# North Creek Forest

University of Washington Restoration
Ecology Network Capstone 2016-2017

Project Site Location: North Creek Forest, 242nd St. SE, Bothell, WA, 98041

## Community Partner

Friends of North Creek Forest (FNCF)

Emily Sprong, Executive Director
Greg Waggoner, Volunteer Coordinator
Sarah Witte, Stewardship Chair

## Team Members

**Jasmine Chung:** University of Washington Seattle, ESRM/Wildlife Management
**Michael Groves:** University of Washington Bothell, Environmental Sciences
**Jaiwei (Nicole) Ma:** University of Washington Seattle, ESRM
**Matthew Martin:** University of Washington Seattle, ESRM
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# Project Summary

## Overview

North Creek Forest is located on the eastern portion of Puget Sound in Snohomish County. The project site is located at the end of the stub road of 242nd Street SE and Interstate 405 is located just east of the project site. The project site is within the North Creek Forest, a 64-acre forest that is a part of both Snohomish and King Counties and is part of the Boy Scout Creek and lower North Creek Sub-basin watersheds. This report describes the North Creek Forest Restoration Project implemented in 2016-2017 for the City of Bothell. A team of six students in the University of Washington Restoration Ecology Network (UW-REN) Capstone course designed and installed the restoration between September 2016 and May 2017, with the support of our community partners, Greg Waggoner (FNCF), Emily Sprong (FNFC), Sarah Witte (FNFC), Cathy Ferbrache (FNFC), and our course instructors, Warren Gold and Shannon Ingebright. The North Creek Forest Project is the sixth restoration project to occur in North Creek Forest through the UW-REN Capstone course.


**Figure 1: Before photo of project site. (January 7, 2017)**

**Figure 2: After photo of project site. (May 20, 2017)**

## Pre-Restoration Description

North Creek Forest Restoration Site #6 is approximately 1500 sq. meters in area with a 191 meter perimeter. The site is on a slight east facing slope from the forest entrance leading downhill to a stream that runs through North Creek Forest. The soil at the start of the project can best be categorized as sandy loam throughout the site. Before restoration, the site was mostly covered in Himalayan blackberry (*Rubus armeniacus*), along with other invasive species throughout, including Reed canary grass (*Phalaris arundinacea*), English Holly (*Ilex aquifolium*), English Ivy (*Hedera helix*), Herb-robert (*Geranium robertianum),* and Yellow Archangel (*Lamiastrum galeobdolon*). There was a moderate amount of native ground cover with sword fern (*Polystichum munitum*), piggyback plant (*Tolmiea menziesii),* bracken fern (*Pteridium aquilinum),* trailing blackberry *(Rubus ursinus),* and stinging nettle (*Utica dioica*). There were also some shrubs along the edges of our site which included beaked hazel (*Corylus cornuta),* Indian plum (*Oemleria cerasiformis*), and vine maple *(Acer circinatum).* Big leaf maple (*Acer macrophyllum*) was towards the middle of our site with Western redcedar (*Thuja plicata*) surrounding the site.

## Ecological concerns

North Creek Forest Restoration Site #6 has numerous issues that were addressed by the 2016-2017 UW restoration team. This site was slated as a restoration area due to the large amounts of *R. armeniacus* covering the northern part of the project site along with several other invasive species. As the project site is located at the end of a stub road, it had also been used as an illegal dumping area. We found poles, signs, plastic, wooden crates, fishing lines, concrete, and more buried in the soil. This environment allowed invasive species to quickly outcompete native plants, leaving no room for other native plants to grow. The major issue with this was that the likelihood of autogenic repair was low. Restoration needed to occur on this site in order to manage the overgrown invasive species and allow native species to establish and improve ecosystem functions. Removing the garbage and invasive plants from the soil were important to decreasing polluted water runoff into the salmon stream downhill from our site. Due to these many factors, human intervention was required to aid in successional advancement of this site to a healthy old growth forest that can be enjoyed by wildlife and humans for many years to come.

## Project Goals

- Establish native plants species that will allow for the development of a mature Puget Sound lowland forest community within North Creek Forest.

- Enhance ecosystem functions of our restoration site, such as carbon sequestration, filtering of storm water runoff, and provision of habitat for native fauna.

- Encourage community involvement and continued development of our restoration site, by ensuring the site is aesthetically pleasing and creating a long term monitoring plan for our site.

## General Approach

- Removed all invasive species on our site

- Installation of native plant species
    - Encourage natural succession
    - Shade out invasive species

In order to accomplish our goals, we hosted 9 work parties, in partnership with the Friends of North Creek Forest. We set out to accomplish a multitude of tasks, including removal of invasive species, primarily *R. armeniacus* and *H. helix*. *R. armeniacus* was a primary constituent of the invasive species present within our restoration site, especially in Polygons 1 and 3. With the assistance of many volunteers, we lopped the *R. armeniacus* stems and dug up root balls, effectively removing it. *H. helix* was also present and was removed during the second and third work parties using the log roll method. Department of Natural Resources (DNR) came in to remove *I. aquifolium* from Polygons 2 and 4.

With invasive species removed, our site was ready for the installation of native plant species. We planted a variety of native species throughout our restoration site including *O. cerasiformis*, *P. munitum*, and red huckleberry (*Vaccinium parvifolium*). We also live staked a variety of tree species within Polygon 3, including red osier dogwood (*Cornus sericea*), Pacific ninebark (*Physocarpus capitatus*), and Pacific willow (*Salix lucida*). Plugs and potted plants were also installed within our site, including red fescue (*Festuca rubra*), tussock grass (*Deschampsia cespitosa*), Oregon oxalis (*Oxalis oregana*), goat's beard (*Aruncus dioicus*), and thimbleberry (*Rubus parviflorus*). Native shrubs and groundcovers that compete with the invasive species will deter reinvasion and allow for successional development and maintenance of a multi-layered forest community to maximize carbon sequestration over time (Smith, 2007). In addition, *P. trichocarpa, R. spectabilis, C. sericea and C. obnupta* are all fast growing species, which will allow for rapid replacement of the *R. armeniacus* (USFS). As all plant species sequester carbon, the removal of *R. armeniacus* diminishes the ability of our site to sequester carbon. Therefore, quickly establishing native species in the removal sites is critical to maintaining the carbon sequestration capacity of our site. In addition, *C. obnupta* has a highly rhizomatous root system which will further stabilize the soil and enhance storm water filtration (Hoag, 2002). Water quality will improve due to these characteristics, as the soil on the slope will be stabilized by roots, reducing sedimentary runoff, and harmful pollutants will be absorbed by plants, which can be properly disposed of (SNP).

After planting, we watered in the installed plants to encourage successful establishment.

- Application of wood chip mulch throughout the restoration site.
    - Prevent invasive plant species from growing
    - Prevent erosion
- Create a community board for our restoration site's entrance.
    - An opportunity to educate the community and bring them closer to nature

We received 4 deliveries of wood chip mulch throughout our restoration project, and we applied a 4-6 inch layer of mulch throughout our restoration site, in order to suppress invasive species. We also surrounded the installed native species with individual mulch rings. In Polygon 2, we only mulched along its western edge and along the trail system. In Polygon 1, we installed a mulch buffer zone along its western edge, to protect against the adjacent Himalayan blackberry thicket. The mulch buffer zone was 8-10 inches thick, 4 feet wide, and extended along the entire western edge of Polygon 1.

During the final work party we installed a community board at the entrance to our restoration site, upon which information and announcements can be posted. This community board is designed to encourage community interest, provide information, and foster a sense of place for our restoration site within the neighborhood.

## Major Accomplishments

- Volunteers, guided and helped by our team, removed approximately 5,240 sq. feet of invasive species from the site.
- 184 unique community members volunteered with our project!
- 9 work parties
- We removed 26 compost bins of invasive species, primarily Himalayan blackberry.
- Four mulch piles were delivered and applied to the site.
- 514 plants were installed, including 51 conifers, 22 deciduous trees, 223 shrubs, 140 graminoids, and 78 ground cover plants.
- The entire restoration process was recorded via GoPro and will be accessible through 7 YouTube videos.

# Team Members


# Team Contact Information

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- The neighbors around the site for opening their homes and compost bins
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- Jim Prather for allowing plant salvage on his private property
- King County Conservation District, Plantas Nativa, Four Corners Nursery, Storm Lake Growers, Watershed Garden Works, Derek Allen and the whole SER-UW nursery team.

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# As-Built Report

## Background

### Site Description

#### *Location*

North Creek Forest Restoration Site #6 is located on the eastern portion of Puget Sound in Snohomish County. The project site location is within the City of Bothell, located 2 miles north of the University of Washington - Bothell campus and northeast of downtown Bothell. The project site is located at the end of the stub road of 242nd Street SE. Interstate 405 is located just east of the project site (Figure 3). The project site is part of the Boy Scout Creek and lower North Creek Sub-basin watersheds, which in turn are part of the Sammamish River watershed. The project site is within the North Creek Forest, a 64-acre forest that is a part of both Snohomish and King Counties.

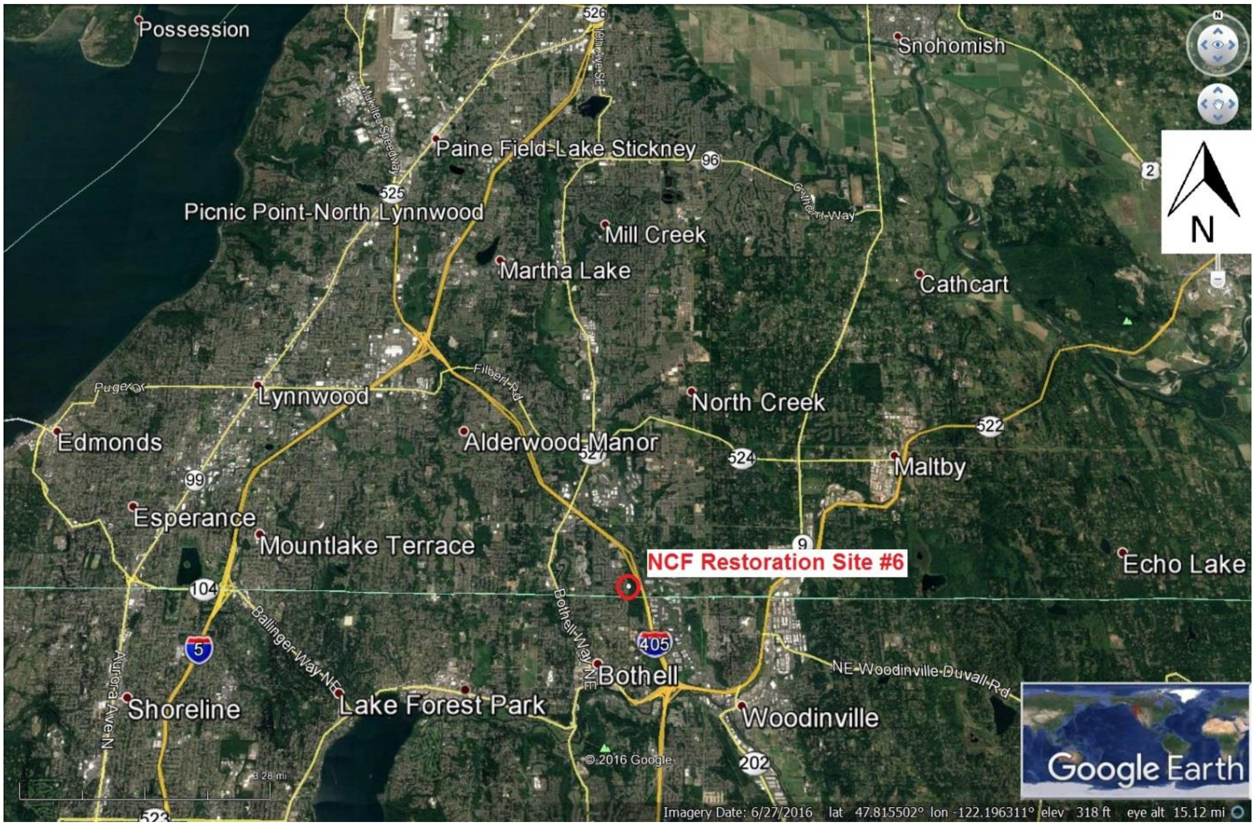


**Figure 3: Placement of project site within Puget Sound.**

## *Site Selection*

North Creek Forest has been the site of UW-REN projects for six years. Restoration sites from previous years have mainly been focused in the southern part of North Creek Forest. This site is in the northern part of the forest along the edge of an urban area. The Friends of North Creek Forest, our Community Partner, hopes to be able to use this site as the beginning of a series of trails throughout North Creek Forest for the use of the community and as teaching and learning tours for local schools and groups.

## *Site Description*

North Creek Restoration Site #6 is approximately 1,500 sq. meters in area with a 191 meter perimeter. The perimeter of the site starts at the edge of an urban area that includes two houses and a stub road leading to a dead end. The project site extends approximately 20 meters into the forest, and approximately 38 meters to each side of the entrance located at the end of the street (Figure 4).

AD1: Our site was expanded to include a seasonal wetland/depression that originally lay outside the southern boundary of Polygon 5, as we believed it would be a valuable microsite to maximize the ecosystem functions of through restoration activities. This addition increased our site's area by approximately 40 sq. meters and is reflected in Figure 11.

The topography of North Creek Forest varies between its northern and southern boundaries. At the northern end, the topography is relatively flat with just a few small hills and gentle declination to the east towards I-405. In comparison, the southern end contains many steep ravines carved by historic creeks and rapid urban discharge from the many housing and business developments in the area. North Creek Forest Site #6 lies just north of these ravines along a housing development. The entrance into the site has a trail with a gentle decline of approximately $8^{o}$ to the flattest area of the site. The area is forested, with a semi-closed canopy, and includes an overgrown trail into the site from the central entrance point and going into the project site approximately 10 meters. The project site elevation varies from approximately 87 meters above sea level at the lowest point, being the northeast corner, to approximately 91 meters at the entrance.

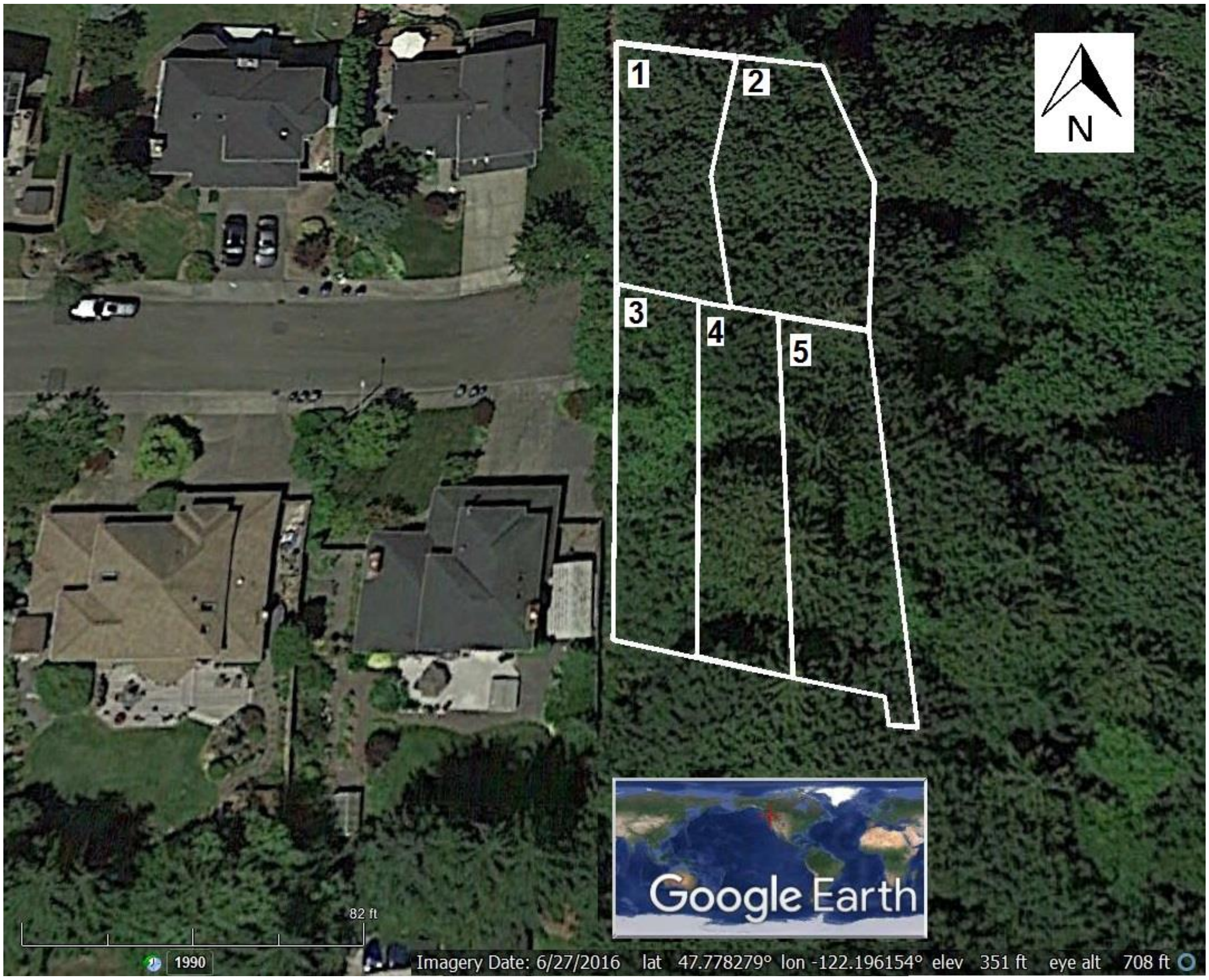


**Figure 4: Polygon delineation of the project site.**

The project site has been divided into five polygons, with divisions based on invasive plant species, trails, native vegetation, and topographic features (Figure 4).

The soil at the project site can best be categorized as sandy loam throughout the site. Moisture levels in Polygons 1 and 3 can become saturated during storm events, as storm water runoff from the urban area to the west runs into the project site. The water table was found at 38 cm in Polygon 5.

Our project site has a partial upper canopy composed of western redcedar (*Thuja plicata*), bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), and Douglas-fir (*Pseudotsuga menziesii*). However, there is very little vertical diversity at the site as the invasive species Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), and yellow archangel (*Lamiastrum galeobdolon*) in the understory have suppressed many native herbaceous, shrub and ground cover species in their domination of the site.

### *Habitat*

Deer, coyote, rabbits, squirrels, salamanders, and a variety of birds, including the northern bobwhite quail (*Colinus virginianus),* have all been seen within the forest according to the residents that live next to the forest. Upland forest regeneration affects the delivery of detritus and invertebrates to the down-land stream (Musslewhite and Wipfli, 2004). Therefore, restoring our upland section of North Creek Forest with native species will help enhance stream fish habitat. Trees such as *A. rubra* that are early successional species and common by streams and disturbed hillsides and can be used to sustain food web productivity after soil disturbance (Musslewhite and Wipfli, 2004). Once we remove the invasive species, *A. rubra* can be placed in our project site to sustain food web productivity until later successional species like *T. plicata* and *P. menziesii* are able to take over. Habitat structure is important in a fragmented system, and having heterogeneity in our landscape encourages native forest species and bird diversity (Donnelly and Marzluff, 2006). During succession of the project site, there is expected to be a lot of diversity in tree canopy heights, providing various nesting and habitat options for songbirds and small mammals. Species such as salal (*Gaultheria shallon*), Indian plum (*Oemleria cerasiformis*), and red huckleberry (*Vaccinium parvifolium*) will also provide berries and fruit for small mammals and birds.

AD2: *A. rubra* was not planted in our site as we determined that there was a great enough presence of this species to continue establishing within the site without restoration intervention. Instead we opted to spend our planting budget on plant species that were not as well represented in the site.

### *Restoration needs and opportunities*

Our site has large dense amounts of *R. armeniacus* and some *H. helix* that choke out native species and do not allow other species to become established. Both species have been known to displace native species and inhibit understory growth (Fierke and Kauffman, 2006). If we want a diverse lowland forest ecosystem to become established on our site, we need to remove the invasive species and replace them with native species. The native species will be compatible with our site and enhance ecosystem functions, wildlife habitat, and diversity. If they are maintained properly, native species will continue to exclude invasive species and ultimately develop into a mature, mixed coniferous-deciduous forest ecosystem through natural succession.

## Tasks and Approaches

**Goal 1:** *Establish native vegetation that will allow for the development of a mature Puget Sound lowland forest community within North Creek Forest.*

**Objective 1.1: Manually remove and suppress existing invasive plant species within the restoration site in an environmentally sensitive manner.**

**Task 1.1a**: Remove invasive species, above and below the ground.

*Approach*: In the case of *R. armeniacus*, *w*e will first cut the stalks and then transport the canes and leaves via buckets onto tarps. We will use loppers to snip the stems about 6 to 12 inches above the ground. Then we will hand-pull the root out. If this strategy doesn't work efficiently or completely, we will use shovels and mattocks to dig the root and root crown out entirely and then move them to the dumpster for Waste Management.

*Approach justification*: Cutting will stunt the growth of *R. armeniacus*, as it will be deprived of its ability to photosynthesize, and also keep them visible for later removal. In addition, with the aboveground bulk of *R. armeniacus* removed, we will able to access its roots far more easily. Root removal is essential, as *R. armeniacus* is rhizomatous and easily spreads and regrows from roots. Removing root balls, roots, and rhizomes is key to preventing regrowth of *R. armeniacus* in our site (SNI).

AD2: *R. armeniacus* and other invasive plant materials were removed from our site using compost bins generously offered to us for use by neighbors of the site. This was recommended to us by FNFC as a simpler and more cost effective option.

**Task 1.1b**: Apply wood chip mulch throughout the site to help prevent regrowth of invasive species.

*Approach:* Apply wood chip mulch to a depth of around 6 inches throughout the entire area where invasive species were removed, with emphasis on *R. armeniacus* removal locations.

*Approach justification:* Mulch used to cover the surface of the soil reduces and suppresses invasive plant species by decreasing light availability (USDA NRCS). Without light, plants are unable to photosynthesize and are unable to acquire carbon for growth. Mulch cover also retains soil moisture and releases nutrients as it decomposes, increasing the fertility of the soil and readying it for new plants (USDA NRCS). This will allow for quicker establishment of native species, which will further shade out the *R. armeniacus* and other invasive species.

AD3: Wood chip mulch application was limited to Polygons 1 and 3, 2-3 feet along the western boundary of Polygon 2, and the trail system - not all throughout the site. Mulching criteria for our polygons was based on the presence of invasive species prior to removal/ risk of re-establishment (Polygons 1 and 3, parts of 2) and the need for erosion control (Polygon 3, trail system).

AD4: Mulch depth ultimately ranged from 4-6 inches for the majority of the site where it was applied, as this range was deemed acceptable by Warren Gold in accomplishing our goal for suppressing invasive species. This also reduced the number of necessary mulch loads and allowed for a margin of error in relative mulch application by volunteers throughout the designated parts of the site

AD5: A buffer area spanning about 3 feet into the site was established along the western boundary of Polygon 1, consisting of both burlap sacks and 8-12 inches of mulch. This was done to limit the re-establishment of *R. armeniacus* from a thicket bordering this polygon on the neighbor's property.

**Task 1.1c**: Plant native species which will limit light availability for invasive species through shading.

*Approach:* Plant native understory species to establish sites formerly occupied by invasive species and plant native tree species to provide canopy cover for the understory plants and shade out invasives. Tree species include *T. plicata* and *T. heterophylla*.

*Approach Justification:* The understory species will grow quickly and reduce light availability for the invasive species, thereby reducing their ability to regrow (Smith, 2007). The tree species we selected do well in sun and in partial shade, which will allow trees to be planted throughout our entire site. As these trees mature, they will provide canopy cover for the understory species, which will continue to shade out invasive species and allow native shade-tolerant species to establish and thrive (Smith, 2007).

**Objective 1.2: Install a structurally and biologically diverse array of native species typical of a Puget Sound lowland forest community, with an emphasis on native conifers.**

**Task 1.2a**: Install native understory plants and tree species to create a varied canopy level suited for successional growth.

*Approach:* Install native understory species such as, Deer fern (*Blechnum spicant), G. shallon, O. cerasiformis*, and *V. parvifolium*. Install native tree species such as *T. heterophylla* and *A. rubra*, to provide canopy cover for the understory species and pave the way for a successional forest ecosystem (Smith, 2007).

*Approach Justification:* Plants will be diverse and provide different ecosystem benefits, ex. *A. rubra* establishes on disturbed soils, and will mature quickly, allowing a native successional environment to develop (Musslewhite and Wipfli, 2004).

AD6: In lieu of *A. Rubra*, native tree species such as P. menziesii, grand fir (Abies grandis), and Sitka spruce (*Picea sitchensis*) were installed to fulfill our objective to emphasize native conifers in the restoration of this site.

**Goal 2:** *Enhance the ecosystem functions of the forest community within the project site and the ecosystem services realized by the local community.*

**Objective 2.1: Establish long-lived, fast-growing native vegetation to maximize carbon sequestration.**

**Task 2.1a:** Plant tree species, with an emphasis on evergreen species, throughout our restoration site.

*Approach:* Plant numerous tree species, such as Sitka spruce (*P. sitchensis)*, *T. plicata*, and *T. heterophylla* in our restoration site according to the planting plan.

*Approach justification:* The large amount of biomass stored in trees and their long lifespans make them ideal for carbon sequestration (Roberts). As *P. sitchensis*, *T. plicata*, and *T. heterophylla* are evergreen tree species, they are longer-lived than deciduous species and will sequester carbon year-round; while the deciduous species will stop photosynthesis during the winter months. By planting a variety of tree species, we will foster habitat diversity and successional processes within our site (Smith, 2007; Tesky, 1992).

**Task 2.1b:** Plant native species in the *R. armeniacus* removal locations.

*Approach:* Install a variety of native deciduous trees, shrub species, and groundcover species in sites heavily disturbed by invasives.

*Approach justification:* Replacing a single vegetation layer with a multi-layer native canopy will serve to increase carbon uptake in addition to serving other objectives such as enhancing animal habitat diversity (Smith, 2007). Native shrubs and groundcovers that compete with the invasive species will deter reinvasion and allow for successional development and maintenance of a multi-layered forest community to maximize carbon sequestration over time (Smith, 2007). In addition, black cottonwood *(Populus trichocarpa),* salmonberry (*Rubus spectabilis),* red osier dogwood (*Cornus sericea*) and slough sedge (*Carex obnupta*) are all fast growing species which will allow for rapid replacement of the *R. armeniacus* patches (USFS). As all plant species sequester carbon, the removal of *R. armeniacus* diminishes our site's total sequestered carbon. Therefore, quickly establishing native species in the removal sites is critical to maintaining and improving upon the carbon sequestration capacity of our site.

**Objective 2.2: Maintain and improve upon the capacity of the forest community to serve as a buffer between storm water runoff from the neighborhood and North Creek, thereby benefiting salmon and other species.**

**Task 2.2a:** Install fascines in Polygon 3.

*Approach:* Dig a bioswale/trench along the western edge of Polygon 3 and install *P. trichocarpa* fascines in it.

*Approach justification:* Polygon 3 receives the most storm water runoff from the neighborhood, which is why it will receive fascines. Fascines root deeply into slopes, which traps soil particles, thereby enhancing slope stabilization (SNP). This reduces the amount of soil erosion on the slope, thus reducing sediment inputs to the North Creek Forest watershed (SNP). Fascines also break up the slope face, slowing the passage of storm water runoff, which provides more time for absorption by the soil (SNP). The deep roots of the fascines also increase soil moisture absorption (SNP). Higher levels of runoff absorption by the soil will decrease the amount of urban pollutants, such as heavy metals, that reach the North Creek Forest watershed. In addition, optimum success with fascines was found with willows or *C. sericea,* in Ohio (Ervin).

AD 7: While fascines including a variety of native species, *P. trichocarpa* included, were installed in our bioswale, the installation specifications we followed per the recommendation of our community partner were incorrect and they did not become established. In place of fascines, the bioswale was live staked with species including Pacific willow (*Salix lucida*), *S. sitchensis*, red osier dogwood (*Cornus sericea),* Pacific ninebark *(Physocarpus capitatus),* and snowberry *(Symphoricarpos albus)* in order to provide some of the same services.

**Task 2.2b:** Install plant species that will enhance our restoration site's ability to filter storm water runoff from the neighborhood.

*Approach:* Install plant species, in Polygons 1 and 3 that grow densely and possess deep root systems, such as salmonberry *(Rubus spectabilis)* and *C. sericea.* Both live stakes and plug plants will be used.

*Approach justification:* Polygons 1 and 3 intercept the storm water which flows into our restoration site, so we are planting in these polygons to improve storm water filtration. *R. spectabilis* has a deep root system which will allow for greater storm water uptake and slope stabilization (Tirmenstein, 1989). *C. sericea* can spread via stolons and will typically form dense thickets or clumps (Gucker, 2012). *C. obnupta* also grows densely and is excellent at nutrient uptake and sediment retention. In addition, *C. obnupta* has a highly rhizomatous root system which will further stabilize the soil and enhance storm water filtration (Hoag, 2002). Water quality will improve due to these characteristics, as the soil on the slope will be stabilized by roots, reducing sedimentary runoff, and harmful pollutants will be absorbed by plants, which can be properly disposed of (SNP).

**Objective 2.3: Create habitat for native fauna to increase the species richness of wildlife within the site.**

**Task 2.3a:** Ensure coarse woody debris (CWD) is available in our restoration site to serve as nurse logs and animal habitat, and that it is replenished by new inputs of CWD at regular intervals.

*Approach:* Assess current distribution and quantity of coarse woody debris in our restoration site. Redistribute or install new coarse woody debris if necessary. Install native species that are consistent providers of CWD, such as *T. plicata*.

*Approach justification:* Coarse woody debris provides food for some insects and animals, and serves as a place for shelter and reproduction (Brown et al. 2003). As such, it should be readily available throughout our restoration site. Replenishment of CWD by trees within our site is ideal, as it will occur in a natural time frame and will not introduce foreign detritus to our restoration site (Brown et al. 2003).

**Task 2.3b:** Plant native species to provide food and shelter for native animal species.

*Approach:* Plant native species that will provide food resources in multiple seasons for a variety of animals, a multi-layered canopy for cover and nesting, and a diversity of structural forms to enhance animal habitat diversity. These structural forms will include evergreen groundcovers, deciduous and evergreen shrubs species, as well as deciduous and evergreen tree species.

*Approach justification:* Installing species such as *R. spectabilis* thickets will provide good nesting sites and cover for a multitude of bird species, and are used by mammals for cover as well (Tirmenstein, 1989). Additionally, increasing the vertical diversity of the site will create a more dynamic and varied habitat for wildlife to utilize as shelter, nesting grounds, food sources, etc.

**Goal 3:** *Develop a sense of place for the site within the community and ensure its continued development into the future.*

**Objective 3.1: Involve members of the local community in restoration activities and establish an enthusiastic base of committed volunteers for future land stewardship with the help of Friends of North Creek Forest.**

**Task 3.1a:** Talk to our CP about using different communication techniques including social media, local newsletters, and flyers.

*Approach:* Talk to our CP about posting regularly on North Creek Forest webpage to teach the community about what we are accomplishing and why. Contact the Bothell Kenmore Reporter to cover a story about the restoration done on our site.

Have a contact phone number and email posted on every communication network that anyone can contact for any questions regarding the forest, restoration work, and any concerns.

*Approach Justification:* Using different outlets of communication could help the community become more involved and interested in our work and become educated about invasive plants occurring in their own neighborhood. It will also reach a wider and more diverse demographic.

AD8: A reporter was contacted through UW Bothell Community Outreach to cover our site and restoration activities instead of the Bothell Kenmore Reporter. This decision was made for means of simplicity as connections had already been established through UW Bothell.

**Task 3.1b:** Promote work parties to maintain volunteer interest.

*Approach:* Post on social media about our work parties and advertise events through volunteermatch.com and local newspaper. We will also receive help from Lake Washington Watershed Internship (LWWIP) high school students and have them take pictures and post on social media. Introducing ourselves to the neighbors and getting to know them, as well as inviting them to our work parties and answering all questions honestly will also be important in fostering good relationships with the community.

*Approach Justification:* Posting through social media will get younger people and their parents involved, as well as people in the community who follow our posts. Using other outlets like the newspaper will help us reach a wider demographic and bring the community together when doing our work parties. Volunteers tend to be present for altruistic reasons, school or work or for social and psychological reasons (Bussell and Forbes, 2001). Our outdoor activities in small groups will be great to meet new people and make a difference that volunteers will be able to see after the work day. Participants are also more likely to be engaged and interested in a project when it is at their front door (Petts, 2007).

**Task 3.1c:** Visit schools and classes within the Bothell area to educate students on what restoration is and to recruit volunteers.

*Approach:* Create a short lesson plan using a backward lesson design with the goal of having students understand what restoration is and how it affects the ecosystem. Open the lesson with an activity and end it with a discussion and questions. Visit classrooms at Canyon Park Junior High and Bothell High School for a short presentation on restoration. We can recruit volunteers that may want extra community service hours.

*Approach Justification:* The backwards lesson design will help us design a short lesson with an effective outcome for students to understand what restoration is (Richards, 2013).

AD8: A lesson plan was created and presented to LWWIP students as part of their introduction to our site and the field of ecological restoration. However, due to scheduling conflicts and time constraints we were ultimately unable to visit Bothell schools and educate students in the way described.

**Task 3.1d:** Get to know community volunteers and foster an interest in restoration.

*Approach:* Introduce everyone at the beginning of the work party and do a short ice breaker. Have people work in small groups and then end with a little feedback about what everyone enjoyed most with the work party. Teach volunteers how to restore the ecosystem and why we are doing restoration, then allow them to do the restoration work in groups under supervision.

*Approach Justification:* Social learning theories suggest people tend to learn better when working in a group and acquiring a new skill (Petts, 2007). Volunteers are more likely to come back if they had a good time and met new people. According to social learning theory, people learn better when learning how to cooperate with others and solve problems together, creating a sense of group solidarity (Petts, 2007).

**Objective 3.2: Develop an aesthetically pleasing natural site that is easily accessible by the local community.**

**Task 3.2a:** Create a community billboard sign to welcome and inform visitors at the trail entrance.

*Approach:* Gather materials to build a community board and have it installed at our last work party. Have volunteers decorate it and have the sign say "This section of North Creek Forest was restored by local community members." with a corkboard for other information and local news.

*Approach Justification:* Artistic design and vivid text is more likely to get people to stop and look at the signage. Narrative, personal anecdotes, images, and humor are all ways of getting people interested in the signage. Sign location and background color also influence how effective signage is (Hall et al. 2010).

**Task 3.2b:** Make our site aesthetically pleasing to members of the community

*Approach:* As succession continues, North Creek Forest can leave pictures on the signage before restoration activities so people can see how the community helped the forest. We can reduce litter and dog feces by redirecting people elsewhere and providing a trash can at the park entrance. Approaching the City of Bothell to provide and service the trashcan will help with trash maintenance on the project site. Creating a habitat favoring the wildlife, birds, and salmon will help increase aesthetic value.

*Approach Justification:* The condition, accessibility, aesthetics, and safety of the park all influence how people use it. Reducing litter and dog feces improves how people view the park and making it a friendly place for nesting birds will increase aesthetic value (McCormack et al. 2010). Poor conditions influence park use, so maintaining and monitoring the site is important.

AD9: No trash can was included in the final site as we were unable to make this arrangement come to fruition with the City of Bothell. Additionally, FNFC determined it would not be a necessary inclusion and that litter pickup could be arranged as part of our management plan.

**Objective 3.3: Develop a long term management and monitoring plan for the site.**

**Task 3.3a:** Finish as-built report

*Approach:* Complete our as-built report by May.

*Approach Justification:* As-built will show what we have accomplished over the year and how we did it. It will be a good reference for future projects in North Creek Forest.

**Task 3.3b:** Create a stewardship plan to give to the Community Partner

*Approach:* Use the relationship we built within the community over our project to inform them of what to expect, how they can continue to help, and who to contact for questions and concerns. Finish our stewardship plan and forward it to our Community Partner.

*Approach Justification:* Informing volunteers of what to expect and how they can continue to help will give volunteers to continue working with North Creek Forest and they can come back and look at how the forest has improved. The stewardship plan will inform our CP of how to maintain and monitor the site once the UW-REN team is gone.

## Specific work plans

### *Current Conditions*

Our project site is divided into five polygons in accordance with the diverse topographical, hydrological, vegetative and canopy characteristics present there, as well as existing trails. Our analysis of soil pits at various locations within the site have shown that soil conditions are relatively consistent throughout, characterized as a sandy loam texture with high levels of organic matter, a significant presence of rocks, and a grey, iron reduced layer at greater depths. Drainage within the site appears to be rather poor, as soil profiles showed gleying at moderate depths in both upland and lowland sites, which is indicative of long periods of being waterlogged. Chunks of concrete and anthropogenic litter are also present sparsely throughout the site, giving evidence to anthropogenic disturbance.

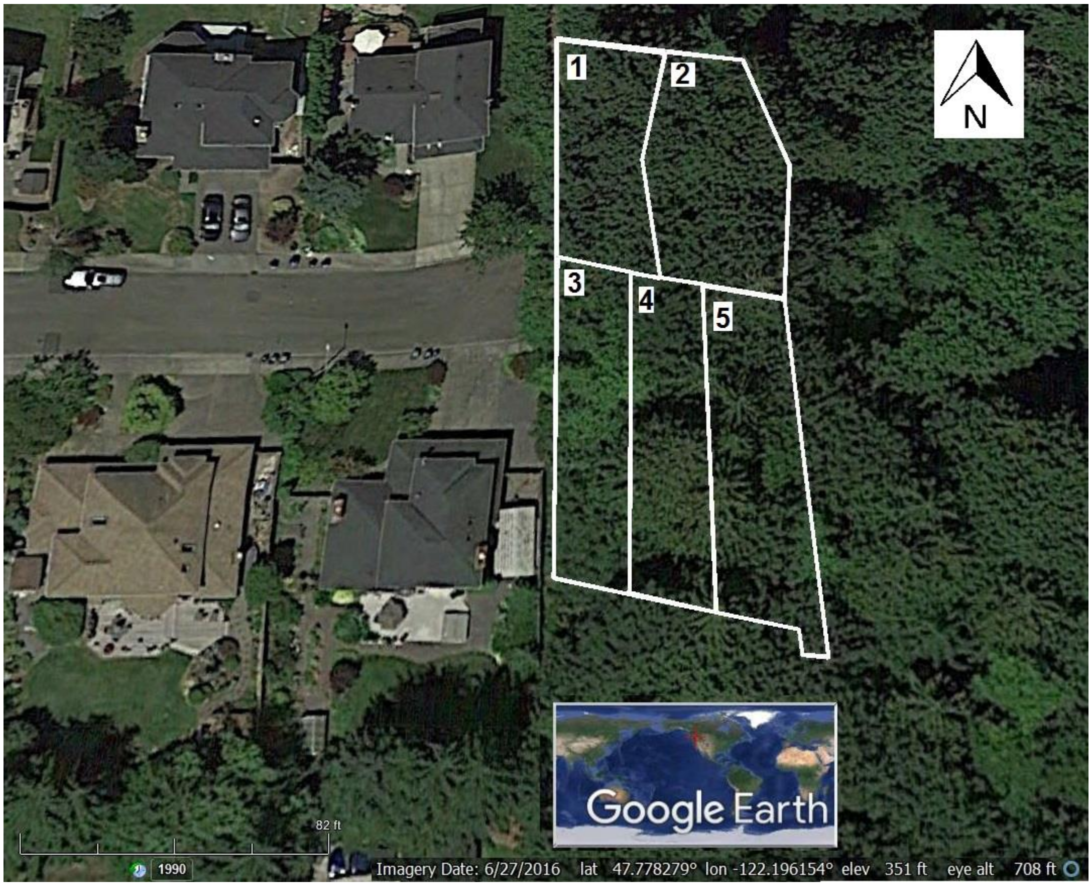


**Figure 5: Polygon delineation of the project site.**

***Site Polygons***

**Polygon 1:** Polygon 1 is the northwestern most polygon, the boundaries of which are delineated by a property boundary to the west, the northern boundary of the North Creek Forest site, the entrance trail to the south, and a north-south running trail to the east. This polygon is notably dominated by *R. armeniacus* and *H. helix* with a moderate abundance of Herb-Robert (*Geranium robertianum)*. There are a few scattered *A. rubra, A. macrophyllum*, and *T. plicata* trees providing partial canopy cover, though gaps allow for a significant amount of filtered and direct sunlight into the area. This polygon has a slight elevation decline of approximately $6^0$ from west to east, with a total elevation decline of 3.4 meters. The proximity to the stub road along the western boundary makes this polygon susceptible to the draining of storm water runoff during heavy precipitation events, and the fairly level topographical gradient suggests it will remain fairly wet following these events.

**Polygon 2:** Polygon 2 is the northeastern most polygon, delineated by the north and east boundaries of our site, the trail extending north out of the site to the west, and a change in vegetative profile to the south from ground cover plants to large, mature *A. macrophyllum* in polygon 5. From west to east, the site is flat with marginal topographical decline, while going north to south there is an approximately $4^o$ decline and an elevation loss of about 1.2 meters. This polygon is characterized by the greatest native species diversity at our site, containing a wide range of ground cover, lower canopy and upper canopy species, the latter of which provides a mostly closed canopy cover that shades the majority of the polygon. *A. macrophyllum* and *T. plicata* are the two most represented upper canopy species, and notably this is the only polygon where Stinging Nettle (*Urtica dioica*) is found in significant abundance within the boundaries of our site. Yellow archangel *(Lamium galeobdolon)* is the most common invasive species here, though it and the others that are present are in fairly low concentration due to shading from the upper canopy.

AD10: Upon closer review of our polygon delineations, *L galeobdolon* was actually largely located in Polygon 5 - not Polygon 2. The most common invasive species in Polygon 2 was *G. robertianum*.

**Polygon 3:** Polygon 3, the southwestern most polygon, is bordered by the edges of the site on the south and west sides and the entrance trail into the site on the north. The eastern edge is delineated by a change in vegetative profile from invasive *R. armeniacus* and *H. helix* to native plant species. This polygon has the highest concentration of *T. plicata* which provides an adequate canopy to suppress invasive species on the southeast quadrant of the plot. However, the proximity to the road allows for a large amount of light to enter from the western boundary, which has facilitated *R. armeniacus* and *H. helix* to dominate much of the site's understory. There are also a few English laurel (*Prunus laurocerasus*). Topographically there is a $7^o$ incline from south to north and a $5^o$ decline from west to east. Also notable is that along the southwest property border there is a moderate slope covered by *R. armeniacus* that will likely need erosion control implemented after the removal of the invasive species.

**Polygon 4:** Polygon 4, the south central polygon, borders the edge of the site on the southern end. In the middle of the polygon runs a trail that travels south into the forest, connecting this site to past UW-REN restoration sites. The western and eastern edges are divided by invasive vegetation profile from *H. helix* to *G. robertianum*, while the northern edge is delineated by the entrance trail. There is a $6^o$ incline south to north, while the east to west slope gradient is mostly flat. The *T. plicata*, *A. rubra*, and *A. macrophyllum*, present here provide partial canopy cover which has limited the presence of invasives to only low concentrations of *H. helix*, *G. robertianum*, and a moderately sized English holly (*Ilex aquifolium*).

**Polygon 5:** Polygon 5 is the southeastern most polygon, and is delineated by the southern and eastern site boundaries as well as vegetative profiles to the north and west. This polygon lies partially in a topographical depression and appears to have the least drainage capacity, as it is the only polygon where we have observed pools of standing water following rain, indicating the presence of a distinctly wet microclimate. There is a $3^o$ incline from south to north, while the topography going east to west is relatively flat. *T. plicata* and *A. rubra* provide partial canopy cover of the site, and invasives are limited to a moderate groundcover of *G. robertianum* and low concentrations of *R. armeniacus* and *H. helix*.

| | Polygon 1 | Polygon 2 | Polygon 3 | Polygon 4 | Polygon 5 |
|---|---|---|---|---|---|
| **Polygon area (m² )** | 287.67 | 288.6 | 509.9 | 478.19 | 326.08 |
| **Soil texture** | Sandy loam | Sandy loam | Sandy loam | Sandy loam | Sandy loam |
| **Soil moisture** | Moist, saturated during storm events due to street runoff | Dry to moist due to cover | Dry to moist due to cover | Dry to moist due to cover | Dry to moist due to cover, Water table at 38cm |
| **Slope** | 6° decline from west to east | 4° incline from north to south, flat from west to east | 7° incline from south to north, 5° decline west to east | 6° incline south to north | 3° incline south to north |
| **Light availability (including seasonal variation and describe over story canopy)** | Direct sun on western exposure after removal of Himalayan Blackberries, mostly open canopy during winter, partially open during summer | Mostly closed canopy year round | Partially open canopy year round, more sun from western exposure after removal of Himalayan Blackberry on northern end | Partially closed canopy year round | Partially closed canopy year round |
| **Present vegetation: species & general abundance (including native and nonnative)** | Figure | Figure | Figure | | Figure |
| **Human impacts** | Housing along the western edge, partial trail along southern edge, used for dumping at one point | Trail along western edge | Housing along the western edge, used for dumping at one point | Trail along eastern edge | Trail along western edge |
| **Other considerations** | Proximity to street means this section is influenced by storm water runoff | | | | |

**Table 1: Pre-restoration polygon specifications.**

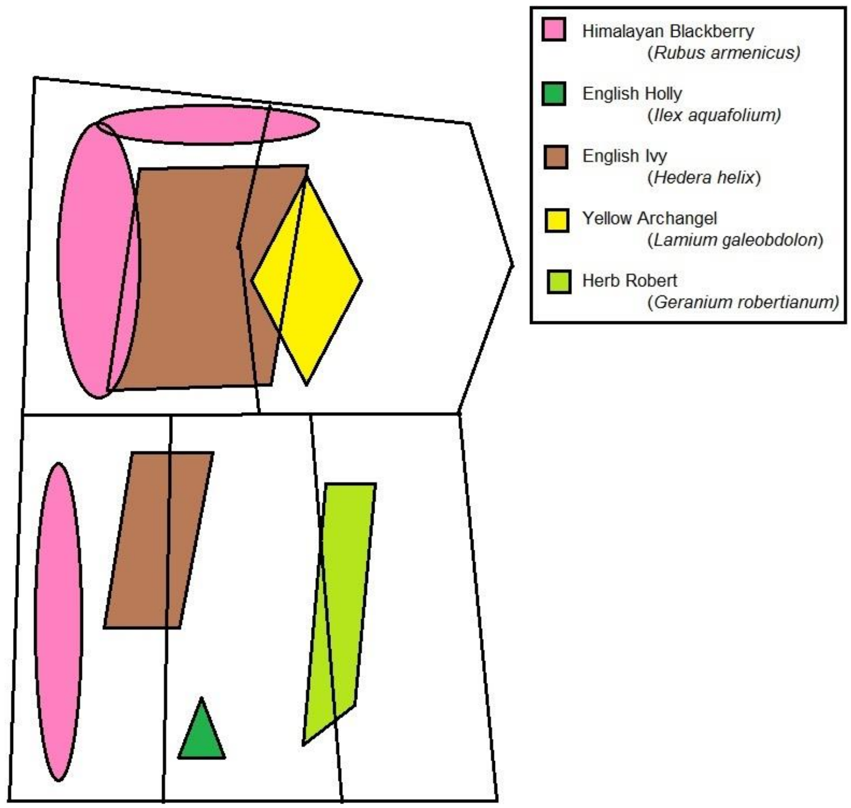


**Figure 6: Pre-restoration placement of invasive species.**

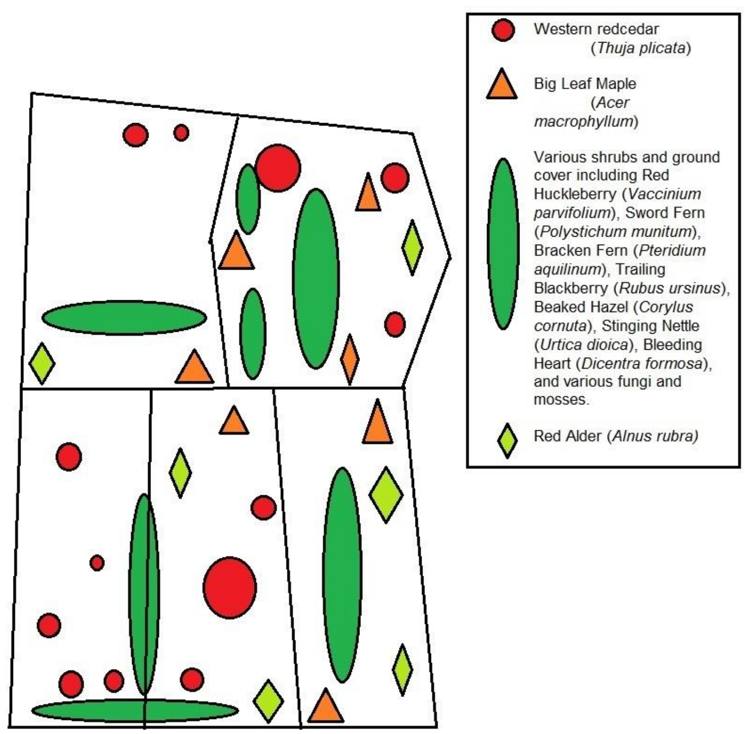


**Figure 7: Pre-restoration placement of native species.**

***Native and Invasives Distribution***

**Polygon 1:** This is the most heavily disturbed polygon in our site in terms of invasive species dominance. While there is a partial canopy composed of scattered native *A. rubra*, *T. plicata* and *A. macrophyllum*, large seasonal gaps in the canopy and proximity to the road/ residences on the western boundary allow ample sunlight to enter the polygon. As a result *R. armeniacus*, *H. helix* and *G. robertianum* have been allowed to dominate the understory and have largely suppressed native species and limited structural diversity within the area. Though there are some isolated patches of native herbaceous species, namely Bleeding Heart (*Dicentra formosa*), Trailing Blackberry (*Rubus ursinus*), and Piggyback plant (*Tolmiea menziesii*), they are all found in low concentrations. There is, however, a large concentration of *O. cerasiformis* along the eastern boundary of the polygon.

**Polygon 2:** Polygon 2 encompasses the greatest native species diversity within our site, with 12 plant species that include understory *D. formosa*, *P. munitum*, and bracken fern (*Pteridium aquilinum*), mid-level trees *O. cerasiformis* and vine maple (*Acer circinatum*) and mature *T. plicata*, *A. macrophyllum*, and *A. rubra* trees which provide varied structural diversity as well. This is also notably the only polygon within our site that contains a substantial amount of *U. dioica*, which exists in a large patch beneath the shade of one of the *T. plicata*. The mature trees provide ample canopy cover and shade to support native ground cover species, and have restricted invasive species to only a moderate sized patch of *G. robertianum* and scattered *R. armeniacus* and *H. helix*.

**Polygon 3:** Polygon 3 also shares a western border with the road and receives large amounts of sunlight as a result of this and a relatively sparse seasonal upper canopy of *A. rubra*, *T. plicata* and *A. macrophyllum*. While some native ground cover species exist on the site (*R. ursinus, P. aquilinum*, *P. munitum*) they are sparsely distributed and far outnumbered by *R. armeniacus, H. helix and* evergreen blackberry (*Rubus laciniatus)* which largely dominate the site.

**Polygon 4:** Polygon 4 is the least impacted by invasive plant species within our site, with only a low concentration of Herb Robert and a single, mid-sized English holly (*Ilex aquifolium*) tree. This is largely due to the relatively dense canopy cover created by *A. macrophyllum, A. rubra*, and a number of *T. plicata* - including the largest within our site. In terms of native ground cover and woody shrubs, our site contains *V. parvifolium, P. munitum* and beaked hazelnut (*Corylus cornuta*).

**Polygon 5:** Polygon 5 has a partial upper canopy composed of *T. plicata*, *A. macrophyllum,* and most notably *A. rubra* - which has in part allowed a relatively large number of native groundcover and woody plant species to become established here and develop a varied structural diversity. Mid-sized woody species include *O. cerasiformis* and *V. parvifolium* while groundcover consists of scattered *P. munitum, P. aquilinum, D. formosa, C. cornuta* and *T. menziesii*. In terms of unique native species, this is the only polygon to contain Oregon grape (*Mahonia nervosa*). Invasives species are mostly limited to a moderate patch of *G. robertianum*. Notably, there is a large *P. laurocerasus* located in this polygon within a patch of *T. plicata*.

***Site Preparation Plan***

**Polygon 1:** Polygon 1's proximity to the road on the western boundary of our site allows a significant amount of light into the site, which has allowed *R. armeniacus* and *H. helix* to flourish here. We plan to manually remove *R. armeniacus*, *H. helix* and *G. robertianum* from our site and proceed to cover the entire polygon with a minimum of 6 inches of wood chip mulch. This will remove the majority of the invasive species biomass from the polygon and serve to suppress the remaining below ground biomass by denying it light. Additionally, the mulch will serve to encourage the growth of native species we will plant by decreasing competition with weeds, moderating soil temperatures and moisture (Maggard et. al, 2012). We will also implement a 2-3 foot wide buffer of 8-12 inches of wood chip mulch alongside the western side of the polygon that borders the neighbor's property line and a dense thicket of *R. armeniacus.* This buffer zone is designed to suppress the highly invasive species there and prevent it from recolonizing our polygon.

AD10: A minimum of 4-6 inches of wood chip mulch was used to cover Polygon 1 as conversations with Warren Gold and FNCF both indicated this range would be adequate and would require fewer mulch deliveries.

**Polygon 2:** Polygon 2 benefits from having a relatively dense canopy cover, so the presence of invasives is not nearly as prominent as in other polygons. We plan to manually remove the existing patches of *G. robertianum*, *L. galeobdolon*, *R. armeniacus* and *H. helix* as the main site maintenance activity. In addition we plan to apply 4-6 inches of wood chip mulch along the western boundary of the polygon shared with Polygon 1 where *H. helix* and *G. robertianum* are the most prominent in order to suppress their potential recolonization of the area.

**Polygon 3:** Polygon 3 shares the same issue as Polygon 1 in high light volume associated with a partially open canopy and proximity to the road. Additionally, Polygon 3 receives the most storm water runoff from the road as the storm water drain close to its western boundary is frequently clogged so storm water floods into the site, washing potentially hazardous compounds into our site. In order to mitigate this, we plan to implement a small bioswale at the western boundary of the polygon that will utilize a variety of willow stakes in a combination of live staking and fascines to establish more shade in the site and filter storm water runoff from the street. We plan for the bioswale to be 2 feet deep and approximately 6 feet across, allowing storm water to percolate there and filter out pollutants before spreading to the rest of the site. We will also manually remove *R. laciniatus*, *R. armeniacus*, and *H. helix* and mulch over the polygon to further suppress these species and facilitate the growth of our native installations. Washington's Department of Natural Resources (DNR) is tentatively planned to remove the *P. laurocerasus*.

AD11: The final dimensions of our bioswale were 2 feet wide , 8 feet long and 1 foot deep. These changes were made after consulting Warren Gold to maximize the survivorship of our installments in the bioswale (depth), as well as to catch runoff from a greater portion of the street (length).

AD12: Washington DNR did not remove the *P. laurocerasus* from our site, and we do not believe we have the means to do so manually. Our community partners suggest future removal will likely have to involve professional herbicide injection.

**Polygon 4:** Polygon 4 is unique in containing an invasive mid-sized *I. aquifolium* that is too large to be removed manually. We have an arrangement with DNR to treat the tree with an herbicide injection in order to kill it, with plans to plant and mulch around it following this event. Additional site preparation will include the manual removal of small *G. robertianum* patches.

**Polygon 5:** Polygon 5 will require the manual removal of *G. robertianum*, *R. armeniacus* and *H. helix*. However, due to the relatively closed nature of the canopy we believe there is ample shade to facilitate the growth of our native plant installations and suppress the resurgence of invasives without mulching.

## Logistical Considerations

### *Entrance Points*

Our site is located in the North Creek Forest in the City of Bothell, bordering a stub road, 242nd ST SE, and the properties of several homeowners. A pre-existing trail connects the end of the stub road to the middle of our site, then branches out in a fork that splits the trail north and south into the forest through our site, connecting our restoration project to the sites of previous UW REN Capstone groups. The trail is largely unused and has become overgrown, though anthropogenic debris throughout the site indicates it still receives some level of use. The trail leading from the stub road leading into the site is our only true access point into the site, and as a result our work parties will be centered at the end of the stub road, as per the suggestion of our community partner.

### *Staging Area*

During work party events, our registration and food and drink tables, portable restroom, and a large cover tent will be staged at the end of the stub road bordering the western edges of Polygons 1 and 3. This site was chosen for its proximity to the entrance point, convenience for delivering materials, and will not interfere with neighbors' ability to enter or leave their driveways. Tools and buckets will be staged on the boundary of Polygon 1 to the north of the coverage tent. Tools and gloves have been supplied by the University of Washington's Center for Urban Horticulture and FNFC.

### *Potential Area Disturbance*

There are, however, potential problems with using this entry point and path in the future. The freshly restored site may be compromised due to human traffic causing damage to the recently planted native species. To prevent this, the entry point and pathway into the main trail (middle of our site) will be temporarily defined using mulch and woody debris to prevent disturbance. Furthermore, dense planting of tall shrubbery will be utilized along the pathway to further contain foot traffic to the pathway.

To reduce the impact, disturbance, and disruption of our site, this single entry and pathway will be highlighted and utilized as an entrance into the site. Being located at the end of a stub-road with a traffic barrier, there is risk for the public to continue using this area to dump their waste. The stub-road is moderately used, with a steep slope into the entry point of the site. This directs all the storm water from the hill towards the drains located at the entry point of our site. Aside from the pollutants in the storm water, there is potential for exotic and invasive species seeds to be reintroduced throughout our site. The invasive seed reintroduction can also happen through foot traffic and contaminated soils. To decrease the possibility of introducing invasive seeds into the site, we will be advising volunteers to clean their shoes and clothing before and after all volunteer events.

Additionally, our activities at the site will undoubtedly cause some degree of noise and spatial disturbance to the homeowners at the end of the street where our activities will be centered. To minimize these impact on homeowners we have designated parking areas along $26^{th}$ Ave SE as well as $242^{nd}$ Pl SE (Figure 4) to refrain from congesting 242 St. We will continue to organize work party times to be between 10 am - 2 pm on Saturdays to avoid disturbing members of the community too early or late in the day. We have also spoken with one of the homeowners whose property borders Polygon 1 to leave a patch of *R. armeniacus* on their side of the property line, as they enjoy picking the berries during the summer months when they fruit.

### *Staging Area for Mulch*

Mulch will be delivered and deposited at the end of the road adjacent to the entry point. This area was chosen for the accessibility and convenience of mulch delivery and proximity to the staging area on the northwestern edge of Polygon 3 (Figure 4). Staging mulch in this area until it is ready to be used does not impede or interfere with trail-users of North Creek Forest Park. We expect to use this space for storing and staging of other restoration materials corresponding to plants and burlap sacks. Any other supplies to be delivered to us, including tools and portable restrooms will use 242nd ST SE as a delivery point and will be temporally staged at the end of the stub road at the boundary of our site, out of the way of residents' driveways and parking spots.

### *Cold composting*

Cold composting of *R. armeniacus* will occur in two designated areas in Polygons 1 and 3 on tarps provided by Friends of North Creek Forest. These cold compost staging areas hold a moderate density of *R. armeniacus* and will serve as a placeholder for woody biomass to stay on our site until we are able to dispose of it. Neighbors have generously allowed us use of their compost bins, which we will use to slowly remove *R. armeniacus* from the site at each work party event.  These zones were designated for cold composting as they conveniently offer a short carrying distance to the entrance point for biomass removal and are located in sparsely vegetated areas of the site.

AD13: Cold compost piles were staged in two areas of Polygon 1 as the density of *R. armeniacus* was much higher there than in Polygon 3. Additionally, Polygon 3 had a steeper slope and fewer open spaces that could be used for cold composting.

## Planting Plan

**Polygon 1:** The long-term goal of this polygon is to establish a conifer-deciduous mixed forest. Currently, Polygon 1 already contains established adult *A. rubra*, *A. macrophylla, and T. plicata*. These trees provide some shade throughout the year, more so during the spring and summer months when they have a full canopy of leaves. However, there will still be some direct sunlight throughout the year through western exposure. *P. menziesii* will be planted along the northwestern corner and the western edge, where more sunlight is available and the soil drains more efficiently given the slope. Using plugs as our source, four *P. menziesii* will be planted in a staggering fashion (Figure 8) using the recommended 10-foot centers (Eversole, 1955). Using the suggested 6-foot centers two *T. heterophylla*, which are more shade tolerant, will be planted in the middle of the site (Figure 8). This species will thrive in the shadier areas of this polygon, enabling them to grow tall and aid in shading-out invasive species in the future (Task 2.1b). Both species will be planted out as 10-12-inch nursery plugs. These coniferous tree species are well known in providing cover and habitat for native wildlife (Moore, 2002) (Task 2.3b). Three *P. sitchensis* will be planted between the canopy gaps at 10-foot centers (Figure 8).

AD14: *A. grandis* and *P. sitchensis* were installed in place of *P. menziesii* in the aforementioned description. This decision was made to increase the species diversity of our site, as neither of these other coniferous trees were present initially, and for budgetary reasons as they were cheaper to order.

AD15: 8 foot centers were used in distributing *A. grandis* and *P. sitchensis* as literature we found suggested that concentrations would be better suited to these species. Staggering was carried out as described in the Work Plan.

The property owner that lines this polygon on the western edge is partial to the Himalayan blackberry bushes on their property and we were unable to remove them. This increases the necessity for dense planting of understory and groundcover plants. White willow (*Salix alba*) is highly adaptable in terms of soil and light conditions, and will add to this diversity in plant communities and wildlife support (Favorite, 2002). A total of 4 will be planted at 3-foot centers. *O. cerasiformis* tolerates mild to moderate shade and prefers moist to wet soil conditions. This makes them good candidates for the moister area(s) between polygon 1 and 2. Three will be planted in a staggered effect at 3-foot centers in the form of bare-root plants. *C. sericea* is an easy plant to establish in disturbed soil (Stevens and Dozier, 2002) and prefers moist soil and tolerates mild shade. There is adequate lighting in the west-center of the polygon. 2 will be planted in this area at 4-foot centers with other plants going in-between. It will grow quickly and provide cover and food for birds and smaller mammals. Sitka willow (*Salix sitchensis*) and Pacific willow (*S. lucida*) prefer moist soil and moderate sun with tolerance to small amounts of shade. Along the western border and northern, 4 (Figure 8) of each species will be live staked. The quick-to-grow root mass will aid in the retention of soil during the rainy season and the canopy density of this species will aid in the suppression of invasive.

AD16: Not enough *S. albus* was recovered at salvage events to be planted in both this polygon and other parts of the site where we had planned, so it was ultimately not included in Polygon 1. It was replaced in the planting plan with serviceberry (*Amelanchier alnifolia*) that we received through another UW REN team.

*B. spicant and D. expansa* do well in moist soil and shaded forests. They will be used to increase groundcover diversity (USDA, 2002)(Figure 8) as well as aid in the density of understory coverage. We will plant 8 of each species depending on size. It is expected to acquire these plants through salvage events. At minimum, 4" pots with 3-foot centers (Figure 8). *P. munitum* does well in moist soils and partial shade. However, when established, does tolerate sunny and dry conditions. 6 will be planted from salvaged and reclaimed plants with a minimum size of 4" pots. The recommended distance for this species is 3-foot centers (Figure 8). Again, as many of these plants as possible will be salvaged plants from reclamation events.

AD17: No *B. spicant* or D. *expansa* were included in our plantings as we had intended to recover them from salvage events but were ultimately unable to do so. We instead opted to plant *P. munitum* in their places as it fills a similar niche and was performing very well on the site.

**Polygon 2:** Currently, Polygon 2 contains established *A. macrophylla, A. rubra, and T. plicata.* These trees provide dense shade and canopy coverage of approximately 70%. During the spring and summer months, sun exposure will be moderate due to the gap(s) in polygon 3 from the west and mid-day sun. In these areas, (Figure 9) in the middle of the polygon 2, one *P. menziesii* will be planted at the recommended 10-foot center (Eversole, 1955) Given the amount of canopy coverage in Polygon 2, *T. heterophylla* will be where majority of conifer introduction comes from. *T. heterophylla* prefers dense shade, a total of 4 will be planted with 6-foot centers. They will be planted in a staggering effect (Figure 9) along the topographical highs-and-lows. This will aid in creating a staggered mid canopy as the trees grow. There is a small area where *R. armeniacus* grows (Figure 9) where one of the *T. heterophylla* will be planted to add more shade and aid in invasive species suppression. Both species are well known in providing habitat coverage for native wildlife (Moore, 2002) *T. heterophylla* is known for its symbiosis and mycorrhizal function with many edible fungi species, including chanterelles (*Cantharellus cibarius)* (Dunham, O'Dell, Molina, 2006). A total of two *P. sitchensis* will be planted along the staggering canopy gaps at a minimum of 10-foot centers to aid in coniferous density and diversity (Task 2.1a).

We will plant 6 *C. sericea* in the wetter areas of the polygon using live stakes. The recommended distance is 4-foot centers. This species grows well in disturbed soil and possesses soil-binding properties that will aid in the suppression of the invasive Yellow Archangel known in this polygon (Stevens and Dozier, 2002). It will also provide food and coverage for wildlife, while aiding in the diversity of this polygon (Stevens and Dozier, 2002). Orange honeysuckle (*Lonicera ciliosa)* will be planted along the western edge of polygon 2 where more dappled sunlight is available. A total of 2 plants will be planted on opposing end of the polygon (Figure 9) from nursery 10" cones. *L. ciliosa* is known for providing coverage, dense vining, food, and active pollination sites for many native birds and especially insects/invertebrate species (Task 2.3b). Utilizing the many downed logs and branches on the site, we can create a micro-habitat that is preferred by *V. parviflorum* (Termenstein, 1990). 1 nursery grown 24" plant will be planted on the northern side, adjacent to the large, established *T. plicata*. In this area, there is dappled to dense shade, moister soil conditions, and acidity in the soil that *V. parviflorum* prefers (Termenstein, 1990). This will be planted to continue our goal of diversity (Task 1.1c) as well as create habitat structure for small mammals and birds(Task 2.3b) and supplying a food source for the aforementioned (Task 2.3b).

AD18: *C. sericea* was not planted in Polygon 2 out of concerns posed by FNCF that the canopy cover in the spring and summer would be too dense in that area for it to perform well. We instead decided to prioritize installations of *T. plicata* and *T. heterophylla* in this polygon on account of the ample canopy cover.

AD19: L. ciliosa was unable to be recovered from plant salvages and was not easily available from local nurseries, so it was not included in our site. Planted in its place were species ranging such as baldhip rose (*Rosa gymnocarpa*), *R. parviflorus*, and *V. ovatum* as they provide pollination opportunities/ food source for wildlife as well.

To create a densely-planted ground cover to suppress invasive species (Task 1.1c), *D. cespitosa* will be planted. A total of 10 plug plants planted at recommended 2-foot centers will be planted along the trail and western edge of polygon 2. This grass species grows wide, spreads quickly through rhizomes and tolerates mild amounts of shade. The use of this grass species will also help keep trail-users on the path because it grows to approximately three-feet. 10 Oregon oxalis (*Oxalis oregana)* plugs will be planted in 2-foot centers. The use of this species will form a dense groundcover competing with invasive species (Task 1.1c). *B. spicant* is another ground cover that we will be planting. This native fern species thrives in shade, moist soils, and large amounts of organic matter. We will be planting 6 around the northern side and western edge where the moisture content and detritus amount is higher, at the recommended 2-foot centers (Figure 9). Similar to *B. spicant,* alpine buckler fern *(Dryopteris expansa)* is another native fern species that prefers moist soils, however, more on the acidic side. We will be planting 6 around the northeastern side and southeastern side, adjacent to *T. plicata* where the soil will be more acidic. We will be planting them at 3-foot centers give their larger size. All of our fern species will come from reclamation events. To aid in diversity and introducing native plant species into our site (Task 1.2a), 2 nursery 4" container western rattlesnake (*Goodyera oblongifolia*) will be planted along the base of the north and south *T. plicata. G. oblongifolia* are native terrestrial orchids that thrive under moist, well-draining soils offered by many coniferous species (Pojar and MacKinnon, 2004). They can tolerate many levels of shade and will do well in our site. All the while offering diversity and adding species that would not establish itself into our site for many years.

AD20: *D. cespitosa* was ultimately not included in Polygon 2 as there was adequate native species groundcover, namely fringecup (*Tellima grandiflora*), along the side of the trail to suppress the majority of invasive species. Additionally, the growing patterns of this grass were determined to be a poor fit for this location.

AD21: As in Polygon 1, no *B. spicant* or D. *expansa* were included in our plantings, as we had intended to recover them from salvage events but were ultimately unable to do so. We instead opted to plant *P. munitum* in their places as it fills a similar niche and was performing very well on the site.

**Polygon 3:** This polygon is the most disturbed of the entire site. The goals associated with this polygon are to establish a mixed conifer-deciduous forest community, attract wildlife, and assist with the filtration of storm water runoff. Approximately 50% of this polygon will require revegetation. Currently, there is a single established *A. rubra* as well as established *T. plicata, A. rubra, and A. macrophylla* in the southern half. Four 18”-24” plug *P. menziesii* will be planted at 10-foot centers across the northern half of the site (Figure 10). 2 more will be planted along the southern half. The same plug method will be used for *T. heterophylla* with a total of 4 plants with 6-foot centers being planted in the southern half where it is shadier, and 2 in the northern half behind areas where we will be densely planting (Figure 10). Within the lone *A. rubra*, in the north half of the polygon, cascara buckthorn (*Rhamnus purshiana*) will be planted. It tolerates shade, does well in moist soil conditions, and is often found near *A. rubra* (Harrington, 1996*).* 2 will be planted from 12”-18” bare root plugs at 4-foot centers, to create and assist with a mid-level canopy.

The north half of Polygon 3 borders the stub road of 242nd St. This road is a hill, where all of the storm water from above is being directed towards the storm drains near our site. It was observed on a rainy day that these drains are often clogged with organic debris and trash, ultimately pushing the overflowing water directly into our site. Over time, this disturbance introduces exotics plant species, invasive species, heavy metals and toxins from vehicles, and other hazardous materials while also causing soil erosion. Along this area (from the entry point through the width of the road) we will be planting fascines that will incorporate *S. sitchensis, R. gymnocarpus, S. lucida, R. spectabilus, S. alba, and C. sericea.* These are species that are known to live stake well, form dense root masses, and aid in soil amendment (Darris, 2002). The goal is to create a dense enough root mass to slow down the water and give it time to filter before percolating into the rest of the site. These plants will also offer dense shade and aggressive competition to suppress any potential invasive species. In addition, 25 bare-root *C. obnupta* will be planted in 2-foot centers (Figure 10). *C. obnupta* is known for its ability to establish in shady conditions and will compete with potential invasive species.

The fascines will be created from freshly collected live stakes of the aforementioned species. They will be wrapped in twine (since it is readily biodegradable) with a random assortment of each species. A small ravine will be dug and the fascines will be placed end-to-end. Ultimately, we will be creating a small bioswale. An area with a slight topographical depression and angled sides where water is able to flow through instead of over. It allows for percolation instead of spreading of the water. This is important when taking the toxins and other environmental risks into consideration (Task 2.2b).

AD22: As described previously, our efforts to implement fascines into the site were ultimately unsuccessful due to improper burial techniques. However, live stakes installed into the bioswale will serve many of the same purposes - such as removing impurities from storm water, creating shade for native species, and increasing slope stability.

The rest of polygon 3, behind the bioswale, will be comprised of many more species. We will plant *R. nutkana*, red elderberry (*Sambucus racemosa*), *and R. parviflorus* at 4-foot centers. These plants will come from nurseries as bare root plants from 18”-24”. The purpose of planting these plants will be to provide coverage, construct a mid-level canopy, and provide food and habitat for native wildlife and invertebrates (Task 2.3b)(Figure 10). These plants grow quickly and will shade out and compete with potential invasive species (Task 1.1c). Using more of the fallen logs and branches, we will create guides along the entry point and trail into our site (Figure 10). They will also be used to create habitat for *V. parviflorum* (Figure 10). *T. trifoliata and T. grandiflora* will be planted at the recommended 2-foot centers to also aid in invasive species suppression. They will be planted along the trail to deter trail-users from stepping off the path and at various points in the middle of the northern half of the polygon. These species are known for their quick growth, growing both tall and wide. These plants will be acquired through reclamation events. *O. oregana* will be planted in between the other tall plants. It tolerates shade, and requires moist conditions. With the dense plantings, we will be able to provide shade and aid in water retention, once established. The *O. oregana* will aid in filling out the groundcover and suppress invasive species (Task 1.1c). These plants will be nursery plants in plug form and planted at 2-foot centers in between the other plants. *B. spicant*, *P. munitum, and D. expansa* will be planted at 3-foot centers from reclaimed plants to provide a dense understory planting as well as shade to suppress invasive species (Task 1.1c).

AD23: *T. trifoliata*, *T grandiflora*, *B. spicant* and *D. expansa* were all intended to be recovered from salvage events but were not available. However, species such as cascara *(Rhamnus purshiana)*, *M. nervosa*, *G. shallon*, and *O. cerasiformis* were able to be recovered at these events and were used to fulfill the intended purposes of shade creation, defining trails and providing food sources for wildlife.

The southern half of polygon 3, along the buffer zone between the homeowners and the forest, will be planted with: *O. oregana, P. munitum, M. aquifolium, G. shallon,* and *S. racemosa.* These plants will provide shade to suppress invasive species as well as aid in soil retention and stabilization on the hill.

**Polygons 4 & 5:** Polygons 4 & 5 are similar. Currently, they both contain established *A. rubra, A. macrophylla, and T. plicata.* The invasive species within these polygons are few (and small) patches of *R. armeniacus,* one lone stand of *H. helix,* and moderate amounts of *G. robertianum.* Both polygons offer approximately 75-80% canopy coverage. The goal of these polygons is to aid in diversifying plant species and habitat communities (Task 2.1a). 4 *T. heterophylla* will be planted in each polygon at 6-foot centers (Figure 11). These plants prefer shaded areas and moist soil conditions, both of which are available within these sites. *T. heterophylla* will provide coverage and for many bird species and is known for its mycorrhizal symbiosis with many edible fungi species. One *T. brevifolia* will be planted adjacent to the topographical depression (Figure 11) in polygon 5. These plants prefer moderate shade and wet soil conditions. At this location, a small vernal pool forms during the wet seasons of spring and fall/early winter. *C. sericea* will be planted at the recommended 4-foot centers with live stakes. We will use a minimum of two in Polygon 5 in the wetter areas of the site (Figure 11). These shrubs will offer food and coverage for many wildlife species.

AD24: The allowable collected amount of *C. sericea* live stakes was less than we had expected. This resulted in us preferentially using the *C. sericea* in the fascines and live stakes of Polygon 3, to assist with the bioswale. Other more shade-tolerant species, such as *R. spectablilis*, *R. parviflorus*, and *V. parvifolium* were used in other polygons to supplement the loss of *C. sericea*. In addition, it was determined that Polygon 4 is not wet enough to support *C. sericea* live stakes.

*O. oregana*, *D. expansa*, *B. spicant, and C. obnupta* will be used to support the deterrence of off-trail walking. They will line the trail in between polygons 4 and 5, while at the same time, providing shade to suppress invasive species, and compete with the *G. robertianum* (Figure 11).

We will also utilize the rest of the fallen logs and branches to contain trail-users. In these areas, habitat will be created for planting of *V. parviflorum.* We will plant 2 in each polygon (Figures 8-11) along the trail in shady habitats using nursery stock 1-gallon container plants. *G. shallon* will be planted using reclaimed plants at 2-foot centers throughout the sight to support the groundcover and understory. *L. ciliosa* be planted using 10" cones adjacent to the *A. rubra* in areas of brighter light during morning and afternoon sun (Figure 11). *L. ciliosa* is known to be a strong pollinator and nectar resource for many insects and hummingbird species. One will be planted in polygon 4 and two will be planted in polygon 5. Western trillium (*Trillium ovatum*), if easily accessible, will be used to add diversity and aesthetics in the moister areas of polygon 5 (Figure 11)(Task 1.2a). *G. oblongifolia* will be planted from 4" pots underneath the established *T. plicata,* with two being planted in the moist and well-draining area on the northwestern corner of polygon 5.

AD25: *R. gymnocarpa, V. parvifolium*, *M. nervosa*, *R. spectabilis*, and *A. dioicus* were actually installed to deter off-trail walking. We did not use what was listed due to obtaining plants that were salvaged from other places and nursery availability.

AD26: *L. ciliosa* was not installed, as the nurseries had no stock available. *V. parvifolium* and *R. parviflorus* were installed as a replacement.

AD27: *T. ovatum* was not purchased, as the price was too expensive for our project budget.

By planting a variety of shrubs, herbaceous, and tree species, we will support the succession and aid in the diversity of plant and wildlife communities (Task 2.3b). *P. menziesii and T. heterophylla* will provide seeds that are eaten by birds and small mammals. Their foliage provides a food source for many invertebrate species and their larvae (Tesky, 1992), while also providing coverage and nesting habitats. The flowers and fruit of *G. shallon, L. ciliosa, O. cerasiformis, C. sericea, S. alba, A. alnifolia, and M. aquifolium* are eaten by birds and various wildlife. Pollinators including native bee species and hummingbirds rely on these species for their nectar (Tirmenstein, 1989).

Note: It is essential that we note the planting recommendations in the aforementioned are relative and suggestions to densities at which we ought to plant. Plants at this restoration site will more than likely be planted closer to each other. This is because we will be taking mortality into consideration during our planting and also the counting of plant representatives per species, with higher emphasis on the live stakes. It is expected that the increased density will help reason for plants lost during the project.

## Education and Outreach Plan

### ***Outreach Plan***

We will get volunteer interest through sites like volunteermatch.com and by posting on social media and the North Creek Forest webpage. We will also talk to the local Bothell paper to do a story on our progress at the end of March. We will be open to communication with the neighbors and always inform them with what is happening at our site and invite them to participate in some of the restoration activities with us.

We will talk to our FNCF about schools in the area that have participated in restoration events at North Creek in the past, then send an email to the Principal of Bothell High School and Canyon Park Junior High to see if there is any interest among teachers to arrange trips to our site. Once we receive responses we can work one on one with those teachers for a designated time to present our presentation. We should continue doing presentations to get people interested in our work parties through April.

AD28: Due to a lack of time and resources, we did not arrange presentation with local schools. Instead, we leaned on FNFC for outreach assistance with the Bothell community.

***Presentation Plan***

We will create a 20 minute presentation defining ecosystem services, ecosystem function, succession, invasive species, and watersheds to help students understand what restoration is and why we do it. At the end of the presentation we will do a watershed activity where students crumple a piece of paper, smooth it out, and draw lines along the edges to show the network of a watershed and how everything's connected and affects each other.. At the end of the activity we will have time for questions and a discussion between students to understand their thoughts on what restoration is and why it is important.

AD29: This presentation did occur with the LWWIP students, however we did not present to local schools as we had originally planned.

***Lake Washington Watershed Internship Program (LWWIP) Plan***

LWWIP reached out to us at the end of 2016 as they were interested in the work we were conducting at North Creek. We will communicate with the leaders of LWWIP with what their timeline looks like through June so we can coordinate a time to do our presentation. Once we meet the students and complete our presentation, we will begin having LWWIP students with us at work parties on the first of every month.

We want LWWIP students to experience as much of the restoration process as possible. At each work party they will practice removing invasives, spreading mulch, and planting. They will be with us until May, so we look forward to showing them how the site has changed through their efforts. We will also describe to them what we expect our site to look like in the future and how the changes will benefit North Creek Forest.

AD30: We did not present lesson plans in local classrooms, due to a lack of time and resources. However, we did conduct a presentation with the LWWIP students.

# Map Revisions

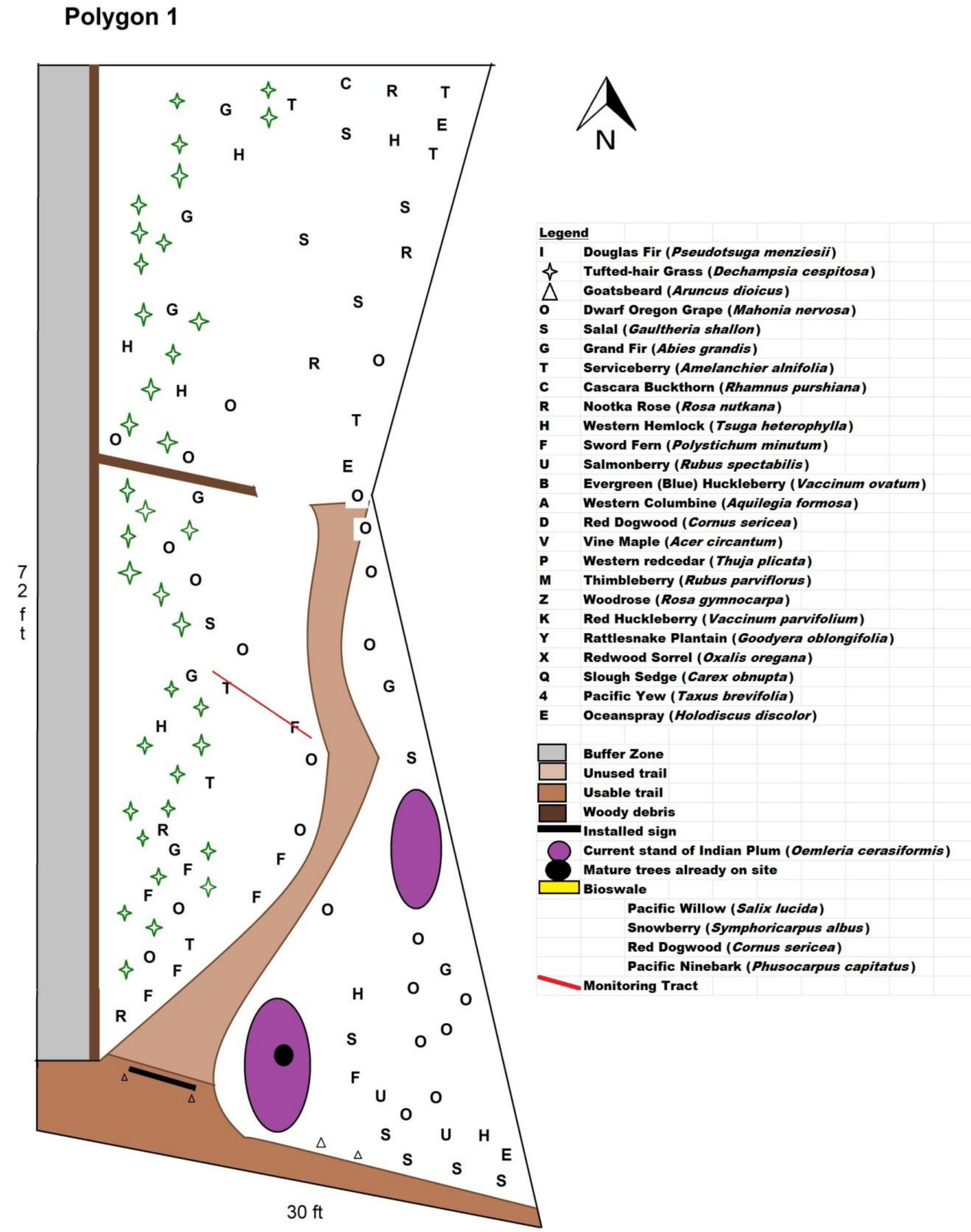


**Figure 8: As-built map of Polygon 1.**

## Polygon 2

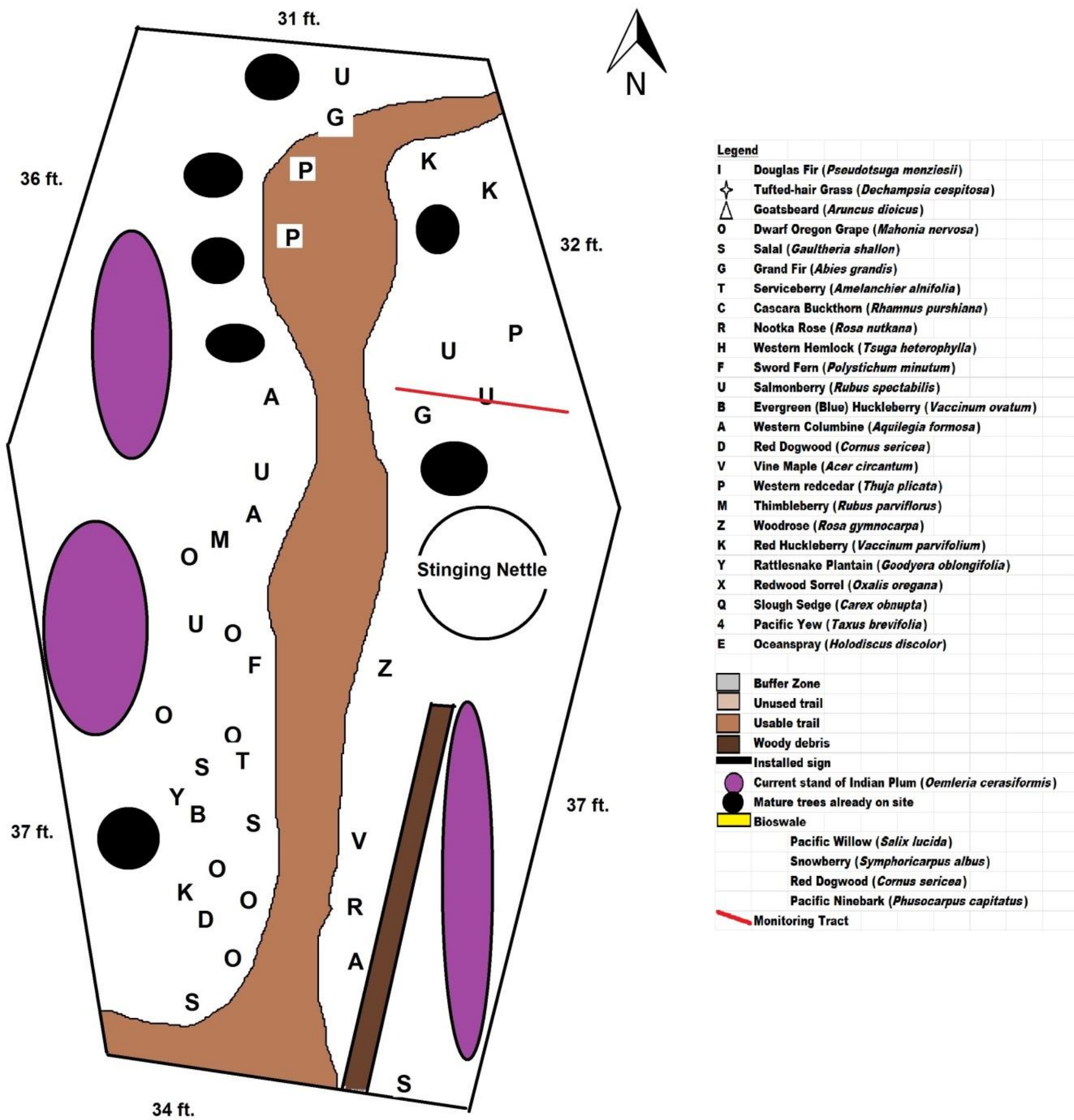


**Figure 9: As-built map of Polygon 2.**

# Polygon 3

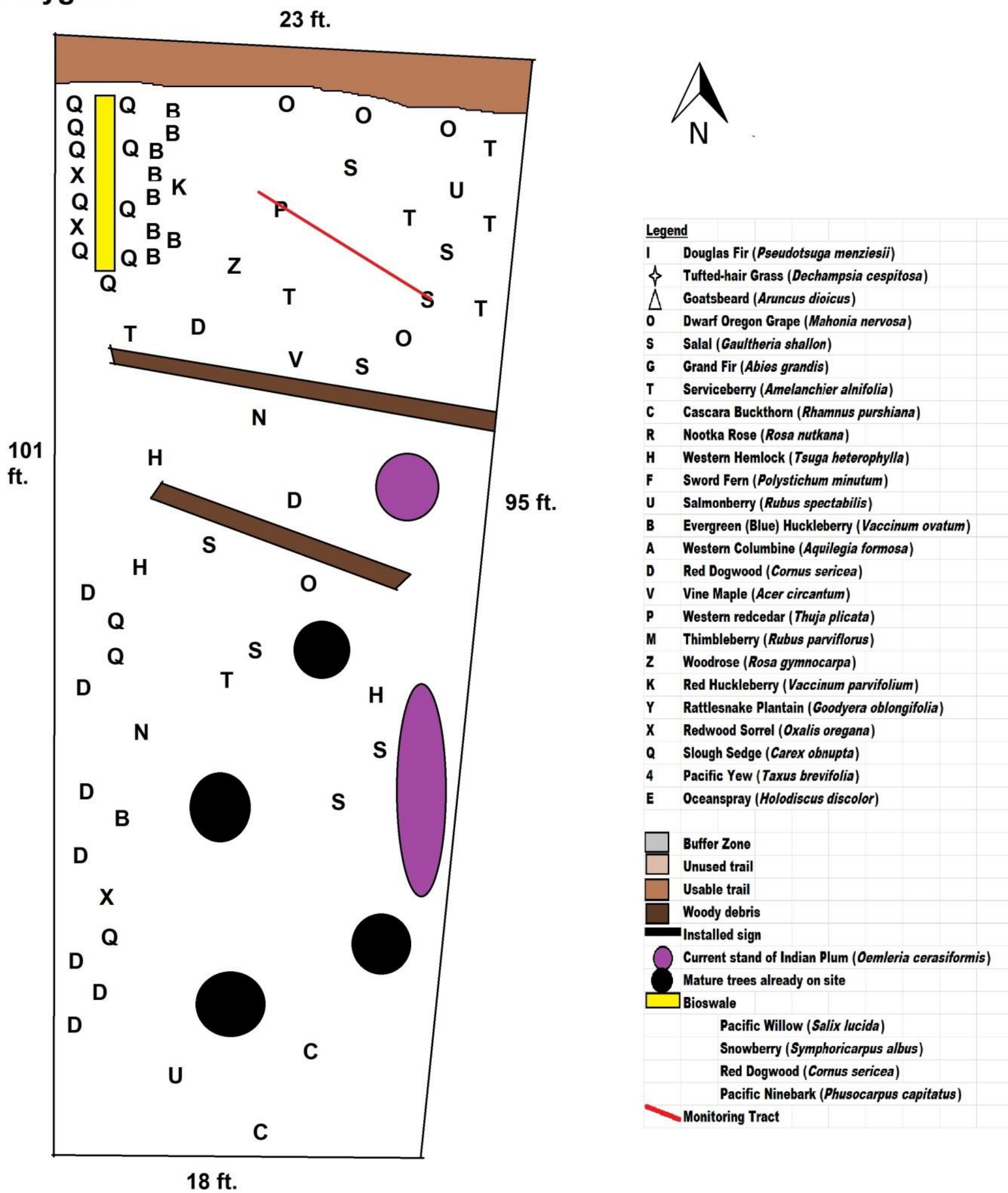


**Figure 10: As-built map of Polygon 3.**

Polygon 4 & 5

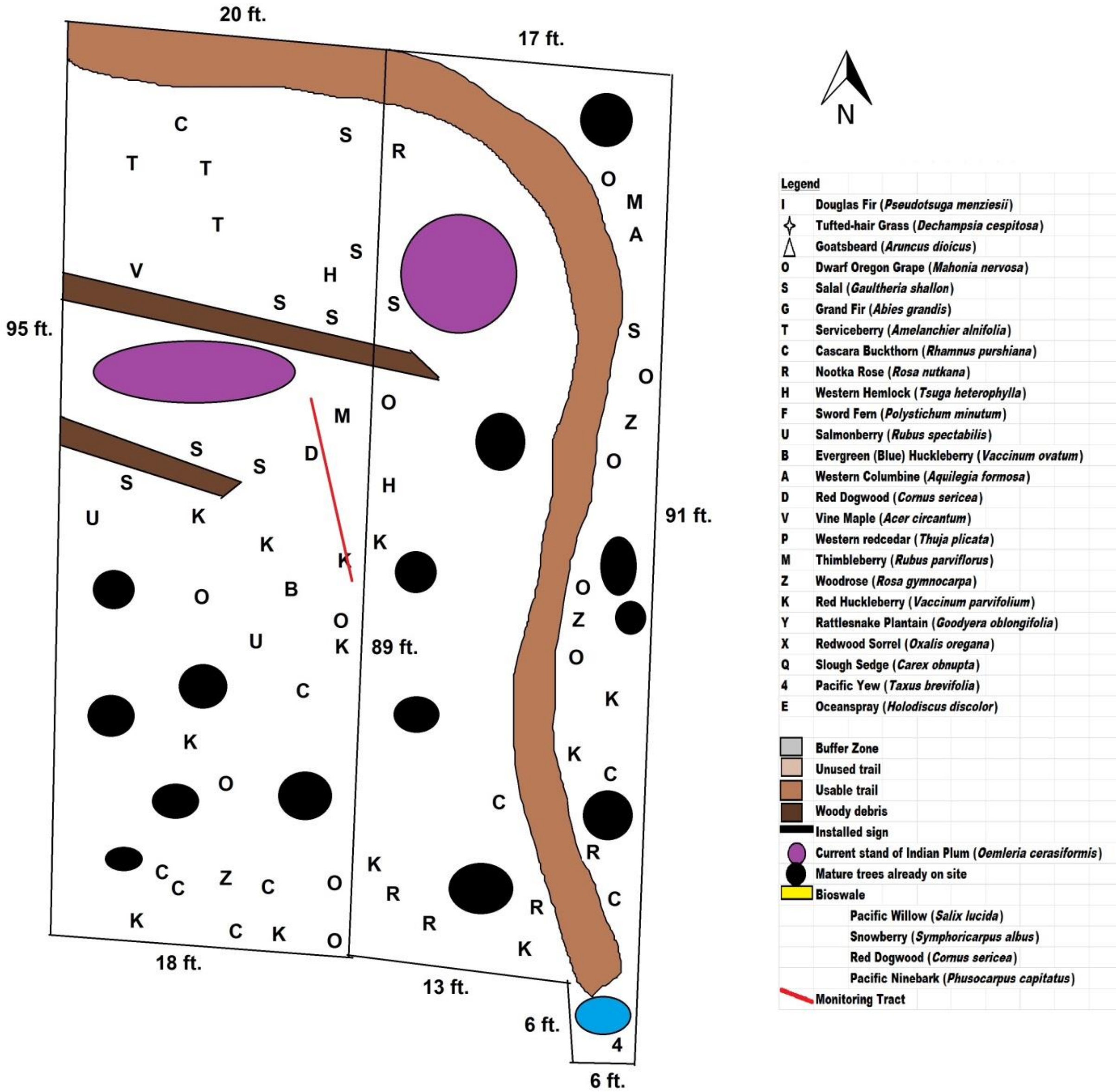


**Figure 11: As-built map of Polygons 4 & 5, showing extension of site in Polygon 5.**

# Planting Table Revisions

| Species | Spacing (m) | Polygon 1 - 287.67 $m^2$ | Polygon 2 - 288.60 $m^2$ | Polygon 3 - 509.90 $m^2$ | Polygon 4 - 478.19 $m^2$ | Polygon 5 - 326.08 $m^2$ | Form |
|---|---|---|---|---|---|---|---|
| | | # to plant | # to plant | # to plant | # to plant | # to plant | |
| **Trees** | | | | | | | |
| *Abies grandis* | 2-3 | 8 | ~~0~~ | ~~8~~ **2** | ~~2~~ | ~~2~~ | Plugs |
| *Picea sitchensis* | 2-3 | ~~3~~ **6** | ~~2~~ **2** | ~~1~~ **2** | ~~2~~ **0** | ~~2~~ **0** | Plugs |
| ~~*Populus trichocarpa*~~ *Not replaced after fascine failure* | ~~2-3~~ | ~~0~~ | ~~0~~ | ~~2~~ | ~~0~~ | ~~0~~ | ~~Live-staking~~ |
| *Pseudotsuga menziesii* | 3 | 3 | 1 | 6 | 0 | 0 | Plugs |
| *Rhamnus purshiana* | 2-3 | 3 | 2 | 2 | 1 | 2 | Container |
| *Salix lucida* | 1-2 | 4 | 0 | 8 | 0 | 0 | Live-staking |
| *Taxus brevifolia* | 2-3 | 0 | 0 | 0 | 0 | 1 | Container |
| *Tsuga heterophylla* | 3 | ~~2~~ **3** | 2 | ~~2~~ **3** | ~~2~~ **1** | ~~2~~ **1** | Plugs |
| **Shrubs** | | | | | | | |
| *Amelanchier alnifolia* | 2-3 | ~~1~~ **3** | 0 | ~~6~~ **4** | ~~0~~ **3** | 0 | Container |
| *Acer circantum* | 2 | ~~2~~ **3** | 1 | 3 | ~~0~~ **2** | ~~0~~ **1** | Bare-root |
| *Cornus sericea* | 2 | ~~4~~ **0** | ~~6~~ **0** | ~~4~~ **12** | 0 | ~~2~~ **0** | Live Staking |
| *Gaultheria shallon* | 1 | ~~4~~ **11** | ~~3~~ **5** | ~~6~~ **8** | ~~3~~ **7** | ~~4~~ **2** | Salvage |
| *Holodiscus discolor* | 1-2 | ~~1~~ **3** | 0 | ~~3~~ **1** | 0 | 0 | Bare-root |
| ~~*Lonicera ciliosa*~~ | ~~1-2~~ | ~~2~~ | ~~2~~ | ~~1~~ | ~~1~~ | ~~2~~ | ~~Container~~ |
| ~~*Mahonia aquifolium*~~ *L. ciliosa, unable to order, nursery stock ran out. Unable to salvage.* | ~~1-2~~ | ~~4~~ | ~~3~~ | ~~6~~ | ~~2~~ | ~~2~~ | ~~Salvage~~ |
| *Mahonia ~~repens~~* ***nervosa*** | 1 | ~~4~~ **23** | ~~3~~ **7** | ~~6~~ **5** | ~~2~~ **5** | ~~2~~ **5** | Salvage |
| *Oemleria cerasiformis* | 1 | 2 | 2 | 3 | 2 | 1 | Bare root, Salvage |
| *Physocarpus capitatus* | 2-3 | ~~2~~ **0** | 0 | ~~2~~ **4** | 0 | 0 | Live-staking |
| ~~*Salix sitchensis*~~ *Not replanted after fascine failure* | ~~1-2~~ | ~~4~~ | ~~0~~ | ~~8~~ | ~~0~~ | ~~0~~ | ~~Live-Staking~~ |
| ***Ribes sanguineum*** | **1-2** | **5** | **3** | **15** | **7** | **0** | **Bare-root** |
| *Rosa nutkana* | 1 | ~~2~~ **5** | ~~0~~ **2** | ~~4~~ **2** | ~~0~~ **1** | 0 | Container |
| *Rosa gymnocarpa* *Only salvaged plants planted due to fascine failure* | 1 | 2 | 2 | 3 | ~~2~~ **5** | ~~0~~ **4** | ~~Live-Staking~~, Salvage |
| *Rubus parviflorus* | 1 | ~~2~~ **3** | 2 | 4 | 2 | 1 | Container |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Rubus spectabilis*<br>Salvaged plants only | 1 | 2 | 1 | 4 | 2 | 2 | ~~Live-staking,~~<br>Salvage |
| *Sambucus racemosa* | 1 | 2 | 2 | 2 | 1 | 1 | Bare root |
| *Symphoricarpos albus* | 2 | ~~2~~ **0** | ~~2~~ **0** | ~~2~~ **4** | ~~2~~ **0** | ~~1~~ **0** | Live-staking |
| *Vaccinum parvifolium* | 1 | ~~1~~ **0** | ~~1~~ **3** | ~~1~~ **0** | ~~2~~ **7** | ~~2~~ **4** | Container,<br>**Salvage** |
| **Ferns** | | | | | | | |
| ~~*Blechnum spicant*~~ | ~~1~~ | ~~8~~ | ~~6~~ | ~~6~~ | ~~4~~ | ~~3~~ | ~~Salvage~~ |
| ~~*Dryopteris expansa*~~ | ~~1~~ | ~~8~~ | ~~6~~ | ~~6~~ | ~~4~~ | ~~3~~ | ~~Salvage~~ |
| *Polystichum munitum* | 1-2 | ~~6~~ **8** | ~~2~~ **1** | ~~6~~ **3** | ~~3~~ **0** | ~~1~~ **0** | Salvage |
| **Graminoids** | | | | | | | |
| *Carex obnupta* | 0.5 | ~~15~~ **25** | ~~10~~ **0** | ~~25~~ **30** | ~~10~~ **0** | ~~5~~ **0** | Plugs |
| *Dechampsia cespitosa* | 0.5 | ~~10~~ **36** | ~~10~~ **0** | ~~20~~ **14** | 0 | 0 | Plugs |
| *Festuca rubra* | 0.5 | ~~15~~ **20** | ~~5~~ **0** | 15 | ~~5~~ **0** | ~~5~~ **0** | ~~Salvage~~, Plugs |
| **Groundcover (Herbs)** | | | | | | | |
| *Aquilegia formosa* | 0.5 | ~~0~~ **1** | 2 | ~~0~~ **1** | 0 | ~~2~~ **0** | Container |
| *Aruncus dioicus* | 2 | ~~6~~ **4** | ~~2~~ **0** | 6 | 0 | 0 | Salvage |
| ~~*Asarum caudatum*~~<br>*Rotted before planting* | ~~0.5~~ | ~~1~~ | ~~1~~ | ~~1~~ | ~~0~~ | ~~1~~ | ~~Container~~ |
| *Cornus unalaschkensis* | 1-2 | 4 | ~~2~~ **3** | ~~5~~ **3** | 0 | 0 | Container |
| *Goodyera oblongifolia* | 0.5-1 | 2 | ~~2~~ **1** | 0 | ~~0~~ **3** | ~~2~~ | Container |
| *Oxalis oregana* | 0.5-1 | 25 | ~~10~~ **5** | 20 | ~~10~~ **0** | ~~5~~ **0** | Plugs |
| ~~*Tellima grandiflora*~~ | ~~0.5~~ | ~~8~~ | ~~2~~ | ~~10~~ | ~~3~~ | ~~1~~ | ~~Salvage~~ |
| ~~*Tiarella trifoliata*~~ | ~~0.5~~ | ~~8~~ | ~~2~~ | ~~10~~ | ~~3~~ | ~~1~~ | ~~Salvage~~ |
| ~~*Trillium ovatum*~~ | ~~0.5~~ | ~~0~~ | ~~3~~ | ~~0~~ | ~~0~~ | ~~3~~ | ~~Container~~ |

**Table 2: Revised planting table.**

AD31) Availability of *Abies grandis* dropped. Unfortunately, only one of the two plant purchasing forms made it and by the time it was discovered, there were only 10 available.

AD32) After receiving the *Picea sitchensis* and going over the site/polygons post-invasive removal, we opted to change the numbers planted in each polygon. With the decrease in *A. grandis,* we also wanted more coniferous species in polygon one, and so planted more *P. sitchensis* here.

AD33) *Populus trichocarpa* was not replaced or live staked after the fascine failure. It was too late to collect more live stakes before the issue with the fascines was brought to our attention.

AD34) With the decreased number of *A. grandis*, we felt that position and planting more *Tsuga heterophylla* in polygons 1 and 3 would be more beneficial.

AD35) *Amelanchier alnifolia* came in bundles of 10 plants, so we added more in polygon 1, less in polygon 4 to make room for other species, and planted three in polygon 4.

AD36) *Acer circantum* also came in bundles of 10 plants, we added more in polygon 1 and added them to polygons 4 and 5.

AD37) We were only allowed to collect a certain number of *Cornus sericea* after the fascine failure and decided to re-stake the bioswale and prioritize placing the rest of the stakes along fence-line perimeter of polygon 3.

AD38) We ended up salvaging and collecting more *Gaultheria shallon* than we originally thought was necessary. Knowing the high mortality rate (especially of the larger plants) we decided to plant them more heavily in polygons 1 and 3 and add extras to polygons 2 and 4. We decreased the number in polygon 5 to add more in polygons 1 and 3.

AD39) Post-invasive removal, we decided that the *Holodiscus discolor* would do better in polygon one and swapped he number we originally would have planted in each polygon. Polygon 1 is going to be drier along the perimeter where they are planted, which is more preferential for this species. They will also have more exposure to sunlight for a longer period-of-time than the plants would receive in polygon 3.

AD40) *Lonicer ciliosa* was unable to be ordered because all nurseries were out-of-stock.

AD41) *Mahonia aquifolium* was unable to be salvaged due to lack of availability in salvage site(s).

AD42) Availability of *Mahonia nervosa* was plentiful. The *repens* species we had originally anticipated turned out to be *nervosa.* However, knowing that it is a sensitive species when salvaging and transplanting, we decided to bulk the number being planted in polygon 1. Post-invasive removal, it was quickly realized the amount of bare ground and needed more plants to aid in our goal of suppressing invasive species.

AD43) We thought it would be too late to collect many more live stakes of *Physocarpus capitatus* to replace the ones lost in the fascine failure as well as the fact that there is a lack of availability in the Bothell area of this plant. By the time the next planting day/volunteer event, the live stakes would not have been as successful.

AD44) For ease of availability, only *Salix lucida* was replanted to replace *Salix sitchensis* after the fascine failure.

AD45) The Saltwater Park restoration group donated their spare (30) *Ribes sanguineum* and decided to place all along the site, with emphasis in polygon 3 given the conditions of the polygon.

AD46) The number of *Rosa gymnocarpa* salvaged was higher than anticipated and decided to disperse them throughout polygons 4 and 5.

AD47) Post-invasive removal, we realized the amount of bare space in polygon one and needed to add more plants, *Rosa nutkana* is a species we added more of to this polygon. We also added more to polygons 2 and 4 because they were ordered in a bundle of 10 plants. However, we decreased the number planted in polygon 3 so we could add more in polygon 1 and add more diversity to polygon 3 with other plant species.

AD48) We ordered more *Rubus parviflorus* and added the extras to polygon 1 given that they were cheaper after being sourced from another nursery.

AD49) After the fascine failure, we opted to only collect to a few *Symphoricarpos albus* live-stakes to spread throughout the bioswale since they were not being added to the fascines and only placed as stakes.

AD50) Due to the price increase, only one *Vaccinum parvifolium* was ordered and the salvage events proved worthwhile in providing many small and large individuals. The extras that were salvaged were planted in only polygons 2, 4, and 5. We opted against planting them in polygons 1 and 3 because of disturbance and

AD51) *Blechnum spicant and Dryopteris expansa* were unable to be salvaged due to the timing of the salvage event being before spring. We were also unable to salvage and collect large enough quantities of *Polystichum munitum* to "replace" the other fern species. We also added more to polygon 1 to aid in invasive suppression and filling out the site.

AD52) Taking the requirements of *Carex obnupta* into better consideration, we decided they would thrive better if planted in polygons 1 and 3. The quantity changed due to outsourcing and being cheaper.

AD53) Quantity changed due to outsourcing and cheaper prices of *Dechampsia cespitosa.* The quantity planted in each polygon changed due to open space in polygons 1 and 3, and taking more consideration in habitat preferences.

AD54) *Festuca rubra* amounts ordered changed due to price increase and nursery availability. It was decided to plant only in polygons 1 and 3 due to habitat preferences and amount of bare space in the polygons.

AD55) The primary reason of ordering *Aquilegia formosa was* to aid in diversity and add a species that would be difficult to establish itself into a working forest in the immediate future. For that reason, we changed the quantities planted in each polygon to focus on trail users to see the plants in bloom and plant them along the trail.

AD56) It was decided to plant *Aruncus dioicus* along the entrance trail and not in polygon 2 to aid in creating a planted barrier that would deter people from entering into the restoration site.

AD57) The *Asarum caudatum* we ordered were rotted by the time we were ready to plant them. It is unsure why this happened as it is the only casualty in the potted plants ordered.

AD58) Only 10 *Cornus unschalakensis* were ordered due to availability and out-sourcing. We prioritized their placement in polygon 1 and 2 due to site conditions being more favorable.

AD59) Only four *Goodyera oblongifolia* were ordered due to their price. In order for the species to thrive better, they were planted in well-draining micro-sites in polygons 2 and 4.

AD60) Due to availability, only 50 *Oxalis oregana* were ordered. It was unnecessary to plant 10 in polygon two and instead only planted five along open areas near the trail.

AD61) *Tellima grandiflora and Tiarella trifoliata* were unable to be salvaged due to the date of salvage event. As spring began to take effect, we were able to visualize large amounts of *Tellima grandiflora* beginning to sprout.

AD62) *Trillium ovatum* could not be sourced for a decent price and other species were of greater priority over this very sensitive grower.

AD63) Compared to the original planting plan we created at the beginning of the year, our actual planting compare on a marginal level. Meaning, we strayed far away from our original intentions. This is not necessarily a bad thing. In fact, it turned out to be a good thing. It allowed us to take better consideration into the requirements and preferences of each species. For example, we were able to take the time with our volunteers and appropriately place and plant *V. parvifolium, T. heterophylla, and V. ovatum.* These are all more delicate species that require ideal placement and finesse with planting to ensure success.

We were also unable to acquire some species or a certain number of species. The intention and hope of Wendy and Michael's salvage events were to acquire free plants that were otherwise going to be demolished with the habitat. However, many of the species we had hoped to acquire, were unable to be found due to the seasonal effects (being too cold) and the plants still being dormant. Although, many other species were able to be salvaged and are currently blooming on our site (*R. gymnocarpa)*. Nursery availability also required us to outsource certain plant species, for example, *A. dioicus.*

The large volunteer events that we were able to maintain did not help in keeping us on track with the original planting plan. Each of us had a group of volunteers consisting of 10-15 individuals at the events and it was difficult to keep them busy without running out of tasks. The next best thing was to start planting. This often times led to plants being planted in incorrect places, too close, not spreading around throughout the polygons, etc. Though, we were able to start accommodating for this and staging plants in certain spots to be planted. This led to less confusion, more efficiency, and more appropriate plantings.

The failure of the fascine had an impact on our planting. We had intentions and designs of a bioswale concept within the edge of polygon 3 that borders the stub-road to aid in filtering away harmful contaminants and pollution into the rest of the site. We collected live stakes of *P. trichocarpa, S. albus, P. capitatus, R. gymnocarpa, C. sericea, S. lucida, and S. sitchensis* to be utilized as fascines and buried under a nominal layer of dirt with anticipation of sprouting as spring was nearing. During this installation of the fascines, a community and North Creek member told us to back-fill the bioswale we had just dug up and to cover the fascines with two feet of dirt, stating that they will grow through. Needless to say, we had to live stake replacements at the end of the live staking window. Some of these, unfortunately, did not make it, but many did. All-in-all, plans are just plans; nothing is ever set in stone and we never know what a volunteer event will bring. We could have been better prepared in the beginning, but it taught us to be better prepared for the following events, allowing us to learn how to shape and mold our original plans to what we are presented with in the future.

# Timeline Revisions


**Table 3: Revised timeline.**

# Lessons Learned

## Financial Budget

Comparing the actual expenditures to the planned expenses, there is an expenditure overage of $2,231.27. This means that the actual expenditures are lower than the planned cost. Actual cost is only $24,987.48 compared to the budget of $27,248.75.

Looking closely at the itemized costs, almost all activities cost less than the original budget from preparing the site to post-installation care. The only items that are over the original budget are in the Apply Mulch section where the actual cost of $1,312.50 exceeded the budget of $1,225.00.

We have learned about the importance of salvaging and live-stalking in this project. Knowing beforehand the availability of the plants we may need before going to a site would have saved us time, which translates into money in the long run. Attending salvage events before undertaking the project would have pushed the cost down further, making our operation more efficient. The second lesson learned is the importance of flexibility within the project plans. This lesson was learned when we just bought only 75% of the total plants we thought we wanted which proved to be beneficial due to changes made to the planting plan once the installation began. We were initially worried about going over the budget so we only bought 75% of what we anticipated. This ended up being beneficial as some plants were already present in more abundance than previously anticipated.

**Revenue Sources**

| Revenue by Fund Source | |
|---|---|
| **Course Fee Allotment** | $600 |
| **Cash Donations** | $270 |
| **Plant Donations** | $25 |
| **Project Total** | $895 |

**Table 4: Revenue Sources.**

## Labor Budget

The original labor budget results as compared to actual performance was that the team had committed to 397.25 hours but only delivered 357.25 hours, showing only 89.93% of target. This indicates that the team is 10.07 % under-budget for total hours. Volunteer hours are also deficient compared to target. The original budget was to achieve 926 volunteer hours, but actual hours that volunteers had put in were only 842 which is only 90.93% of target or 9.07% below budget. Project leaders should address this shortcoming as it could result in the delay of the project as labor hours are significantly below target.

The reason for the significant gap between actual work hours rendered (team and volunteer) was due to overestimation on how many volunteers would be present and the fact that the length of work parties was modified to last 3 hours instead of 4. The exercise however taught us that more manpower is not always good. While more manpower was needed in the first few work parties, such is not the case in the later parties. This was evident in the fourth work party where it was actually more beneficial to have fewer people on site as more people raised the risk of damaging the plants. It is more difficult to instruct a large amount of people on proper planting methods.

The following tables show the comparison of labor hours between expected labor hours and actual labor hours, where significant gaps are to be found between expected labor hours and actual hours rendered, and teaching us the lesson of accuracy of labor estimation.

**Labor By Activity**

| | Team Hours | Volunteer Hours | Total |
|---|---|---|---|
| ***Site Assessment*** | | | |
| ***Expected*** | 20 | 0 | **20** |
| ***Actual*** | 20 | 0 | **20** |
| ***R. armeniacus Removal*** | | | |
| ***Expected*** | 25 | 125 | **150** |
| ***Actual*** | **26** | **125** | **151** |
| ***Mulching*** | | | |
| ***Expected*** | 15 | 60 | **75** |
| ***Actual*** | **15** | **55** | **70** |
| **Planning** | | | |
| ***Expected*** | 155 | 540 | **695** |
| ***Actual*** | **147** | 517 | **664** |
| **Salvages** | | | |

| | | | |
|---|---|---|---|
| ***Expected*** | 6 | 0 | **6** |
| ***Actual*** | **6** | 0 | **6** |
| **Live stake acquisition** | | | |
| ***Expected*** | 4 | 5 | **9** |
| ***Actual*** | **4** | 0 | **4** |
| ***Stewardship Plan*** | | | |
| ***Expected*** | 20 | 0 | **20** |
| ***Actual*** | **20** | 0 | **20** |
| ***Reports and presentation*** | | | |
| ***Expected*** | 70 | 0 | **70** |
| ***Actual*** | **68** | **22** | **68** |
| **Total Hours** | | | |
| ***Expected*** | 314 | 725 | **1039** |
| ***Actual*** | **306** | **719** | 1025 |

**Table 5: Labor table by activity.**

## Planting Plan

- Species – We may have bought 75% of the total plants that we needed but this is actually sufficient as there are already plants in the site. Thus, it was not necessary to plant in as many places as planned, because native vegetation already existed on the site.
- Densities – Achieving required density does not actually correlate with the number of people working on the area.  We learned that there are instances where fewer people are more beneficial in areas where the plants could easily be trampled upon, defeating reaching the intended density.  Again, it underscores the importance of accuracy of estimates in labor as there are some jobs that need more people, where the excessive manpower in the fourth party could be channeled into the first party where more people are required.

- Dispersion – The lack of manpower due to overestimation of labor hours among volunteers have affected dispersion as there was lack of hours put in the installation of plants in the various polygons. Installing of plants in polygon 1 is deficient by 2 hours and 3 hours by team members and volunteers which could mean that required dispersion of plants is not complied with. Dispersion in polygon 2 is likely deficient as volunteer hours lacked by 10 which is 10% of all required work hours. Required dispersion in polygon 5 is also questionable as it is also deficient by 10% in team and volunteer hours. This activity requires more manpower where we overestimated the availability of volunteer work hours.

# Baseline Monitoring

**Upper Canopy**

| Plot | Species | % Cover | Layer Type |
|---|---|---|---|
| 1 | Bigleaf Maple | 90-95% | C |
| 2 | Bigleaf Maple #1 | 20% | C |
| | Bigleaf Maple #2 | 10% | C |
| | Western red-cedar | 65% | C |
| 3 | Bigleaf Maple | 90-95% | C |
| 4 | Western red-cedar | 40% | C |
| | Bigleaf Maple | 65% | C |

**Lower Canopy**

| Plot | Species | # Live | % Cover | # Dead | Recruitment? | Layer Type | ° of Tract Line |
|---|---|---|---|---|---|---|---|
| 1 | Wood-sorrel | 2 | 2% | | | G | 290° W |
| | Dwarf Oregon Grape | 1 | 4% | 1 | | G | |
| | Sword fern | 1 | 7% | 1 | | G | |
| | Serviceberry | 1 | 3% | | | G | |
| 2 | Indian Plum | 1 | 8% | | | S | 260° W |
| | Western Hemlock | 1 | 4% | | | G | |
| | Western Hemlock | 1 | 6% | | | G | |
| | Sword fern | 1 | 24% | | | G | |
| | Trailing Blackberry | 1 | 3% | | Yes | G | |
| | Trailing Blackberry | 1 | 3% | | Yes | G | |
| | Trailing Blackberry | 1 | 2% | | Yes | G | |
| 3 | Snowberry | 1 | <1% | | | G | 300° NW |
| | Indian Plum | 1 | 18% | | | G | |
| | Nootka Rose | 1 | 7% | | | G | |
| | Trailing Blackberry | 1 | 2% | | Yes | G | |
| | Bracken Fern | 1 | 21% | | Yes | G | |
| | Sword fern | 1 | 14% | | | G | |
| | Red Elderberry | 1 | <1% | | | G | |
| | Western redcedar | 1 | 20% | | | Mid | |
| 4 | Cascara Buckthorn | 1 | 3% | | | G | 330° NW |
| | Trailing Blackberry | 1 | 2% | | Yes | G | |
| | Red Huckleberry | 1 | <1% | | | G | |
| | Vine Maple | 1 | 3% | | | G | |
| | Dwarf Oregon Grape | 1 | 2% | | | G | |
| | Inidan Plum | 1 | 13% | | | G | |
| | Trailing Blackberry | 1 | 2% | | Yes | G | |

**Table 6: Baseline monitoring table.**

# Appendix

**Vegetation Monitoring Plots**

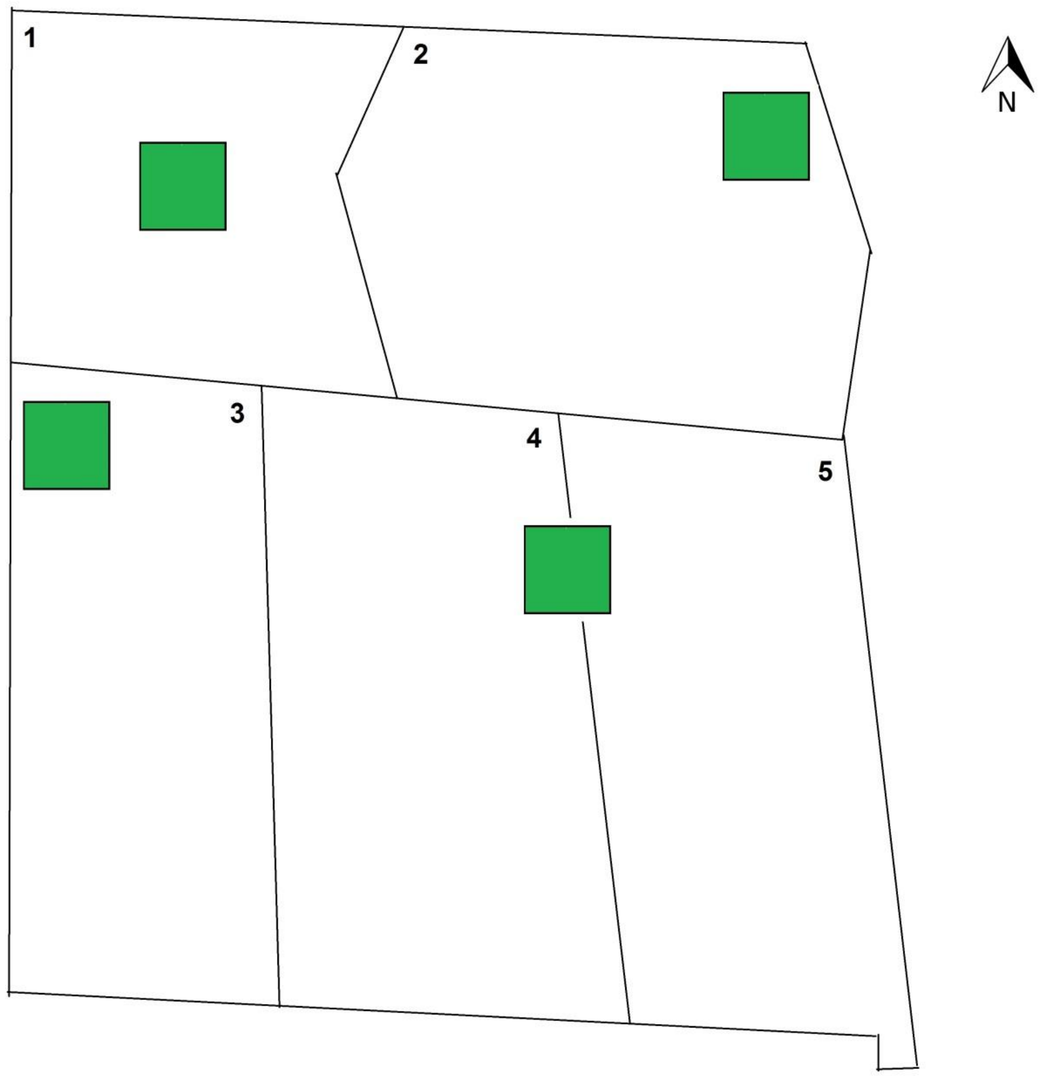


**Figure 12: Vegetation monitoring plot map.**

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