Yampa River Forest Restoration Project

Final Report

Prepared for:
Colorado Watershed Restoration Program
Water Supply Reserve Fund Yampa-White-Green Basin Roundtable
Attn: Chris Sturm and Steve Hinkemeyer
January 31, 2022

City of Steamboat Springs and Yampa Valley Sustainability Council
Grant Amount: $75,000
Prepared by: Tim Sullivan, Resilient Land and Water Program Director,
Yampa Valley Sustainability Council

City of Steamboat Springs

YAMPA VALLEY SUSTAINABILITY COUNCIL

Table of Contents

Introduction

This project grew out of the findings and recommendations contained in the Yampa River Health Assessment and Streamflow Management Plan developed by the City of Steamboat Springs in 2018. The Plan evaluated a 12.5 mile stretch of the Yampa River above, through, and below the city limits, and made recommendations for priority actions to address issues affecting the health of the river. One of the priority recommendations for actions from the SMP was to: Establish a native riparian revegetation program for implementing the identified revegetation projects along the Yampa River through Steamboat.

The Yampa Valley Sustainability Council (YVSC) has been organizing an annual community tree planting event since 2010 called ReTree. The City of Steamboat Springs and YVSC partnered to build on the success of ReTree to create the Yampa River Forest Restoration Project to advance the goals and recommendations of the Steamboat Springs Stream Management Plan.

Background

The 2018 Yampa River Health Assessment and Streamflow Management Plan (aka The Stream Management Plan) found that the riparian forest is degraded on the reach of the Yampa River above the Chuck Lewis State Wildlife Area, through town and to the Wastewater Treatment Plant and that improving the quality of the vegetation, particularly the shading canopy cover, will lead to improvements in stream temperature and water quality on the Yampa River. The 3-year project covered in this grant report was identified as a top priority action item in the Stream Management Plan. Restoring riparian forests, in addition to providing water quality benefits, will also help to improve aquatic and terrestrial habitat and stabilize the river channel, thus making it more resilient to floods, droughts, or human impacts. The full Stream Management Plan and supporting documents can be found at: https://steamboatsprings.net/587/Yampa-River-Health-Streamflow-Management

The Land and Stream Restoration Opportunities Report, an appendix to the Steam Management Plan analyzed and prioritized opportunities to conduct on-the-ground restoration projects to meet the Plan's management objectives. Many of these projects were for riparian revegetation. These projects could help improve aquatic life, channel form and process, and water quality. In addition, the Water Temperature Management Opportunities Report indicated that riparian shading could help to reduce water temperatures warming due to sunlight. YVSC's ReTree Program, and other efforts had coordinated successful riparian plantings in the past and were to be leveraged to implement a larger-scale, targeted riparian plant restoration effort beginning with and expanding on the restoration opportunities identified in the Steam Management Plan.

The long-term goals for the Yampa River Forest Restoration Project (for this grant period and beyond) are to advance the following goals from the Stream Management Plan.

1. Maintain or improve natural river form and processes
2. Maintain or improve riparian vegetation extent and condition
3. Maintain compliance with State stream temperature standards

4. Establish and implement a long-term program for riparian vegetation restoration, protection, monitoring and stewardship
5. Foster a culture of shared stewardship of the Yampa River among community members, especially youth

More specifically, the project aims to increase the amount of riparian area in the reach of the Yampa River from Lake Catamount to the Elk River with vegetative cover that provides shading of the river in critical summer months. Assessments conducted as part of this grant, indicate that it would take adding vegetative cover that shades the width of the river on an additional 18 acres of land (in a 20m buffer from river's edge) to meet the short-term goal in the Stream Management Plan (goal of 20% of mapped acres with sufficient vegetative cover). The work in this grant was intended to undertake the first three years of a longer-term plan to meet the goal, to test methods of efficiently planting cottonwood trees, and to develop recommendations for how to achieve the goal over the long term. Further, the project aimed to accomplish the on-the-ground goals by building community support and capacity and to increase education about river health issues.

The objectives for this grant, were to:

1. Develop and implement a short-term (3-year) plan for riparian vegetation protection and planting
2. Develop a long-term plan for riparian forest restoration
3. Develop and execute a procurement plan for riparian vegetation materials
4. Coordinate volunteer groups and educate about river health

The short-term implementation plan objective focused on tree planting in the Chuck Lewis State Wildlife Area in Routt County just south of the City of Steamboat Springs (Figure 1) and in the City of Steamboat Springs' Rotary Park (Figure 2). Plantings in Chuck Lewis SWA occurred in the area marked as Lower Chuck Lewis in Figure 1. Figure 3 is map of specific tree planting locations in Rotary Park. The complete short-term plan is attached as Appendix A.

The "*Long-Term Implementation Plan for The Yampa River Forest Restoration Project*" outlines opportunities for meeting the goals of the Stream Management Plan and identifies specific locations for future planting projects, outlines methods for securing sufficient riparian vegetation materials and successfully planting and maintaining those trees, and suggests approaches for engaging private landowners in planting projects and for securing long-term funding. The complete long-term plan is attached as Appendix B.

Figure 1. Project Area in Chuck Lewis State Wildlife Area

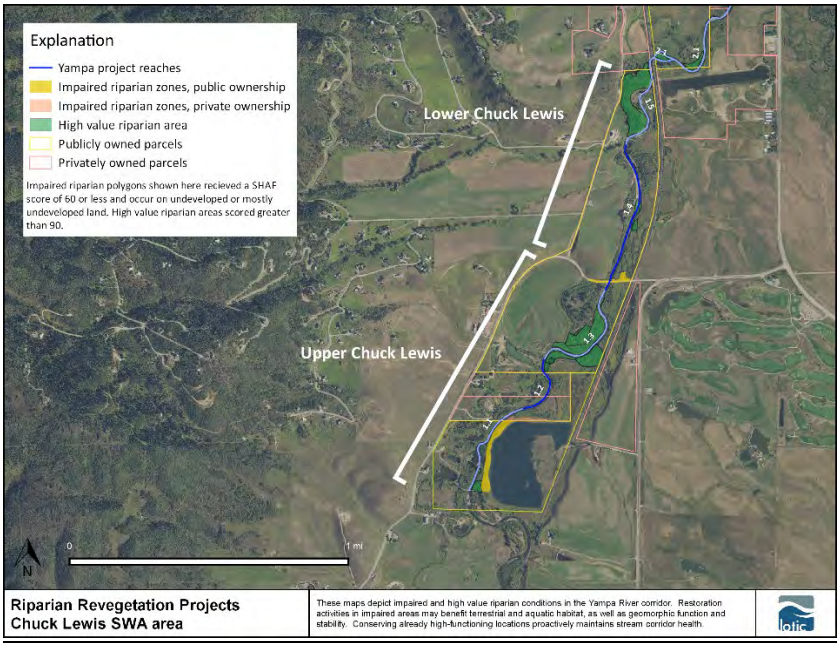


Figure 2. Project Area in Rotary Park

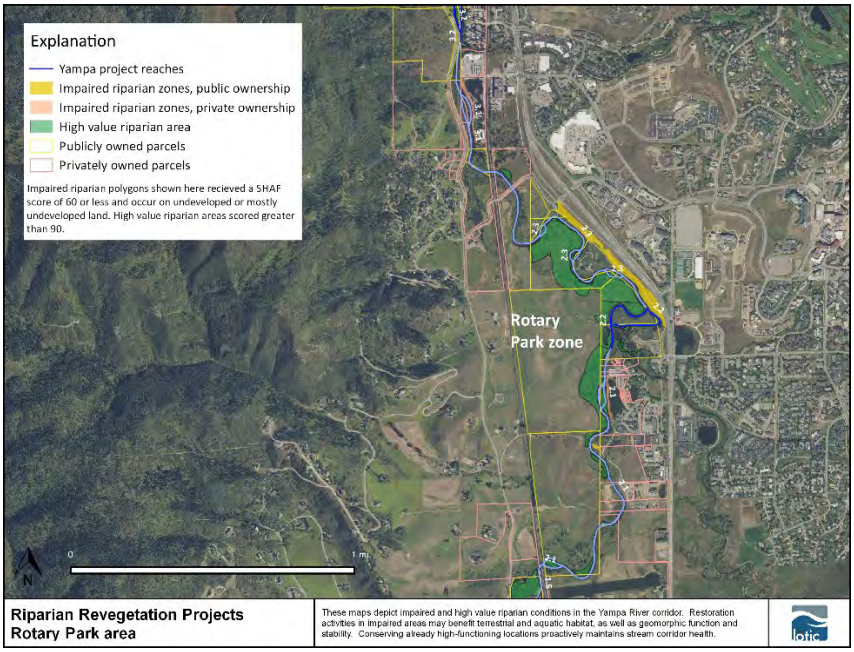


Figure 3. Location of 2019-2021 plantings from first phase of Yampa River Reforestation Project in Rotary Park, Steamboat Springs

Methods

Task 1 - Convene a project team

The core project team for this grant included representatives from Yampa Valley Sustainability Council (Project Manager), City of Steamboat Springs Public Works Department, City of Steamboat Springs Parks and Recreation, Colorado State Forest Service, and Colorado Parks and Wildlife. The individuals representing some of these organizations changed over the course of the project, but all organizations remained directly involved in planning and implementation. Other key groups involved through the project, but not on the core team, include the Natural Resources Conservation Service, Colorado Cattlemen's Agricultural Land Trust, CSU Extension, Confluence Resources Management, and Friends of the Yampa.

Task 2 - Develop and implement a short-term (3-year) plan for riparian vegetation protection and planting

During 2019, 2020, and 2021, the team planned and implemented planting projects in the City of Steamboat Springs Rotary Park parcel (Figure 2). And in 2019, the project worked with CPW to plant 200 trees at Chuck Lewis SWA (Figure 1). Planting events in 2020 and 2021 in Chuck Lewis were postponed due to COVID concerns. Those areas will be planted in 2022 and 2023. A total of 1100 cottonwoods were planted in 17 plots at Rotary Park (Figure 3). The plots varied in distance to the river, irrigation method, arrangement of planting holes and number of trees per hole. Prior to the first plantings, the team installed groundwater monitoring wells near potential planting sites and developed test plots comparing relative effectiveness of different reed canary grass (*Phalaris arundinacea*) control methods.

The key methods developed in this project that should guide future plantings are as follows (note that some of these recommendations may change as trees age in the next few years, so these are initial guidance):

1. Seedling selection: The project worked with the Colorado State Forest Service Nursery to develop the following protocol for growing native Yampa valley stock of narrowleaf cottonwood. Cuttings from mature trees, with active same year growth on terminal ends and branchlets, are collected in the Steamboat area after full dormancy has set in (late November-early December). The Nursery prepares cuttings for rooting individual trees in early Spring and start them in D40 deepot tubes (2"x10" size). D40 pots offer the best balance of price, ease of handling, and good root production. Seedlings are raised in a greenhouse until late summer and then moved to outside shade structures for hardening before transport. Trees are either transported to the Yampa Valley at the end of the first year of growth or held over until second planting season. Depending on the amount of time between transport and planting, trees can be stored in Yampa Valley provided they can be watered every 2nd or 3rd day and protected from browsing.

2. Planting locations and preparation: The initial three years of planting were all in similar vegetation and bank condition. 2019 included planting some trees more than 60 feet from the river to simulate a larger gallery forest. Those plantings consistently fared worse than trees closer to the river (likely due to depth to groundwater) and they are less likely to provide shading benefits to the river. Going forward, the team recommends planting within 60 feet of the river channel, unless the site is in a regularly inundated floodplain and there is value in a wider forest canopy. For ease of irrigation and fencing, a series of rows of planting parallel to the river provide the most potential shading. All current sites were accessible with a skid steer-mounted 12-inch augur that could drill 3-foot-deep holes prior to planting. For sites where skid steer access is possible, this is the recommended approach. In less accessible sites, a handheld augur is recommended. In sites with shallow depth to groundwater, hand dug holes may be acceptable, though not recommended as the auger can loosen soil more effectively. Spacing between planting holes should be 6-8 feet. If sufficient planting stock is available, planting two trees per 12-inch hole allows for shared irrigation emitters and provides redundancy to account for tree mortality. In smaller than 12-inch holes, one tree per hole is recommended.

3. Weed control: Most riparian areas without mature canopy cover in the stretch of the Yampa targeted for this project are covered with either smooth brome (*Bromus inermis)* or reed canary grass (*Phalaris arundinacea*). Both are non-native grasses that create dense mats and can compete for water and sun with small seedlings. Of the non-chemical control methods tested by the project team (mechanical cutting, mulching, and black plastic) only the plastic controlled regrowth successfully, but at the cost of preventing precipitation from reaching plantings. Heavy mulch was successful at preventing regrowth for at least one growing season. In sites where herbicide use is not feasible (e.g. designated open space), the best method of control appears to be mechanical clearing (with a weed-whacker) prior to planting, application of heavy mulch out to one to one and half feet from tree stems, and annual weeding and re-mulching when needed of grass resprouts in the irrigation zone near seedlings. Landscape fabric extending beyond the mulched area might be indicated in heavily infested locations (particularly for reed canary grass), though at higher cost and with uncertain results due to the aggressive growth of the invasive grass. After three years of growth, seedlings should be tall enough, with deep roots to be able to outcompete grasses.

4. Fencing: All planting sites to date have been enclosed with 6-foot tall 12-gauge woven wire fence with T-posts spaced in 6-foot increments. This fencing approach is designed to protect against both ungulate browsing and beaver predation. The main ungulate pressure in this reach of the river is from moose, where density is low. If large wildlife fencing is unwieldy based on site conditions, the project will use beaver cages for individual trees made from 3-foot high fencing. In areas with active cattle grazing, the taller wildlife fence is the best treatment. In addition to new planting, there are areas along the entire study stretch of the Yampa with young (3—10 foot tall) naturally generating cottonwoods. Protecting these trees from beaver predation is a high priority, particularly in spots along the river that provide high shading benefits. The project team worked with Confluence Resources Management to develop a

protocol for caging young trees that even young volunteers (such as the Service Learning Crew of Rocky Mountain Youth Corps) can implement.

5. Irrigation: Irrigating seedlings until they have developed roots deep enough to access groundwater (three to four years, particularly in sites with high banks) will be necessary to ensure success. In two of the three years monitored at the initial planting sites, three-foot-deep groundwater wells showed no groundwater presence by June of each year. These were years without significant spring over-bank flooding. Given recent trends and future projections, it seems more likely that we will continue to see multiple years without overbank flows. Going forward, all plantings will have irrigation. At the present site, the irrigation system that is proving the most efficient involves running 3/4" pipes to the planting area with 1/4" hoses connected from 2 gallon per hour emitters to a drip stake at each tree. Future sites will require specific assessment of irrigation needs, but this configuration is the basis for initial planning.

6. Monitoring and Data Collection: We are collecting data on location and number of all trees planted in a geospatial database. The data show location of enclosures and planting holes, along with initial number of seedlings, and surviving numbers at the end of each growing season. Additionally, we will record the location of any trees protected with beaver cages to allow regular inspection. We have found numerous trees planted perhaps a decade ago where the trees had grown into the cages. If the City ever proposes to develop an alternative action to meet its water quality requirements by increasing shading, data on new trees planted and surviving will be necessary.

Task 3 - Develop a long-term plan for riparian forest restoration

The project team developed a long-term plan for riparian forest restoration over the three years of the project (Appendix B). The process included consultation with public land managers on the schedule of proposed restoration projects in the next ten years, collaboration with the Yampa/White/Green Basin Roundtable as it developed an Integrated Water Management Plan for the entire Yampa (members of the project team serve on the Riparian work group of the IWMP), and establishment of a work group focused on opportunities for engaging private landowners along the river (focused mostly on NRCS projects). Project team members also worked with The Freshwater Trust to complete an analysis of the potential of tree planting to reduce solar loading on the river to help address water temperatures (the report from this work is available upon request from the City of Steamboat Springs, but is not included in the scope of this project other than in how it informed the long-term plan).

To better understand current riparian forest cover and to identify the potential for new reforestation projects, YVSC conducted an analysis of cottonwood site suitability along the Yampa River from Lake Catamount to the confluence with Elkhead Creek (59 river miles) and on the Elk River from Clark to the confluence with the Yampa (26 river miles). While this area is larger than covered by the SMP, it includes the major river segments included in the potential water quality trading program analyzed by the Freshwater Trust for the City of Steamboat Springs.

A full description of the methodology for the YVSC site suitability analysis is included as an appendix to the attached long-term plan. Sites were analyzed for their frequency of flood return, existing woody vegetation, vegetative class, and slope. The sites with the highest potential (most suitable) were those that had frequent flood return intervals, supported natural vegetation, but did not have any current trees above .5m tall and were mostly flat. We also scored sites as suitable (but needing more field evaluation) if existing vegetation was between .5m and 4m. Sites with dense vegetation above 4 m were considered to have "mature cottonwood" cover.

The Routt County tax parcel map was overlaid on the suitability map to identify land ownership, including public versus private ownership. We then further used the Colorado Ownership Management and Protection (CoMap) database to identify parcels with a conservation easement or other restrictions to development. Parcels were ranked by the amounts of river frontage with contiguous suitable habitat to identify areas where trees could be planted in larger groupings (to simplify projects for irrigation and site preparation).

The result is a map that can identify locations to prioritize field verification, and to support outreach to private landowners. Figure 4 is a sample of the model outputs and the full map and outputs can be viewed at: https://yvsc.maps.arcgis.com/apps/webappviewer/index.html?id=c79dda9d0974496d9b141e09a29da1bc YVSC initially ran the analysis on the Yampa running from Lake Catamount to the confluence with Elkhead Creek and on the ElK River downstream from Clark. The full extent of the analysis helps identify parcels, particularly those in private ownership, outside the range of the SMP area that could be useful to evaluate if there are not sufficient suitable parcels in the river reach closer to the City of Steamboat Springs.

Figure 4. Overview of Cottonwood Suitability Site map with ranked parcels.

Task 4 - Develop and execute a procurement plan for riparian vegetation materials

The project team negotiated a service agreement with the Colorado State Forest Service Nursery in Ft. Collins to grow cottonwoods from cuttings taken in the Yampa Valley. The methodology developed is described above under Task 2.

The project team evaluated options for creating local capacity for a seedling nursery to potentially increase the number of trees available on an annual basis. The bottleneck for seedling production is the early stages of growth where a heated greenhouse is required (the State Nursery has adequate space for holding trees outdoors once they are established). The cost of acquiring and staffing a new greenhouse in the Steamboat area is far more than the cost of working with the State Nursery. Given the ability to meet current rates of planting from the Nursery and potential for the Nursery to increase production with advance notice, the team decided it was not prudent to pursue development of a new nursery. Temporary holding of trees prior to planting will continue to be needed, but the requirements for this are not hard to meet. Currently, the small outdoor nursery area at Chuck Lewis SWA meets the needs for planting projects. Seedling production requires planning two years in advance, so this is an issue that the project team will continue to monitor.

Task 5 - Coordinate volunteer groups and educate about river health

Most of the labor for this project was contributed by community volunteers. This greatly increased the value of the project as a tool to educate about river health, climate change/drought, and the importance of riparian areas. The focus for volunteer engagement was an annual ReTree event. Since this is a community event running for over a decade, it has great visibility in the community and attracts media attention and community sponsors. Local artist Jill Bergman has been developing a poster each year to celebrate ReTree, and for this project built on the theme of trees benefitting river health. Volunteers at ReTree receive t-shirts with the annual poster image, and the unique shirts have become a reason to attend each year. The City of Steamboat Springs passed a resolution in 2021, designating the day of the ReTree event as the official Arbor Day in Steamboat, as part of its process to gain designation as a "Tree City USA."

The project team recruited individuals, businesses, community groups and schools as volunteers to harvest, maintain, plant, and care for the seedlings and to build cages for beaver mitigation. The project developed a partnership with the Rocky Mountain Youth Corps, supported by funding from the urban forestry program of the US Forest Service. Over each of the three years, Service Learning Corps groups (ages 11-13) made multiple trips to the tree planting sites to help with maintenance and with beaver mitigation. As a result of the success of volunteer engagement in this project, in 2021, YVSC created a new Yampa Valley Climate Crew to engage volunteers in natural resource projects throughout the Yampa Valley, focusing in its first year on assisting the Yampa River Forest Restoration Project.

CWCB funding was used to support each of the tasks. The main uses of CWCB funds were for project management, including overseeing all of the tree planting and maintenance, recruiting and managing volunteers, communications around the project, and production of the short and long term plans and grant reports. CWCB funds also helped with procurement of materials, including tree seedlings and fencing, and allowed hiring of contractors to help with heavy equipment operations.

Results

The results from this project fall into three main categories: trees planted and amount of riparian area improved (including measures of survival); development of a long-term plan and generating sustained funding for the work; and community engagement and awareness.

On-the-ground results

Table 1 Planting results over the three years of the project

Year/Site	Trees (spp.)	Acres-60ft. buffer	River length in ft.
2019 Chuck Lewis	200 (willow/alder)	0.9	675
2019 Rotary Park	250 (cottonwood)	.72	525
2020 Rotary Park	350 (cottonwood)	1.35	980
2021 Rotary Park	500 (cottonwood)	1.6	1132
Totals	1300	4.57	3312

Since a key goal of the project is to reduce solar input to the river that is contributing to increasing water temperatures, it is possible to roughly calculate what the benefit of the planted trees (when at maturity) would be in terms of solar load. Using the results from an analysis performed by The Freshwater Trust for the City of Steamboat Springs, the Rotary Park sites if fully stocked could reduce average August daily solar loading by 21.3 million kcal/day.

In addition to the new trees planted, the project also installed beaver mitigation (cages) at four sites along the Yampa: downstream from 9th St. bridge; around Snake Island/Rich Weiss Park; Rotary Park (on east side of river across from new plantings; and River Creek Park. The project did not track specific numbers of trees or areas protected with beaver mitigation. Going forward, it will be part of project protocol to document beaver mitigation in a spatial database to allow for ongoing monitoring and tracking.

YVSC is tracking seedling survival by year for the Rotary Planting sites. First year survival (2019 to 2020) was approximately 70%; survival from 2020-2021 (including both first- and second-year trees) was 50%. The lower survival in the second year is most likely due to drought conditions early in the growing year of 2021 as discussed below.

Long-term plan and funding

The project team was able to identify, through the cottonwood suitability analysis described in the methods section, approximately 68 acres of potentially suitable planting sites on City or State-owned land in the project area. Field verification identified twelve medium to large sized high priority planting sites on those lands. Based on projections of river construction projects, it appears feasible to plant on all the sites within the next ten years. A schedule for completing planting on the sites is documented in the long-term plan included as Appendix B in this report. The Cottonwood Suitability GIS analysis is also

a lasting product from this grant. It will help guide outreach to private landowners and to identify additional planting opportunities on the full reach of the Yampa and Elk Rivers.

A key result of the work under this grant has been to develop new and likely sustainable sources of funding for tree planting in the years ahead. Most significant, was the receipt of a new three-year $150,000 grant from the Colorado River District's Community Funding Partnership for the initial implementation of the three-year plan. Receipt of that grant would not have been possible without the demonstrated success of the initial planning and on-the-ground work supported by this CWCB grant. Additionally, during the period of the grant, the project was awarded two grants from the newly established Yampa River Fund to support maintenance of initial plantings beyond the period of the CWCB grant, and to implement the first priority project of the long-term plan in reforestation on Snake Island within the City limits (a priority site identified in the Stream Management Plan). New funding for on-going work is also being provided by the US Forest Service specifically for ongoing youth engagement in riparian conservation. YVSC has received new direct contributions for this work from the VF Corporation and other private donors. In 2021, Colorado Lottery became a sponsor of the program, seeing it as a way to extend and publicize their impact on conservation in the state. The addition of these new donors allows the project team the ability to immediately continue and expand the work begun under the CWCB grant.

Community Engagement and Awareness

As discussed under methods, the primary engagement tool for this project is volunteer work days planting and maintaining trees. Over the three-year period, the project involved 535 volunteers in half to full work days. In 2019, 146 volunteers participated in plantings at Chuck Lewis and Rotary Park as well as in beaver mitigation projects. In 2020, 100 volunteers joined ReTree at Rotary Park in the fall, and 80 Rocky Mountain Youth Corps members volunteered in tree maintenance during the summer. In 2021, 130 volunteers joined ReTree at Rotary Park, 60 Rocky Mountain Youth Corps volunteers helped with maintenance at Rotary and Chuck Lewis, and 19 Yampa Valley Climate Crew volunteers helped with site prep and maintenance. See Appendix C for a collection of photos that demonstrate the volunteers at work.

All volunteer days included a presentation by YVSC staff on the objectives of the forest restoration work and the benefits of healthy riparian areas to the Yampa River. The Rocky Mountain Youth Corps teams received more intensive information about riparian ecology. For ReTree, volunteers are broken into crews led by members of the project team are others with long experience working in restoration. These crew leaders can engage with the volunteers over the half day of tree planting to further explain the benefits of the project.

The project gained good media coverage locally all three years. Appendix D has a list and links to stories featured in the *Steamboat Pilot* and elsewhere about the project. In 2021, *Yale Climate Communications* featured the project in a national story about responses to drought in the Colorado River basin and produced a radio segment about the project. For the 2021 ReTree event, Colorado

Lottery hired a professional videographer to produce a video about the project, speaking with some of the project leaders, and highlighting the true community spirit of the event.

Conclusions and Discussion

The objectives of this project were fully met. The short-term implementation plan was executed, and a long-term plan completed with significant steps made towards funding its implementation. We have grown community engagement year over year in the project, even during the COVID pandemic. However, the long-term goal of the project will only be met if the trees planted during this grant survive until maturity. The project team has obtained funding to continue irrigation and other needed maintenance (weeding, fencing, etc.) for at least the next three years, at which point all remaining trees should be able to survive without supplemental water. As part of the long-term plan, YVSC has build a spatial database to collect and maintain monitoring data on tree survival. The City of Steamboat Springs is developing a stream temperature monitoring program through which we will be able to measure the impact of shading from trees as they reach maturity.

The two biggest challenges to the project in the past three years have been drought conditions and the COVID pandemic. In both 2020 and 2021 peak runoff was below average and the summers were abnormally hot and dry—among the hottest and driest ever recorded. Particularly in 2021, when there was no overbank flooding, groundwater receded quickly. In 2021, the project team was late to have irrigation functional and in the month of June when groundwater should have been sufficient to sustain plantings, there was a higher rate of tree mortality than in prior years. The team responded to this by engaging volunteers to deep water trees by hand, which sustained trees until irrigation was fully functional. Going forward the project will be ready to begin irrigation as early as June each year in the absence of flood flows and will continue to supplement the drip irrigation with periodic deep watering by volunteers.

COVID had less of an effect on the project than drought but did force some changes. Instead of having volunteers work at both Chuck Lewis and Rotary Park, we only did large volunteer days at the latter. The sites that were to be planted at Chuck Lewis are now scheduled for 2022 and 2023 and funding is in hand to complete that work. Due to COVID, we kept volunteers in smaller work groups and did not have a period when all volunteers were gathered in the same spot. This made the planting less of a social occasion and required training and educational presentations to happen multiple times to small groups. In many ways, having a chance for people to engage in a community project in a safe setting was more special during these unprecedented times. We heard from numerous participants how pleased they were that we continued with the project and the volunteer opportunities.

This project was designed from the start to set up a long-term project to meet the goals of the Stream Management Plan. The long-term plan lays out multiple years of continuing work, and all members of the core team are committed to continuing the project. The fact that new funders have stepped up to support the work going forward helps guarantee the project continuance. And the lessons learned in

the first three years will be extremely valuable at improving and streamlining the process of obtaining outcomes. We expect continued growth in the amount of land and river restored on a yearly basis.

Actual Expense Budget

The actual budget including all cash match is provided in Table 2. In-kind funding was not included in the original budget. However, there was significant additional contribution of YVSC staff time, City staff time, volunteer time, and donated supplies.

Table 2 Actual project budget 2019-2021

Task	Description	CWCB Funds CWRP	CWCB Funds WSRF Basin	City of Steamboat Springs Cash	Other Funding Cash	Other Funding In-Kind	Total
1	Convene a Project Team	$0.00	$0.00		$0.00	$0.00	$0.00
2	Develop and Implement a short-term plan for current riparian vegetation protection and planning	$14,597.50	$12,000.00	$48,402.50	$40,000.00	$0.00	$115,000.00
3	Develop and implement long-term plan for riparian forest restoration	$19,727.17	$2,529.00			$0.00	$22,256.17
4	Develop and execute a procurement plan for riparian vegetation materials	$10,132.33	$4,014.00	$1,597.50	$3,912.00	$0.00	$19,655.83
5	Coordinate volunteer groups and educate youth about river health	$5,543.00	$6,457.00		$20,000.00	$0.00	$32,000.00
	TOTALS	**$50,000.00**	**$25,000.00**	**$50,000.00**	**$63,912.00**		**$188,912.00**

The actual budget for individual tasks varied from the estimated budget. The original Task 4 budget anticipated the need to find or build a local facility to support plant materials that were not available from the CSFS nursery. The project team worked with the CSFS nursery over the period of the grant to establish a cost-effective, reliable procedure for propagating and raising to planting stage locally sourced cottonwoods and an additional facility was not needed. In addition, the project received a Colorado Lottery Fund grant to pay for the cost of seedlings in 2021. Thus, the Task 4 expenses were less than budget. However, Tasks 2, 3, and 5 expenses were more than budgeted. The cost overruns were

covered through additional grant funding and in-kind contributions. In addition to the $50,000 from the City of Steamboat Springs, the other cash funding included the original match of $50,000 from the Valerie Gates Foundation, and additional funding from the VF Foundation in 2020 ($10,000) and the Colorado Lottery Fund in 2021 ($3,912).

Appendices

Appendix A - Short Term Implementation Plan

Appendix B - Long Term Implementation Plan

Appendix C – Media Coverage ReTree 2019-2021

Appendix D - Photos from ReTree volunteer days 2019-2021

Yampa River Forest Restoration Short Term Plan

This is the short-term implementation plan outlining site preparation, planting, protection activities, methodology and timeline for two priority areas in the next three years (2019-2021). The two areas identified are Colorado Parks and Wildlife (CPW) Chuck Lewis State Wildlife Area (SWA) and City of Steamboat Springs' Rotary Park.

The goals are based primarily on Objective 5.3 of the *Yampa River Health Assessment and Streamflow Management Plan (YRHASMP)*: "*To maintain or improve riparian vegetation extent and condition greater than or equal to 20% of mapped riparian area with woody vegetation cover by reach for Chuck Lewis, Rotary Park and other identified parcels*".

The ReTree program's philosophy has been to start small, be successful, and build on that success through an adaptive management approach. Although the aim is to mitigate temperature issues by providing shade in the riparian areas, the overall goal is to improve the system's resiliency by growing the overstory component while increasing species and genetic diversity.

Background

The City of Steamboat Springs' 2018 Yampa River Health Assessment and Streamflow Management Plan (aka Stream Management Plan) found that the riparian forest along the Yampa River is degraded on the reach above the Chuck Lewis SWA and through town to the Wastewater Treatment Plant. Enhancing the quality of the vegetation, particularly the shading canopy cover, was identified as a top priority action in the Stream Management Plan that would improve stream temperature and water quality on the Yampa Rive, over time. It will also help to restore aquatic and terrestrial habitat and stabilize the river channel, thus making it more resilient to floods, droughts and human impacts.

Area Selection

The YRHASMP divided the river into sections (reach), and those were mapped and inventoried (Figures 1 and 2). Each reach is 100 m in width from each side of the river and reflects varying levels of overall health and riparian processes (Figures 4 and 4 - Dominant Cover Maps). Working in conjunction with one of the consultants that developed this report, the plan is to continue working in two public areas: City of Steamboat Rotary Park and CPW Chuck Lewis SWA. These two public areas encompass reaches 6,7 and 8, and 2,3,4 and 5, respectively. They have been selected as the short-term plan priority based on access, land ownership (public), existing shade (east bank), river structure and depth.

Riparian Forest Restoration Approach

Riparian forest restoration project will focus on native shade trees in critical parts of those two public areas, by protecting vegetation that already exists and expanding the vegetative cover in areas where there is no overstory and/or it has been impacted by beaver activity. The project team will work with

already present native riparian species such as cottonwood (*Populus angustifolia*), mountain alder (*Alnus incana*) and willows (*Salix sps*).

Riparian forest restoration is an iterative process of site preparation, planting, long-term care, protection, monitoring and evaluation, and replanting if necessary. The project team will ground truth the riparian mapping and inventory done by the YRHASMP project. During this process there will be further refining of specific areas for planting and protection within each reach, based on need, access and future river or wetland restoration projects.

Planting Tactics

Although the restoration goals are the same at both Chuck Lewis SWA and Rotary Park, the planting tactics may be different. Planting efforts at Chuck Lewis SWA is led by CPW with assistance from the project team. Planting effort at Rotary Park are led by the project team.

The following describes planting tactics conducted by the project team:

Measuring wells will be set up during high flow to establish water table ranges within the areas of planting, and thus inform planting location and irrigation needs. Plant material will be procured through the Colorado State Forest Service (CSFS) Seedling Nursery on an annual basis. The project team has been working with the nursery, providing clippings of local vegetation stock and/or seeds to grow native seedlings for this project. In addition, the project team will set up test plots to determine successful removal of invasive reed canary grass (*Phalaris arundinacea*). Reed canary grass is a major threat to natural wetlands as it outcompetes native species by forming dense vegetative mats that prevent seedlings from reaching soil and establishing roots.

The general schedule is to plant in the fall, therefore site preparation takes place through the summer. Seedlings are fenced and mapped, to aid in their protection, and monitoring efforts take place in the spring and fall. For each planting season, the project team will prepare a specific planting plan with detailed instructions for each planting location. The project team will coordinate and implement all riparian planting project phases, from well monitoring set up to fencing. After each season, the team will evaluate the monitoring data and modify the following year's project plan as needed, adapting to succeed.

<u>Chuck Lewis Wildlife Area</u>

Baseline:

CLSWA Dominant Cover Type and Reach Number	**Acres**	**Percentage**
Total	111.123	100.00%
Bareground	7.238	6.51%
3	5.170	4.65%
4	0.542	0.49%
5	1.525	1.37%
Developed	1.167	1.05%
4	1.167	1.05%
Flowing Open Water	11.393	10.25%

2	0.338	0.30%
3	3.097	2.79%
4	5.402	4.86%
5	2.556	2.30%
Herbaceous	53.011	47.70%
2	3.166	2.85%
3	13.923	12.53%
4	26.223	23.60%
5	9.699	8.73%
Lantic Open Water	0.190	0.17%
3	0.190	0.17%
Subcanopy Forest	8.389	7.55%
3	5.100	4.59%
4	2.571	2.31%
5	0.718	0.65%
Shrub scrub	29.735	26.76%
2	0.298	0.27%
3	6.780	6.10%
4	13.686	12.32%
5	8.971	8.07%

As shown on the Chuck Lewis SWA Dominant Cover Maps (Figure 3), the baseline indicates this CPW area currently has 7.9 % subcanopy forest cover in 3 different reaches. The ReTree program calculates that an additional area of approximately 1.2 acres will be added to this total, with 0.5 acres increase in reach 4 and 0.7 acres in reach 5. These areas will be covered by cottonwood, alder and willow seedlings after the short-term project has been implemented, increasing overall subcanopy forest in the reach.

Chuck Lewis SWA Short Term Planting Schedule

(see Figure 5, Chuck Lewis SWA planting map, for more details)

2019	Plant in existing fenced area: • 127 coyote willows • 20 peach willows • 54 mountain alders
2020	Plant 250-300 cottonwoods and mountain alders behind existing fenced area from 2019
2021	Go back to meadow area (2015) and plant 250-300 cottonwoods and mountain alders

Part of the plan is to also continue monitoring previous planting efforts (ReTree 2015-2018).

Rotary Park

Baseline

Rotary Park Dominant Cover Type and Reach number	**Acres**	**Percentage**
Total	64.438	100.00%
Bareground	1.852	2.87%
7	1.840	2.86%

8	0.013	0.02%
Developed	0.016	0.03%
8	0.016	0.03%
Flowing Open Water	12.240	19.00%
6	0.244	0.38%
7	5.816	9.03%
8	6.180	9.59%
Herbaceous	37.855	58.75%
6	0.554	0.86%
7	8.590	13.33%
8	28.703	44.54%
9	0.008	0.01%
Lantic Open Water	0.883	1.37%
7	0.883	1.37%
Shrub scrub	11.591	17.99%
6	1.004	1.56%
7	3.608	5.60%
8	6.979	10.83%

As shown on the Rotary Park Dominant Cover Maps (Figure 4), the baseline indicates that there is no subcanopy forest in any of the reaches. In three years, the subcanopy forest vegetation cover will have been increased by 1-2 acres in reach 8, with a target of 40% survival of the seedlings planted.

Rotary Park Schedule of Activities

June 2019: Set up measuring wells at planting areas and define monitoring frequency. Wells will be placed on a 20-meter grid starting a meter from the bank edge, 9 wells total in 2 areas within the selected planting sites.

June 2019-October 2019: Measure water level in wells bi-weekly.

July 2019: Inventory all overstory trees above 10 inches within the reach. Begin beaver mitigation work. (See below for details of mitigation work.)

July – September 2019: Prepare site by removing the sod layer along planting lines, weed whacking (on going) and clearing/pruning of existing overstory trees. Begin reed canary grass removal testing. (See below for details of testing.)

September - October 2019: Plant 200 cottonwoods planted along monitoring wells and reed canary grass trials. Fence planted area to prevent browsing and map planted areas.

Rotary Park Short Term Planting Schedule
(See Figure 6, Rotary Park Planting Map, for more details)

2019	200 – cottonwood and alder (70/30).
2020	400 – cottonwood and alder (70/30). Try cottonwood stakes
2021	600 – cottonwood and alder (70/30)

The strategy is to go back the first year after planting and replace up to half of what was planted if it has not survived to the target percentage. Additional monitoring will take place at year 3, and year 10 to assess survival rate and overall condition of plant material. Another planting effort would take place at year 10 if needed to meet the target goal.

If needed, irrigation systems will be set up to respond to water table monitoring levels at the identified planting sites. There might be need to irrigate plants for the first two years to allow for enough root development.

Monitoring

Monitoring of water levels, trees survival and health, and fencing will be conducted according to the following schedule:

- Water level measurements – will be collected bi-weekly from June (or earliest access to the site) through October.
- Tree survival and healthy – Will be assessed annually in year 1, 3, and 10, as described above.
- Fencing – will be evaluated bi-annually in spring (earliest access to the site) and fall to ensure effective protection of the seedlings.

Monitoring data will be collected, mapped and reported to the project team and City of Steamboat Springs Water Resources Manager according to schedule.

Reed Canary Grass Removal Tests (1x1 m): Reed canary grass presents significant competition to native species seedling. During the summer of 2019 and 2020, test plots will be set up to try different methods for control and/or removal of the grass. The successful strategy identified for reed canary grass removal will be used in all future plantings, where reed canary grass is an issue.

The following provides the process for set up and monitoring of the test plots.

Set up 1 m squares with wooden sakes and flagging. Set up will take place in June-July. Removal measures include:

- Control
- Tarp/weed barrier
- Weed Whacking
- Mulch
- Willow staking

Control, weed barrier, weed whacking and mulch will be started in June-July and continued through the summer. Willow staking will take place in spring 2020. These tests will be set up and replicated for a total of 3 areas through Planting Areas 1 & 2.

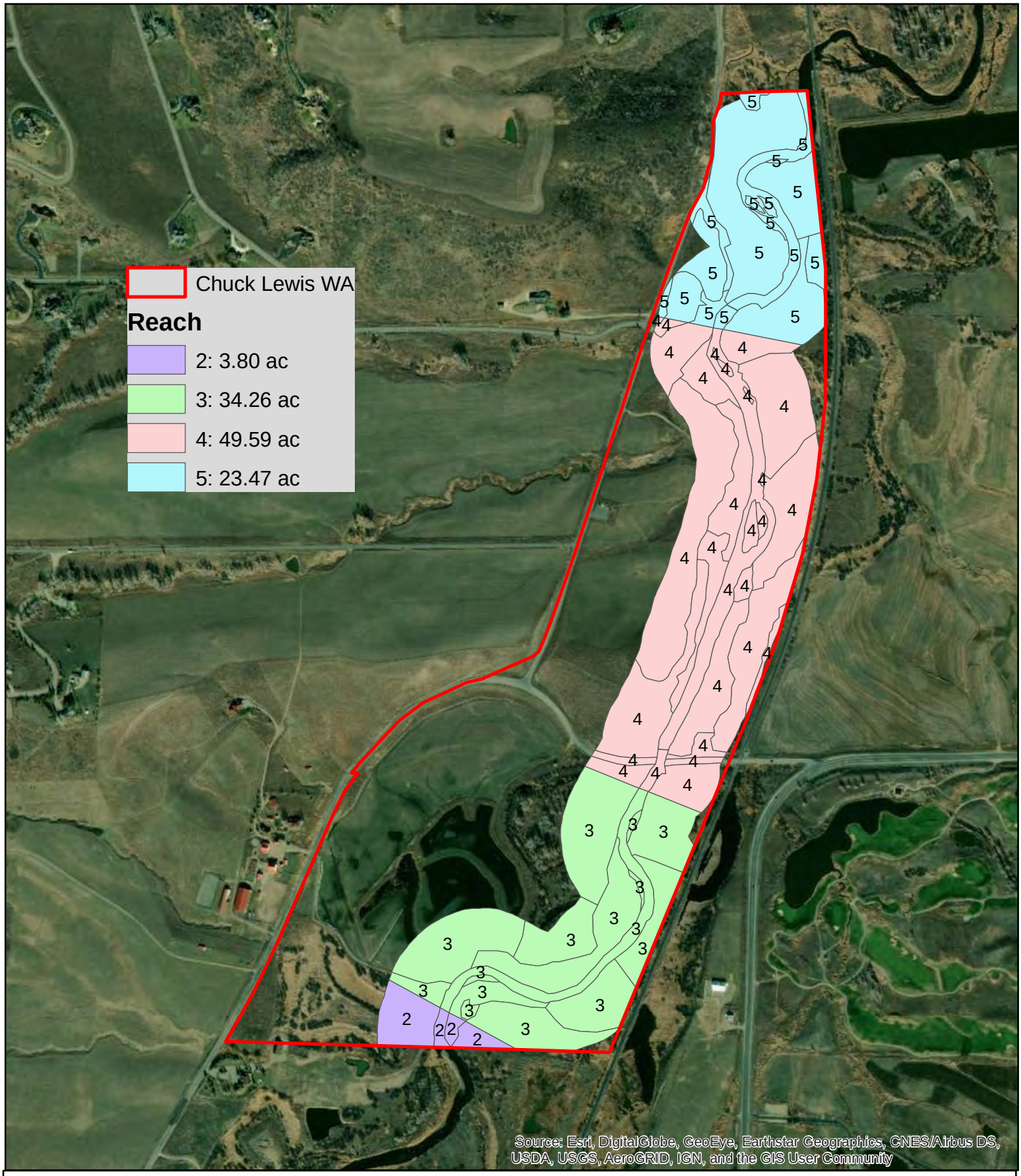
Beaver Mitigation: Beaver activity impacts the survival of young cottonwood saplings. To help meet restoration goals, existing cottonwoods saplings through these reaches will be caged to reduce damage by beaver activity. The following provides the process for protecting the young cottonwoods.

- Choose young trees to be protected based on beaver activity and tree diameter (between 5 & 25 cm diameter) with a focus on cottonwood and alder.

- Fence the trees according to standard operating procedure provided by Confluence Resource Management. GPS each location after completion.
- Monitor previous efforts and repair/expand cages where needed (Rotary, 9th street bridge, River Creek Park and Workman Park).

Project team will continue to expand program expand on a yearly basis.

Yampa River Restoration Project - Reaches within Chuck Lewis Wildlife Area



N
W E
S

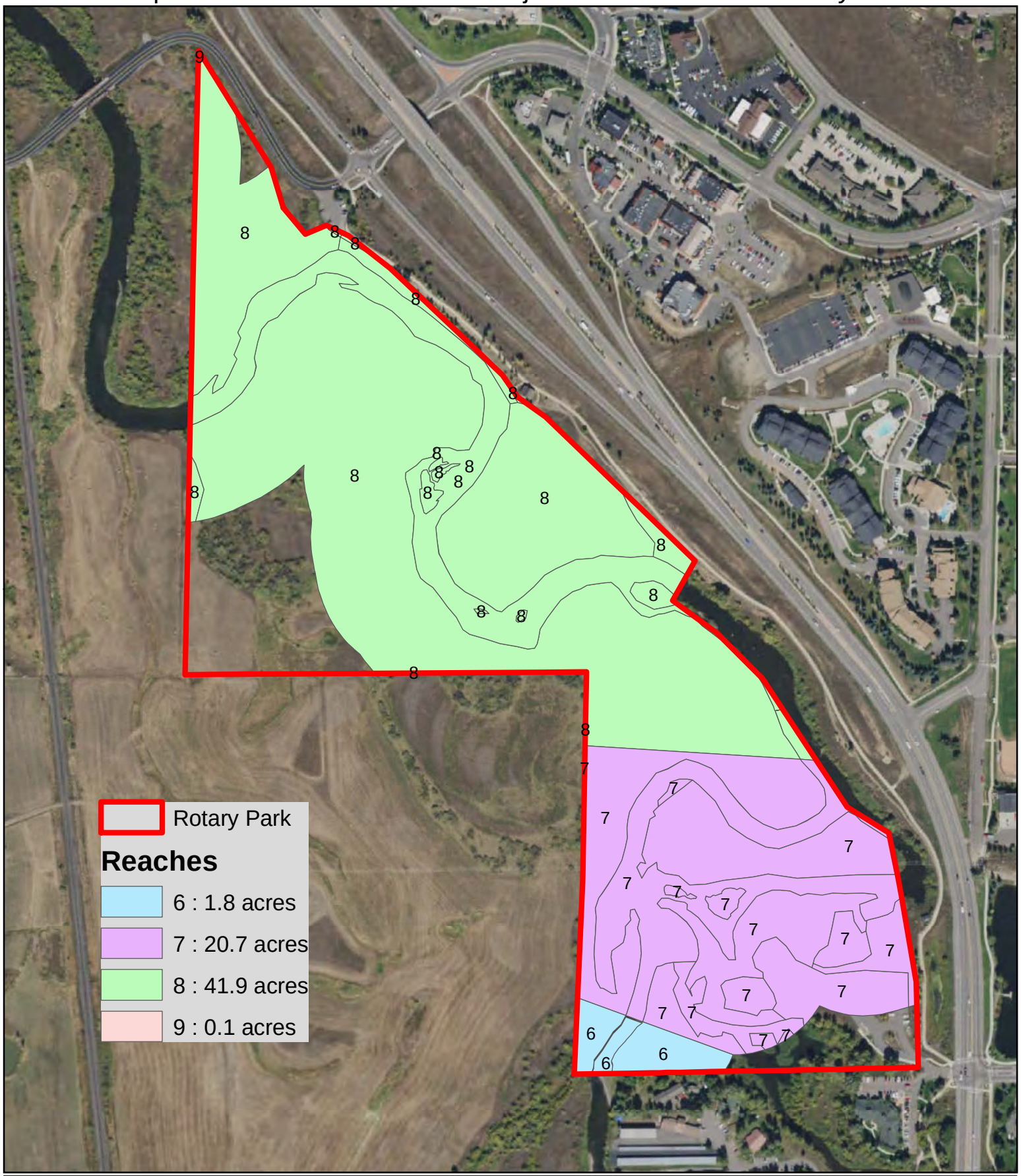
Prepared By:
Colorado State Forest Service
Steamboat Springs District
October 12, 2019

0 300 600 1,200 1,800 Feet

1:9,000

COLORADO STATE FOREST SERVICE
COLORADO STATE UNIVERSITY

Yampa River Forest Restoration Project - Reaches within Rotary Park



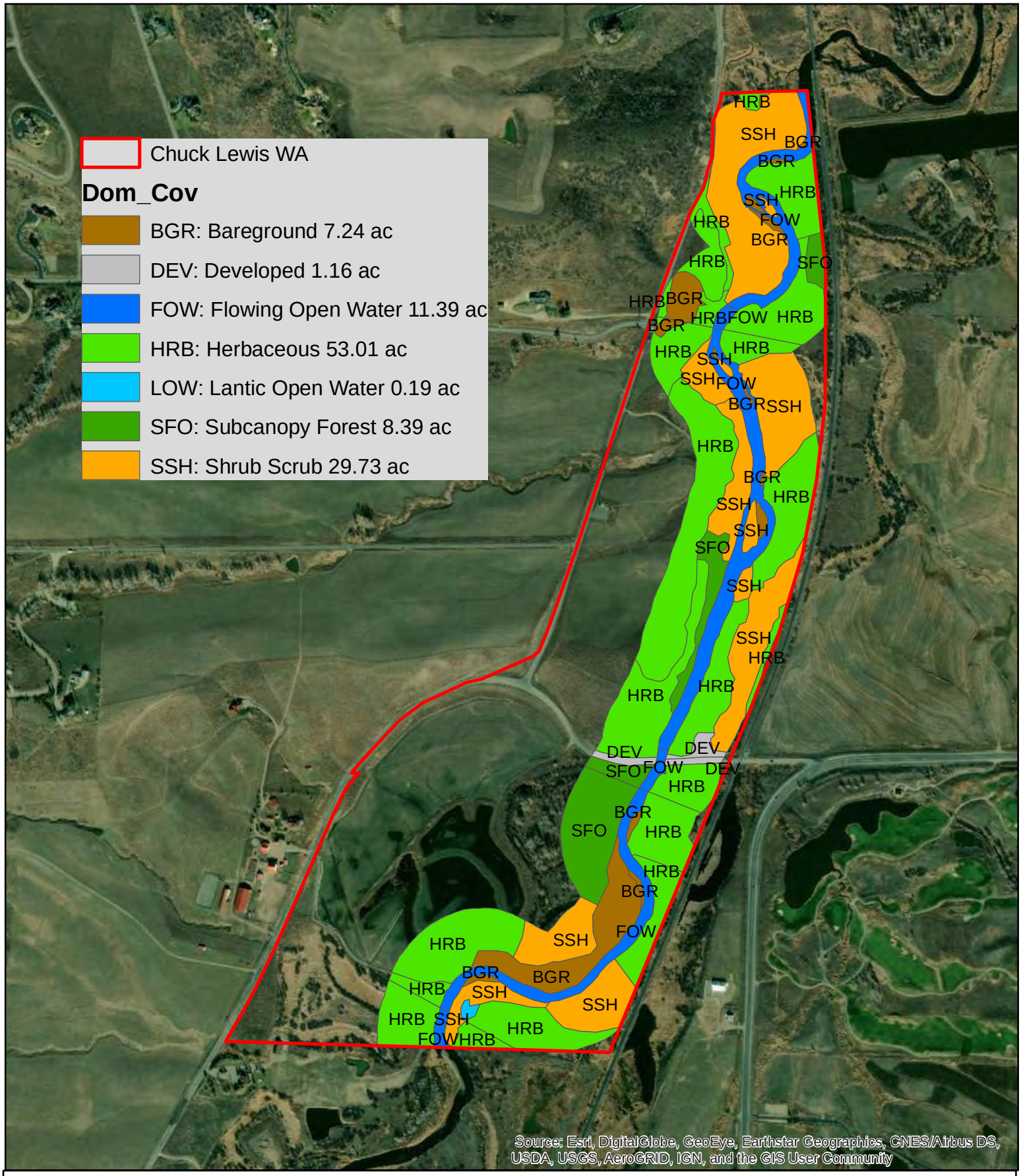
Prepared By:
Colorado State Forest Service
Steamboat Springs Field Office
October 12, 2019

0 250 500 1,000 Feet

1:5,000

COLORADO STATE FOREST SERVICE

Yampa River Restoration Project - Dominant Cover - Chuck Lewis Wildlife Area



N
W E
S

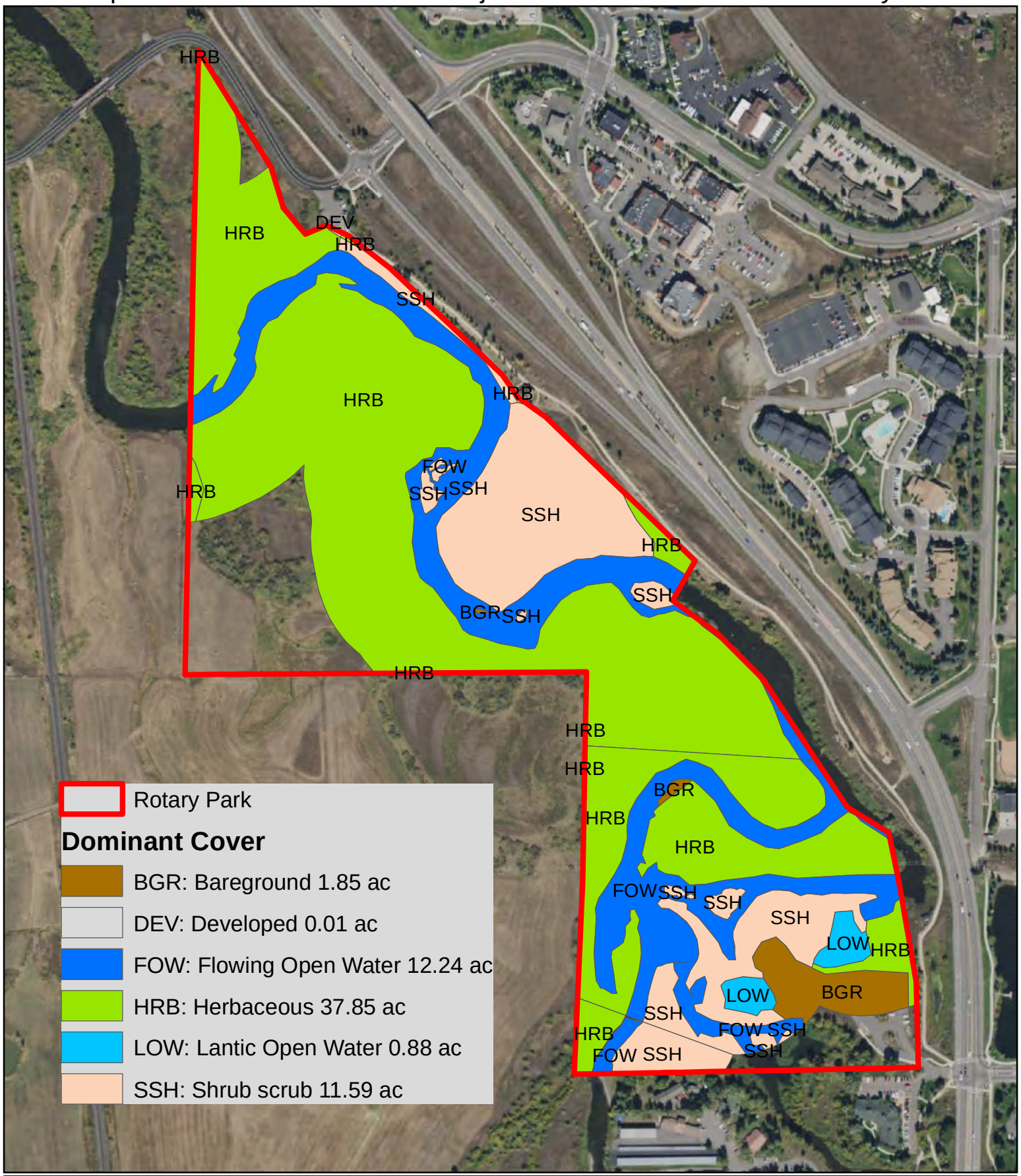
Prepared By:
Colorado State Forest Service
Steamboat Springs District
October 12, 2019

0 300 600 1,200 1,800 Feet

1:9,000

COLORADO STATE FOREST SERVICE
COLORADO STATE UNIVERSITY

Yampa River Forest Restoration Project - Dominant Cover within Rotary Park



N
W E
S

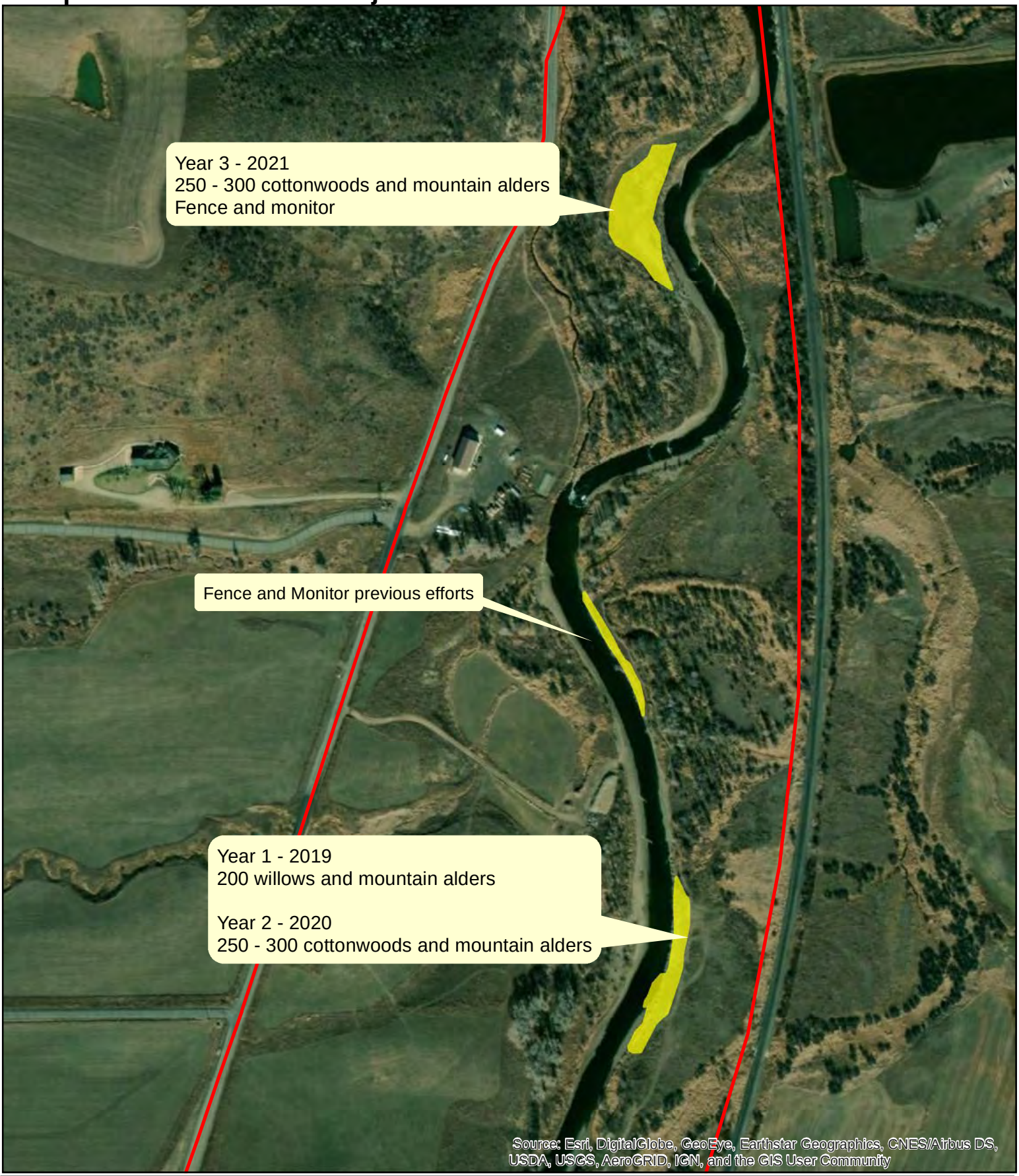
Prepared By:
Colorado State Forest Service
Steamboat Springs Field Office
October 12, 2019

0 250 500 1,000 Feet

1:5,000

COLORADO STATE FOREST SERVICE
COLORADO STATE UNIVERSITY

Yampa River Restoration Project - Short Term Plan - Chuck Lewis Wildlife Area



N
W E
S

Prepared By:
Colorado State Forest Service
Steamboat Springs District
October 12, 2019

0 200 400 800 Feet

1:4,000

Chuck Lewis WA Planting Areas

COLORADO STATE FOREST SERVICE
COLORADO STATE UNIVERSITY

Yampa River Forest Restoration Project - Short Term Implementation Plan

N
W E
S

Prepared By:
Colorado State Forest Service
Steamboat Springs Field Office
October 12, 2019

0 250 500 Feet

1:3,500

COLORADO STATE FOREST SERVICE
COLORADO STATE UNIVERSITY

Long-Term Implementation Plan for

The Yampa River Forest Restoration Project

Prepared by the Yampa Valley Sustainability Council

For the City of Steamboat Springs

December 2021

Background and Purpose

This project grew out of the findings and recommendations contained in the Yampa River Health Assessment and Stream Management Plan (SMP) developed by the City of Steamboat Springs in 2018. The SMP evaluated a 12.5 mile stretch of the Yampa River above, through, and below the city limits, and made recommendations for priority actions to address issues affecting the health of the river. One of the priority recommendations for actions from the SMP was to: Establish a native riparian revegetation program for implementing the identified revegetation projects along the Yampa River through Steamboat.

A key focus for the SMP was addressing water temperatures in this stretch of the Yampa that regularly exceed state standards for temperature in cold-water streams. While the SMP did not conclusively identify the cause of elevated temperatures, it did conclude that reducing radiative warming by increasing shading from riparian vegetation would be the most practical means of limiting water temperature increases. A more recent analysis by The Freshwater Trust for the City (discussed below) similarly concluded that increased tall woody riparian vegetation could also significantly reduce solar loading in summer months.

The SMP set an objective of increasing mapped riparian areas with woody vegetation from current extent to greater than 20% in the short-term (5-10 years) and greater than 30% over the long-term. Analysis by YVSC estimates that about 14% of mapped riparian acres in the reaches covered by the SMP currently supports vegetation above 4 m (a threshold that either can currently provide some shading benefits, or which likely has the potential to grow to full shading height). Meeting the targets will require a combination of protecting vulnerable smaller trees that have the potential to meet shading height and planting new trees in areas that have little to no woody vegetation at present. Based on the YVSC analysis, this would require protection and/or replanting on 18 acres (for short-term goal) or 48 acres (for long-term goal) of streamside buffers within 20-30m of the river. This report outlines a plan to achieve those goals.

The SMP only covered a small stretch of the Yampa, though the area covered are where water temperature concerns are most acute. A more extensive health assessment and action plan, an Integrated Water Management Plan, for the entire river is in process under the auspices of the Yampa-White-Green Basin Roundtable. YVSC participates on the IWMP Riparian work group which included as an objective for the IWMP "integrating riparian restoration works in order to reduce stream water temperature." In suitability mapping for cottonwood planting, YVSC included the stretch of the Yampa from Lake Catamount to the confluence with Elkhead Creek, and the Elk River from Clark to the confluence with the Yampa. There are parcels with high suitability for cottonwood planting in stretches of the Elk and below its confluence on the Yampa. None of these sites are identified in this plan as priorities for reforestation to increase river shading as they will have less impact on the issues raised in the SMP. However, as climate change increases warming concerns for the entire river, these sites should be considered as candidates for reforestation as opportunities arise.

Reducing solar loading in the river through increasing mature, tall canopy cover (which in the Yampa and Elk basins generally means restoring dense cover of narrowleaf cottonwood *Populus angustifolia*) is the primary focus of this plan. Comprehensively restoring riparian areas (include more diverse plantings of

mid canopy and shrub communities as well as bank rehabilitation) has significant river health benefits in addition to shading as outlined in the SMP and the IWMP health assessments. This full suite of benefits is currently driving projects along the rivers and will continue to do so. Priority sites selected in this plan include future planned larger restoration projects by government entities, although the work proposed in this plan (and the funding in hand) only includes adding a cottonwood planting to the proposed projects.

Lessons from Short-Term Plan Implementation

The recommendations in this long-range plan are informed by lessons learned in the most recent three years of reforestation projects led by YVSC along with partners in the short-term implementation team (Colorado State Forest Service, City of Steamboat Springs, Colorado Parks and Wildlife, Confluence Resource Management, and others).

During 2019, 2020, and 2021, the team planned and implemented planting projects in the City of Steamboat Springs Rotary Park parcel (Fig. 1). A total of 1100 cottonwoods were planted in 17 plots. The plots varied in distance to the river, irrigation method, arrangement of planting holes and number of trees per hole. Prior to the first plantings, the team installed groundwater monitoring wells near potential planting sites and developed test plots comparing relative effectiveness of different reed canary grass (*Phalaris arundinacea*) control methods.

The key lessons learned from planting that should guide future plantings are as follows (note that some of these recommendations may change as trees age in the next few years, so these are preliminary guidance):

1. Seedling selection: The project worked with the Colorado State Forest Service Nursery to develop the following protocol for growing native Yampa valley stock of narrowleaf cottonwood. Cuttings from mature trees, with active same year growth on terminal ends and branchlets, are collected in the Steamboat area after full dormancy has set in (late November-early December). The Nursery will prepare cuttings for rooting individual trees in early Spring and start them in D40 deepot tubes (2”x10” size). D40 pots offer the best balance of price, ease of handling, and good root production. Seedlings will be raised in a greenhouse until late summer and then moved to outside shade structures for hardening before transport. Trees will either be transported to the Yampa Valley at the end of the first year of growth or held over until second planting season. The project will work with the Nursery beginning in 2022 to start enough seedlings to have 1000 second year trees available in the fall of each year for planting. Depending on time between transport and planting, trees can be stored in Yampa Valley provided they can be watered every 2nd or 3rd day and protected from browsing.

2. Planting locations and preparation: The initial three years of planting were all in similar vegetation and bank condition. 2019 planting included planting some trees more than 60 feet (20m) from the river to simulate a larger gallery forest. Those plantings consistently fared worse than trees closer to the river (likely due to depth to groundwater) and they are less likely to provide shading benefits to the river. Going forward, the team recommends planting within 60 feet of the river channel, unless the site is in a regularly inundated floodplain and there is a need for a broader forest canopy. For ease of irrigation and fencing, a series of rows of planting

parallel to the river provide the most potential shading. All current sites were accessible with a skid steer mounted 12-inch augur that could drill 3-foot-deep holes prior to planting. For sites where skid steer access is possible, this is the recommended approach. In less accessible sites, a handheld augur is recommended. In sites with shallow depth to groundwater, hand dug holes may be acceptable, though not recommended. Spacing between planting holes should be 6-8 feet. If sufficient planting stock is available, planting two trees per 12-inch hole allows for shared irrigation emitters and provides redundancy to account for tree mortality. In smaller than 12-inch holes, one tree per hole is recommended.

3. Weed control: Most riparian areas in the stretch of the Yampa targeted for this project are covered with either smooth brome (*Bromus inermis)* or reed canary grass (*Phalaris arundinacea*). Both are non-native grasses that create dense mats and can compete for water and sun with small seedlings. Of the non-chemical control methods tested by the project team (mechanical cutting, mulching, and black plastic) only the plastic controlled regrowth successfully, but at the cost of preventing precipitation from reaching plantings. Heavy mulch was successful at preventing regrowth for at least one growing season. In sites where herbicide use is not feasible (e.g. designated open space), the best method of control appears to be mechanical clearing (with a weed-whacker) prior to planting, application of heavy mulch to within one to one and half feet of tree stems, and annual weeding and re-mulching when needed of grass resprouts in the irrigation zone near seedlings. Landscape fabric extending beyond the mulched area might be indicated in heavily infested locations (particularly for reed canary grass), though at higher cost and with uncertain results due to the aggressive growth of the invasive grass. After three years of growth, seedlings should be tall enough, with deep roots to be able to outcompete grasses.

4. Fencing: All planting sites to date have been enclosed with 6-foot tall 12-gauge woven wire fence with T-posts spaced in 6-foot increments. This fencing approach is designed to protect against both ungulate browsing and beaver predation. The main ungulate pressure in this reach of the river is from moose, where density is low. If large wildlife fencing is unwieldy based on site conditions, the project will use beaver cages for individual trees made from 3-foot high fencing. In areas with active cattle grazing, the taller wildlife fence is the best treatment. In addition to areas needing new plantings, there are areas along the entire study stretch of the Yampa with young (3—10 foot tall) naturally generating cottonwoods. Protecting these trees from beaver predation is a high priority, particularly in spots along the river that provide high shading benefits. The Project team prepared an SOP prepared for beaver fence construction and installation methods.

5. Irrigation: Irrigating seedlings until they have developed roots deep enough to access groundwater (three to four years, particularly in sites with high banks) will be necessary to ensure success. In two of the three years monitored at the initial planting sites, three-foot-deep groundwater wells showed no groundwater presence by June of each year. These were years without significant spring over-bank flooding. Given recent trends and future projections, it seems more likely that we will continue to see multiple years without overbank flows. Going forward, all plantings will have irrigation, unless they are in low-lying areas with shallow depth

to groundwater. At the Rotary Park site, the irrigation system that is proving the most efficient involves running 3/4" pipes to the planting area with 1/4" hoses connected from 2 gallon per hour emitters to a drip stake at each tree. Future sites will require specific assessment of irrigation needs, but this configuration is the basis for initial planning.

6. Monitoring and Data Collection: We are collecting data on location and number of all trees planted in a geospatial database. The data show location of enclosures and planting holes, along with initial number of seedlings, and surviving numbers at the end of each growing season. Additionally, we will record the location of any trees protected with beaver cages to allow regular inspection. We have found numerous trees planted perhaps a decade ago where the trees had grown into the cages. If the City ever proposes to develop an alternative action to meet its water quality requirements (as discussed below relative to the Freshwater Trust research), data on new trees planted and surviving will be necessary.

Figure 1. Location of 2019-2021 plantings from first phase of Yampa River Reforestation Project

Reforestation Potential Analysis

To better understand current riparian forest cover and to identify the potential for new reforestation projects, YVSC conducted an analysis of cottonwood site suitability along the Yampa River from Lake Catamount to the confluence with Elkhead Creek (59 river miles) and on the Elk River from Clark to the confluence with the Yampa (26 river miles). While this area is larger than covered by the SMP, it includes the major river segments included in the potential water quality trading program analyzed by the Freshwater Trust for the City of Steamboat Springs.

A full description of the methodology for the YVSC site suitability analysis is included in Appendix A. Sites were analyzed for their frequency of flood return, existing woody vegetation, vegetative class, and slope. The sites with the highest potential (most suitable) were those that had frequent flood return intervals, supported natural vegetation, but did not have any current trees above .5m tall and were mostly flat. We also scored sites as suitable (but needing more field evaluation) if existing vegetation was between .5m and 4m. Sites with dense vegetation above 4 m were considered to have "mature cottonwood" cover.

The Routt County tax parcel map was overlaid on the suitability map to identify land ownership, including public versus private ownership. We then further used the Colorado Ownership Management and Protection (CoMap) database to identify parcels with a conservation easement or other restrictions to development. Parcels were ranked by the amounts of river frontage with contiguous suitable habitat to identify areas where trees could be planted in larger groupings (to simplify projects for irrigation and site preparation).

The result is a map that can identify locations to prioritize field verification, and to support outreach to private landowners. Figure 2 is a sample of the model outputs. YVSC initially ran the analysis on the Yampa running from Lake Catamount to the confluence with Elkhead Creek and on the ElK River downstream from Clark. The full extent of the analysis helps identify parcels, particularly those in private ownership, outside the range of the SMP area that could be useful to evaluate if there are not sufficient suitable parcels in the river reach closer to the City of Steamboat Springs.

The highest priority for action is in the reaches of the Yampa above, though, and just below the City of Steamboat Springs. This is the stretch of the Yampa that is subject to seasonal closures for water temperature exceedances and is most directly connected to the reach with the city's wastewater discharge.

To assess the potential for additional reforestation in these key reaches, YVSC conducted additional analyses only covering the Yampa River from Lake Catamount to the confluence with the Elk River. The results from this analysis are presented in Table 1. Looking only at the highest suitability parcels, there are more than 165 acres of suitable areas for planting in this reach, more than enough to exceed the goals identified in the SMP for increasing riparian cover. Since landowner willingness to host tree planting projects is the most likely limiting factor for meeting acreage goals, the analysis sectioned parcels into three categories most likely to be available for future planting projects: 1) City owned parcels are the area with the least barriers to instituting new planting projects, and those parcels contain 16.8 acres in the most suitable category and an additional 20.6 in the second most suitable category; 2) State-owned parcels (mainly in Chuck Lewis State Wildlife Area) contain 16.8 acres in the most suitable category and an additional 13.1 in the second most suitable category; and 3) private lands

under a qualified conservation easement contain 14.9 acres in the most suitable category and an additional 11.7 in the second most suitable category. Collectively, these public lands or private lands with a conservation easement hold 93.83 acres mapped in one of the two suitability classes.

Figure 2. Overview of Cottonwood Suitability Site map with ranked parcels.

Table 1. Acres within 30m of the river channel in three categories of cottonwood reforestation suitability in different ownership classes. Class 0 Unsuitable. Class 1 Suitable but with some taller woody vegetation present. Class 2 Suitable with minimal woody vegetation present.

Catamount to Elk River confluence

Total area

	Pixels (1x1)	Acres	%
0	1,004,230	248.15 Acres	47%
1	445,244	110.02 Acres	21%
2	667,699	164.99 Acres	32%
Total		523 Acres	100%

City of Steamboat owned land

	Pixels (1x1)	Acres	%
0	102,045	25.21 Acres	40%
1	83,328	20.59 Acres	33%
2	67,934	16.786 Acres	26%
Total		62.5 Acres	100%

State of Colorado owned land

	Pixels (1x1)	Acres	%
0	43,433	10.7 Acres	27%
1	53,116	13.1 Acres	32%
2	67,786	16.75 Acres	41%
Total		40.55 Acres	100%

Private Land with Conservation Easements

	Pixels (1x1)	Acres	%
0	**78,212**	**19.3 Acres**	**42%**
1	**47,396**	**11.7 Acres**	**25%**
2	**60,248**	**14.9 Acres**	**33%**
Total		**45.9 Acres**	**100%**

Proposed Schedule for Restoration Projects

It is not possible to lay out a specific planting plan beyond the next year or two. Proposed construction or river restoration projects (with uncertain timelines) will cause both delays and open opportunities for planting. Willingness of private landowners to host projects is also unpredictable. This section of the plan identifies specific parcels where projects are (or are likely to be) feasible and estimates likely times for project implementation. As in the suitability analysis, the projects are broken down by city-owned, state-owned, and privately-owned parcels.

City-owned parcels

The goal of this plan would be to complete planting on high-suitability city-owned parcels in the next three to four years (by end of 2025). All the identified sites have been discussed and visited with City open space staff and are suitable for planting projects.

a. Snake Island/Hitchen's island (Figure 3): This is a high priority site identified in the SMP. The City and YVSC are planning on implementing plantings at this site in 2022. With funding from the Yampa River Fund, Brad Johnson has developed a planting plan that builds on his recommendations in the *Wetland Restoration Opportunities Report.* The complicating factor for this site is that while it is owned by the City, it is under a life-lease to a private individual for grazing of horses. The lessee has given tentative approval to a planting project in 2022, but still needs to approve final plans.

b. Williams Preserve (Figures 4 and 5). The Williams Preserve from near the confluence with Walton Creek up to the railroad bridge contains a number of high priority sites. A few short stretches of this section are on land owned by Mt. Werner Water and Sanitation District (which is amenable to tree planting). In general, this area is easily accessible, and suitable for mass plantings. However, there is currently a planning process underway for significant river restoration in the area downstream from the City's infiltration gallery to the confluence. If that project proceeds, it will include a significant amount of riparian reforestation, so in either case, this stretch of river should see increased tree cover in the next 2 to five years. Planning for the

river restoration should be complete by end of 2022, and at that stage decisions can be made about timing of future replanting projects. Upstream from the infiltration gallery, there are areas with high potential for planting (figure 5), and these will be targeted for projects in 2022 and 2023.

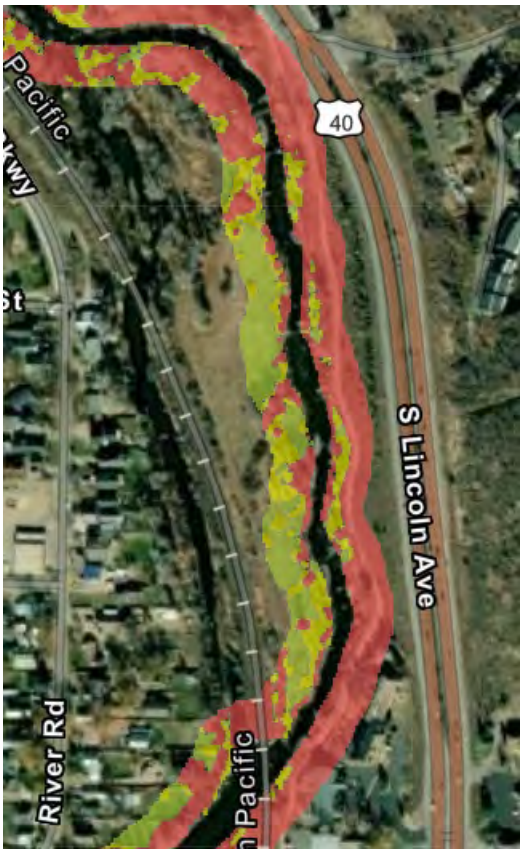


Figure. 3 Snake Island planting site with suitability ratings.

c. Emerald Park/Botanic Garden area (Figure 6): The reach of river directly across from the Botanic Park, including on a small island in the river, holds high potential for additional tree planting. The City is proposing a restoration project, on the far side of the river closest to the Botanic Park in summer/fall 2022. Depending on specific plans for this project, tree planting could take place in 2022 or 2023.

d. Downtown area between 3rd and 12th Streets (Figure 7): In the narrow stretch of riverbank on the west side between the railroad and the river there is both potential for new tree plantings, and priority for protecting naturally regenerating cottonwoods. This site is not conducive to large-scale massed plantings but will be considered for new scattered plantings as planting stock is available in all years from 2022-2024. In 2022, protecting any unprotected existing trees will be completed.

e. Fournier open space (Figure 8): Fournier is a small open space parcel with City owned lands on both sides of the river. Based on a site visit, there is potential for new tree planting on the south bank of the river, though access to the site would be through the KOA campground. There are also naturally regenerating cottonwoods that could be protected from predation. This

is a lower priority site than the preceding sites, so it can be seen as a potential site in years 2023-2025 if other higher priority sites are not available.

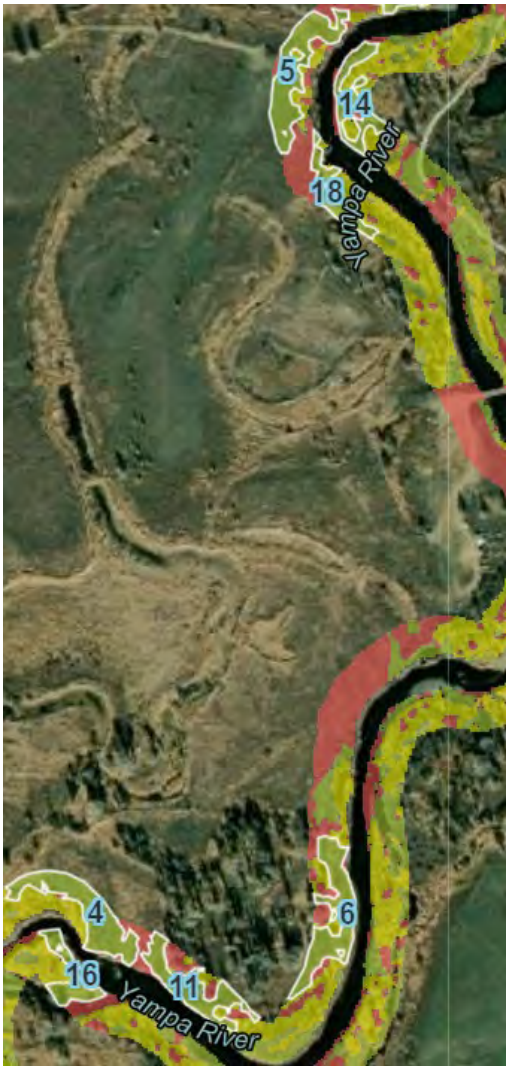


Figure 4 (left). Williams Preserve downstream from City infiltration galleries to Walton Creek with suitability rankings.

Figure 5 (right). Williams Preserve over City Infiltration galleries and upstream to railroad bride with suitability rankings.

f. James Brown Bridge (Figure 9): There is a City owned parcel just upstream of the James Brown Bridge that has potential for increased forest cover. A site visit suggests that this property is seeing good natural regeneration and should be a priority for increased beaver mitigation. If more detailed site evaluation uncovers areas with potential for planting, it can be considered for small scale reforestation similar to the downtown stretch described above.

Figure 7. Downtown stretch from 3rd to 12th Streets with suitability rankings.

Figure 8. Fournier open space with suitability rankings.

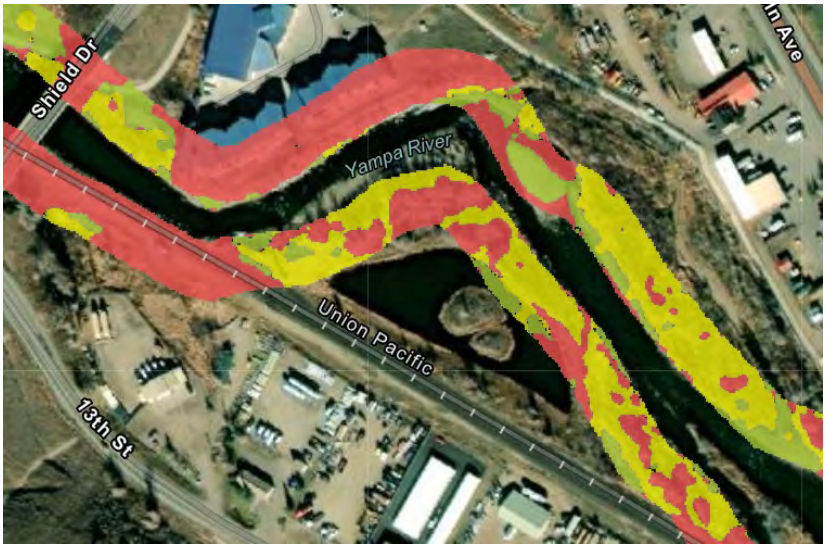


Figure 9. James Brown Bridge with suitability rankings.

State Parcels (Chuck Lewis)

The Chuck Lewis State Wildlife Area (SWA) was identified in the SMP as high potential for tree plantings in conjunction with ongoing river restoration projects for fishery health. One part of the SWA is in City ownership (Figure 13) and managed by Colorado Parks and Wildlife (CPW), and is included in this section. CPW is systematically allocating funding for river restoration in short stretches of the river on an annual basis. Generally, the restoration includes lowering of banks, and establishing "benches" for riparian vegetation. CPW plans to replant new benches one to two years following construction. Future years of construction (beyond the 2022 and 2023 projects identified here) are dependent on funding, and the dates included in the plan are subject to change. Identified projects with tree planting potential are as follows:

a) 2022 Downstream of 14F, river right (Figure 10): A project in 2020 established a "cottonwood bench" that is ready for planting in 2022.
b) 2023 Downstream of 14F, river right (Figure 11): A project completed in 2021 will have willow and other smaller shrubs planted in 2022, with cottonwood plantings in 2023.
c) 2023-2024 Downstream of 14F, river right (Figure 10): CPW proposes to improve an informal boat launch area near the 14F bridge in 2022 or 2023. Downstream from this area, there is currently dense willow growth. More scattered plantings of cottonwoods, in conjunction with other planting projects are planned.
d) Downstream of 14F, river left (Figure 11): CPW moved the river out of an old oxbow to eliminate pike spawning habitat in the past. They plan a project to lower the banks in front of the old river corridor and establish new riparian vegetation. This should create an opportunity to plant cottonwoods in 2025 or later.
e) Upstream of 14F, both sides (Figure 12): CPW has a series of restoration projects planned along about 2000 linear feet of river. Currently projected to occur in 2023 and 2024 funding permitting. These sites would be the highest priority for tree planting in Chuck Lewis SWA. If projects proceed as planned, planting would be in 2025 and 2026.

f) Upstream of 14F (LaFarge site), river left (Figure 13): The final phase of river restoration projects by CPW would be at the farthest upstream reach of the SWA on land owned by the City of Steamboat Springs. There is not a definite schedule for these projects, but it will be after 2026.

Figure 10. Chuck Lewis State Wildlife Area downstream of 14F. 2022 planting on established "cottonwood bench" at downstream end of #8. 2023-2024 scattered plantings on upstream reach.

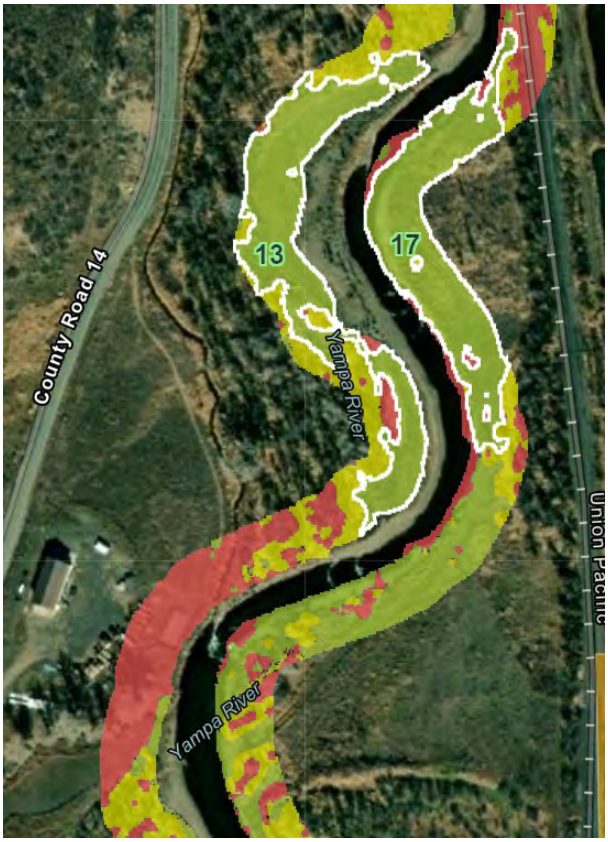


Figure 11. Chuck Lewis State Wildlife Area, downstream of 14 F with suitability rankings. 2023 plantings in and around #17; 2025 plantings around #13

Figure 12. Chuck Lewis State Wildlife Area, upstream from 14F. Plantings following restoration projects from 2024-2026.

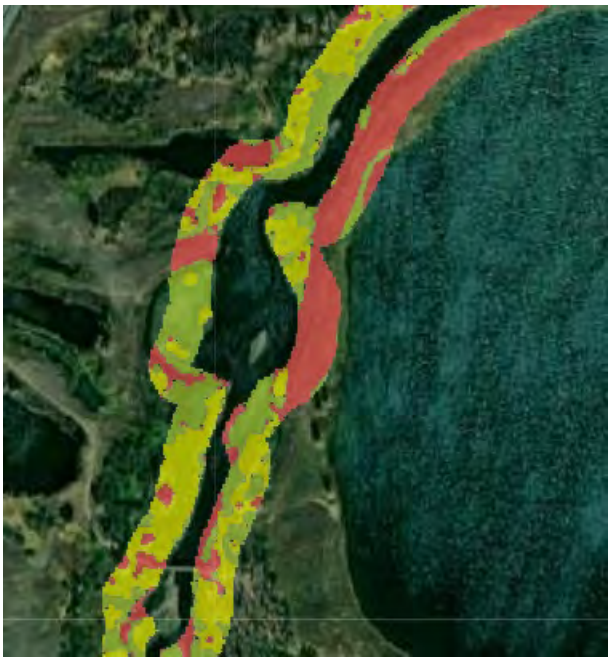


Figure 13. Chuck Lewis State Wildlife Area upper property (“Lafarge site” owned by City of Steamboat Springs-) Plantings following construction after 2026.

Private Lands

The highest percentage of lands in the reaches most relevant to addressing temperature concerns discussed in the SMP, are in private ownership. Approximately 80% (429 acres) of the riparian lands along the Yampa from Lake Catamount to the confluence with the Elk River are private. Approximately 75% of the identified suitable planting acres (207 acres) are on private lands. Generally, the public lands in these reaches of river have a higher percentage of suitable acres for planting, and due to their location within or just above city limits are likely to have a greater impact on stream temperatures in the areas where measurement is most critical. Due to the higher benefits, and the lack of ownership barriers in pursuing planting projects, this plan prioritizes planting on state and city owned lands. Nonetheless, there are significant opportunities for reforestation on private lands, and as part of the development of this plan the planning team evaluated a number of opportunities for identifying and encouraging projects on private property.

i. NRCS Farm Bill Programs

The Natural Resources Conservation Service (NRCS) through its Environmental Quality Incentives Program (EQIP) and other initiatives is continuously in the process of outreach to landowners to develop projects for cost-sharing to improve environmental conditions. Riparian forest buffers are a priority practice for agricultural lands in the Yampa Basin. Riparian forest buffers also qualify as a "climate smart agriculture" practice, making them eligible for increased funding within the Farm Bill. NRCS staff have been part of the long-term planning group for the Yampa River Forest Restoration Project and will continue to explore options with landowners for riparian forest projects. Non-federal funding raised for the project can serve as match for NRCS funds, increasing the incentive for landowners to agree to host projects. The project team will continue to coordinate with NRCS staff as they develop projects with landowners to integrate tree planting efforts when feasible.

One possible initiative that could help increase funding for river restoration projects would be the development of a Regional Conservation Partnership Program (RCPP) project. An RCPP creates a dedicated pool of funding to address regional conservation concerns. It opens more tools than traditional EQIP funding, such as land rental payments when agricultural land is dedicated to conservation management and allows combining of Farm Bill and non-federal funding to create a larger funding pool. The entire Colorado River Basin, including the Yampa River, is designated as a Critical Conservation Area for RCPP. As part of the Integrated Water Management Plan discussed below, there is interest in potentially developing an RCPP designation for the Yampa Basin, focused on river health, including riparian restoration and projects to address water temperature issues.

ii. Integrated Water Management Plan of the Basin Roundtable

The Yampa White Green Basin Roundtable is in the process of developing an Integrated Water Management Plan (IWMP) for the reaches of the Yampa and Elk rivers that were not covered by the Steamboat Stream Management Plan. The IWMP Committee has created a dedicated work group focusing on "Riparian habitat, wetlands, and natural bank stability." The work group has developed a number of recommendations for the Basin Roundtable. Two of which are directly relevant to this plan:

- incentivize protection and/or restoration of riparian lands in strategic locations
- integrate riparian restoration work in order to reduce stream water temperature

One of the Riparian work group's projects is to interview landowners along the Yampa about their interest in riparian restoration projects, and what they would need in order to engage in a project. That work is currently underway, with results expected in early 2022. The project team is represented on the riparian work group and will be in position to follow up on landowner interest identified through the IWMP process.

The Riparian work group will also make recommendations to the full Basin Roundtable about programs and projects to incentivize landowners to pursue riparian restoration projects. One such recommendation could be the development of an RCPP as discussed above. Another product would be a landowner guide to riparian restoration, including identification of funding sources. The riparian group is also developing a Fluvial Hazard Zone map for the stretch of the Yampa above Hayden. The intent of this work is to see if FHZ mapping can identify riparian areas that would benefit from restoration projects and increased protection to protect property from flood risks. This could be a model for identifying restoration areas that carried clear benefits to individual landowners and broader community assets. The final report, due in May 2022, should create more momentum for engaging private landowners in riparian projects.

iii. Water Quality Credit Trading Program

During the development of this long-term plan, the City of Steamboat Springs and YVSC partnered with The Freshwater Trust to scope the potential of using a water quality credit trading program (focused on tree planting for river shading) as an alternative to investment in physically cooling discharge from the City's wastewater treatment plant. The Freshwater Trust developed a model evaluating the amount of reduction in solar loading (measured in kcal/day reduction in July and August) from tree planting in riparian areas. Using a larger study area than included in the SMP, the analysis concluded that there was potential of 2.3 billion to 2.8 billion kcal/day reduction from 794 acres analyzed. This substantially exceeds the temperature reduction that the City might need to meet with future discharge permits (an estimated maximum of 57 million kcal/day). The analysis concluded that the City's thermal load reduction targets could be met from planting on as few as two to nine sites and that the modeled potential thermal benefits from City of Steamboat springs owned parcels were estimated at 138 million kcal/day. These results indicate that there is ample supply on the city-owned land to meet offset requirements in the event recruitment of private landowners is unsuccessful. The Freshwater Trust estimated an offer of $262,800 over 20 years for an average site of 2.14 acres would be sufficient to incentivize landowner participation. This is significantly higher than costs for current tree planting efforts but includes 20 years of monitoring and maintenance for compliance purposes.

Development of a water quality credit trading program for the City is a long-term prospect. Further, meeting the specific compliance needs of the wastewater discharge permit are not likely sufficient to meet the goals of the SMP to reduce water temperatures in the reaches of the river above and through Steamboat (in part because credits for the trading program could be obtained significantly further downstream from the wastewater treatment plant). Nonetheless, the analysis showed that tree planting over time can significantly reduce solar loading. And, based on experiences in Oregon, suggest that landowner recruitment is possible with proper incentives (particularly if regulatory compliance is not a necessity).

iv. Conservation Easements

As noted earlier in this plan, there are a significant number of private properties with conservation easements along the Yampa above and below the City of Steamboat Springs. While the purposes of these easements are mainly to prevent additional development of private lands with conservation values, there are opportunities and advantages of working on lands under easement to prioritize tree planting efforts. The primary advantage is that the easement precludes development and often conversion of land to another use. Thus, trees planted on conserved land are protected from direct conversion. The opportunity is that conservation easements require annual monitoring which often creates an opportunity for discussion with the landowner about stewardship on their lands.

The Colorado Cattlemen's Agricultural Land Trust and The Nature Conservancy hold most of the easements in Routt County along the Yampa and Elk Rivers. The project team for this plan has met with both groups to inform them of our interest in working with easement holders on riparian reforestation. Both have agreed to let us know if they identify landowners interested in hosting a project as they have discussions about stewardship.

Funding and Capacity

Implementation of this long-term plan and meeting the goals established in the Steamboat SMP are dependent on sustained funding for planting and maintaining trees, access to adequate and appropriate planting stock, and sufficient labor to complete the work.

Funding

Since the beginning of this planning process, several new funding opportunities have arisen that create solid opportunities for sustained funding for riparian reforestation. Significant funding has already been secured for tree planting in years 2022-2025.

i. Community Funding Partnership of the Colorado River District

The Colorado River District's Community Funding Partnership was created in 2021 to fund multi-purpose water projects on the Western Slope in five project categories: productive agriculture, infrastructure, healthy rivers, watershed health and water quality, and conservation and efficiency. Funding for the program was approved by Western Colorado voters as part of ballot question 7A in November 2020. These funds provide a catalyst for projects that are priorities for residents in the District to receive matching funds from state, federal and private sources. The District's Board included the Yampa River Forest Restoration Project as an example of the type of project that would be supported if the bond measure passed.

In 2021, the District Board approved a $150,000 grant to the City of Steamboat Springs and YVSC to support three years of work for the Yampa River Forest Restoration Project. This grant, with matching funds as discussed below, will fully fund the next three years of projects as outlined in this long-term plan, with a focus on completing projects on public lands in the project area.

ii. Yampa River Fund

The Yampa River Fund was established in 2019 as a collaborative effort among more than 20 partners in the Yampa Valley. Since establishment, the Fund has grown its endowment to more than $5 million.

There is an annual grant cycle, supporting a range of projects supporting river health. One of the core purposes of Fund grants is to: Maintain or improve river function through a holistic approach to restoration of riparian and/or in-channel habitat. The Yampa River Forest Restoration Project received Yampa River Fund grants in each of the first two annual grant cycles. While the amounts of grants are modest (usual less than $30,000), these funds are very valuable for matching external grants, such as the Community Funding Partnership. The project team sees the Yampa River Fund as an important base of sustained funding for riparian reforestation projects going forward.

iii. Local Government Support

In 2021, both the City of Steamboat Springs and Routt County included financial support for the Yampa River Forest Restoration Project in their approved fiscal year 2022 budgets. Both entities recognized the importance of the project for protecting water quality, and also saw it as part of implementing the Routt County Climate Action Plan. Budgeting for both the City and the County is done annually, but both entities have expressed interest in continuing to support his project in future budgets. These funds are also providing match to the Community Funding Partnership grant.

iv. Colorado Water Plan and Water Supply Reserve Fund Grants

The Colorado Water Plant grant program and Water Supply Reserve Fund (WSRF) grants through the basin roundtables are both potential sources of support the Yampa River Forest Restoration Project. The WSRF supported the initial implementation of this project and the long-term planning described in this report. Future WSRF grants require approval from the Basin Roundtable. The Integrated Water Management Plan described above will help set direction for the Roundtable in projects to support. The forest restoration project is consistent with the preliminary recommendations of the IWMP, so these grants should continue to be a potential source of support. The newer Colorado Water Plan grant program funds environmental and recreation projects that promote watershed health, environmental health, and recreation as well as conservation and land use projects that implement long-term strategies for conservation, land use, water efficiency, and drought planning. The Yampa reforestation project should be eligible under one or both categories for funding from the Water Plan grant program which has an annual grant cycle.

v. Farm Bill and other Federal Sources

Potential Farm Bill programs that could provide funding for private land projects are discussed above in the Private Land opportunities section. As discussed, the local office of NRCS is actively promoting riparian restoration projects and new funding programs favor projects with a climate change connection. EPA Urban Waters and USFS Urban Forestry programs are also both possible funding sources for the tree planting projects. USFS has provided funding for community tree planting projects on the Yampa in the past two years.

Tree Seedling Supply

YVSC has negotiated a service agreement with the Colorado State Forest Service Nursery in Ft. Collins to grow cottonwoods from cuttings taken in the Yampa Valley. The agreement specifies having up to 1000 2-year-old seedlings available each fall for planting. The Nursery has committed the space necessary to rear and store this many trees. One thousand seedlings should allow for 2 to 2 ½ acres of riparian

plantings each year, which combined with acres with new protection efforts for regenerating cottonwoods would meet the short-term goals of the Steam Management Plan in less than 10 years.

The project team evaluated options for creating local capacity for a seedling nursery to potentially increase the number of trees available on an annual basis. The bottleneck for seedling production is the early stages of growth where a heated greenhouse is required (the State Nursery has adequate space for holding trees outdoors once they are established). The cost of acquiring and staffing a new greenhouse in the Steamboat area is far more than the cost of working with the State Nursery. Given the ability to meet current rates of planting from the Nursery and potential for the Nursery to increase production with advance notice, the team decided it was not prudent to pursue development of a new nursery. Temporary holding of trees prior to planting will continue to be needed, but the requirements for this are not hard to meet. Currently, the small outdoor nursery area at Chuck Lewis SWA meets the needs for planting projects. Seedling production requires planning two years in advance, so this is an issue that the project team will continue to monitor.

Labor

Access to sufficient seasonal labor to implement projects is an issue that may require additional action. To date, the project has planted trees in a single area with relatively easy access for workers. The bulk of the work has been conducted by volunteers. As the project grows and becomes more geographically dispersed, planting and maintaining trees will require either a larger, more organized volunteer force and/or access to more paid seasonal workers. YVSC has hired a full-time seasonal lead for tree planting work in the future and has the potential to build a small work crew to meet some of the needs of the project. The project team also recommends several additional approaches to guarantee access to sufficient labor to meet the goals of this plan.

i. Volunteers/Yampa Valley Climate Crew

In 2021, YVSC launched a new program called the Yampa Valley Climate Crew. Its goal is to build a permanent cadre of adult volunteers to work on restoration projects throughout the Yampa Valley. In its first year, the Climate Crew engaged 84 volunteers on eight projects in addition to the volunteers that participated in the annual ReTree event. Participant surveys reveal that volunteers are looking for more opportunities for engagement in outdoor restoration projects. YVSC will continue to build the number of regular volunteers in the Climate Crew and will organize them to meet specific needs, particularly on-going maintenance of tree plantings.

ii. Rocky Mountain Youth Corps

The Rocky Mountain Youth Corps (RYMC) organizes work crews for young adults ranging in age from 11 to their early 20s. The Yampa Forest Restoration Project has used younger crews for the past three years to help with tree maintenance and beaver mitigation. The older crews have the potential to help with more challenging work, such as site preparation and heavier fencing. RMYC continues to grow, and the project team will continue to coordinate with them to identify ways in which this young labor force can advance the goals of the project.

iii. Parks and Recreation seasonal staff

The City of Steamboat Springs hires and manages a number of seasonal employees for work on City parks and open space. Seasonal staff have helped with past planting projects, particularly in site prep and work with heavy equipment. As part of matching commitments to the Community Funding Partnership grant, the City has committed to continuing to supply some seasonal labor to implement this project.

iv. Professional Contractors

In the past three years, the project team has also hired professional contractors to help with some tasks such as operating heavy equipment for site prep. This will continue to be an option, though the availability of contractors to work on restoration projects is limited at present. Landscaping companies have the required skills and workers, but re in heavy demand for residential landscaping projects. Creating a steady list of restoration projects could help provide business certainty for new contractors to enter the area. The project team will continue to work with exiting restoration firms and will be open to engaging new entrants.

APPENDIX A - Cottonwood Suitability Analysis Methods

1. Methodology

1.1 Overview

This project utilized high resolution multispectral images and LiDAR data to model site suitability for cottonwood reforestation along a section of the Yampa River Riparian Corridor, from Lake Catamount to the Elkhead confluence, and the Elk River Riparian Corridor, from the town of Clark to its confluence with the Yampa River. To do so, we mapped the current extent of cottonwood along the riparian corridor and performed a site suitability analysis based on topography, land cover, and LiDAR derived above ground vegetation structure. The physical suitability of the site was further refined by overlaying the most suitable areas with Colorado parcel ownership boundaries. An area function was then applied to the most suitable sites to estimate carbon sequestration potential upon reforestation.

1.2 Data Acquisition & Processing

We acquired aerial imagery from the National Agricultural Imagery Program (NAIP) from the most recent fly over of our study area in 2019. These NAIP images have a spatial resolution of 1 meter and collect 4 multispectral band values including red, green, and blue visible light as well as near infrared light. In ArcGIS Pro we generated a directional 30 meter buffer from both Elk and Yampa river bank, left and right, shapefiles to delineate the riparian corridor that this study focuses on. Additionally, we utilized this imagery to calculate the Normalized Difference in Vegetation Index (NDVI). In Google Earth Engine, we accessed and mosaiced the 2019 NAIP aerial images, clipped the mosaic to the riparian buffer, and then calculated the NDVI using the preset normalized difference function on the near-infrared [N] and red bands [R] (Table 1). NDVI is a calculation used in remote sensing that can be used to indicate whether or not the target observation is live vegetation and, if so, how densely covered said area is with dense, productive vegetation. The index is often referred to as a "greenness" index, such values range from -1 to 1, where values from 0 to 1 the presence of vegetation (Table 1). We exported these layers from Google Earth Engine and transferred the files for further processing in ArcGIS Pro.

Table 1

Formulas, scales, and interpretations of the indices used in the analysis.

Name	**Formula**	**Scale**	**Scale Interpretation**
NDVI: Normalized Difference Vegetation Index	[NDVI = (Near-Infrared - Red) / (Near-Infrared + Red)]	-1 to 1	High positive values near 1 indicate areas with productive and dense vegetation, low positive values near 0 indicate very sparse or unproductive vegetation, and negative values represent non-vegetated areas, such as water, snow, or urban areas

LiDAR data from the Colorado Water Conservation Board, Colorado Hazard Mapping program was acquired and preprocessed by our partners at the Freshwater Trust. Our partners provided us with 2 LiDAR derived products, including a 1 meter resolution Digital Elevation Model (DEM) and a 1 meter resolution layer of forest canopy height in a Tagged Image File (.tif) format. We clipped these layers to our 30 meter riparian buffer in ArcGIS Pro. The forest canopy layer indicates the height of vegetation and other objects of our target observation. Next we derived the percent slope from the DEM layer using the slope function in the image analysis toolbox.

The Colorado Parcel Boundaries layer is a shapefile that identifies property ownership by parcel. We obtained this layer from Routt County.

1.3 Data Analysis

Map Current Mature Cottonwood Extent

We set a height minimum threshold of 5 meters to pick out mature cottonwood habitat from the LiDAR forest canopy layer. This threshold selected all values that fell above 10 meters, which left us with all of the features that fulfilled this parameter within the 100 meter riparian buffer. To further refine this selection we removed all areas of the selection that overlapped with NDVI values lower than 0.1. Near zero and below zero NDVI values indicate areas that are likely obstructions from buildings and other non-living structures, such as telephone poles (Table 1). Additionally, we set a minimum pixel cluster value to 5 pixels to eliminate additional noise from potential obstructions. This resulted in a shapefile output for the current extent of mature Cottonwood habitat along our study area.

Cottonwood Suitability Analysis

To identify riparian areas that are most suitable for cottonwood reforestation we performed a multivariate overlay analysis in ArcGIS Pro Modelbuilder. In this context, suitability was defined as an area that is located on a land cover type that is able to support vegetation (ie. not concrete or an impermeable surface), is within the moderately recurring flood zone, is located on a low to moderate slope, and is not currently covered by mature cottonwood trees. The variables that we used to define such parameters include a LiDAR Forest Canopy Height, Slope, NDVI, and Floodplain layer. In Modelbuilder, first we clipped each variable to the 30 meter riparian buffer and converted all polygon feature layers to raster data. Next we reclassified each variable to 2 classes, suitable (1) or not suitable (0) for all but one layer (Table 3).

In this context, suitability will be defined as an area that is located in a land cover class that is able to support vegetation (ie. not concrete or an impermeable surface), is within 30 meter proximity to the river center, and is not currently covered by mature cottonwood trees. \To prepare the input files for the analysis, we use the classification tool to convert discrete values to class values based on class parameters.

Next, we constructed a site suitability analysis in ArcGIS that scored sites based on multiple weighted criteria and classes (Table 3). Once we set the weight and scores appropriately, we performed the additive weighted overlay model that created an output where the higher scores corresponded to the more desirable locations, from a scale of 1 (least suitable) to 10 (most suitable). This physical site suitability analysis was further refined by using land parcel ownership data to determine public versus private ownership of the potential reforestation sites.

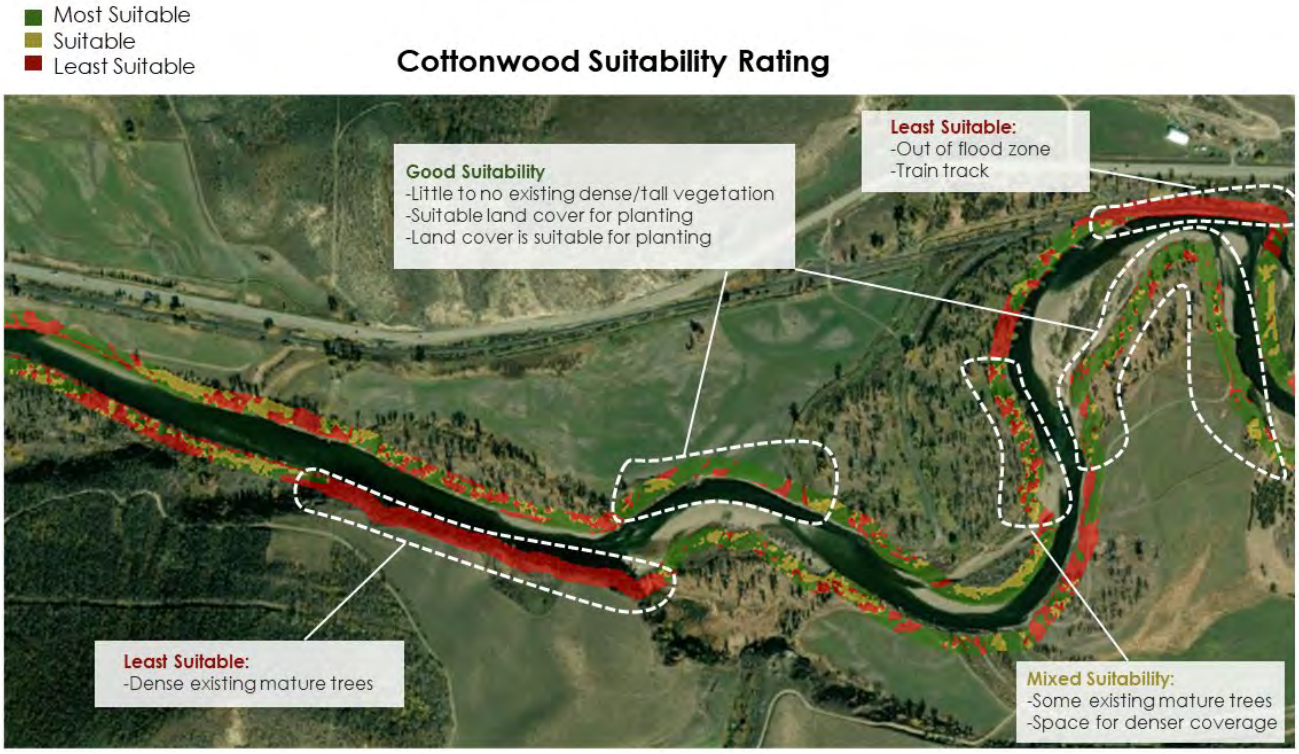


Table 2

Variable Descriptions and Sources.

Variable	File Type	Description	Source	Link
Forest Height	(.tif) 1m res	This variable was processed by our partners at the Freshwater Trust using LiDAR data from Colorado Hazard Mapping & Risk	Colorado Hazard Mapping & Risk	Colorado Hazard Mapping & Risk MAP Portal - CO Hazard Mapping & RiskMAP Portal
Slope	(.tif) 1m res	Our partners at the Freshwater Trust generated a digital elevation model (DEM) layer using LiDAR data from Colorado Hazard Mapping & Risk. We utilized the DEM to calculate the slope.	Colorado Hazard Mapping & Risk	Colorado Hazard Mapping & Risk MAP Portal - CO Hazard Mapping & RiskMAP Portal
Normalized Difference in Vegetation Index (NDVI)	(.tif) 1m res	This layer was calculated using the red and near infrared (NIR) bands from NAIP imagery captured in 2019. **NDVI** = (NIR -RED) / (NIR + RED)	National Agriculture Imagery Program	NAIP Imagery (usda.gov)
Floodplain Connectivity A	(.shp)	The active floodplain delineates the areas where inundation duration and frequency are capable of maintaining riparian vegetation and active fluvial processes. Used for Floodplain extent from Elk and Yampa River confluence to the confluence of the Yampa and Elkhead rivers.	River Network, IWMP	http://www.rivernetwork.org/
Floodplain Connectivity B	(.shp)	We used High and Moderate Frequency Floodplain boundaries. The High-Frequency Floodplain variable rates impairment to the floodplain area regularly saturated or inundated during average annual to semi-annual	Steamboat Stream Health Assessment, City of Steamboat Springs	https://steamboatsprings.net/587/Yampa-River-Health-Streamflow-Management

		high flow events based on a proxy measurement of 2-4 ft above the active channel (which is assumed to emulate the 2- to 5-year return interval). The Medium-Frequency Floodplain variable rates impairment to higher floodplains and benches, based on a proxy measurement of 4-6 ft above the active channel (assumed to emulate the 5- to 10-year return interval). Used for Floodplain extent from Lake Catamount to the Elk and Yampa River confluence.		
Conservation Easements	(.shp)	Conservation Easements	Colorado Ownership Management and Protection (COMaP)	https://comap.cnhp.colostate.edu/comap/
Parcels	(.shp)	Tax Parcels in Routt County used for land ownership details to rank potential site locations.	Routt County GIS Open Data	Search for '*' | Routt County GIS Open Data (arcgis.com)
Yampa and Elk River Shapefiles	(.shp)	NAIP imagery was employed to digitize the river boundaries by our partner organization at The Freshwater Trust, who provided us with the resulting shapefiles. These river shapefiles included 3 separate line shapefiles for the Yampa and Elk rivers individually, including a left bank, right bank, and river center shapefile.	The Freshwater Trust (Derived from NAIP Imagery)	

Table 3

Suitability analysis parameters and explanation.

Layer Name	**Proxy**	**Range**	**Parameter**	**Scale Value (1 to 5)**	**Explanation**
Height Classes *LiDAR Forest Canopy*	Vegetation height		0.5> 2 0.5<1.5 >3	Most Suitable Suitable Restricted	
Slope Lidar DEM	Terrain slope	0 - 86.87%	*0-15%* *15%* <	Suitable Restricted	
NDVI Classes *NAIP NDVI*	Land surface type (imperamble, water, or vegetation)	-0.96 to 1	-0.03 < -0.03>	Suitable Restricted	
Floodplain	Within the floodplain or not	Within FP Outside FP	Yes No	Suitable Restricted	
Shade Value					

Appendix C – Media Coverage ReTree 2019-2021

National and State-wide media coverage

1. Colorado Lottery ReTree video, 2021 https://www.youtube.com/watch?v=oM-_dzciWI4
2. Water Education Colorado, 2019 *A feverish stream, a legion of volunteers, a $1.7 million grant. Is it enough to help the Yampa River keep its cool?* https://www.watereducationcolorado.org/fresh-water-news/a-feverish-stream-a-legion-of-volunteers-a-1-7-million-grant-is-it-enough-to-help-the-yampa-river-keep-its-cool-in-the-face-of-global-warming/
3. Yale Climate Communications, 2021 *Drought-stricken Colorado River Basin could see additional 20% drop in water flow by 2050* https://yaleclimateconnections.org/2021/01/drought-stricken-colorado-river-basin-could-see-additional-20-drop-in-water-flow-by-2050/
4. Yale Climate Communications, 2021 *Trees planted along Colorado's Yampa River will help protect it in hot, dry weather* https://yaleclimateconnections.org/2021/04/trees-planted-along-yampa-river-will-help-protect-it-in-hot-dry-weather/
5. Home Link Magazine, 2021, Trees: Why we should love and protect them https://issuu.com/fanbaseco/docs/f21_hl_lowres/s/13121428

Local Media Coverage

1. Steamboat Pilot and YVSC Blog, 2019, *Retree celebrating 10 years of planting trees around the Yampa Valley this weekend* https://yvsc.org/2019/09/26/retree-celebrating-10-years-of-planting-trees-around-the-yampa-valley-this-weekend/
2. Steamboat Pilot, 2020, *Why we plant trees* https://www.steamboatpilot.com/news/talking-green-why-we-plant-trees/

3. Steamboat Pilot, 2020, *City, Botanic Park partner to help mountain whitefish spawn in Fish Creek* https://www.steamboatpilot.com/news/city-botanic-park-partner-to-help-mountain-whitefish-spawn-in-fish-creek/
4. Steamboat Pilot, 2020, *Retree, volunteers plant more than 350 trees along Yampa River on Saturday* https://www.steamboatpilot.com/news/retree-volunteers-plant-more-than-350-trees-along-yampa-river-on-saturday/
5. Steamboat Pilot, 2021, *Yampa Valley Sustainability Council launching volunteer program for community members* https://www.steamboatpilot.com/news/yampa-valley-sustainability-council-launching-volunteer-program-for-community-members/
6. Steamboat Pilot, 2021, *City to plant up to 500 trees along stretch of Yampa River in response to negative impacts* https://www.steamboatpilot.com/news/city-to-plant-up-to-500-trees-along-stretch-of-yampa-river-in-response-to-negative-impacts/
7. Steamboat Pilot, 2021, *The best time to plant trees* https://www.steamboatpilot.com/news/talking-green-the-best-time-to-plant-trees/
8. Steamboat Pilot, 2021, *Yampa Valley Climate Crew connects volunteers with local conservation opportunities* https://www.steamboatpilot.com/news/talking-green-yampa-valley-climate-crew-connects-volunteers-with-local-conservation-opportunities/
9. Steamboat Pilot, 2021, *Annual ReTree event brings 500 new trees to banks along the Yampa River* https://www.steamboatpilot.com/news/annual-re-tree-event-brings-500-new-trees-to-banks-along-the-yampa-river/
10. Steamboat Pilot, 2021, *Yampa Valley Climate Crew concludes successful 1st season of volunteer projects* https://www.steamboatpilot.com/news/talking-green-yampa-valley-climate-crew-concludes-successful-1st-season-of-volunteer-projects/

Appendix D—Photos from ReTree volunteer days 2019-2021

2019 Rotary Park and Chuck Lewis SWA

2020 October ReTree Rotary Park

2021 October ReTree Rotary Park