21 ACRES RESTORATION
University of Washington Restoration Ecology Network 2016 - 2017

Prepared for
Melissa Sokolowsky, 21 Acres

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Project Summary

Overview

This report describes the 21 Acres Center Restoration Project undertaken in the 2016 - 2017 by University of Washington Restoration Ecology Network (UW-REN) students from both the UW Bothell and UW Seattle campuses. A team of three students designed and implemented the restoration between October 2016 and May 2017 with the support of our community partners, Melissa Sokolowsky and Nick Jennison, as well as our course instructors. This is the first project to be completed by UW students for the 21 Acres Center, restoring approximately .5 acres and will hopefully not be the last project by students for 21 Acres.

Figure 1 & 2. Before and after photos of polygon 1 (January 15th, 2017 and May 8th, 2017)

Pre-Restoration Conditions

21 Acres is located south of 171st St in Woodinville, Washington. The building for 21 Acres began construction in 2009, previously the land was excavated for agricultural purposes. The property is bordered by a farm, with the Sammamish River to the south and west, and residential area to the east. The average elevation of the property is roughly 35 feet above sea level and sits on a 21-acres parcel (Google Earth). The 21 Acres site is predominantly flat, with a bioswale running from the east part of our project site along the border of the 21 Acres property back to a water delineation system. The main building sits on a small hill and the rest of the property is historic flood plains, making it incredibly flat ground.

Before the restoration, the overstory canopy that existed on the section closest to the road consisted of black cotonwood (*Populus trichocarpa*), red alder (*Alnus rubra*), green alder (*Alnus virdis*), and red oak (*Quercus rubra*). The midstory consisted of dwarf arctic willow (*Salix arctica*), Himalayan blackberry (*Rubus armeniacus*), red-osier dogwood (*Cornus sericea*), Scotch broom (*Cytisus scoparius*), and vine maple (*Acer circinatum*). The ground cover and understory consisted of blackeyed susans (*Rudbeckia hirta*), reed canarygrass (*Phalaris arundinacea*), swamp smartweed (*Polygonum hydropiperoides*), tufted hairgrass (*Deschampsia cespitosa*), curly dock (*Rumex crispus*), creeping buttercup (*Ranunculus repens*), and creeping thistle (*Cirsium arvense*).

<u>Ecological Concerns</u>

The building for 21 Acres began construction in 2009, previously the land was excavated for agricultural purposes. Due to this disturbances and edge effect a large thicket of Himalayan Blackberry (*Rubus* armeniacus) has emerged on our project site. This species decreases the overall vegetative and structural diversity of the site. Part of the construction plans of 21 Acres also included a rain garden and bioswale that transects our site and wraps around the property to a water delineation area (Figure 2). The rain garden was installed in order to filter water using native vegetation. Currently the rain garden and bioswale are overgrown with invasives like creeping buttercup (*Ranunculus repens*) and reed canarygrass (*Phalaris arundinacea*). Although, *P. arundinacea* does help with filtration, its aggressive growth blocks out native graminoids that increase diversity and habitat. Along the edge of the property at 21 acres also runs a hedgerow project, intended to prevent the spread of invasive into the site from the farm to the west (Figure 2).

<u>Project Goals and General Approach</u>

- Promote the establishment and dominance of native vegetation typical of low elevation Puget Sound riparian areas that enhances various ecological functions such as water filtration, wildlife and pollinator habitat
- Develop a diverse structural and biological landscape that reflects the earlier stages of succession
- Promote education for human communities and environmental stewardship in order to ensure the success of the restoration

We have set out three main goals in order to begin the restoration of our project site. First, we plan to promote the establishment and dominance of native vegetation typical of low elevation Puget Sound riparian areas that enhances various ecological functions such as water filtration, wildlife and pollinator habitat. In order to accomplish this, we have removed and suppressed invasives species that have prevented the establishment of native plants, as well as increased the number of native pollinator plant species that bloom throughout the year in order to attract more pollinators. We also have selected species that help with filtration and infiltration of storm water in the bioswale and rain garden as well as the creation of microenvironments throughout the site with the use of woody debris and brush and rock piles in hopes to increase site complexity and diversity of habitat. These approaches should help establish a native plant community because with continued maintenance, we have provided native plants an opportunity to reestablish themselves without the competition from invasive species as well as attracted animals to the site that will help promote the growth and dispersal of the natives.

Our second goal for the site was to develop a diverse structural and biological landscape that reflects the earlier stages of succession. To attain this goal, we have developed a plan for successional tree and shrub development on the site. We have planted a variety of plants on site that will grow and develop a diverse physical and temporal structure, such that quick growing plants such as bigleaf maple (*Acer* *macrophyllum*) snowberry*(Symphoricarpos albus),* tall Oregon grape *(Mahonia aquifolium),*and salmonberry (*Rubus spectabilis)* which will all establish quickly and provide a closed canopy. This shrub canopy in turn will help provide the microenvironment necessary for species such as shore pine and sitka spruce to grow and thrive, moving towards our intended climax ecosystem.

Our third and final goal was to promote education for human communities and environmental stewardship in order to ensure the success of the restoration. As we have worked on the site, we have held many volunteer work parties. This has increased the involvement of local community members with the hope that we can help them feel like they were a part of the restoration project and that the site is theirs to continue to provide the monitoring it will need. We also have built a walking path through the site. This helps us meet this goal by encouraging community members to visit the site and feel welcome there. The path will also help prevent people from aimlessly meandering through the site, potentially killing plants, compacting the soil, or spreading seeds of invasive species.

Major Accomplishments:

- 715 sq. ft. of reed canarygrass removed from the rain garden
- 2,993 sq. ft. of Himalayan blackberry removed from site
- 434 plants installed on site
- 4,786 sq. ft. covered in wood chips with a depth of 8 inches.
- Held 5 work parties and engaged with 44 volunteers

Team Members

Figure 3. Members of the 21 Acres team (from left to right: Jacob, Sara, and Kyle).

Team Member Contact Information:

Sara Rocero-Barrett: saradianebarrett@gmail.com
Jacob Wessel: matthewjwessel@gmail.com
Kyle Gibbs: gibbs.kyle@gmail.com

Acknowledgements

This restoration project would not be possible without all of the additional help we received from community members, professors, and our community partners. We would like to thank:

- First off, we would like to thank 21 Acres for giving us the chance to restore their piece of their land that allowed us to learn the restoration process and also offering all of their tools willingly for us and our volunteers to use. Specifically, we would like to give a big thanks to Melissa Sokolowsky, our community partner, and Nick Jennison, who gave up much of his time towards the project.

- We would also like to thank the many volunteers that gave up their weekends willingly to assist in the site work, rain or shine. Restoration would not be possible without your help.

- We would also like to extend our gratitude towards Professors, Kern Ewing, Jim Fridley, Warren Gold, and Cynthia Updegrave who helped us through the process every step of the way.

- We would also like to thank our TA Shannon Ingebright for all of her hard work.

As-Built Report

Background

Site description

21 Acres is located south of 171st St in Woodinville, Washington; Township 26 N, range 5 E. The property is bordered by a farm to the south and west and residential area to the east (Figure 4). The average elevation of the property is roughly 35 feet above sea level (Google Earth 2016) and sits on a 21-acre parcel. The 21 Acres site is predominantly flat, with a bioswale running from the east part of our project site along the border of the 21 Acres property back to a water delineation system (Figure 5). The main building sits on a small hill and the rest of the property is historic floodplains, creating topography that is universally flat within the relative area. The past modifications of the Sammamish River have disconnected 21 Acres from the historic floodplain. The location of our project site is west of the entrance to 21 Acres, situated on the most northwestern corner of the property (Figure 5). The site is approximately a quarter of an acre and has been divided into 6 polygons based on the dominant invasive or native plants (Figure 6 & 7).

Figure 4: This map shows the location of 21 Acres in the Puget Sound Lowland Region. There are scales in the bottom left of each map (Google Earth 2016).

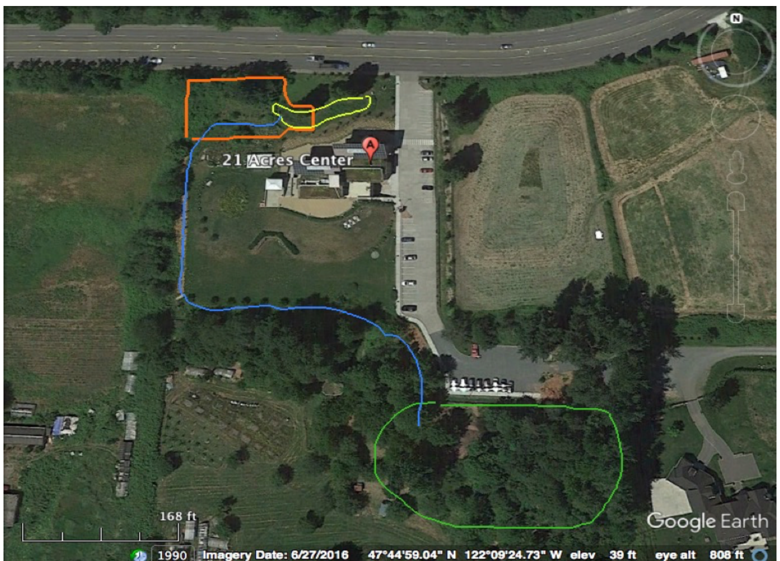

Figure 5: This map displays 21 Acres property. Orange= site outline, yellow= rain garden, blue= bioswale on and off site, green= restored wetland

Restoration needs and opportunities

The building for 21 Acres began construction in 2009, previously the land was excavated for agricultural purposes. Due to this disturbances and edge effect a large thicket of Himalayan Blackberry (*Rubus* armeniacus) has emerged on our project site. This species decreases the overall vegetative and structural diversity of the site. Part of the construction plans of 21 Acres also included a rain garden and bioswale that transects our site and wraps around the property to a water delineation area (Figure 5). The rain garden was installed in order to filter water using native vegetation. Currently the rain garden and bioswale are overgrown with invasives like creeping buttercup (*Ranunculus repens*) and reed canarygrass (*Phalaris arundinacea*). Although, *P. arundinacea* does help with filtration, its aggressive growth blocks out native graminoids that increase diversity and habitat. Along the edge of the property at 21 Acres, also runs a hedgerow project, intended to prevent the spread of invasive into the site from the farm to the west (Figure 5).

To increase plant and structure diversity, water filtration, wildlife and pollinator habitat we plan to incorporate a variety of species that will serve many of these functions and services. Establishing shady conditions with tree and shrub species such as shore pine (*Pinus contorta),* Pacific ninebark (*Physocarpus capitatus),* red-osier dogwood (*Cornus sericea),* and other native shrub species will help establish a native canopy cover used to suppress invasive and create the desired native vegetation community. We chose a variety of tree and shrub species with varying phenology, ensuring the success of creating a habitat that will support insect and animal species throughout the seasons. Our Community Partners [WG1] (CP), Melissa Sokolowsky and Nick Jennison at 21 Acres would like to use this site as an educational tool to foster and encourage knowledge of native species and wildlife habitats, making structural and wildlife diversity our main goals for this restoration.

Tasks and Approaches

Goal 1: Promote the establishment and dominance of native vegetation typical of low elevation Puget Sound riparian areas that enhances various ecological functions such as water filtration, wildlife and pollinator habitat.

Objective 1-1: Remove and suppress invasive species impeding the establishment of native plants.

Task 1-1a: Remove above and below ground biomass of invasive species, with a large emphasis on *R. armeniacus* and *P. arundinacea*.

Approach: Using loppers and cutting *R. armeniacus* stalks to shin height, then pulling or digging out the below ground biomass with a shovel. The other invasive species, curly dock (*Rumex crispus*) and creeping thistle (*Cirsium arvense*), will also be removed by hand pulling. *P. arundinacea* will excavated with a shovel, while lowering elevation as a means to ensure no re-colonization.

Approach Justification:
Removal of root systems is found to be the best approach to in removal of *R. armeniacus* (Bennett, 2007). To control *R. crispus* we will utilize shovels to target the taproots of the plant to ensure minimal regrowth (DiTomaso and Kyser, 2013). We will remove the roots of *C. arvense* as as start to controlling this invasive, however repetitive removal of seedlings in June will continue during managment (Walker and Shaw, 2016). *P. arundinacea* will be controlled with two methods. The first will be complete removal of the rhizomes to

decrease the recolonization of *P. arundinacea* (Waggy, 2010). Then we will lower the elevation of the area with invasives, which keeps *P. arundinacea* from recolonization *P. arundinacea* cannot handle a completely inundated soil regime (Kim et al., 2006).

AD1: *P. arundinacea* had edges removed by shovel except in the middle of the raingarden where is was removed by hand. We did not receive approval to deepen and dig in the rain garden, so we removed as much belowground biomass as possible without digging.

Task 1-1b: Carpet the site with woodchip mulch to reduce the re-colonization of invasive plant species.

Approach: Using a wheelbarrow we will distribute mulch to throughout the site, except the rain garden, bioswale, and on the slope in polygon 2 leading to the drainage ditch. Woodchip mulch will be spread with a thickness of 8 inches (Chalker-Scott 2009)

Approach Justification:
Mulch is used to deprive the invasive species of light to young weeds and non-germinated seeds (Chalker-Scott 2009). The rain garden and bioswale will not receive mulch because of the inundation that occurs seasonally. Since woodchip mulch floats the seasonal flooding will displace the woodchips downflow of the bioswale of their installation site.

Task 1-1c: Install a fast growing, native canopy over invasive removal sites of *R. armeniacus* and *P. arundinacea*.

Approach:
Using plant species such as *P. capitatus* and *C. sericea* we will develop a canopy to deprive the invasive species of light and create a shady habitat to ensure the success of our native vegetation. The plants will come in the form of live stakes for *P. capitatus* and *C. sericea*.

Approach Justification:
P. arundinacea and *R. armeniacus* thrive in sunny habitats. In order to create a habitat that suppresses these two invasive we need to limit the sun that reaches the seedlings that sprout after mechanical removal (Farelly, 2012; Bennett, 2007).

Objective 1-2: Increase the richness and evenness of native pollinator plant species that bloom through different stages of the seasons.

Task 1-2a: Plant species throughout the site that will provide habitat and nectar and/or pollen to native pollinators.

Approach: Using shovels we will plant tree, shrub, and herbaceous species such as, red flowering currant (*Ribes sanguineum)*, oceanspray (*Holodiscus discolor*), big leaf maple (*Acer macrophyllum),* Canada goldenrod (*Solidago canadensis*), and kinnikinnick (*Arctostaphylos uva-ursi*). Plant phenologically diverse species that will provide constant food sources for pollinators and wildlife through the seasons.

Approach Justification: We have chosen at least three plant species that bloom in each season, ensuring that pollinators will be provided a stable food source. Incorporating these elements will not only benefit wildlife, it will also be beneficial to the farm on 21 Acres, as well as, the surrounding farms (Ley et al. 2017).

AD2: *A. uva-ursi* ended up not making our final plant list for ordering because it was a bit more expensive than we had anticipated. Also, *R. sanguineum* was a species that we planned on acquiring from 21 Acres nursery, but never pulled from their stock because Fourth Corners Nursey had given us more plants than we paid for, leaving us with more plants than we had anticipated.

<u>Objective 1-3</u>: Select species complementary to the conveyance, filtration, and infiltration of stormwater in the bioswale and rain garden.

<u>Task 1-3a</u>: Install native plants that will increase ecosystem functions specific to rain gardens and bioswales.

<u>Approach:</u>
We plan to plant native graminoid species such as slough sedge (*Carex obnupta),* small-fruited bulrush (*Scirpus microcarpus*), and sawbeak sedge (*Carex stipata*) in the form of bare roots with a shovel.

<u>Approach Justification:</u>
C. obnupta, S. microcarpus, and *C. stipata* help reduce excess nitrogen and phosphorus found in water systems through their symbiotic relationship with anaerobic bacteria (Stevens and Hoag, 2006; Thomas et al. 2009; Mitsch and Gosselink, 2015).

<u>Objective 1-4</u>: Add microenvironments, such as woody debris and brush and rock piles to increase site complexity and diversity of animal habitat.

<u>Task 1-4a:</u> Deposit woody debris, rock piles, and brush piles in strategic locations to ensure wildlife enhancement.

<u>Approach</u>: Setting up diverse animal habitat will encourage more species to utilize the site. After obtaining woody debris, rocks, and wood branches we will bring them into the site using wheelbarrows. We will skillfully and purposefully arrange rock pile(s) (dependent on how many large rocks we can get), create a brush pile using branches (ranging in sizes), and place woody debris in shady areas.

<u>Approach Justification</u>: These elements will provide shelter, habitat, area to reproduce, bask in the sun, for amphibians and reptiles. The brush piles will be placed near shrubs, which makes it more effective in serving a variety wildlife other than amphibians and reptiles (Cates et al. 2002). Placing woody debris near the stand of red alder (*Alnus rubra)* and black cottonwood (*Populus trichocarpa)* will provide some shade during the year as a way to retain more moisture under the debris, which is especially important for salamanders. Many of our native salamander species can be found under woody debris, which is their preferred microclimate. The placement of a rock pile near the rain garden and will serve as additional habitat for amphibians.

Goal 2: Develop a diverse structural and biological landscape that reflects earlier stages of succession, while diversifying biological elements.

Objective 2-1: Setup successional sequence of tree and shrub development on site.

Task 2-1a: Plant species that occur in early stages of succession.

Approach: We will plant *A. macrophyllum,* snowberry *(Symphoricarpos albus),* tall Oregon grape *(Mahonia aquifolium),* and salmonberry (*Rubus spectabilis)* throughout the site to create a tree and shrub canopy that will establish the conditions for other plant species to colonize.

Approach Justification: The species listed above are characterized as species that colonize a recently disturbed or open area and can tolerate full or partial sun. Their environmental tolerances allow them to colonize an open area, establish shade, and set the environmental conditions for species that occur in mid or late successional stages (Swanson et al. 2010). Species like *A. macrophyllum* will provide the site with woody debris once throughout its lifecycle, increasing biological and species diversity in the process.

Goal 3: Promote education for human communities and environmental stewardship.

Objective 3-1: Involve community members and local students in the restoration process.

Task 3-1a: Plan and advertise volunteer work parties

Approach: Collaborate with CP to see when volunteer work parties best fit into their schedule. CP also has a well-established volunteer base that we can draw upon to fit our needs. We will also use information given in the volunteer events lecture by Rodney Pond to plan our timeline for the work parties (Pond, 2017)

Approach Justification: Using volunteer work parties has many benefits including continued stewardship of the site, more manpower for the project, utilize our funding efficiently, and potentially secure more funding for the project. Involving volunteers in restoration sites has been proven to "effectively nurture personal growth while fostering a powerful constituency for the environment among volunteers" (Ryan et al. 2010). Instead of trying to build our own volunteer base, we are lucky to have the resources of our CP to save us time and energy.

Objective 3-2: Encourage access and curiosity of the site, while minimizing human disturbance.

Task 3-2a: Build a walking path through the site

Approach: Define path area and edge path with logs and or branches. Then dig roughly two inches into the soil to create a shallow ditch in the ground, then proceed to cover the ground with canvas or landscape mesh and cover with 4-5 inches of mulch provided by CP. Depending on path design, we may need to contact local artists or wood workers and ask them to donate a small footbridge to cross the bioswale that transects our project site. We considered lining the path with species that would encourage visitors to stay within the confines of the trail. This however, does not encourage visitor interaction and curiosity if we want this area to be a learning opportunity and decided against it.

Approach Justification: Soil compaction has many adverse effects on the surrounding vegetation and site visitors can also spread seeds of unwanted species, potentially introducing non-native species. Additionally, "Compaction typically alters soil structure and hydrology by increasing soil bulk density; breaking down soil aggregates; decreasing soil porosity, aeration and infiltration capacity; and by increasing soil strength, water runoff and soil erosion" (Kozlowski, 1998). To both increase site accessibility while also promoting plant health and growth, a long-term solution in the form of designated walking paths is necessary. Using salvaged materials and mulch to design and build the path will not only help lower construction costs, but intern will make the project more environmentally friendly and help to involve members of the community.

Site preparation plan

Current Conditions

Polygon 1

This polygon has an area of 437 sq. meters that is consistently flat throughout. It contains land outside of our site delineated by the dashed line through the polygon. This portion of the site is dominated by *R. armeniacus* (Figure 6). We increased the size of this polygon due to ecological considerations and challenges of measuring the site through the large bramble of *R. armeniacus*.

Polygon 2

With an area of 214 sq. meters it is transected by a drainage ditch and is also dominated by *R. armeniacus* (Figure 6). The topography is primarily flat with exception to the drainage ditch that has a slope of 20%, perhaps larger since we could not measure from the bottom of the ditch, located at the north side of the polygon (Table 1). This polygon also contains a large portion of the tree canopy cover found on our site. Here we can find *P. trichocarpa* and *A. rubra* (Figure 7).

Polygon 3

This polygon is a mixed grassland with large patches of tufted hairgrass (*Deschampsia cespitosa*) surrounded by a rhizomatous grass in the *Poa* genus. It contains populations of *C. sericea* (Figure 6). The grassland is also populated with a spread of *R. crispus*, *C. arvense,* and spotted with black-eyed Susans (*Rudbeckia hirta*). Polygon 3 is primarily all flat ground and has an area of 114 sq. meters, it has four green alders (*Alnus viridis*) planted along the north side of the polygon and extending into the south side of polygon 2.

Polygon 4

This section of the site is part of a rain garden that is almost completely populated by *P. arundinacea* with a small area also populated by swamp smartweed (*Polygonum hydropiperoides*) (Figure 6). There is also an area on the west side of the polygon that has a healthy population of *S. acutus.* The total area for this polygon is 54 sq. meters with an 11% slope on either side (Table 1).

Polygon 5

This polygon has an area of 102 sq. meters and it follows the bioswale roughly a foot deep, three feet wide, and runs through the entire polygon connecting to the rain garden in polygon 4. It has a dense colony of *R. repens* (Figure 6). Along the south border of polygon 2 there is a dense line of purple willow (*Salix purpurea*) and *C. sericea*. Along the north border is a line of planted burning bush (*Euonymus alatus*).

Polygon 6

With an area of 203 sq. meters, the center of polygon 6 is a stand of *P. trichocarpa,* within that stand is a green alder (*Alnus viridis*). It also is a mixed grassland with large patches of *D. cespitosa* surrounded by a grass in the *Poa* genus (Figure 7). This grassland is also populated with a spread of *R. crispus*, *C. arvense,* and *R. hirta*.

AD3: Polygon 6 was removed from plan. The reason for removal was based of the loss of team members throughout the project. Currently only having three team members it was decided to decrease the total site area.

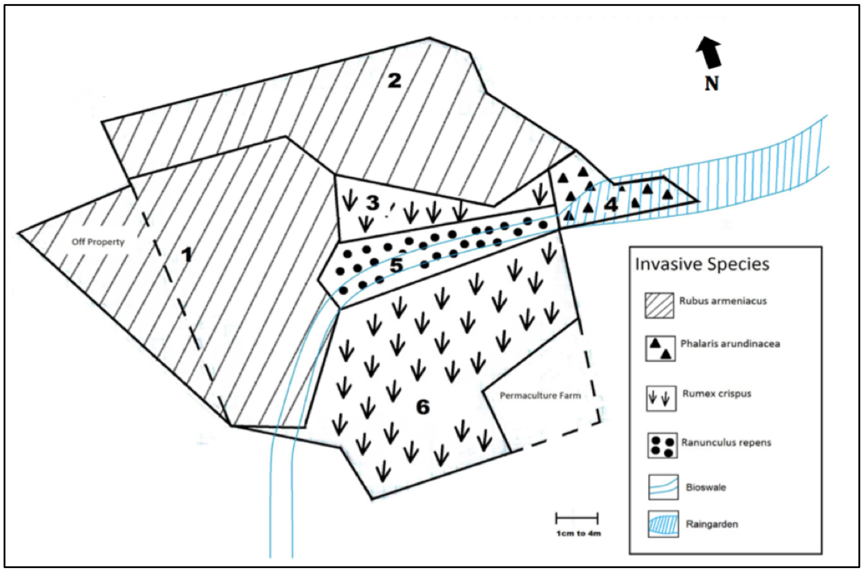

Figure 6: Map of dominant invasive species on the project site. The bioswale leads into the rain garden in polygon 4

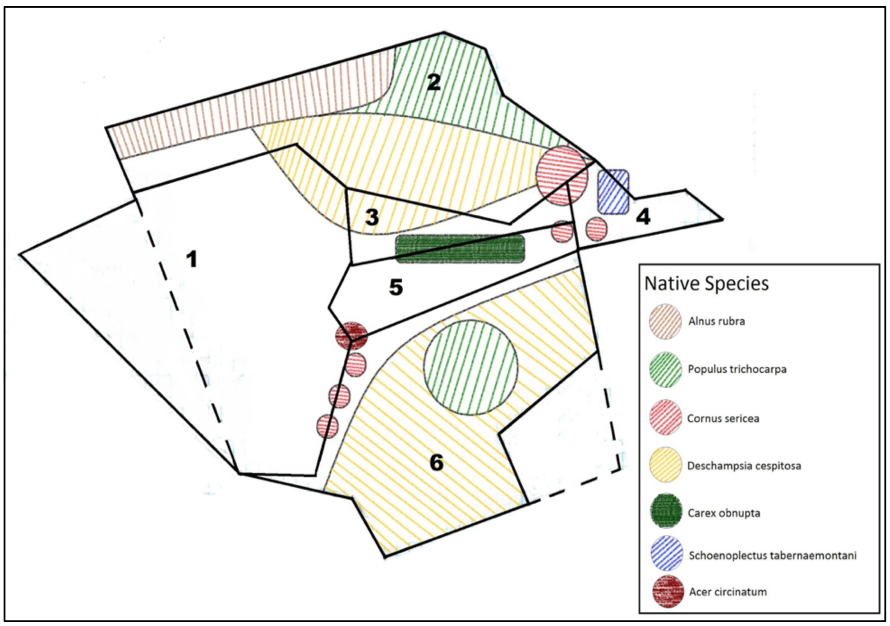

Figure 7: Map of dominant native species on the project site.

Table 1: Environmental Conditions in polygons 1 through 6

	Polygon 1	Polygon 2	Polygon 3	Polygon 4	Polygon 5	Polygon 6
Polygon area (m^2)	437	214	114	54	102	203
Soil texture	silt loam	silt loam	silt loam	muck	silt loam	silt loam
Soil moisture (each polygon, with exception to polygon 4, the soil moisture slightly varied from damp to dry. To capture this variation, we will denote using numbers 1 to 5) Dry= 1 Damp= 5	3	3	4	saturated	5	2
Slope	no slope	20% north side of polygon- roadside ditch	no slope	11%	20%	no slope
Light availability	no canopy	little canopy of deciduous trees	no canopy	no canopy	Small areas with shade from shrubs	tiny canopy from deciduous trees
Present vegetation	See Appendix D					
Human impacts	edge effects from neighboring farm	edge effects from street, noise pollution, and construction down the street	trampling		trampling	trampling
Other considerations	none	drainage ditch	none	raingarden	bioswale	none

<u>Site Preparation Activities</u>

Polygon 1 is the largest of the 5 polygons. Its vegetation currently is made up almost entirely of *R. armeniacus* with a couple of *C. serecia* that are being overtaken by *R. armeniacus*. To prepare the polygon we will first need to clear most of the above ground mass to shin height stalks utilizing loppers, shears, and hand pruners. We will then use shovels to dig out the root crowns of *R. armeniacus* in order to deter regrowth of the invasive. Once the aboveground and belowground biomass is removed we will use woodchip mulch on the site with a depth of 8 inches.

Polygon 2 has *P. trichocarpa* dominated canopy with *R. armeniacus* growing below. To prepare this polygon we will also be removing the aboveground and belowground biomass of *R. armeniacus* as mentioned in polygon 1 site preparation activities. We will then mulch the polygon with woodchip mulch to ensure suppression of invasive species.

Polygon 3 is currently a mixed grassland with invasives *R. hirta, R. crispus* and *C. arvense.* In order to prepare this polygon for planting we are going to remove *R. hirta, R. crispus* and *C. arvense* with shovels making sure to remove the 6-8 inch taproot. To rid the site of these two invasives yearly invasive removal will need to occur during the season in which each species stores the most energy in their roots. To assist in suppression, we will also mulch this polygon with a depth of 8 inches.

Polygon 4 is where the rain garden is located. Currently there is a healthy population of *S. acutus,* however most of the rain garden is invaded by *P. arundinacea.* To prepare this site for planting we will remove this invasive by digging out the aboveground and belowground biomass making sure to clear the site of rhizomes. This will remove the population, lower the elevation of the invaded site increasing the frequency and depth of inundation to reduce the likelihood of recolonization of this invasive and lower the competition for our native plantings. We will also be using shovels to lower the elevation of the berm on the west side of the raingarden. This will allow connectivity between the bioswale and the rain garden giving more plant individuals a chance to decrease the excess nutrients of the gray water.

Polygon 5 consists largely of the bioswale. The bioswale is most dominated by the invasive *R. repens*. This invasive is particularly hard to get rid of and does not have any particularly negative effects on native plantings, which mean to save time we will not utilize any mechanical means to remove this species. We will rely on the growth of our plantings to control this invasive. On the sides of the bioswale are ornamental species consist of burning bush (*Euonymus alatus)* and purple willow (*Salix purpurea*). These ornamentals will not be removed because these species act as a functional ecological niche in the engineered community we hope to establish, they also do not appear to be invasive so it will not be detrimental to the ecosystem since their presence will not hinder the success of native plants.

<u>Logistical Considerations</u>

Having 21 Acres as our Community Partner has given us many added benefits. First, they have experience with hosting work parties and have them planned for every Saturday. We will use this to our advantage by using their resources to organize volunteers for invasive species removal and planting. Secondly, they have the proper equipment and tools on site to conduct invasive species removal and planting. Furthermore, they have a nursery to store our plants until we are able to plant them. This gives us the added benefit of reducing herbivory, evidence of which we have seen at the site location in past site visits. After plant installation, we might have to take precautionary measures to ensure plant success among foraging herbivores. We will have a staging area for the invasive plant species removed from the site, after invasive removal the pile will be moved to a more permanent compost location on 21 Acres property. The location of 21 Acres woodchip mulch pile is not too far from our site and will be able to use wheel barrows cover our site with woodchip mulch (Figure 8).

Since our site location is directly in front of the 21 Acres building near a patio with picnic tables establishing a looped trail in our site will likely reduce soil compaction in sensitive areas, trampling of native plant species, and the dispersion of non-native or invasive seeds attached to shoes and/or clothing. Depending on how many volunteers we have for work parties, volunteer parking may overflow into 21 Acres market customers. When advertising for work parties we will emphasize and place signs for volunteer parking in selected areas (Figure 8).

Figure 8: Logistical locations. Orange = site outline, purple = proposed path, green = staging area for invasive species that have been removed, pink= staging area for woody debris, rock and brush piles, dark blue = pathways for entry and access, yellow = entry point to site, light green= 21 Acres mulch pile location, red = parking available for volunteers.

Planting plan

Polygon 1

The current conditions of this polygon are representative of a disturbed area, it is sun-exposed with damp soil. To improve ecosystem functions and services, this particular polygon is going to contain shrub species such as *R. spectabilis*, *P. capitatus*, thimbleberry (*Rubus parviflorus*), *S. albus*, and *M. aquifolium* (Objective 1-1, 1-2). The shrub species tolerate soil moisture varying from damp to dry, because *C. sericea* is currently present indicates that current conditions are within the range of tolerant for the species we have selected. Many of these species are fast growing, which will assist in the establishment of a quick canopy for shading out *R. americanus* and creating native wildlife habitat (Soll 2004). The benefits of planting shrubs[WG1] , especially in an agriculture area, range from (but not limited to) providing habitat for various forms of wildlife, result in higher farm yields, and increase the diversity and number of native pollinators (Neumann, 2006). Other shrubs species that will be planted here to fulfill this specific niche are *R. sanguineum*, serviceberry (*Amelanchier alnifolia*), mock orange (*Philadelphus lewisii*), and *H. discolor* (Objective 1-2) (Figure 9).

Due to the fact that much of this polygon is currently overrun by *R. americanus* we're going to refrain from planting any herbaceous species, as a means to ensure the suppression and ease of maintenance for controlling invasive species trying to recolonize. Shrub species like *P. capitatus* and *S. albus* will be planted using live stakes, while the rest will be bare root. All shrub species will be planted with 1 m spacing from center (Figure 9). The tree species we chose to plant in this polygon will later on provide more shade to add to the resiliency of the ecosystem by contributing woody debris, organic matter, and providing habitat and food for insects and various birds (Objective 2-2). These trees include *P. contorta* and *A. macrophyllum*, the density of these species will be sparse and will be planted with 2 meter centers.

Polygon 2

This polygon is one of our lowest priorities when it comes to planting. Due to logistical constraints and the unfortunate loss of team members, we have decided that we need to focus primarily on polygons 1,3,4 and 5. These polygons contain the most invasive species and require the most restoration. Working with the existing *A. rubra* and *P. trichocarpa* in this polygon we intend to plant some early successional shrub species such as *S. albus, R. spectabilis,* and *M. aquifolium.* The species are able to tolerate the sun-exposed and damp to dry soil conditions (Objective 2-1). These species will be planted on the south side of the canopy with 1 meter spacing and dispersed throughout the polygon along with *R. parviflorus.* Herbaceous species like *S. canadensis* will complement the site and sustain native pollinators during the fall (Ley et al. 2017), when most of the other species have bloomed. Self heal (*Prunella vulgaris)* will only be planted in polygon 2 in raised beds to ensure its establishment and will be an additional pollinator added to the site. The raised beds will be small and triangular in shape and we will construct them out of cut logs. This will allow it to naturally replicate and establish in the site without being outcompeted by more aggressive native species (Figure 9). We will also be splitting this polygon into two. The north side of the polygon will be 2a, and the south side 2b. The line will follow the thick row of plants (Figure 9). At the south side of polygon 2a, we will be placing a thick bed of mulch to prevent the spread of invasive from 2a into 2b.

Polygon 3

Polygon 3 will act as a buffer between the bioswale and polygon 2. Here we will plant shrubs that will help shade and prevent the spread of invasive grasses as well as an already established colony of *R. crispus.* The specific species that are being used in this polygon are *A. alnifolia*, *S. albus*, and *R. sanguineum*. These species will be planted evenly across the polygon, making sure that one of the polygon does not receive more than the other. Herbaceous species like *P. vulgaris* and *S. Canadensis* will be planted in 3 cluster in raised beds throughout polygon 2 and 3 (Figure 9).

Polygon 4

The main goal of this polygon is to increase the ecosystems services provided by the rain garden within its boundaries. 21 Acres recycles all of their gray water on site and filter it back into the Sammamish watershed. The gray water on site has increased levels of nitrogen and phosphors which we will reduce through the use of nitrogen and phosphors absorbing plants. The specific species being used are *C. obnupta, S. microcarpus*, and *Scirpus acutus* (Figure 9). These three species are known to absorb extra nitrogen through their rhizome roots (Objective 1-3) (Stevens and Hoag, 2006; Thomas et al., 2009).

AD5: Runoff into rain garden is not from graywater, but from storm water runoff. However *S. microcarpus* storm water filtration is still necessary and can be accomplished by these species (Thomas et al., 2009).

Polygon 4 already contains a good population *S. acutus* which will help to establish a good population in the rain garden. The polygon also contains a few individuals of *S. microcarpus*. To ensure the success of the future emergent sedges we will be planting the bare roots in bunches of 4 to imitate natural growth patterns (Sound Native Plants, 2006; Pojar and Mackinnon, 1994). These emergents will be replacing the removed *P. arundinacea.* While removing the *P. arundinacea* we will also be lowering the elevation of the area to increase the inundation depth and frequency. This will create a habitat better suited for emergents and decrease the likelihood of recolonization of *P. arundinacea* (Objective 1-1) (Farelly, 2012). Emergents will be planted at the recommended 12 to 18 (.5 meters) inch spacing (Tilley, 2012).

AD6: We did not lower the elevation of the raingarden. CP did not give approval to dig beneath rain garden.

In the seasonally inundated areas higher in elevation along the banks we will plant *C. obnupta.* These sedges will also assist in excess nutrient absorption during higher inundation periods (Mitsch and Gosselink, 2015). The sedges will be planted at the recommended spacing of 1.5 feet (.5 meters) (Sound Native Plants, 2006). We will be planting 30 *C. obnupta* along the edge of the completely inundated elevations of the rain garden.

Along the edge of the rain garden at the highest elevation of the polygon we are planting *C. sericea* and *P. capitatus.* These shrubs are rapid growing species, which will provide shade in the rain garden (Objective 1-1) (Crowder et al. 1999). Shade will decrease the likelihood of recolonization of *P. arundinacea* (Kim et al. 2006). Our community partner wants to maintain visibility between the main building and the street which limits our canopy to shrubs around 3 meters. Maintenance of these shrub species will be required to achieve desired heights.   We will plant 12 of each species around the rain garden at the recommended spacing of 3 feet (1 meter) (Crowder et al. 1999).

AD7: Planting around edges of rain garden only utilized *C. sericea* as a shading species. *C. sericea* was abundant around the site and easy to collect.

Polygon 5

This polygon contains the site bioswale, which transport the water from the rain garden to the wetlands located 200 meters south of the restoration site (Figure 5). The bioswale is about 2 meters in width and completely dominated by *R. repens*. The main goal of this polygon is to establish a native plant population that can compete with buttercup and also assist in the absorption of excess nutrients from the released greywater (Objective 1-1, 1-3). To achieve this goal, we will be planting the sedge species of *C. obnupta* and *C. stipata.* These two species are also known to help mitigate excess nutrients (Tomas, 2009; Jurries, 2003). We picked these two different sedges because they have varying ranges of light tolerance from full sun to considerable shade between the two species. We plan to plant *C. obnupta* and *C. stipata* mixed throughout the bioswale. This will ensure success from both species in the current light conditions. As the shrub and tree species grow taller on the bank *C*. obnupta will be able to persist and spread across the whole bioswale (Stevens and Hoag, 2006). We will be planting each species along the length of the bioswale using a spacing of 1.5 feet (.5 meters) (Sound Native Plants, 2006). Within this mix we will also be planting *D. cespitosa*, a native grass that grows in bunches. *D cespitosa* has been used in restoration to establish native vegetation in disturbed areas (Walsh, 1995).

AD8: Runoff into rain garden is not from graywater, but from storm water runoff. However *S. microcarpus* storm water filtration is still necessary and can be accomplished by these species (Thomas et al., 2009).

In order to ensure the success of our native planting we will grow a canopy along the banks of the bioswale with Sitka spruce (*Picea sitchensis)* and *C. sericea*. *C. sericea* is a fast-growing shrub which will establish a canopy relatively quickly (Gucker, 2012). *P. sitchensis* is a light loving species and will grow very well in the moist well-draining soils (Griffith, 1992). Not only will these two species fulfill objective 1-1 requirement for polygon 5, they also are a dominant community found along rivers in the Pacific northwest (Gucker, 2012). We will be planting 8 *C. sericea* with a spacing of 1 meter in the bank areas of the polygon that do not already hold *C. sericea* populations. We will be planting 7 *P. sitchensis* at the recommended spacing of 3 meters (Cameron, 2015) (Figure 9).

AD9: After further consideration, we decided that the population of *C. sericea* was already abundant enough.

Polygon 6

Our team has decided to not plant polygon 6. The reason behind this decision is a choice to focus more on invasive removal than planting. We do not believe we have enough time to make a considerable difference in this area. We choose this polygon to omit because Nick Jennison will be expanding his permaculture farm to this area in the future.

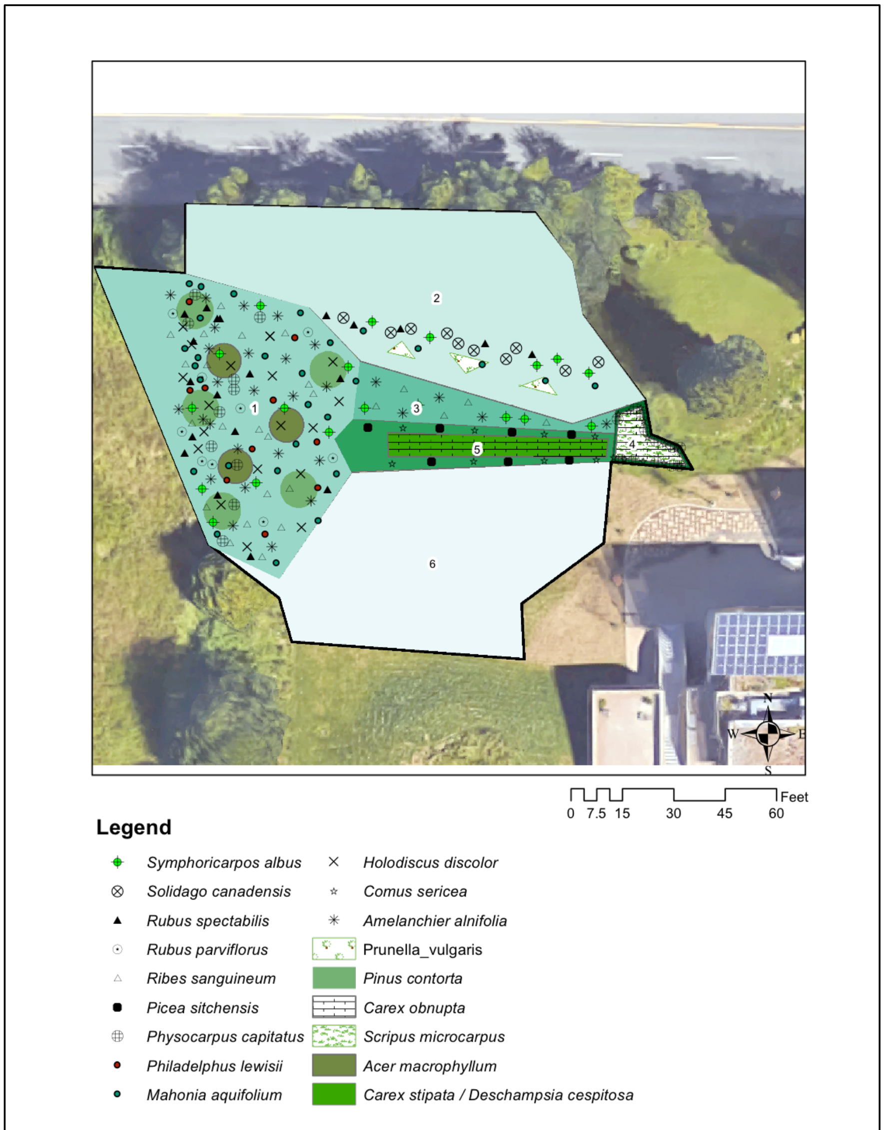

Figure 9. Planting map of 21 Acres restoration site

Other Plans:

Creating a diverse habitat for wildlife is still a goal of this project even though our current plans deviate from our project design and the amount of work we are able to accomplish. With that being said we can use free resources to create habitat structures for birds, amphibians, and reptiles. Our plan is to skillfully install a rock pile, that is half a meter tall and less than a meter in diameter, to provide cavities and crevices for amphibians, reptiles, and insects. Keeping the rock pile small with tight spaces we intend to use large rocks with a diameter of 5-8 inches and small rocks will be about 2 inches in diameter, and will discourage non-native rats. To accomplish this, we will place larger rocks at the base of the pile and smaller rocks towards to top, thus creating spaces varying in size to accommodate many species. Placing the rock pile near the rain garden or roadside ditch may be the most effective location for providing the optimal environment for these species. To construct a proper brush pile it is best to choose branches that are at least 5-8 inches in diameter and 1 meter long for the bottom later and then choosing branches the continually get smaller, for an overall brush pile size of 1 meter tall and at least 1 meter in diameter. For optimal species utilization, larger branches at the bottom with have 6-12 inches of space in between each branch (Cates et al. 2002). This will strategically create different size gaps for different species to use. Amphibians and reptiles will primarily use the bottom layer of the brush pile, while many different species of birds will utilize the top layers. The brush pile will be placed in polygon 1, near shrubs in order to make sure this feature is used by a variety of animals (Cates et al. 2002). The addition of woody debris is important to ecosystems, especially when considering the array of species whose life cycle is dependent on such habitat structures. To create the ideal habitat structure, we intend to place woody debris ranging from 4-6 inches in diameter and 1 meter in length in and near the stand of *A. rubra* and *P. trichocarpa*. This will provide some shade, as a means of making sure the microclimate under the woody debris will have more moisture.

The rain garden is potential habitat for amphibians. To better serve their needs, plant species *S. microcarpus and S. acutus* will provide the habitat for insects. Providing habitat to see shelter, habitat for their food source has the potentially to attract native frogs to the site. Some of the targeted species for the rock and brush piles are: Common garter snake (*Thamnophis sirtalis*), Northwestern garter (*Thamnophis ordinoides*), Pacific chorus frog (*Pseudacris regilla*), white-crowned sparrow (*Zonotrichia leucophrys*), Anna's hummingbird (*Calypte anna*), house wren (*Troglodytes aedon*), yellow-breasted chat (Icteria virens), and Wilson's warbler (*Cardellina pusilla*). Plant species *A. macrophyllum* and *P. contorta* will eventually contribute woody debris, enhancing the site over time.

Specific plant species that host native caterpillars and provide resources for butterflies are species like, *P. contorta*, *C. sericea, R. parviflorus*, *R. spectabilis*, *A. alnifolia, P. lewisii, H. discolor, S. canadensis, M. aquifolium, C. obnupta, D. cespitosa.* Some of these plant species are hosts for the red admiral (*Vanessa atalanta*), painted lady (*Vanessa cardui*), juba skipper *(Hesperia juba)*, dun skipper (*Euphyes vestris*), Western tiger swallowtail (*Papillio rutulus*), pale tiger swallowtail (*Papillio eurymedon*), and brown elfin (*Incisalia augustinus*). Some of the plant species we are planting will benefit native bees. These species include, *S. canadensis*, *R. sanguineum*, *M. aquifolium*, *R. spectabilis*, and *S. albus.*

The path we will create through our site will create a loop extending out to polygon 1, 2, 3, and in between where polygon 4 and 5 meet. One entrance will near Nick's permaculture site and come out in between polygon 4 and 5 (Figure 5). Once invasive species are removed, we will place flagging along the area described above, dig out about 2 inches of soil, place landscaping fabric, and then cover with 4-5 inches of mulch. If we have the time and ability, we plan to line the path with logs of any size and bundled branches.

AD10 : The path on site starts in polygon 6, goes over the bioswale where it meanders along the edge of polygon 1 into polygon 2.

Table 2. Planting Table

	Polygon 1			Polygon 2			Polygon 3			Polygon 4			Polygon 5		
Species	#	(m)	Form	#	(m)	Form	#	(m)	Form	#	(m)	Form	#	(m)	Form
Acer macrophyllum	~~3~~ **1**	3	1 gal container												
Amelanchier alnifolia	~~25~~ **35**	1	bare root	**15**	**1**	**bare root**	5	1	bare root						
Carex obnupta										60	0.5	bare root	40	0.5	bare root
Carex stipata													50	0.5	bare root
Cornus sericea										12	1	live stakes	~~8~~	~~1~~	~~live stakes~~
Deschampsia cespitosa													20	1	plugs
Holodiscus discolor	~~20~~ **15**	1	bare root	**5**	**1**	**bare root**									
Mahonia aquifolium	25	1	bare root	5	2	bare root									
Philadelphus lewisii	20	1	bare root												
Physocarpus capitatus	~~10~~ **12**	1	live stakes							~~12~~	~~1~~	~~live stakes~~			
Picea sitchensis													7	3	1 gal container
Pinus contorta	5 **10**	3	1 gal container												
~~*Prunella vulgaris*~~				~~10~~	~~1~~	~~plugs~~									
~~*Ribes sanguineum*~~	~~20~~	~~1~~	~~1 gal container~~				~~5~~	~~1~~	~~1 gal container~~						
~~*Rubus parviflorus*~~	~~10~~	~~1~~	~~bare root~~												
Rubus spectabilis	15	1	bare root	5	3	bare root									
Scirpus microcarpus										60	0.5	bare root			
Solidago canadensis				~~10~~ **6**	1	~~plugs~~ **4"pot**									
Symphoricarpos albus	10	1	live stake	5	1	live stake	5	1	live stake						

Table 3. General Materials

Task	Material	Qty	Source		Task	Tools	Qty	Source
1-1a	Tarp	~~1~~ **2**	~~CP~~ **Self-brought**		1-1a	Wheelbarrows	5	CP
					1-1a	Gloves	30	CP/Self-brought
					1-1a	Shovels	20	CP
					1-1a	Loppers	30	CP
1-1b	Mulch	TBD	CP		1-1b	Wheelbarrows	5	CP
					1-1b	~~5 gal buckets~~	4	~~Self-brought~~
					1-1b	Gloves	30	CP
1-1c	Live stakes	~~64~~ **34**	Multiple		1-1c	Shovels	30	CP
1-1c	~~4" pots~~	~~29~~	~~Multiple~~		1-1c	Gloves	30	CP
1-1c	~~Bare root~~		~~Multiple~~		1-1c	Wheelbarrows	5	CP
1-2a	Live stakes	~~64~~ **10**	Multiple		1-2a	Gloves	20	CP
1-2a	~~Plants~~	~~29~~	~~Multiple~~		1-2a	Shovels	20	CP
1-2a	Bare root	180	Multiple		1-2a	Wheelbarrows	5	CP
1-2a	~~Plugs~~	~~30~~	~~Multiple~~					
1-2a	Flagging	bundle	CP					
1-3a	Bare root	270	Multiple		1-3a	Gloves	20	CP
1-3a	Flagging	bundle	CP		1-3a	Shovels	30	CP
					1-3a	Wheelbarrows	5	CP
1-4a	Rocks of various size	TBD	Private land with owner's permission		2-2a	Gloves	3	Self-brought
1-4a	woody debris	TBD	Private land with owner's permission		2-2a	Wheelbarrows	3	CP
1-4a	Branches of various sizes	TBD	Private land with owner's permission					
2-1a	Bare root	50	Multiple		2-1a	Shovels	20	CP
2-1a	Live stakes	~~20~~ **25**	Multiple		2-1a	Gloves	30	CP
2-1a	~~Marking tape~~	~~1~~	~~CP~~		2-1a	Wheelbarrows	5	CP
3-2a	Flagging	bundle	CP		3-2a	Wheelbarrows	5	CP
3-2a	~~Material for path border~~ **mulch**	~~TBD~~	~~TBD~~ **CP**		3-2a	Shovels	20	CP

Comment [WG1]: We have at UWB if needed

Comment [WG2]: What does "plants" mean? You have all sorts of categories here that are also plants (live stakes, bare root, plugs).

Comment [WG3]: Will this be a possible problem?

Labor Budget:

21 Acres Labor Budget			Project To-Date (as of 05/25/2017)	
Tasks	Team (hours)	Volunteers (hours)	Team (hours)	Volunteers (hours)
Remove invasive species	64.5	140	60.5	69
Apply Mulch	51	110	48.5	40
Site Preparation	21	0	8	0
Plant Site	32	155	26.5	52
Plan and manage work parties	55	0	34.5	0
~~Care for site post-Installation~~	~~35~~	~~0~~	~~0~~	~~0~~
Prepare and deliver reports and presentations	455	0	426	0
Total:	713.5	405	604	161

Notes:
Invasive volunteer is estimate based on experience
Planting hours based on number of plants and an average planting time of 5 minutes
Mulch time is estimation based on experience

AD11: Two volunteer parties were added on to the original labor plan and monetary plan. We added two more parties because we did not get the amount of volunteers expected.

AD12: These tasks were removed from the original work plan. We decided to focus on invasive removal and suppression because with the loss of team members we did not have enough people to complete the original goals.

Monetary Budget:

21 Acres Monetary Budget

EXPENSES	UW (labor)	UW (cash)	CP (cash)	In-Kind (non-labor)	In-Kind (labor)	Total
Remove invasive species	$1,362.50	$0.00	$0.00	$0.00	$3,280.00	$4,642.50
Apply Mulch	$1,300.00	$0.00	$0.00	$0.00	$0.00	$1,300.00
Site Preparation	$525.00	$0.00	$0.00	$0.00	$0.00	$575.00
Plant Purchase	$325.00	$449.19	$0.00	$215.00	$0.00	$930.60
Plant Site	$500.00	$0.00	$0.00	$0.00	$2,070.00	$3,590.00
Plan and manage work parties	$550.00	$0.00	$0.00	$23.86	$0.00	$848.86
~~Care for site post-Installation~~	~~$875.00~~	~~$0.00~~	~~$0.00~~	~~$0.00~~	~~$0.00~~	~~$875.00~~
Prepare and deliver reports and presentations	$13,125.00	$20.00	$0.00	$0.00	$0.00	$13,145.00
Project Total Budget	**$18,563**	**$469**	**$0**	**$239**	**$5,350**	**$25,907**

EXPENSES TO DATE 02/10/2017	UW (labor)	UW (cash)	CP (cash)	In-Kind (non-labor)	In-Kind (labor)	Total
Remove invasive species	$1,487.50	$0.00	$0.00	$0.00	$828.00	$2,315.50
Apply Mulch	$1,237.50	$0.00	$0.00	$0.00	$720.00	$1,957.50
Site Preparation	$125.00	$0.00	$0.00	$0.00	$0.00	$125.00
Plant Purchase	$325.00	$449.19	$0.00	$215.00	$0.00	$989.19
Plant Site	$662.50	$0.00	$0.00	$0.00	$936.00	$1,598.50
Plan and manage work parties	$206.25	$0.00	$0.00	$0.00	$0.00	$206.25
~~Care for site post-Installation~~	~~$0.00~~	~~$0.00~~	~~$0.00~~	~~$0.00~~	~~$0.00~~	~~$0.00~~
Prepare and deliver reports and presentations	$10,175.00	$20.00	$0.00	$0.00	$0.00	$9,800.00
Project Total Budget	**$14,219**	**$469**	**$0**	**$215**	**$2,484**	**$16,992**

Notes:
1. Team labor is calculated at $25/hr.
2. Volunteer labor is calculated at $18/hr.
3. Mulch at 30.00/yd.
4. See appendix A for sub-task

Legend:

Addendum to original budget

~~Task removed from final work plan~~

AD13: Two volunteer parties were added on to the original labor plan and monetary plan. We added two more parties because we did not get the amount of volunteers expected.

AD14: These tasks were removed from the original work plan. We decided to focus on invasive removal and suppression because with the loss of team members we did not have enough people to complete the original goals.

Work Timeline

	% Complete / Date Completed		**Apr.**				**May**					**Jun.**
Tasks			1st-7th	8th-14th	15th-21nd	22nd-30th	1st-7th	8th-14th	15th-17th	18th-24th	25th-31st	1st-7th
1-1a: Remove above and below ground biomass of invasive species	Completed 19 May	**Projected**										
		Actual										
1-1b: Carpet the site with mulch to reduce the re-colonization of invasive plant species	95% Complete	**Projected**										
		Actual										
1-1c: Install fast growing, native canopy over invasive removal sites	Completed 29 April	**Projected**										
		Actual										
1-2a: Plant species throughout the site that will provide habitat and nectar and/or pollen	Completed 29 April	**Projected**										
		Actual										
1-3a: Install native plants that will increase ecosystem functions specific to rain gardens and bioswales	10% Complete	**Projected**										
		Actual										

1-4a: Collect and deposit woody debris, rock piles, and brush piles in strategic locations to ensure wildlife enhancement	Completed 19 May	**Projected**										
		Actual										
2-1a: Plant species that occur in early stages of succession	Completed 29 April	**Projected**										
		Actual										
3-1a: Plan and advertise volunteer work parties	Completed 13 May	**Projected**										
		Actual										
3-2a: Plan/ construct a walking path through the site	Completed 19 May	**Projected**										
		Actual										

Design for the Future:

For our project site at 21 Acres, we hope to lay the foundation for what will eventually become a resilient native plant community, encompassing native elements of lowland Puget Sound riparian ecosystems. With exception of the rain garden, we envision the small parcel of land to have matured into a forested ecosystem, comprised mainly of deciduous trees, speckled with emerging conifers, creating a biologically and structurally diverse and closed canopy. This point in the restoration should see microclimates produced by the canopy, leading to temporal variability that will influence not only the light that reaches the soil, but also the soil temperature and moisture, humidity, and wind through the site.

Our long-term goal for the site, roughly 100 to 200 years after our involvement, we want the site to be dominated by native conifers, experiencing less temporal variability in the understory microclimate associated with a deciduous forest. Under the canopy, you would probably find flourishing trailing blackberry (*Rubus ursinus)*, red huckleberry *(Vaccinium parvifolium)*, indian plum (*Oemleria cerasiformis),* and sword fern *(Polystichum munitum*). This far in the future, we predict that many of the deciduous trees already populating the site will be nearing the end of their lifespans creating snags and woody debris, as well as gaps in the canopy to promote biological diversity. These gaps will allow for more conifers to dominate and offer more diversity for wildlife to thrive.

To realize these long-term goals, much work and planning is necessary. Due to limitations of manpower, focusing on site stewardship and maintenance is of utmost importance. To lay the foundation for the success of this site, we will focus on polygons 1, 3, 4, 5 with slight consideration for polygon 2. Our efforts will be focused on the removal of invasive and exotic species and the creation of walking paths through the site that can be used for both educational and recreational purposes. To set the project site on the right trajectory, over the next 5 months we will be holding volunteer work parties and putting many hours in ourselves to assure the success of the project. These work parties over the next couple months will be led by our team and we hope to draw upon the volunteer group that has already been formed by 21 Acres. It is our goal to bring the members of the community out and get them excited about trying restore the area they live in and hopefully model for them how to fix problems that could potentially be occurring in their backyards. We hope that for future projects for the site that relationships can be built with local teachers, allowing them to bring their students and receive hands on experience with restoration work at an early age. The site could also be used as an educational example for native habitats and species.

After we are finished, continued stewardship and potentially another capstone project are crucial. To ensure the success of the site, a few things will need to be addressed; the continued monitoring and removal of invasives, path maintenance and upkeep, outreach to the local community, and continued planting of natives. We expect that bi-annual cutting of invasives will be necessary and roughly every 1 - 3 years a larger purge of the site will also prevent the destruction of the natural habitat. The mulch that is used to create the walking paths will also need to be replaced every 2 - 4 years. We hope that the volunteers that come help restore the site will have built a relationship with the area and want to continue to come back and be part of the upkeep of the site. Our goal is to plant in such a way that we have high survival rates but plants will die. We hope that the natives will propagate and reproduce naturally, but replanting could be necessary.

Lessons Learned

Labor Budget:
The first and earliest lesson learned while working on the budget is how important volunteers are to a successful restoration project. With little experience in hosting and implementing a volunteer party we learned quickly why there is emphasis on community engagement within the restoration community. When first creating the labor budget we believed that most of the work would be done by the team. Especially, the harder tasks like removing the aboveground and belowground biomass of the Himalayan blackberry and mulching. After the first work party, where we had only five volunteers, we realization of their how much their work helped removal the belowground biomass. With only five people working we removed most of the roots within the north half of polygon one. If we had stuck to the original plan of using mostly team member work it would have taken us triple the amount of time when having help from volunteers. The most significant fact from this experience was that as little as five volunteers can make a huge difference in you the outcome of your project. After this experience, we instantly decided that we needed more volunteer parties and added three more into the labor budget.

After adding three more volunteer work parties and looking back on the labor put for we can say that volunteer labor is extremely varied, which makes it hard to know the number of hours needed to complete the project. An example that shows this variability is difference between our fourth and fifth work parties. The fourth work party had many different task that volunteers could participate in. This variability in task was good for the volunteers who did not want to mulch or pull invasive. Instead they planted or spread the mulch that was being brought on site by the few who did mulch. This turned out to not be the most successful work party because there were only a few people working on many task. The fifth work party was centered on one task, mulching. This was the most effective work party in amount of work being accomplished. We mulched all of polygon 2 and 3, while also adding more depth to the mulch on polygon 1. It seemed that when volunteers are focused on one task there is a common goal which increases work effort.

Another lesson learned around volunteer work parties is how much organization and explanation of tasks can increase the amount of work done within the work parties scheduled hours. For instance, during our third work party, which had four hours designated to planting polygon one, we implemented a flagging and symbol system to help volunteers find the species and find the specific place to plant each species. This system proved to be very effective. The amount of time it took to plant polygon one was cut in half of what was expected. However, because the planting time was cut to half the expected time we were not prepared with another task immediately afterwards. The two lessons taken away from this work party were organization increase work effectiveness and always have another task on hand in case the main task is finished.

Monetary Budget:
One important lesson we learned while working with a finance table was the importance of form when ordering plants. When first creating the planting plan we decided on purchasing plant in the form of 1 gallon containers. After viewing the prices of potted plants compared to bare root plants we quickly changed the forms of our plantings to bare roots in order to save money. Bare root was also quicker to plant, which save money in the form of work hours. Another planting form that saved us money was scavenging, for live stakes and transplanting. We transplanted a big-leaf maple (*Acer macrophyllum*) from the 21 Acre property. Transporting did not only save us money but reducing the amount of plants needed to be order, but also decreased the time of establishing a canopy over that specific area. In the end this will not only save money in purchasing, but will also save money on future maintenance cost by establishing a canopy quicker and decrease the amount of maintenance hours needed for that specific

area. Live stakes were important because we harvested around 40 individual plant species that we would not have been able to afford with our limited budget. These live stakes were of critical fast growing shade species and necessary to the restoration process.

While completing a formal financial budget for the whole restoration process it became apparent just how expensive restoration can be. This further reinforces the lesson learned from the labor budget that volunteer help is absolutely necessary when implementing a restoration process on any level. Our in-kind labor ended up being $2,484.00 compared to the $12,843.75 used on team labor. The lesson learned from the comparison of these two total is that volunteer labor should have been used more in this process. In a restoration project where the team members are being paid for their time, this would save the community partner money and decrease the total cost of the restoration project. One way we could have changed this outcome is by utilizing more volunteer resources. We relied on the volunteer pool at 21 Acres. Our last volunteer party, as mentioned before, was our most successful. The difference between this restoration party and the others was the utilization of volunteermatch.org. If this free volunteer database was utilized at the beginning of the project and sustained throughout, we would have much more in-kind labor and reduce the teams on site work hours.

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Appendix

Appendix A: Baseline Monitoring Table

PLOT	SPECIES	#LIVE	#DEAD	%COVER	RECRUITMENT?	LAYER
1 A-D	Acer macrophyllum	1	0	1	No	C
	Amelanchier alnifolia	13	0	4	No	S
	Equisetum arvense	21	0	5	No	G
	Holodiscus discolor	8	0	3	No	G
	Mahonia aquifolium	6	0	2	No	G
	Phalaris arundinacea	32	0	15	No	S
	Philadelphus lewisii	7	0	4	No	G
	Physocarpus capitatus	2	0	1	No	S
	Pinus contorta	3	0	4	No	S
	Rubus armeniacus	46	0	12	No	G
	Rubus spectabilis	5	1	2	No	G
	TOTALS	**144**	**1**	**53**		
Totals	**Native**	**66**	**1**	**26**		
	Invasive	**78**	**0**	**27**		
Totals	**Ground**	**93**	**1**	**28**		
	Shrub	**50**	**0**	**24**		
	Canopy	**1**	**0**	**1**		

PLOT	SPECIES	#LIVE	#DEAD	%COVER	RECRUITMENT?	LAYER
2 A-D	*Amelanchier alnifolia*	6	0	3	No	S
	Holodiscus discolor	4	0	2	No	G
	Mahonia aquifolium	1	1	1	No	G
	Ranunculus repens	35	0	15	No	G
	Rose nutkana	2	0	6	No	S
	Rubus armeniacus	23	0	12	No	G
	Solidago canadensis	2	0	1	No	G
	TOTALS	**73**	**1**	**40**		
Totals	**Native**	**15**	**1**	**13**		
	Invasive	**58**	**0**	**27**		
Totals	**Ground**	**65**	**1**	**31**		
	Shrub	**8**	**0**	**9**		

PLOT	SPECIES	#LIVE	#DEAD	%COVER	RECRUITMENT?	LAYER
3 A-D	*Carex stipata*	3	0	1	No	G
	Deschampsia cespitosa	1	1	1	No	G
	Picea sitchensis	2	0	2	No	S
	Ranunculus repens	50	0	40	No	S
	TOTALS	**56**	**1**	**44**		
Totals	**Native**	**6**	**1**	**4**		
	Invasive	**50**	**0**	**40**		
Totals	**Ground**	**4**	**1**	**2**		
	Shrub	**52**	**0**	**42**		

PLOT	SPECIES	#LIVE	#DEAD	%COVER	RECRUITMENT?	LAYER
4 A-D	*Cornus sericea*	4	0	3	No	S
	Phalaris arundinacea	8	20	8	No	G
	Populus trichocarpa	3	0	20	No	S
	Ranunculus repens	24	0	10	No	G
	Scripus microcarpus	18	2	25	No	S
	TOTALS	**57**	**22**	**66**		
Totals	**Native**	**25**	**2**	**48**		
	Invasive	**32**	**20**	**18**		
Totals	**Ground**	**32**	**20**	**18**		
	Shrub	**25**	**2**	**48**		

Appendix B. Monetary Budget

EXPENSES	Project Total Budget						Project To-Date (as of 05/25/2017)					
	UW (labor)	UW (cash)	Client (cash)	In-Kind (non-labor)	In-Kind (labor)	Total	UW (labor)	UW	Client	In-Kind (non-labor)	In-Kind (labor)	Total
Remove Invasive Species												
Cut himalayan blackberry stalks to shin height	$450.00				$720.00	$1,170.00	$600.00				$180.00	$780.00
Remove himalayan blackberry	$300.00				$1,480.00	$1,780.00	$675.00				$630.00	$1,305.00
Remove Scotchbroom	$12.50					$12.50	$12.50					$12.50
Remove Creeping Thistle	$150.00					$150.00						
Remove reed canary grass and lower elevation	$300.00				$720.00	$1,020.00	$200.00				$18.00	$218.00
~~Remove curly dock~~	~~$150.00~~				~~$360.00~~	~~$510.00~~						
Subtotal	**$1,362.50**	**$0.00**	**$0.00**	**$0.00**	**$3,280.00**	**$4,642.50**	**$1,487.50**	**$0.00**	**$0.00**	**$0.00**	**$828.00**	**$2,315.50**
Apply Mulch												
Needed	$25.00					$25.00	$25.00					$25.00
Aquire Mulch	$25.00					$25.00						$0.00
Aquire Wheelbarrows	$50.00					$50.00	$12.50					$12.50
Spread Mulch Across Site						$0.00						
Spread mulch in polygon 1	$375.00					$375.00	$675.00				$180.00	$855.00
Spread mulch in polygon 2	$250.00					$250.00	$275.00				$144.00	$419.00
Spread mulch in polygon 3	$50.00					$50.00	$250.00				$396.00	$646.00
Spread mulch in polygon 5	$150.00					$150.00						$0.00
~~Spread mulch in polygon 6~~	~~$375.00~~					~~$375.00~~						~~$0.00~~
Subtotal	**$1,300.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$1,300.00**	**$1,237.50**	**$0.00**	**$0.00**	**$0.00**	**$720.00**	**$1,957.50**
Site Preperation												
Place flags at planting locations	$50.00					$50.00	$25.00					$25.00
~~Design Bioswale burm~~	~~$50.00~~					~~$50.00~~						~~$0.00~~
~~Implement bioswale burm~~	~~$150.00~~					~~$150.00~~						~~$0.00~~
~~Design microdpression~~	~~$50.00~~					~~$50.00~~						~~$0.00~~
~~Install microdepression~~	~~$150.00~~					~~$150.00~~						~~$0.00~~
Design and map location of debris piles	$25.00					$25.00						$0.00
Aquire rocks and dead logs	$50.00					$50.00	$100.00					$100.00
Place rocks and logs to create habitat	$50.00					$50.00						$0.00
Subtotal	**$525.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$575.00**	**$125.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$125.00**
Plant Purchase												
Fourth Corner Nursery	$100.00					$100.00	$100.00					$100.00
SER-Nursery	$50.00					$50.00	$50.00					$50.00
21 Acres Nursery	$25.00					$25.00	$25.00					$25.00
3-Acer macrophyllum						$0.00						$0.00
30-Amelanchier alnifolia		$65.00				$65.00		$65.00				$65.00
100-Carex obnupta		$47.00				$47.00		$47.00				$47.00
50-Carex stipata		$28.50				$28.50		$28.50				$28.50
20-Cornus sericea (scavenge)	$50.00					$50.00						$0.00
20-Deschampsia cespitosa		$11.40				$11.40		$11.40				$11.40
20-Holodiscus discolor		$56.00				$56.00		$56.00				$56.00
25-Mahonia aquifolium		$30.00				$30.00		$30.00				$30.00
20-Philadelphus lewisii		$25.00				$25.00		$25.00				$25.00
22-Physcocarpus capitatus (scavenge)	$50.00					$50.00	$75.00					$75.00
7-Picea sitchensis		$28.00				$28.00		$28.00				$28.00
5-Pinus contorata		$22.50				$22.50		$22.50				$22.50
10-Prunella vulgaris				$40.00		$40.00				$40.00		$40.00
25-Ribes sanguineum				$125.00		$125.00				$125.00		$125.00
10-Rubus parviflorus				$50.00		$50.00				$50.00		$50.00
20-Rubus spectabilis		$22.00				$22.00		$22.00				$22.00
30-Scirpus microcarpus		$34.20				$34.20		$34.20				$34.20
10-Solidago canadensis		$21.00				$21.00		$21.00				$21.00
20-Symphoricarpos albus (scavenge)	$50.00					$50.00	$75.00					$75.00
sales tax (15%)		$58.59						$58.59				$58.59
Subtotal	**$325.00**	**$449.19**	**$0.00**	**$215.00**	**$0.00**	**$930.60**	**$325.00**	**$449.19**	**$0.00**	**$215.00**	**$0.00**	**$989.19**
Plant Site												

Polygon 1 - Planting 183 plants												
Install plants	$300.00				$720.00	$1,020.00	$300.00				$630.00	$930.00
Polygon 2- Planting 35 plants						$0.00						
Install plants	$125.00				$450.00	$575.00	$100.00				$90.00	$190.00
Polygon 3- Planting 15 plants						$0.00						
Install plants	$125.00				$450.00	$575.00	$162.50				$198.00	$360.50
Polygon 4-Planting 144 plants						$0.00						
Install plants	$100.00				$450.00	$550.00						$0.00
Polygon 5- Planting 125 plants						$0.00						
Install plants	$150.00				$720.00	$870.00	$100.00				$18.00	$118.00
Subtotal	**$500.00**	**$0.00**	**$0.00**	**$0.00**	**$2,070.00**	**$3,590.00**	**$662.50**	**$0.00**	**$0.00**	**$0.00**	**$936.00**	**$1,598.50**
Community Engagment												
Plan work party 2/25 VWP												
Approval from CP	$25.00					$25.00	$6.25					$6.25
Design task explination	$25.00					$25.00	$12.50					$12.50
Locate and obtain tools	$25.00					$25.00	$12.50					$12.50
Request donations form local stores	$25.00					$25.00	$12.50					$12.50
Retrieve and bring refreshment	$50.00			$23.86		$73.86	$50.00					$50.00
Organize volunteers	$100.00					$100.00	$12.50					$12.50
Collect and return tools	$25.00					$25.00	$6.25					$6.25
Plan work party 3/4 VWP						$0.00						
Approval from CP	$25.00					$25.00	$6.25					$6.25
Design task explination	$25.00					$25.00	$12.50					$12.50
Locate and obtain tools	$25.00					$25.00	$12.50					$12.50
Request donations form local stores	$25.00					$25.00	$0.00					$0.00
Retrieve and bring refreshment	$50.00					$50.00	$25.00					$25.00
Organize volunteers	$100.00					$100.00	$12.50					$12.50
Collect and return tools	$25.00					$25.00	$25.00					$25.00
Plan work party 3/11 VWP						$0.00						$0.00
Approval from CP	$25.00					$25.00	$6.25					$6.25
Design task explination	$25.00					$25.00	$25.00					$25.00
Locate and obtain tools	$25.00					$25.00	$12.50					$12.50
Request donations form local stores	$25.00					$25.00	$0.00					$0.00
Retrieve and bring refreshment	$50.00					$50.00	$12.50					$12.50
Organize volunteers	$100.00					$100.00	$25.00					$25.00
Collect and return tools	$25.00					$25.00	$25.00					$25.00
Plan work party 4/29 VWP						$0.00						$0.00
Approval from CP	$25.00					$25.00	$6.25					$6.25
Design task explination	$25.00					$25.00	$25.00					$25.00
Locate and obtain tools	$25.00					$25.00	$12.50					$12.50
Request donations form local stores	$25.00					$25.00	$0.00					$0.00
Retrieve and bring refreshment	$50.00					$50.00	$12.50					$12.50
Organize volunteers	$100.00					$100.00	$125.00					$125.00
Collect and return tools	$25.00					$25.00	$25.00					$25.00
Plan work party 5/13 VWP						$0.00						$0.00
Approval from CP	$25.00					$25.00	$6.25					$6.25
Design task explination	$25.00					$25.00	$25.00					$25.00
Locate and obtain tools	$25.00					$25.00	$12.50					$12.50
Request donations form local stores	$25.00					$25.00	$0.00					$0.00
Retrieve and bring refreshment	$50.00					$50.00	$12.50					$12.50
Organize volunteers	$100.00					$100.00	$25.00					$25.00
Collect and return tools	$25.00					$25.00	$25.00					$25.00
Subtotal	**$550.00**	**$0.00**	**$0.00**	**$23.86**	**$0.00**	**$848.86**	**$206.25**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$206.25**
Care for site post-installation												
~~Remove new invasive growth~~	~~$375.00~~					~~$375.00~~						

~~Scheduled watering~~	~~$250.00~~					~~$250.00~~						
~~Replace plants as needed~~	~~$250.00~~					~~$250.00~~						
Subtotal	**$875.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$875.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Reports												
Team meetings												
Weekly meetings	$750.00					$750.00	$400.00					$400.00
Produce site assesment	$1,250.00					$1,250.00	$1,250.00					$1,250.00
Produce budget	$375.00					$375.00	$375.00					$375.00
Produce plant purchase form	$250.00					$250.00	$250.00					$250.00
Produce planting plan	$1,500.00					$1,500.00	$1,500.00					$1,500.00
Produce work plan	$3,000.00					$3,000.00	$3,000.00					$3,000.00
Produce Sewardship	$2,000.00					$2,000.00	$1,650.00					$1,650.00
Develop and deliver presentation to CP	$250.00					$250.00	$250.00					$250.00
Produce as-built report	$2,000.00					$2,000.00	$1,125.00					$1,125.00
Design, prepare, print final poster	$750.00	$20.00				$770.00	$375.00	$20.00				
Subtotal	**$13,125.00**	**$20.00**	**$0.00**	**$0.00**	**$0.00**	**$13,145.00**	**$10,175.00**	**$20.00**	**$0.00**	**$0.00**	**$0.00**	**$9,800.00**
Total	$18,562.50	$469.19	$0.00	$238.86	$5,350.00	$25,906.96	$14,218.75	$469.19	$0.00	$215.00	$2,484.00	$16,991.94

Legend:
Addendum to original budget
~~Task removed from final work plan~~

Appendix C. Labor Budget

21 Acres Labor Budget

Tasks	Project Budget		Project To-Date (as of 05/25/2017)	
	Team (hours)	Volunteers (hours)	Team (hours)	Volunteers (hours)
Remove Invasive Species				
Cut himalayan blackberry stalks to shin height	28		24	10
Grub out himalayan blackberry	12	80	27	58
Remove Scotchbroom with weed wrench	0.5		0.5	
Remove creeping thistle	6		1	
Remove reed canary grass and lower elevation	12	40	8	1
~~Remove curly dock~~	~~6~~	~~20~~		
Subtotal	**64.5**	**140**	**60.5**	**69**
Apply Mulch				
Determine amount of mulch is needed	1		1	
Aquire Mulch	1		0	
Aquire Wheelbarrows	2		0.5	
Spread Mulch Across Site				
Spread mulch in polygon 1	15	30	27	10
Spread mulch in polygon 2	10	20	11	8
Spread mulch in polygon 3	2	10	10	22
Spread mulch in polygon 5	6	20		
~~Spread mulch in polygon 6~~	~~15~~	~~30~~		
Subtotal	**51**	**110**	**48.5**	**40**
Site Preperation				
Place flags at planting locations	2		1	
~~Design Bioswale burm~~	~~2~~			
~~Implement bioswale burm~~	~~6~~			
~~Design microdpression~~	~~2~~			
~~Install microdepression~~	~~6~~			
Design and map location of debris piles	1		1	
Aquire rocks and dead logs	2		4	
Place rocks and logs to create habitat	2		2	
Subtotal	**21**	**0**	**8**	**0**
Plant Purchase				
Fourth Corner Nursery	4			
SER-Nursery	2		1	
21 Acres Nursery				
3-Acer macrophyllum				
30-Amelanchier alnifolia				
100-Carex obnupta				
50-Carex stipata				
20-Cornus sericea (scavenge)	2		1	
20-Holodiscus discolor				

25-Mahonia aquifolium				
20-Philadelphus lewisii				
22-Physcocarpus capitatus			3	
7-Picea sitchensis				
5-Pinus contorata				
10-Prunella vulgaris				
25-Ribes sanguineum				
10-Rubus parviflorus				
20-Rubus spectabilis				
30-Scirpus microcarpus				
10-Solidago canadensis				
20-Symphoricarpos albus (scavenge)	2		3	
Subtotal	**10**	**0**	**8**	**0**
Plant Site				
Polygon 1 - Planting 183 plants				
Install plants	12	40	12	35
Polygon 2- Planting 35 plants				
Install plants	5	25	4	5
Polygon 3- Planting 15 plants				
Install plants	5	25	6.5	11
Polygon 4-Planting 144 plants				
Install plants	4	25		
Polygon 5- Planting 125 plants				
Install plants	6	40	4	1
Subtotal	**32**	**155**	**26.5**	**52**
Community Engagment				
Plan work party 2/25 VWP				
Approval from CP	1		0.25	
Design task explination	1		0.5	
Locate and obtain tools	1		0.5	
Request donations form local stores	1		0.5	
Retrieve and bring refreshment	2		2	
Organize volunteers	4		0.5	
Collect and return tools	1		0.25	
Plan work party 3/4 VWP				
Approval from CP	1		0.25	
Design task explination	1		1	
Locate and obtain tools	1		0.5	
Request donations form local stores	1		0	
Retrieve and bring refreshment	2		1	
Organize volunteers	4		2	
Collect and return tools	1		1	
Plan work party 3/11 VWP (plant poly 1)				
Approval from CP	1		0.25	
Design task explination	1		2	
Locate and obtain tools	1		0.5	

Request donations form local stores	1		0	
Retrieve and bring refreshment	2		1	
Organize volunteers	4		2	
Collect and return tools	1		1	
Plan work party 4/29 VWP				
Approval from CP	1		0.25	
Design task explination	1		2	
Locate and obtain tools	1		0.5	
Request donations form local stores	1		0	
Retrieve and bring refreshment	2		1	
Organize volunteers	4		2	
Collect and return tools	1		1	
Plan work party 5/13 VWP				
Approval from CP	1		0.25	
Design task explination	1		2	
Locate and obtain tools	1		0.5	
Request donations form local stores	1		0	
Retrieve and bring refreshment	2		1	
Organize volunteers	4		6	
Collect and return tools	1		1	
Subtotal	**55**	**0**	**34.5**	**0**
Care for site post-installation				
~~Remove new invasive growth~~	~~15~~			
~~Scheduled watering~~	~~10~~			
~~Replace plants as needed~~	~~10~~			
Subtotal	**35**	**0**	**0**	**0**
Reports				
Team meetings				
Weekly meetings	30		16	
Produce site assesment	50		50	
Produce budget	15		15	
Produce plant purchase form	10		10	
Produce planting plan	60		60	
Produce work plan	120		120	
Produce sewardship plan	80		85	
Develop and deliver presentation to CP	10		10	
Produce as-built report	80		45	
Design, prepare, print final poster	30		15	
Subtotal	**455**	**0**	**426**	**0**
TOTAL	713.5	405	604	161

Legend:

Addendum to original budget
~~Task removed from final work plan~~

Appendix D. Present vegetation on site

Polygon 1	Common Name	Scientific Name	Abundance (% of area covered)
Native species	red-osier dogwood	(*Cornus sericea*)	3%
	vine maple	(*Acer circinatum*)	1%
Non-native species	Himalayan blackberry	(*Rubus armeniacus*)	80%
	creeping thistle	(*Cirsium arvense*)	10%
	curly dock	(*Rumex crispus*)	3%
	northern red oak	(*Quercus rubra*)	1%
	creeping buttercup	(*Ranunculus repens*)	2%

Polygon 2	Common name	Scientific name	Abundance (% of area covered)
Native species	red alder	(*Alnus rubra*)	20%
	black cottonwood	(*Populus trichocarpa)*	15%
	tufted hairgrass	(*Deschampsia cespitosa*)	15%
	nootka rose	(*Rosa nutkana*)	15%
	red-osier dogwood	(*Cornus sericea*)	5%
Non-native species	Himalayan blackberry	(*Rubus armeniacus*)	19%
	creeping buttercup	(*Ranunculus repens*)	10%
	green alder	(*Alnus viridus*)	1%

Polygon 3	Common name	Scientific name	Abundance (% of area covered)
Native species	tufted hairgrass	(*Deschampsia cespitosa*)	10%
	slough sedge	(*Carex obnupta)*	5%
	blackeyed susans	(*Rudbeckia hirta*)	5%
	red-osier dogwood	(*Cornus sericea*)	25%
	yarrow	(*Achillea millefolium*)	10%
	cleaver	(*Galium aparine*)	5%
	velvet grass	(*Holcus lanais*)	20%
Non-native species	curly dock	(*Rumex crispus*)	15%

	creeping thistle	(*Cirsium arvense*)	3%
	green alder	(*Alnus viridus*)	2%

Polygon 4	Common name	Scientific name	Abundance (% of area covered)
Native species	red-osier dogwood	(*Cornus sericea*)	5%
	hardstem bulrush	(*Schoenopluctus acutus*)	15%
	Small-flowered bulrush	(*Scirpus microcarpus*)	5%
Non-native species	reed canarygrass	(*Phalaris arundinacea*)	60%
	creeping buttercup	(*Ranunculus repens*)	9%
	Swamp smartweed	(*Polygomun hydropiperoides*)	6%

Polygon 5	Common name	Scientific name	Abundance (% of area covered)
Native species	slough sedge	(*Carex obnupta)*	10%
	red-osier dogwood	(*Cornus sericea*)	15%
Non-native species	creeping buttercup	(*Ranunculus repens*)	60%
	purple willow	(*Salix purpurea*)	5%
	burning brush	(*Euonymus alatus*)	10%

Polygon 6	Common name	Scientific name	Abundance (% of area covered)
Native species	tufted hairgrass	(*Deschampsia cespitosa*)	15%
	blackeyed susans	(*Rudbeckia hirta*)	5%
	red-osier dogwood	(*Cornus sericea*)	5%
	yarrow	(*Achillea millefolium*)	6%
	cleaver	(*Galium aparine*)	5%
	velvet grass	(*Holcus lanais*)	5%
Non-native species	curly dock	(*Rumex crispus*)	15%
	creeping buttercup	(*Ranunculus repens*)	27%

	creeping thistle	(*Cirsium arvense*)	10%
	green alder	(*Alnus viridus*)	5%
	scotch broom	(*Cytisus scoparius*)	2%