversity.
- We will eliminate the long, linear ridges by pushing the tailings into adjacent depressions, making a smooth transition. In some areas, long linear tailings are flanked on either side by wetlands. In such cases, the tailings will simply be smoothed over to avoid wetlands filling.
- In 2011, overburden piles were graded but only lightly treated. In its present state, the south overburden ridge presents a physical barrier between the meadow and the riparian corridor. Our objective is to completely remove and re-shape this ridge so it no longer poses a barrier to wildlife migration and stream access. This will be accomplished by using a large wheeled loader and dump truck. Fine (soil) material from the overburden ridge will then be spread over the graded tailings to create a thin soil cap that can be mulched and seeded.

In addition to expanding earthwork and grading treatments in 2012, we also propose to re-vegetate many treated areas. Because aesthetics are an important consideration in this project, vegetation will be established on reclaimed areas as soon as practicable. In 2011, we had immediate success establishing native grasses on 0.3 acres by using sprinkler irrigation. However, irrigating 4-5 acres of reclaimed land would be very costly. Our recommendation and proposed action is, therefore, to seed and mulch all reclaimed areas with straw or hay harvested from a local field. Mulching will improve water retention in the soil cap, insulate it from heat/cold extremes, protect seeds from predation, and add organic material to the soil. By using hay from native fields, we create the added benefit of passively introducing seed from local grass stock.

Goal 2: Riparian Edge Community Enhancements

Proposed riparian edge community enhancements are depicted in Appendix C. In addition to employing methods used on the property in 2011, we also will construct a narrow floodplain where the stream is confined by steep rock piles (tailings) along the banks. This will be accomplished by pulling the tailings back 10-20 feet from the channel and grading small benches and coves that become inundated during periods of high water (Figure C-1). These benches will then be re-vegetated with native riparian plants as necessary.

We fully recognize the value of a robust shrub community for ecological function and a healthy fishery, but opening the willow canopy is paramount to increasing habitat diversity and access throughout the central section. While an aggressive approach to canopy removal is necessary to make the stream accessible, this will be accomplished in a very selective manner. Our preference is to leave overhanging branches along the south bank wherever they provide shade and overhead cover for fish. The same approach was used in 2011 to maintain existing stream habitat values while increasing recreation and wildlife access along the stream (Figure C-2).

We should point out that the central portion of this property is quite different from natural meadow streams that depend heavily on mature shrubs for bank stability. For better or worse, most of this reach is artificially stable and confined by rock tailings. While we do not support the removal of native shrub cover on natural meandering meadow streams, the approach described above is justified on this reach and poses little risk of causing channel instability.

The majority of proposed willow cutting will be accomplished by trimming large branches with a saw rather than uprooting mature shrubs. Root masses will remain intact and continue to provide riparian habitat and bank stabilization. Trimmed willows will continue to grow but can easily be maintained by cutting back new growth every year or two (Figure C-3).

Goal 3: Increase Aquatic Habitat Diversity

Essentially, the central reach is one long riffle with very limited pool area, velocity refuge, or in-stream cover. The main objective of proposed in-channel treatments is to increase aquatic habitat diversity for fish, anglers, water birds, insects, and small mammals. This will be accomplished through a combination of earthwork and low profile structure placement throughout this uniform section of stream. By constructing new and enhancing existing pool features, we expect the fishery to respond positively. Moreover, recreation experiences will immediately become more diverse and interesting.

On one hand, this reach appears ideal for the installation of artificial habitat structures such as drop structures, weirs, and vanes. It is a relatively stable, straight, confined channel within which such features could be installed with little concern about channel migration, aggradation, or down-cutting. On-site materials for constructing these structures are abundant. Boulders are prevalent on the property and tailings reclamation will produce many more boulders that may be harvested to create aquatic habitat structures.

On the other hand, we prefer treatments that are less intrusive and more natural in appearance and function. Our approach in the central reach will therefore tend to be subtle. We know that large numbers of trout utilize this area for feeding and spawning despite the obvious lack of pools or other stream features. Since this reach is mostly comprised of clean riffles with a cobble substrate, it probably functions as a huge "bug factory." Owing to bed composition and the dense willow canopy, there are numerous and diverse aquatic insects that seasonally attract fish to this reach from overwintering areas (beaver ponds) up and down stream. We therefore need to ensure that in-stream habitat improvements do not significantly impact aquatic insect populations or existing trout niches.

We propose creating additional resting habitat by mimicking features currently utilized by trout. Rather than excavating artificial pools in the streambed, we will enhance hydraulic agents that create and maintain pool and pocket water features. This involves enhancing scour in one of several ways: (1) augmenting small meander bends or "dog-legs" in the channel to promote lateral scour and bend pool formation; (2) creating or augmenting channel constrictions to promote contraction scour in long, straight sections; (3) creating small plunge pools below boulders and steps; and (4) augmenting existing grade control and/or riffle crest features to increase the depth of impounded water upstream. Photos of the different channel treatments described above are presented in Appendix D.

Goal 4: Encourage Beaver Colonization

New beaver dams will add habitat diversity and provide multiple benefits to fish and water birds in the central reach (Appendix E). In fact beaver ponds are the dominant habitat feature on the lower 1,600 feet of the property. A variety of migratory water birds currently nest there during summer and we believe that resident trout overwinter on this neighboring reach (Figure E-1). Beaver seem to frequent the central portion (signs are common) but dams and lodges are virtually nonexistent. This is likely because the gradient is so steep and the channel is narrowly entrenched. Each year, we observe one or two beaver dams within this reach and their dams are necessarily very tall (up to 6 ft) and narrow. These ephemeral dams offer winter habitat for trout but they rarely survive runoff.

Currently, the central reach does not lend itself to perennial beaver dams because of artificially high stream gradients and channel entrenchment. However, some areas could become centers of beaver activity wherever the gradient is less steep and/or broader floodplains exist. In conjunction with riparian edge and in-channel treatments, we also propose luring beaver by constructing "beaver starts." These are very low-profile, woody grade control structures across the stream. As demonstrated on three other Tarryall Creek properties, beaver readily utilize these structures as dam foundations at specific locations along the channel (Figures E-2 and E-3). The key to successfully employing new beaver starts entails:

- Identifying suitable cross sections based on multiple criteria (Figure E-4);
- Using cut or fallen trees (with branches intact) as foundational materials; and
- Stockpiling green aspen or willow cuttings to attract beaver to these sites. An abundance of cuttings will be generated from the riparian edge community enhancements proposed under Goal 2.

Goal 5: Trail and Access Improvements

The landscape and riparian treatments proposed herein will facilitate human and wildlife access to considerably more area. At the same time, physical connections are needed between the existing meadows, reclaimed tailings and streamside habitat. Trail work will entail grading a foot path parallel to the creek, and creating lateral connections from that path down to the stream and south to the meadow. We will then extend the main path to form a continuous loop around the entire reclaimed tailings area. Trail planning will occur near the end of the earthwork phase while heavy equipment is still available for trail construction.

Goal 6: Create an Attractive, Functional & Accessible Corridor

Existing dredge tailings are steep, unconsolidated piles of round cobbles that provide little habitat value and are difficult for people and animals to negotiate. The proposed earth and vegetation work will facilitate easier access and greater wildlife use on a broad scale by reclaiming several acres of tailings, creating wider riparian benches along the stream, and providing physical connections between upland and riparian habitats. Following reclamation, the entire area will be more attractive to deer, elk, hunters, anglers, naturalists and a variety of nesting birds.

Reclaimed tailings will provide a verdant, undulating landscape that facilitates greater wildlife use and viewing opportunities. Examples of how area topography will appear upon project completion are provided in Appendix A. However, the graded tailings will also be covered with an overburden soil cap that is mulched and re-vegetated with native grass seed. Moreover, multiple trail connections will increase wildlife movement between the reclaimed tailings area, existing meadows, and enhanced stream and riparian habitats.

Time schedule

The following table is a proposed schedule of work. Actual construction times may vary due to weather and stream flow conditions. Revegetation may take place in June-July or Aug-Sept. depending on the availability of local hay for mulching.

2012	Earthwork/ grading	Vegetation clearing	In-stream habitat work	Re-vegetation	Trails/ access
April					
May					
June					
July					
August					
September					

Appendix A: 2011 Reclamation Project Summary

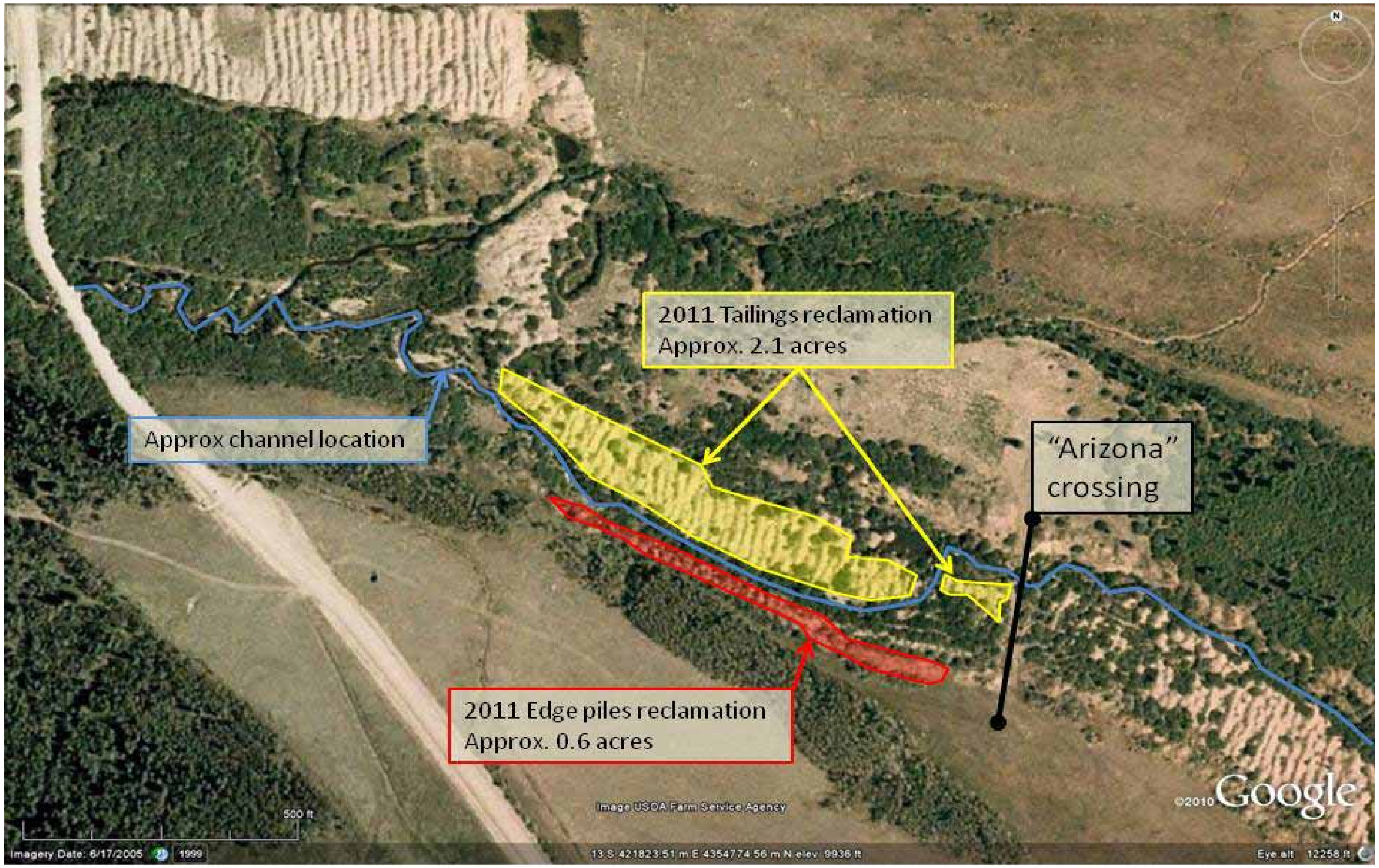

Figure A-1: Overview of reclamation work accomplished at TMR in 2011

Figure A-2: Southeast view of reclaimed tailings area

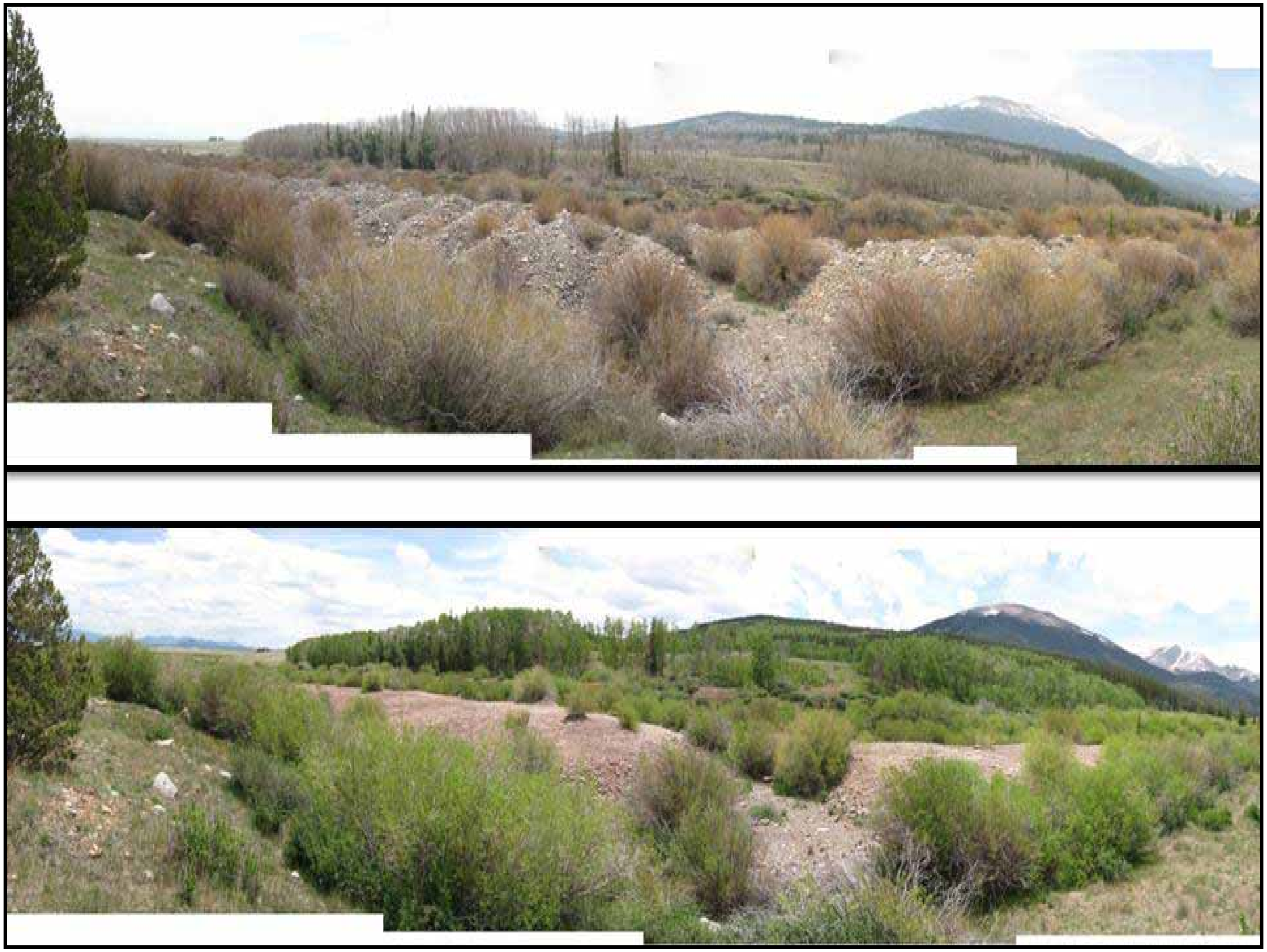

Figure A-3: Northwest view of reclaimed tailings area

Figure A-3: Native grass seed and irrigation were used to re-vegetate graded overburden (edge) piles

Appendix B: Summary and Design Plans for 2012 Earthwork and Grading

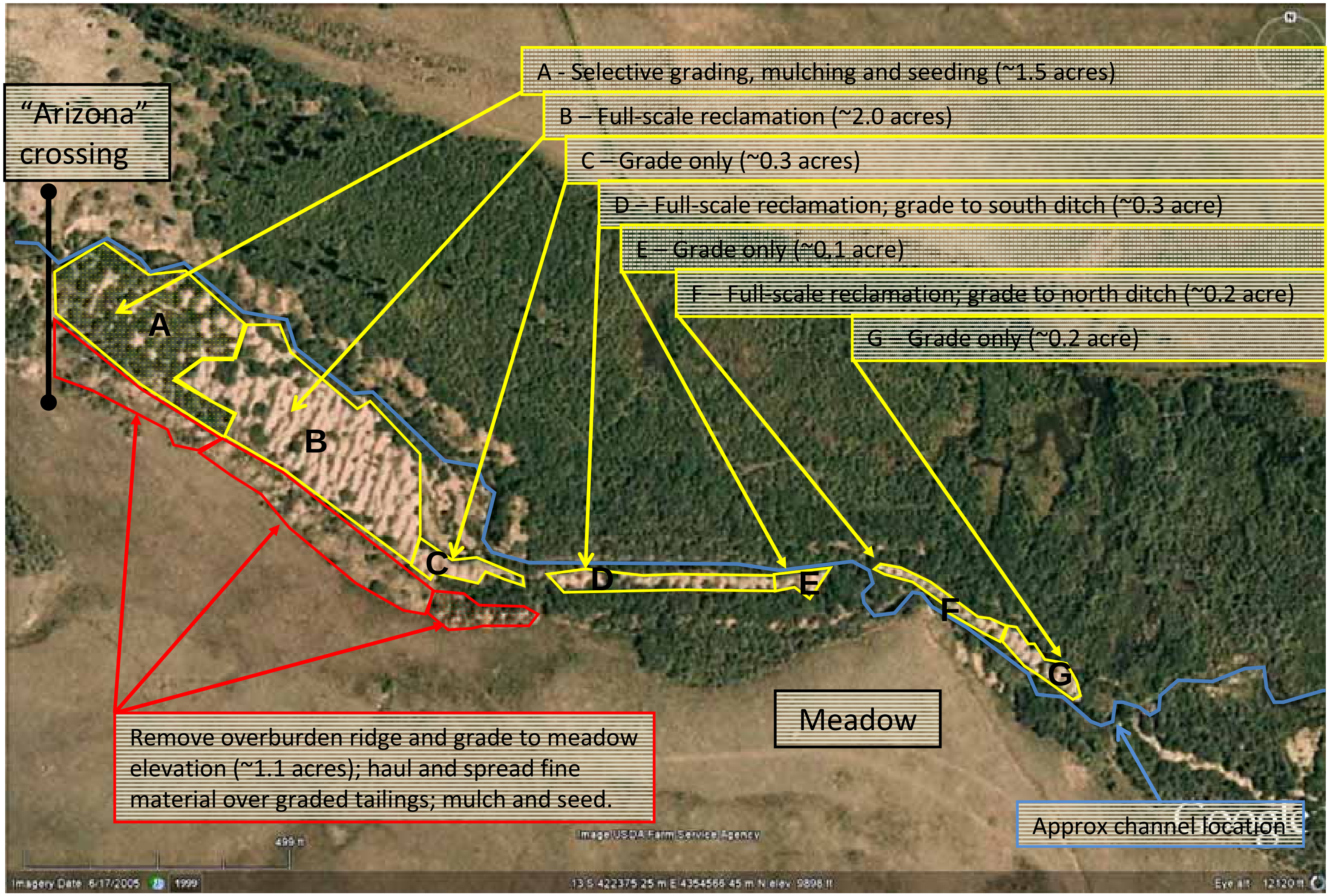

Figure B-1: Overview of Proposed 2012 Reclamation Work

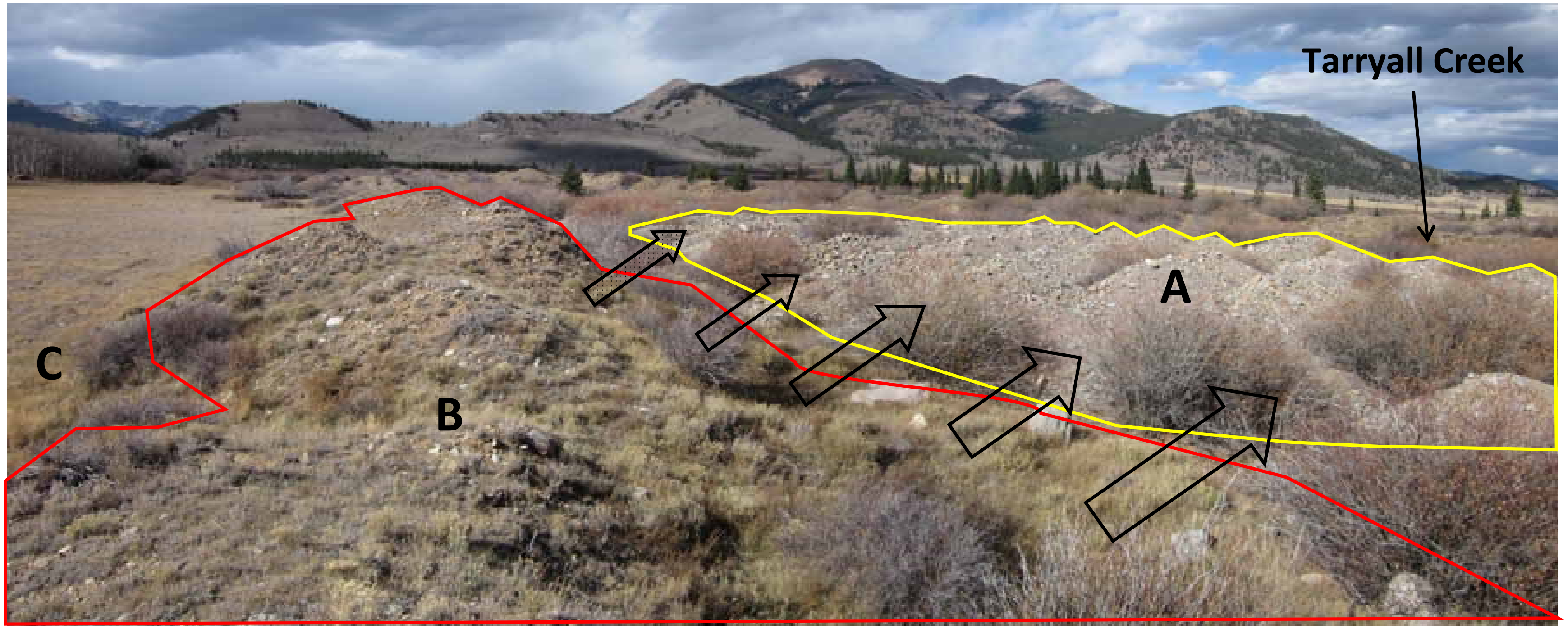

Figure B-2: Proposed 2012 Tailings Reclamation Work (typical)

Tailings piles in area “A” will be graded to a smooth, undulating landscape. The overburden ridge (“B”) will then be removed and spread over the graded tailings (“A”) to create a thin soil layer. All treated areas will be mulched and seeded; mature willows will be salvaged wherever possible. As a result, the grass meadow (“C”) will be reconnected to the riparian corridor along Tarryall Creek (far right).

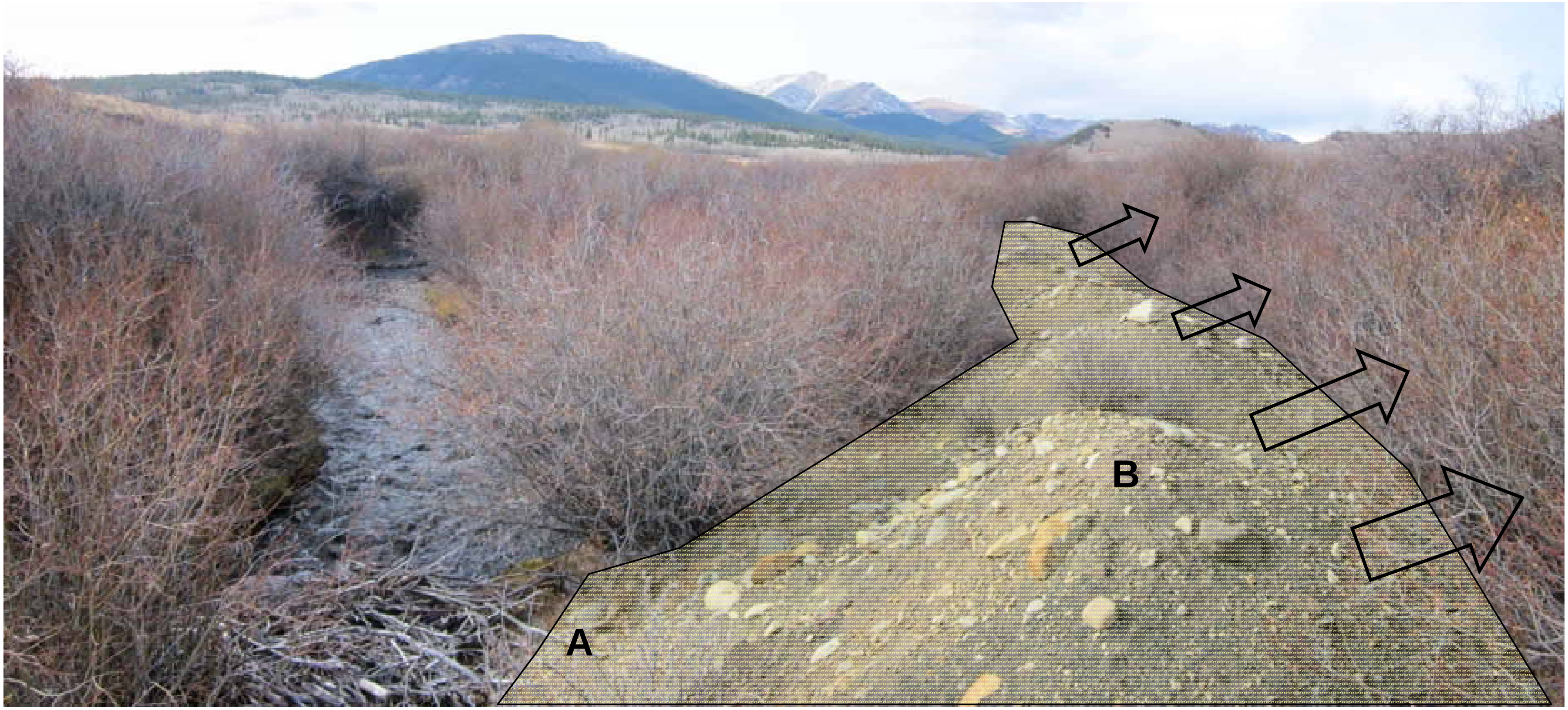

Figure B-3: Proposed Riparian Tailings Treatment (typical)

Bare dredge tailings extending down to the stream ("A") will be pulled away from the channel and deposited on the opposite side of the tailings ridge ("B"). In the process, new riparian benches and coves will be created along the stream (see Figure C-1 below). The steep tailings ridge ("B") will then be pushed laterally (arrows) into the adjacent depression and contoured. All treated areas will be mulched and re-vegetated. Earth work will be performed in a manner that avoids filling existing wetlands and viable willows will be salvaged wherever possible.

Appendix C: Riparian Edge Enhancements

Figure C-1: Floodplain Benches

Narrow but stable riparian benches (”A”) have become established along much of this straight, confined reach of channel. In contrast to most of this drainage, erosion resistant bryophytes line the south bank (“B”) in these shady, moist sections of stream.

Throughout much of this unusual corridor, dredge tailings (cobbles) severely limit the lateral extent to which riparian vegetation may become colonized. Consequently, tailings will selectively be pulled back to increase the width of existing riparian benches (see Figure B-3 above) and allow water to inundate a broader, more irregular floodplain. This, in turn, will dissipate stream energy during high flows and encourage lateral riparian community development.

This work will be accomplished in a judicious manner so that stable riparian soil and plants (i.e. bryophytes) remain undisturbed. Within a matter of years, width of the riparian (flood plain) community is expected to increase from its current extent (0-5 feet) to 10-20 feet in treated areas. As a result, habitat diversity will be greatly enhanced by creating a non-linear floodplain over long distances of the channel.

Figure C-2: Selective Vegetation Cutting in the 2011 Project Area

This before and after sequence shows a test reach on the Tarryall Meadows ranch where willows were selectively cut along the stream channel in 2011. The “after” photo (right) shows how willows were generally cleared from the north bank and selectively trimmed along the south bank. Our 2012 plan is to leave root material and smaller shoots intact, and to maintain a willow canopy on one bank for cover and shade (typically along the south bank).

Figure C-3: Vegetation Cutting Areas in the Central Reach

These photos are representative of the central ("tube") section of channel. Channel stability in this artificially straightened, confined reach is not generally dependent on vegetation. However, shrub cover is very important from an aquatic habitat perspective. This reach would benefit from selective clearing and pruning of senesced willows. Consequently, our 2012 clearing efforts will necessarily be selective and judicious to maintain stream cover and shade.

Appendix D: Stream Habitat Enhancements

Located toward the bottom of the property on "Reach 9," this bend pool is the deepest pool on the property (except beaver ponds). Pool depth is self-maintained by scour against a strong vegetated bank created by a very tight bend (Rc~1.0). Here the channel turns more than 90 degrees to the right and 90 degrees back to the left within 40 feet (yellow arrows). Turbulent cover, overhanging banks, and deep slack water areas provide excellent fish habitat under a variety of conditions. This type of feature may be replicated in a few reaches of the project area.

Small, incipient bend pools are present within the project area. In this example, a nice pool has formed below a slight "dog leg" meander. The channel is about five feet wide where the stream turns abruptly to the right (red line). As it's directed back to the left, it widens into a pool that's about 15 feet wide and 24 inches deep (yellow line). This reference demonstrates that bend pools can be maintained even on very slight bends or "dog legs" as long as bank materials are strong. Opportunities exist to create similar "dog-leg" bend pools at a few other locations within both the floodplain and confined reaches of channel.

Figure D-1: Existing Bend Pools

Bend pools (a.k.a. lateral scour pools or meander pools) are created and maintained by scour along the outside bank at a bend in the channel. For the pool to be self-maintaining (stable) it is important to have sufficient radius of curvature and strong bank materials.

This modest bend pool is one of several locations throughout the central reach where aquatic habitat could be improved by adding subtle grade control structures.

The small cove and bench along the north bank (yellow arrow) dissipates energy and provides slack water during runoff.

A low profile grade control structure comprised of embedded boulders and cobbles would be constructed at the red line to provide greater depth and fish cover at low flows, without excavating the bed to make it deeper.

Willow branches would be selectively pruned at this location to increase upstream access while maintaining summer shade and overhead stream cover along the south bank.

Figure D-2: Proposed Bend Pool Enhancement in the Central Reach

A hard riffle crest at the tail of this pool (white line) maintains the upstream pool elevation at low flows. A wide bench along the north bank (yellow arrow) dissipates stream energy and provides quiescent aquatic habitat during high flows. This pool tails out gradually from its deepest point (photo at right), providing both feeding and spawning habitat at different stream stages.

At the head of this pool, channel width contracts to about 8 feet (red line) where it plunges into deeper water. Good depth (18”-24”) and turbulent cover provide pool habitat for fish under base flow conditions. This constriction and downstream plunge pool are maintained by a cemented cobble bed with willow “hard points” on either bank.

Figure D-3: Existing Hard Point Constriction Pool in the Central Reach

Constriction pools (a.k.a. contraction scour pools) naturally form at locations where a channel constricts between two hard points. The contraction causes downstream bed scour which creates and maintains pool depth.

Figure D-4: Reference Constriction Pool

This reference pool is maintained by contraction scour through the constriction (yellow line) which maintains greater pool depth and turbulent fish cover at low flows. The hard riffle crest (red line) is comprised of larger material that maintains upstream depth at low flows. The strong willow bank serves as an ideal "hard point" at the constriction (yellow line) and also maintains an undercut bank.

Figure D-5: Constriction Pool in 2011 Project Area

Large dredge tailings (boulders) in the channel serve as hard points for this small constriction pool located in the 2011 project area. The thalweg offers considerable depth (24") and turbulent in-stream cover for fish. Larger trout were observed feeding in the slack water (red arrow) in October 2011. A natural riffle crest (yellow line) is apparently maintaining a stable pool elevation below the scour area. This type of feature will be replicated using boulders as constriction materials at several locations in the 2012 project area. However, boulders will be embedded and keyed into very strong banks to create more natural looking pool features.

This is a typical location where incipient pools could be enhanced with subtle constriction structures in the central reach. Embedded boulders near the head of the pool will be used to create contraction scour and maintain greater pool depth. The pool tail out (red line) would be elevated several inches by embedding small boulders to increase depth. Additionally, the small floodplain area will be enlarged by pushing the tailings south 5-10 feet and grading a wider riparian bench (green arrow).

This gentle bend pool is currently about 15 feet wide, 50 feet long and 18 inches deep at low flows. Pool area and depth could be greatly increased by simply elevating the hardened riffle crest a few inches, and tying it into the strong (south) bank.

Overhanging willows along the south bank (white arrow) provide fish cover and shade. At high flows, a small floodplain along the north bank (green arrow) and cove on the south bank (yellow arrow) dissipate stream energy and provide quiescent aquatic habitat during runoff.

The largest brown caught to date in the tube section (15") was surface feeding near the tail of this pool during August 2011 (red arrow).

Figure D-6: Proposed Pool Enhancements in the Central Section

Figure D-7: Existing Step Feature in the 2011 Project Area

In the photo above, an assortment of boulders and cobbles maintains an impound pool above, and small plunge pools below each of three hydraulic jumps or “steps.” Similar features will be constructed within the steepest reaches of confined channel during 2012. The longitudinal distance between steps will be increased to provide larger plunge pool areas below each drop.

Figure D-8: Proposed Pocket Water Enhancements in Riffle Sections

This photo demonstrates how scattered boulders have formed small plunge pools or “pocket water” in a fast riffle. Flat boulders will be placed strategically in riffle sections to mimic this natural type of aquatic habitat structure. Willow trimming along the north (right) bank will facilitate stream access in this reach.

In this image of a natural impound pool, several boulders have become embedded across the channel to form a grade control or "dam" structure (red line). Here a small plunge pool has formed below the natural control structure. Pool area and depth may be increased by simply elevating the structure a few inches.

In this image, cobbles have been added in PhotoShop to demonstrate how materials might be arranged below the same grade control structure to form an inclined riffle below the impound pool. While this would eliminate the downstream plunge pool, it would also create a more gradual stream elevation change.

Figure D-9: Proposed Impound Pool in the Central Reach

Hard materials spanning the entire channel act as grade control structures, thereby impounding water upstream.

Appendix E: Beaver Colonization

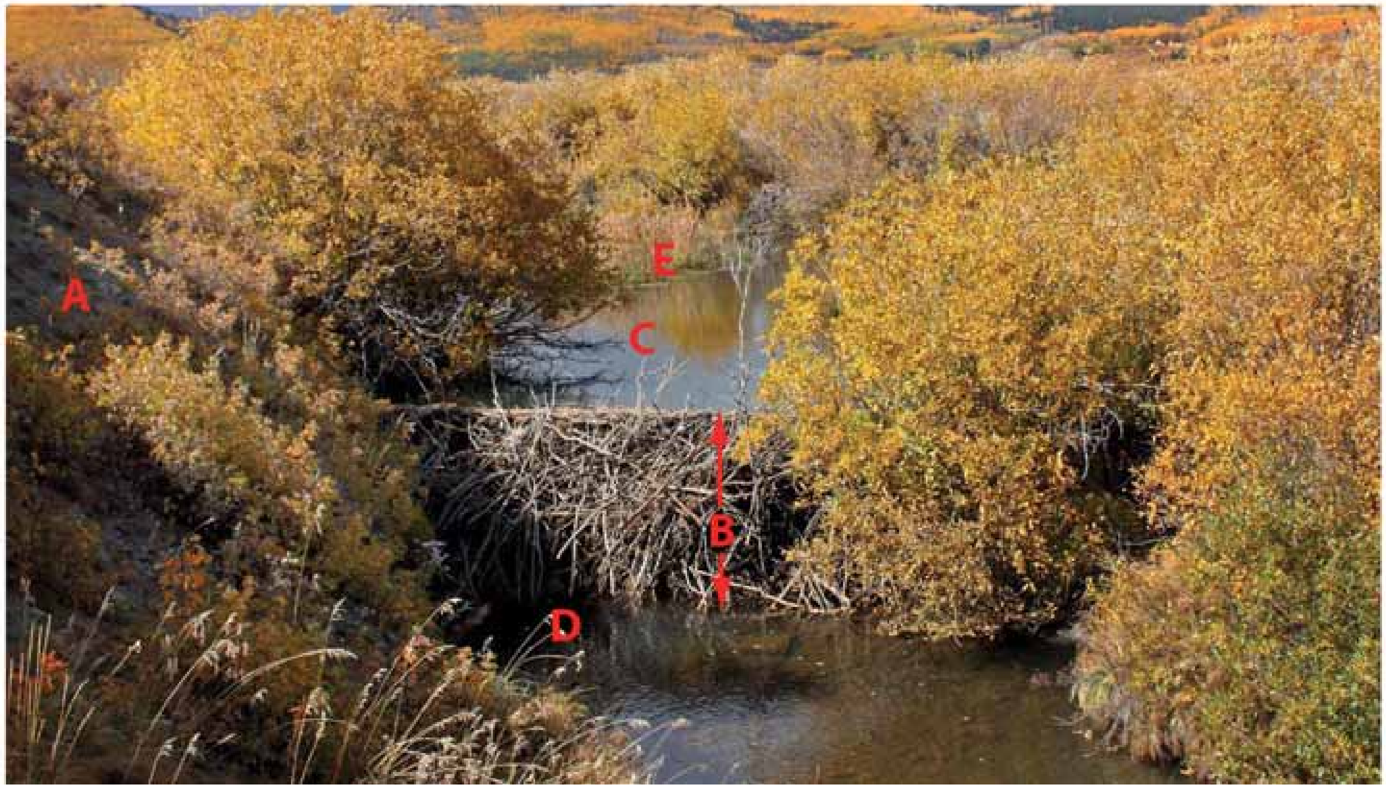

Figure E-1: Reference Area for Beaver Colonization

This reach of Tarryall Creek is immediately below the 2012 project area. Here the stream is confined by historic dredge workings along the south bank ("A"). Beaver effectively have created a series of steps in this confined channel. This, in turn, has raised the water elevation ("B"); created deep ponds ("C") and plunge pools ("D") that now provide trout and water bird habitat. Moreover, wetland (mainly sedge) communities have become established on sediment bars and floodplain benches that have formed along the channel ("E").

This reach demonstrates what is possible when beaver are encouraged to colonize dredged areas. Accordingly, beaver "starts" will be constructed at strategic locations in the central reach once tailings reclamation is complete.

This photo shows a low profile beaver “start” immediately after it was constructed at the Williams Ranch on lower Tarryall Creek. In this example, pine trees with limbs attached were embedded into the structure. This site was selected, in part, because of the abundance of dam building materials available to colonizing beaver.

This is the same structure two weeks after beaver utilized available building materials to elevate the dam and pond elevation by two feet. If the beaver dam fails during runoff, the base structure (“start”) will continue to maintain residual pool depth upstream.

Figure E-2: Beaver “Start” at the Williams Ranch

Beaver “starts” are low profile, cross-channel grade control structures with embedded woody material.

This sprawling beaver dam appeared one week after constructing a beaver start at Ute Creek Ranch in 2010.

This new beaver pond at the Williams Ranch has inundated a long section of river and adjacent meadows above the dam.

This beaver start at Allen Creek Ranch encouraged both dam construction and scour pool formation in 2011.

Figure E-3: Successful Beaver Starts

Beaver “starts” have been employed at three strategic locations on lower Tarryall Creek. In each case beaver have constructed dams at these sites within a few weeks of project completion. As a result, new ponds provide habitat diversity for mammals, fish, water birds, and insects, as well as floodplain recharge. Over time sedges and willows will become established on sediment bars that build along upstream meander edges.

Figure E-4: Typical Beaver Start Location on TMR

This photo depicts one of several locations where beaver colonization may be encouraged by constructing beaver “starts” and stockpiling fresh cuttings within the project area. This location is strategic because the channel is confined by tailings along the south bank (”A”); it contains several large boulders and remnant beaver dam materials (”B”); and a broad riparian bench exists along the north bank (”C”).

A new beaver dam at cross section ”D” would diversify aquatic habitat in this channelized riffle; create a deep pond that supports trout and water birds; and inundate the riparian bench (“C”) where fine sediment will deposit over time. This, in turn, will stimulate riparian (sedge and willow) development, and provide shallow-water habitat for a variety of avian species. Within a few years this site could potentially look and function like the beaver colonization reference area depicted in Figure E-1.