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-Goals

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 thee 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.

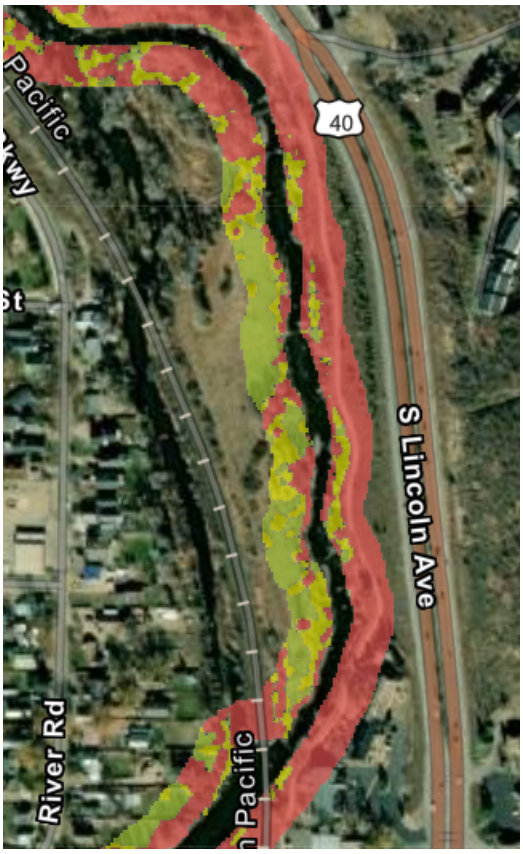


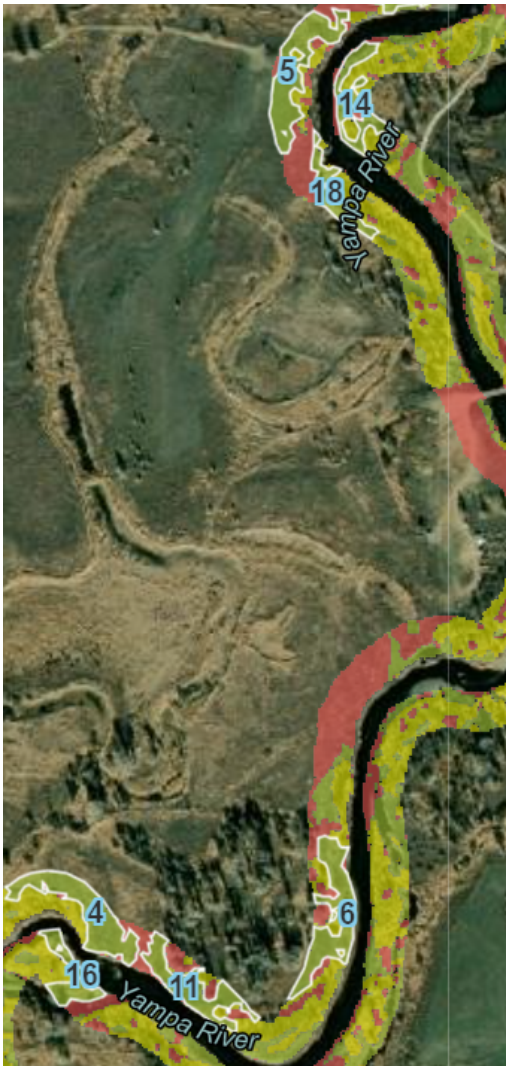
Figure. 3 Snake Island planting site with suitability ratings.

c. Emerald Park/Botanic Gardens 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.



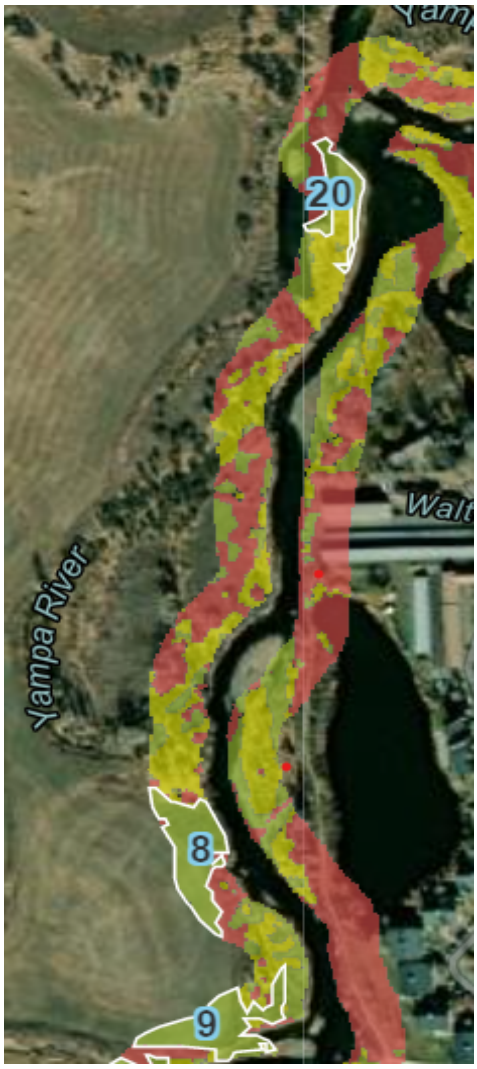


Figure 4 (left). Williams Preserve downstream from City infiltration galleries to Walton Creek with suitability rankings.

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.

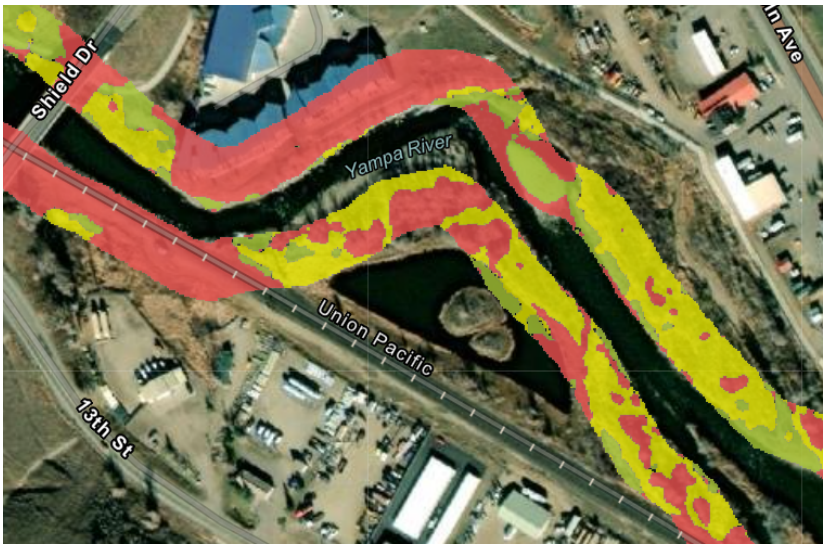


Figure 9. James Brown Bridge with suitability rankings.

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.

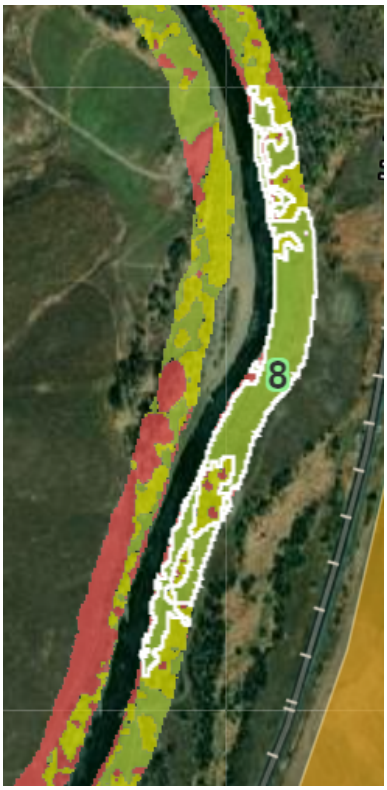


Figure 10. Chuck Lewis State Wildlife Area downstream of 14F. 2022 planting on established "cottonwood bench" at downstream end of #8. 2023-2024 scattered plantings on upstream reach.

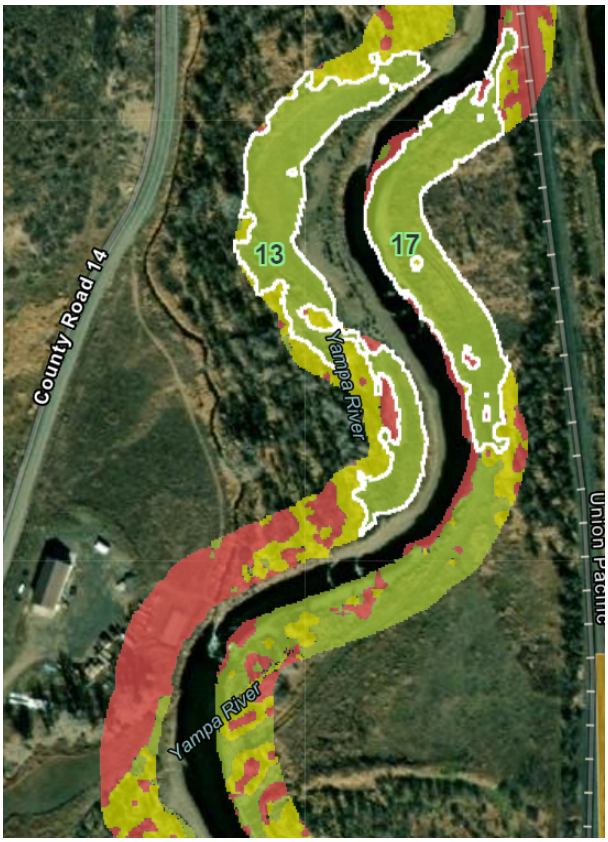


Figure 11. Chuck Lewis State Wildlife Area, downstream of 14 F with suitability rankings. 2023 plantings in and around #17; 2025 plantings around #13

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.

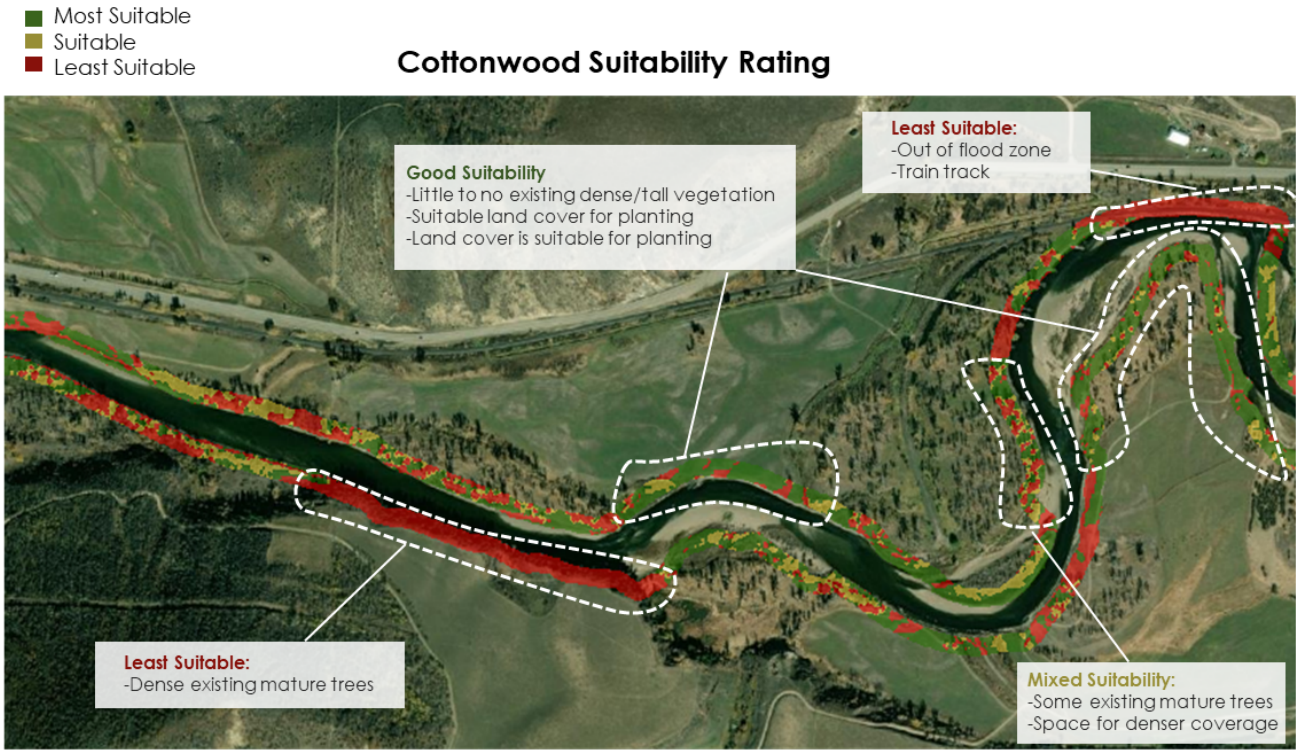


Table 2

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 high flow events based on a proxy	Steamboat Stream Health Assessment, City of Steamboat Springs	https://steamboatsprings.net/587/Yampa-River-Health-Streamflow-Management

		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 Iidar 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					