Cotton Hill Park
University of Washington Restoration Ecology Network Capstone 2011-2012

Location: Cotton Hill Park, 110th Ave NE and NE 98th St, Kirkland WA 98033

Clients:
Karen Story, Kirkland Highlands Neighborhood Association
Sharon Rodman, City of Kirkland

Team members:

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Project Summary

Cotton Hill Park is located near the intersection of 110th Ave NE and NE 98th Street, in Kirkland, Washington (Figure 4). It is a part of the Forbes Creek watershed, and is surrounded by houses on its north, east, and south sides. Abandoned railroad tracks can be found along the park's western border, and the local junior high can be found to the northwest. Parts of the site have been restored in previous years, by other UW-REN teams; this year's site is bordered on its northern side by last year's restoration (Figure 5). The community partners for this project include Karen Story and Sharon Rodman, who are part of the Kirkland Highlands Neighborhood Association and the City of Kirkland, respectively. They work directly with the community as well as the City of Kirkland and have been thoroughly involved within the restoration. Their input has been taken into account throughout the project, and they have worked hard to ensure that the restoration was a smooth process.

Figure 1 and 2: Before and After Photos of the Site (Oct. 22, 2011 and May 8, 2012)

Pre-Restoration Description

This year's site was originally around 520 m^2 in area, made up of four polygons defined by their various characteristics. The area is relatively flat in most places, although the topography changes slightly in some areas. The road slopes west, down towards the edge of the site, at an angle of around 20 degrees. An unnamed, natural stream flows north to south through the site, originating from a natural spring and then connecting to the Forbes Creek. There is also water draining into the park from a storm run-off drain, located on NE 98th St, creating standing water that runs through the east portion of the site during times of heavier rainfall (Figure 6). Heavier rainfall can cause higher velocities in the stream. There is a public trail at the edge of the site, utilized by many people, especially joggers, dog-walkers, and students going to and from the local junior high.

Before restoration, the site was covered by a deciduous forest, with the canopy mostly formed by native species like red alder (*Alnus rubra*), as well as black cottonwood (*Populus balsamifera*). The sub-canopy consisted of the native species salmonberry (*Rubus spectabilis*), vine maple (*Acer circinatum*), and willow (*Salix* spp). The understory contained more of a variety in terms of native species, including field horsetail (*Equisetum arvense*), skunk cabbage (*Lysichiton americanum*), bracken fern (*Pteridium aquilinum*), piggyback plant (*Tolmiea menziesii*), western sword fern (*Polystichum munitum*), and lady fern (*Athyrium filix-femina*). Non-native species included Himalayan blackberry (*Rubus armeniacus*), bittersweet nightshade (*Solanum dulcamara*), reed canary grass (*Phalaris arundinacea*), English holly (*Ilex aquifolium*), creeping buttercup (*Rananculus repens*), and Japanese knotweed (*Polygonum cuspidatum*).

Ecological Concerns

The major issue on site is the forest's inability to naturally advance, in terms of succession, towards a conifer-dominated forest due to the abundance of non-native species, especially Himalayan blackberry. Sunlight filters through the early succession, deciduous canopy to reach the forest floor. These conditions make it advantageous for invasive species that require sunlight to become established on site, out-competing native plants and suppressing the regeneration of conifers and other native plants. Autogenic repair and advancement into a conifer-dominated forest was highly unlikely, due to the excessive amounts of invasive species. In fact, if left alone, the invasive species would likely continue to spread and continue to limit biodiversity and the habitat benefits to wildlife. Therefore, restoration and human intervention was necessary to aid in successional advancement.

Project Goals:

- Encourage successional advancement towards conifer-dominated, forested wetland typical of the Puget Sound area.
- Improve habitat for a diversity of native fauna.
- Improve hydrological functions on site.
- Promote stewardship and maintenance of the site.
- Provide educational opportunities on northwest ecosystems, restoration and this project.

General Approach:

The first priority for site preparation was the removal and suppression of invasive species, particularly Himalayan blackberry. Next, the site was mulched (wood chip variety), with emphasis on Polygon 4, where there was considerably more bare ground. A thick layer of mulch helps prevent Himalayan blackberry from returning to the site, and will help retain moisture (Chalker-Scott 2007). Planting taller, fast-growing shrub species and native conifers will create a larger, thicker canopy for shade, which will help discourage re-growth of Himalayan blackberry. Planting a wide range of species in different micro-environmental conditions will increase the biological and structural diversity of the plant community. Slightly raised mounds were created for plants that are more adapted to slightly drier soil and to create a wider gradient of micro-climates.

- Western red cedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), grand fir (*Abies grandis*), and Sitka spruce (*Picea sitchensis*) will eventually grow taller and shade out invasive species.
- Dense plantings of fast-growing shrubs like red-osier dogwood (*Cornus sericea*) and Pacific ninebark (*Physocarpus capitatus*), as well as plants with high survival and dispersal rates such as lady fern (*Athyrium filix-femina*) and salal (*Gaultheria shallon*), will help compete with invasive species and shade them out in the short-term.

Planting numerous plant species at different height levels will improve habitat for wildlife by providing cover, foraging, and nesting habitat, as well as food sources to various birds, insects, amphibians, mammals, and reptiles. Planting specific species near the stream to serve as potential shelter and breeding habitat will be beneficial to amphibians (Table 8).

- Pacific ninebark provides good browsing material for wildlife and can form thickets for sheltering birds (Gage 2006).
- Red-osier dogwood, Sitka willow (*Salix sitchensis*), and twinberry honeysuckle (*Lonicera involucrata*) also provide food and shelter for ungulates, birds, and other animals, and forage for native pollinators (Moore 2003).
- Sitka willow, Pacific ninebark, and red-osier dogwood slow down water and create shelter along the stream for wildlife such as Pacific tree frogs.
- Frog eggs can be attached to species such as slough sedge and small-fruited bulrush (*Scirpus microcarpus*). Deer fern (*Blechnum spicant*), lady fern, and western sword fern (*Polystichum munitum*) provide low shelter for amphibians and reptiles (Table 8). (Nafis 2012)

We also chose species that are beneficial for stream bank stability, as well as choosing species that will encourage filtration of street run-off pollutants, to help improve hydrologic functions on site.

- Western red cedar, Sitka willow, twinberry honeysuckle, and red-osier dogwood are good for stabilization of stream banks.
- Sitka willow, slough sedge (*Carex obnupta*), Pacific ninebark, and small-fruited bulrush slow and filter water.

Clustering of plants in “islands” and “mounds” in reasonable sizes will ensure easier maintenance, and will leave sufficient space for volunteers to walk in. Species along the edge that discourage pedestrians from entering the site were incorporated. Collaboration with the CP and our community will encourage people to take an active role in the site, by helping to maintain it, or volunteering at work parties. A detailed maintenance plan will also help achieve that goal.

- Nookta rose (*Rosa nutkana*) forms dense thickets, and is covered in thorns, forming a natural barrier to pedestrians.

The site can be used to demonstrate a restoration in progress, and will prove to be valuable in terms of educational opportunities. Students can view the site and take part in its restoration during field trips or work parties, particularly when the site can help increase their understanding of the topics they learn about in school. Playing a role in restoration may encourage them to continue doing so in the future. The site, once restored, can also be an example of what a natural Pacific Northwest ecosystem might look like.

Major accomplishments:

- We restored approximately 631 m^2 of forested wetland.
- A total of 418 plants were installed, which includes 63 conifers, 33 deciduous trees, 199 shrubs, and 123 ground cover plants.
- An additional area of 111 m^2 was restored adjacent to our original plan.
- Over 111 community members were engaged during 4 work parties.
- An area of at least 300 m^2 of Himalayan blackberry was removed, with a lot of help from volunteers.
- Two 1-hour lessons on restoration ecology and native Pacific Northwest ecosystems were taught to approximately 210 7^{th} grade students on-site.

Team members:

Figure 3: Team Members
(From left to right: Linda, Merrie, Jessica, Oleksandr, Napha, Lindsey)

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Acknowledgements:

We would like to thank everyone who supported and helped out with this project:

- Karen Story, the Volunteer Park Steward for Cotton Hill Park, part of the Highlands Neighborhood Association, and our primary contact, who recruited volunteers, organized the work parties and assisted with educational events.
- Sharon Rodman and others at the City of Kirkland for providing tools, mulch, and soil.
- Susan Buyarski-Crauer and Kathy Colombo, 7th grade teachers at Kirkland Junior High, who collaborated with us on the educational component of our project.
- UW-REN professors, Kern Ewing, Warren Gold, Jim Fridley and TA Caitlin Guthrie who provided guidance and encouragement throughout the year.
- UW Center for Urban Horticulture and Highlands Neighborhood Association for generously donating planting and funding for the project.
- Sasi's Cafe who donated hot soup, bread and cookies to 49 of our volunteers during a major work party.
- All of the volunteers who helped us remove invasive species, spread mulch, and install native plants. Special shout out to Noel Daniel who came to almost all of the work parties, even though she had a capstone project of her own to work on.

As-Built Report

Background

Site Description

Location

Cotton Hill Park is located in Kirkland, Washington near the intersection of 110th Ave NE and NE 98th Street. The park is four acres and is a part of the Forbes Creek Watershed. Residential neighborhoods surround the park to the north, east and south, and unused railroad tracks run along the west side of the park. One trail runs through the park from the south to north and splits into two trails, which run to the east and west. The trail to the west runs adjacent to the south border of Crestwood Park (27 acres) before connecting with Kirkland Junior High School (Figure 4). Crestwood Park connects with Juanita Bay Park (110 acres) to the northwest, which is located on the east side of Lake Washington (Figure 4).

Figure 4: Aerial map of Cotton Hill Park in relation to surrounding parks and greenbelt.

Site Selection

Student groups from the University of Washington’s Restoration Ecology Network (UW-REN) have worked on restoration projects at Cotton Hill for the past three years. The Highlands Neighborhood Association has been working to restore a section between the UW-REN sites. We chose our site based on an area our community partner expressed as a priority spot, as well as the fact that it would form one contiguous restoration site with the last year’s two sites (Figure 5). This would make it easier for future volunteers to walk into the site to perform maintenance as well as reduce the likelihood of the spread of invasive plants through seed and root dispersal from adjacent areas. The connectivity may also increase the chance for native seed dispersal and establishment between project sites. Our proposed project site is located to the south of UW-REN 2010’s southern project site (Figure 5).

Figure 5: Aerial map of Cotton Hill Park with reference to previous and current restoration sites.

Site Description

The area of the project site we chose is approximately 520 m^2. The western edge runs parallel to the railroad but does not include the 10-15 m wide easement that runs adjacent to the railroad. This easement is primarily dominated by Himalayan blackberry (*Rubus armeniacus*) (Figure 6). The eastern edge of our site is defined by the eastern border of the park and does not include the 3 m strip of land that is adjacent to 110 Ave NE, which the Highlands Neighborhood Association is managing. This section has a western-facing slope of 20 degrees and contains some non-native species including knotweed (*Polygonum* sp), creeping buttercup (*Ranunculus repens*), and turf grass (*Poa* sp) (Figure 6).

AD1: The boundaries of the site were later extended to include three more areas. Two areas were added to the north (13 m^2 and 23 m^2) and one area added to the south (75 m^2). These additions brought the total area of the site to 631 m^2.

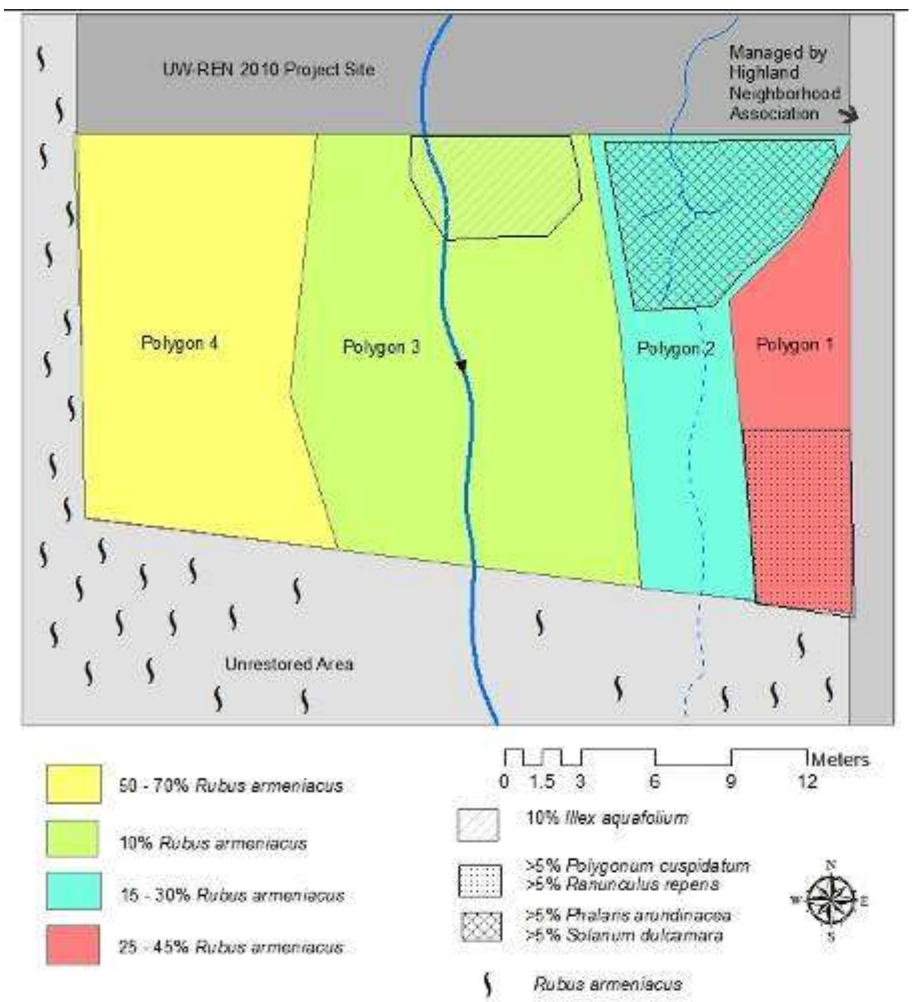

Figure 6: Current non-native vegetation.

Overall, the site's topography is flat, with some areas of uneven ground with 0-5 degree changes. This section of Cotton Hill is located slightly downhill from the rest of the park. Directly east of the entire park is a large hill with about a 20 degree grade facing west, into the park. Water from this hill flows into the park and then into this section either from run-off or an unnamed creek. This creek runs the length of the site from the north to south (Figure 6). Water that drains in from NE 98th Street flows into the northeast corner of the site into a topographical depression that is approximately ⅓ m deep. This creates a seasonal creek that raises the water table of this section. Both of these creeks flow into Forbes Creek outside of Cotton Hill Park, which then flows into Lake Washington.

The soils throughout the site reflect the high levels of moisture flowing into the park. Our site assessment on October 29, 2011 revealed mottling in some areas and a high water table. The majority of the soil texture at the site ranges from fine-sandy clay loam to moderate-sand clay loam, with a deep mineral-rich top layer. Twigs and leaves have fallen from the deciduous trees, causing an accumulation of organic matter on the surface of the soil.

This site is primarily an early successional deciduous forest, mainly comprised of red alder *(Alnus rubra*) and black cottonwood (*Populus balsamifera* ssp. *trichocarpa*). The sub-canopy is dominated by native species in the areas with the most amount of shade, including salmonberry (*Rubus spectabilis*), vine maple (*Acer circinatum*), sword fern (*Polystichum munitum*), skunk cabbage (*Lysichiton americanum*), horsetail (*Equisetum arvense*), willow sp. (*Salix* sp.) and lady fern (*Athyrium filix-femina)* (Figure 7). Along the eastern edge of the park, and in areas with less upper canopy cover, *R. armeniacus* is the dominant sub-canopy species. More sunlight is able to reach the ground in areas with less canopy coverage, helping *R. armeniacus* to prosper. Other non-native species include English holly (*Ilex aquifolium*), English ivy (*Hedera helix*), *Polygonum* sp., bittersweet nightshade (*Solanum dulcamara*), reed canary grass (*Phalaris arundinace*a), and *R. repens* (Figure 6).

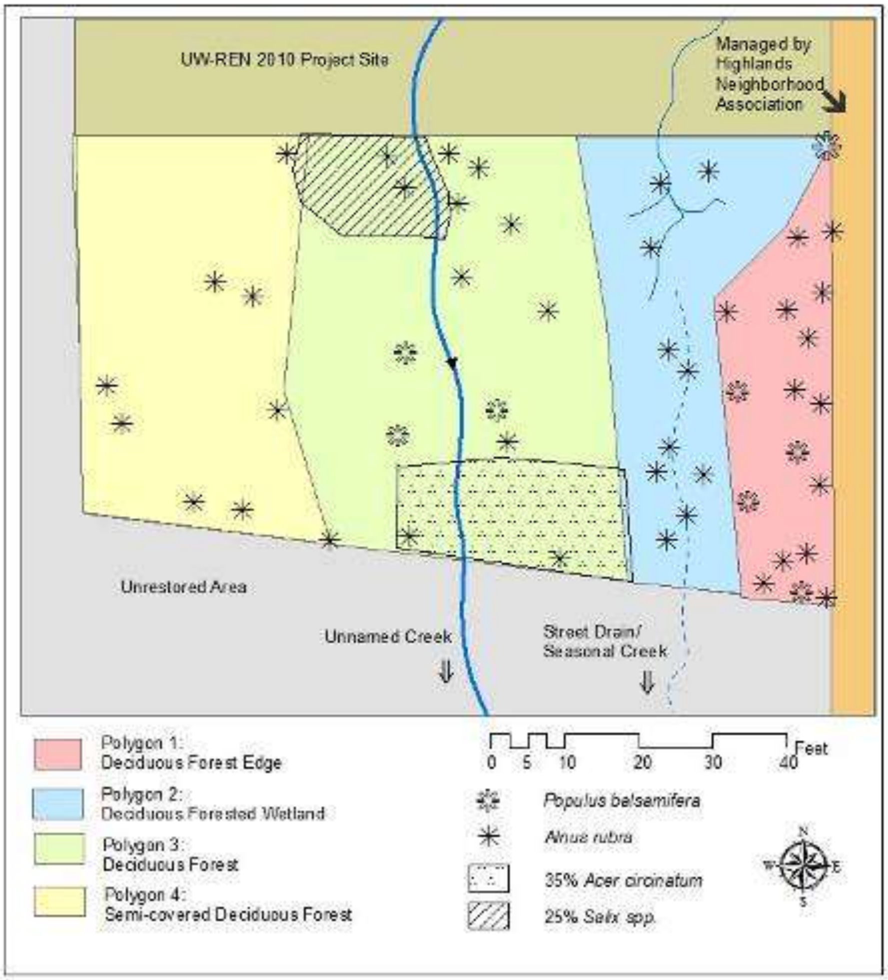

Figure 7: Current native vegetation.

Habitat

The numerous types of vegetation serve as food sources and cover for many wildlife species ranging from tiny earthworms to larger animals such as deer. Many animals feed on the twigs, leaves, berries, stems, bark, seeds, and buds of the vegetation (Tirmenstein 1989a; Tirmenstein 1989b; Uchytil 1989a; Uchytil 1989b). Some species that serve these functions are *A. rubra*, *R. spectabilis*, *R. armeniacus*, and *A. circinatum* (Tirmenstein 1989a; Tirmenstein 1989b; Uchytil 1989a; Uchytil 1989b). Structural diversity, both vertical and horizontal, provides valuable habitat to a variety of species. For example, birds use the trees for perching, nesting, and as cavity sites. Even the abundance of *R. armeniacus*, which could be classified as a stressor, provides thickets for animals to hide in, and berries for animals to feed on (Tirmenstein 1989a). Biological and structural diversity is not as complex as our reference site, St. Edwards State Park, which is an example of a late succession forest.

Restoration Needs and Opportunities

The abundance of invasive plants, especially *R. armeniacus*, is significantly limiting the forest's inability to mature into a conifer forest. *R. armeniacus* is thriving in the deciduous forest, where sunlight filters through more easily than in a mature coniferous forest. Its dominating presence decreases regeneration of coniferous trees. Establishment of later succession conifers would eventually create strong, persistent shade which would reduce *R. armeniacus'* ability to return. By establishing conifer trees and a variety of native shrubs we would encourage the establishment of a more diverse ecosystem that supports a greater number of insects and animals. The stability of banks of the unnamed stream that runs through the center of the site could be enhanced by planting native plants that naturally fill this role. In addition adding some structural diversity to the stream could create habitat for amphibians. The street runoff washes pollutants into the watershed, which could be mitigated by planting appropriate wetland species that also help to filter these pollutants. This site connects to a larger greenbelt (Figure 4), so encouraging restoration would not only create a patch of native habitat, but also would continue to connect these natural areas for easier migration and species distribution. Also, since this site is regularly visited by neighbors and students, continuing restoration here would further enhance the awareness of the importance of restoration and native Northwest ecosystems. The restoration plan would create numerous volunteer opportunities and even educational programs.

Tasks and Approaches

Goal 1: Encourage successional advancement towards conifer-dominated forested wetland typical of the Puget Sound area.

Objective 1-1: Remove and suppress invasive species throughout site.

Task 1-1a: Remove invasive species, above and below ground, specifically *R. armeniacus*.

Approach: We will be using loppers to snip the stem of *R. armeniacus* at a height of 8-12 inches, then, using a shovel, we will dig out the root ball by starting at 3 to 5 inches in front of the cane. Where possible, we will attempt the hand-pulling method. If needed, we will obtain pick mattocks for removing the root wads. To clear *I. aquifolium* we will attempt to simply pull up the plant. If it does not come up easily there may be an underground thick root system. In this case, we will make plans with our CP to have it treated with herbicide.

Approach Justification: Hand-pulling and the digging out root crowns have proven to be the most effective and successful approaches (Bennett 2007). Cutting and mowing may leave large chunks of the root system in the soil, making weeds more likely to return. *I. aquifolium* will continue to return if not removed and/or treated with herbicide appropriately (Shaw 2012).

Task 1-1b: Apply a 6 inch layer of wood chip mulch over the site.

Approach: Mulch, provided by The City of Kirkland, will be wheel-barrowed onto the site, where it will then be spread to a thickness of 6 inches. Mulch will be spread throughout the site except along streams and in seasonally saturated areas.

Approach Justification: Spreading mulch over the site will help prevent invasive species such as *R. armeniacus* from re-emerging once it has been removed (Chalker-Scott 2007).

Task 1-1c: Plant species that will shade out *R. armeniacus*.

Approach: Plant coniferous trees, *Thuja plicata*, *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies grandis* and *Picea sitchensis* and dense plantings of fast-growing shrubs, like *Cornus sericea* and *Physocarpus capitus*, throughout the site. We will be planting understory plants that are likely to survive and spread easily, such as *Anthyrium felix-femina* and *Gaultheria shallon.*

Approach Justification: *R. armeniacus* thrives in sunlight. Fast-growing shrubs, tall-growing trees and an understory layer will provide the shade needed to suppress *R. armeniacus*.

Objective 1-2: Prepare and alter surface topography where appropriate to enhance diversity of plant habitat.

Task 1-2a: Create different micro-environmental conditions in Polygon 4.

Approach: Three triangular mounds will be constructed and boarded up with found wood on the site. They will be approximately 6ft on all sides, and will be around four inches in height. Each mound will then be planted with native vegetation; we will make sure that they are not planted too densely.

Approach Justification: Polygon 4 is the least shaded area, making it the most disturbed part of the site. *R. armeniacus* has dominated this polygon, leaving little room and resources for any other species to grow. The use of mounds will increase habitat structure, improve establishment and survival of plants and seedlings, and make it easier for volunteers to walk around (Falk et. al 2006). The structure of the mounds may cause the mounds to be drier, meaning that dense planting may be detrimental. The size of the mounds was chosen to make it easy for people to weed from the edges. Using on-site soil may deplete resources from the site it is dug from, so we will be looking into using an off-site soil if it is inexpensive and of similar soil quality.

Objective 1-3: Establish a biologically and structurally diverse plant community.

Task 1-3a: Acquire a diverse array of tree, shrub and herbaceous species from a variety of sources including the Snohomish Conservation District Native Plant Sale, King

Conservation District Native Plant Sale, salvaging and donations. The plant community is based off our reference site Saint Edwards Park.

Approach: We will submit forms for request of plants from plants sales, and will attend events where we can salvage plants.

Approach Justification: Our CP informed us that plants from Snohomish Conservation District Native Plant Sale are generally very healthy, which means they may transplant more successfully. Salvaging plants is a cost effective approach and also saves plants that may have otherwise died. The plants chosen are a combination of conifers, small trees, various shrubs and some herbaceous species (Table 7). We are only salvaging plants that Leigh recommends to salvage (1999). The various species are of many different sizes, helping to create an upper canopy, mid-canopy and ground cover level.

AD2: Salvaging did not occur at all, because events were not in areas that had enough plants that we could use to make the money spent on gas worth it.

Task 1-3b: Install selected native plants throughout site according to planting plans.

Approach: For potted plants and bare root plants, we will rinse the roots in water and trim them if they are root-bound. Using a shovel, planters will dig a hole twice the size of the plant's diameter and a little deeper than the base of the plant. Before planting, soil will be back filled just enough so that base of the stem/trunk will not be below the surface of the soil. We will then create a slurry of mud and water and pour it around the roots of the plant. This is called mudding in the plant and will be used as a form of back filling. For lives stakes, we will directly insert the stake into the soil, at least two to three nodes below the surface of the soil. These will be heavily watered, in order to mud in as best as possible. For the saturated areas, plugs of plants will be used and holes will be dug with a trowel.

Approach Justification: Plants acquired from nurseries are often root bound; root trimming reduces the likelihood of girdling later on, which reduces the chance of reaching full maturity and even kills the plant (Chalker-Scott 2009). Mudding in the plants removes air pockets, and makes sure that there is maximum contact between the soil and plant roots (Flott 2006). It also helps to anchor the plants in the ground, which will reduce maintenance later on (Flott 2006). Live staking and using plugs are common planting techniques that are used for specific material. Live staking will occur as soon as possible, during the end of winter, before the trees leaf out and shade the stakes.

AD3: A slurry of mud was mixed within each hole instead of poured in, because this was easier for volunteers and more efficient.

Goal 2: Improve habitat for a diversity of native fauna.

Objective 2-1: Establish a diverse plant community that provides cover, foraging, and nesting habitat.

Task 2-1a: Take into consideration what animals exist on-site, or could exist on site, learn what their habitat needs are, and choose plants accordingly.

Approach: Select plants based on their benefits to birds, insects, amphibians, reptiles and small mammals.

Approach Justification: We chose an array of plants that could benefit a wide variety of species so that this area can serve a greater function than at present (Table 8). For example, *P. capitatus* provides good browsing material for wildlife and can form thickets for sheltering birds (Gage 2006). *C. sericea*, *Salix sitchensis*, and *Lonicera involucrata* also provide food and shelter for ungulates, birds, and other animals, and forage for native pollinators (Moore 2003). Having a wide variety of beneficial plants may help initiate the return of native fauna that used the park in the past.

Objective 2-2: Promote amphibian habitat structurally along the streams.

Task 2-2a: Incorporate plants that will provide potential shelter and breeding habitat for amphibians and reptiles.

Approach: We will be planting *S. sitchensis*, *P. capitatus* and *C. sericea* along the streams, *Carex obnupta* in the saturated areas, and *B. spicant* and *P. munitum* throughout the site.

Approach Justification: *S. sitchensis, P. capitatus*, and *C. sericea* are plants that help to stabilize the stream bank and slow down the water. This will help with filtration, which benefits animals that use the water, as well as create more shelter along the stream. Pacific tree frogs, which are of specific concern among the community, require slow moving water and small ponds, where they can attach their eggs to small twigs and grasses. By establishing these plants, we would be creating a potential breeding habitat. Furthermore, the ferns, *B. spicant*, *A. felix-femina*, and *P. munitum* provide low shelter for amphibians and reptiles while *C. obnupta* provides evergreen cover year-round for these types of animals (Table 8) (Nafis 2012).

Goal 3: Improve hydrological functions on site.

Objective 3-1: Promote stabilized stream banks using riparian native plants.

Task 3-1a: Install plants that are good due to their stabilizing qualities.

Approach: Plant *T. plicata, S. sitchensis, P. capitatus, C. sericea,* and *L. involucrata* alongside edges of stream bank in Polygons 2 and 3 (Figure 7; Figure 8).

Approach Justification: *T. plicata, S. sitchensis, C. sericea,* and *L. involucrata* are all species that help stabilize stream banks. For example, *C. sericea* has extensive root systems used to bind soils that have already been damaged (Stevens and Dozier 2002). *T. plicata* also serves the same purpose but does not have extensive root systems (Nesom 2002).

Objective 3-2: Establish plant communities that encourage filtration of street run-off pollutants.

Task 3-2a: Plant species such as *S. sitchensis*, *C. obnupta*, and *Scirpus microcarpus* along the stream bank and in saturated areas of Polygon 2.

Approach: We will be planting a high density of plugs and various shrub species.

Approach Justification: Shrubs such as *S. sitchensis* and *P. capitatus* will help to slow the water down for better filtration. *S. sitchensis, C. obnupta* and others (Figure 7) are beneficial to the site through their ability to filter pollutants. *C. obnupta* helps provide sediment retention and nutrient uptake. It also helps contribute to the improvement of water quality (Native Plant Guide 2005). *S. microcarpus* has dense root mass which makes it a good choice for soil stabilization. Its aboveground biomass will provide protection from stream currents that erode stream banks (Native Plant Guide 2005). Establishment of these species will encourage the development of a wetland that can filter street runoff more efficiently, instead of letting it flow through the watershed.

AD4: The Native Plant Guide citation should be "Guide for Using Willamette Valley Native Plants" instead, as pointed out by Professor Gold.

Goal 4: Promote stewardship and maintenance of the site.

Objective 4-1: Design the site in a way that discourages human disturbance of soil and plants.

Task 4-1a: Plant species that deter human traffic.

Approach: We will be planting *Rosa nutkana* along the edges of the site.

Approach Justification: *R. nutkana* can grow to a height of 3 to 6 feet, forms dense thickets, and has thorns. These characteristics make *R. nutkana* a natural barrier that will prevent people from walking through certain parts of the site (Tirmenstein 1989).

Task 4-1b: Create structural mounds in Polygon 4 and plant in clusters throughout the site.

Approach: Three triangular mounds will be constructed. Each mound will be planted with native vegetation, leaving enough distance between plants to ensure that there is sufficient water. Elliptical islands (clusters of plants) will also be utilized, though they will not be raised or require any movement of soil. These will be planted more densely (Figure 10; Figure 12).

Approach Justification: Planting in mounds and islands creates areas for volunteers to walk, so that they are less likely to damage installed plants. This was requested by our CP. They will be small enough for volunteers to weed from the edges. Planting less densely will help prevent plants from drying out within the mounds.

Objective 4-2: Work with the CP to create opportunities for public engagement, while effectively communicating and advertising said opportunities to community.

Task 4-2a: Determine which methods of communication will be used.

Approach: We will consult with our community partner to spread the word of the restoration project through fliers, notices on networks, community websites, and local newspapers.

Approach Justification: Having a well-informed community might help people become invested in the park, making them more likely to dedicate their time towards helping to restore it. The CP will be an important factor in getting the community involved.

Objective 4-3: Host volunteer work parties in various phases of the project.

Task4-3a: Determine when work parties are needed and schedule accordingly.

Approach: Collaborate with the CP so that she can help inform the community of upcoming work parties, as well as do our own informing using the methods as the previous task.

Approach Justification: When people see notices of a work party, they may become more interested in the project and volunteer their help. People who perform actual work on the site may become personally invested in its future, and may be more likely to take an active role in its restoration and maintenance. Volunteers are crucial for the success of the restoration, due to the fact that much of the short-term and long-term maintenance is performed by volunteers.

Objective 4-4: Create a long-term maintenance and monitoring plan for the CP.

Task 4-4a: Work with the CP to develop maintenance and monitoring plan.

Approach: We will work with the CP to create a long-term maintenance plan for the site.

Approach Justification: Frequent communication will help enable us to achieve the CP's vision of the park in the future. Any input given to us will be welcome and taken into consideration in order to ensure that the goals of the community partners are addressed. This will help ensure that the restoration's effects will be more long lasting, and that the park will be well maintained and monitored in the future to prevent it from reverting back to its previous state.

Goal 5: Provide educational opportunities on Northwest ecosystems, restoration and this project.

Objective 5-1: Create improved lesson plans based on past years for use in biology classes at Kirkland Junior High School.

Task 5-1a: Collaborate with the biology teachers to create a lesson plan.

Approach: Work together with Susan Buyarski-Crauer and Kathy Colombo, two biology teachers at Kirkland Junior High School, to improve upon past lesson plans that will best incorporate the restoration project into their biology classes.

Approach Justification: Using past years' lesson plans as a basis will help us determine with Ms. Buyarski-Crauer and Ms. Colombo what was successful and what was not. Improving upon them will benefit the students, because these students will get a better educational experience in relation to our restoration site.

Specific Work Plans

Current Conditions

Our project site is divided into four polygons based on hydrology, topography and upper canopy cover. Non-native vegetation is present throughout the site, depending on the polygon (Figure 6). A thin layer of organic deciduous leaf litter up to 3 cm in depth was found consistently throughout the site. Soil types are also fairly consistent. Based on the information provided by the Bothell weather station, the average total rainfall per year is 38.85 in., based on measurements taken since 1930, with an average total of 1.85 in. during July and August (DRI 2010).

Site Polygons

Polygon 1 is located on the eastern edge of the site, receiving filtered sunlight as well as direct sunlight from the east. The soil here is well-drained, because this area is on a 5 degree slope facing west. The soil is a sandy clay loam texture. There is a deciduous tree layer of *P. balsamifera* and *A. rubra* and many non-natives, predominantly *R. armeniacus*.

Polygon 2 is a topographical depression. There is water draining into the park 5 meters north of the project site from a storm runoff drain on NE 98th St. The stream causes the creation of a wide moist area, and contains runoff from the streets and residents' yards. There is standing water on the north side of the polygon, which runs through the length of the polygon when it rains or during the times of the year with heavier rainfall. During heavy rainfall, this stream connects with the other creek to the south of the project site. This area is mostly shaded by *A. rubra*.

Polygon 3 is located in a mostly shaded area with well-established deciduous tree cover of *P. balsamifera* and *A. rubra*. Slightly more leaf litter is present here, with decreased amounts of *R. armeniacus* due to the shade. A stream runs through this polygon, and there are moist to saturated soils throughout this polygon. This creek, which originates from a natural spring, connects with the Forbes Creek, which then drains into the northeast corner of Lake Washington. The creek runs year-round, but with a greater velocity and amount of water during rainier seasons. The side of the bank does not appear to be heavily eroded by the stream. Soil texture here was moderately-grained sandy clay loam underlain by fine-grained sandy clay loam and the area is relatively flat.

Polygon 4 is a topographically raised area. The soil is drier and there is only partial canopy cover from *A. rubra*. The trees are more spread out in this polygon, causing *R. armeniacus* to dominate the understory at over 50% cover. There is a large part of the polygon that is almost completely open in terms of lack of canopy. Soil textures in this polygon are sandy clay loam with some mottling detected in the B horizon.

Site Vegetation

Polygon 1 has little variation in structure and species. It has dense tree stands, predominantly *P. balsamifera* at 15% cover and *A. rubra* at 35-40% cover. The main invasive species is *R. armeniacus*, covering between 25-45%. The distribution of *R. armeniacus* is positively correlated with light availability, as it is more commonly found in areas where sunlight is able to reach down into the understory. This occurs in areas where canopy-forming trees are more spread out from each other. The other two invasive species are *Polygonum* sp and *R. repens*, both covering more than 5% of the area. Both understory species are located in front of the tree clumps, where there are little to no other structural features to block sunlight and water in-flow. Therefore, these two species have the potential to continue to grow and spread across the site if they are not dealt with.

In Polygon 2, the dominant upper canopy species is *A. rubra* with a cover of about 25-30%. The sub-canopy is not particularly dominated by any one species. 15% of the cover is *R. spectabilis*, which is the highest percentage. The understory is 15-30% dominated by *R. armeniacus* and about 20% by *E. arvense*. Other existing native species include *L. americanum* with a cover up to 12%, *Pteridium aquilinum* up to 4%, and *Tolmiea menziesii* with 5%. The other invasive species that are slowly making their way towards the site are *Solanum dulcamara* and *Phalaris arundinacea*. This polygon contains some diversity in terms of species, but not as much in terms of density.

Polygon 3 has dense top canopy and sub-canopy layers, making it more shaded. The top canopy consists of 10% *P. balsamifera* and 30% *A. rubra*. The sub-canopy is semi-dominated by *Salix* sp. which covers 25% and *A. circinatum* covering up to 35%. Other native species include *A. filix-femina*, *E. arvense*, and *P. munitum*, none of which are prominent. The only invasive species found here is *R. armeniacus*, and it is not extensive. All of the canopy cover in this particular polygon creates shade, which inhibits its growth.

AD5: *Ilex aquifolium* can also be found within this polygon.

Polygon 4 is the section with the most open area. There is only up to 20% canopy coverage of *A. rubra* and they are fairly scattered. The sub-canopy is not dominated by any species. Cover consists of 2% *Salix sp.* and up to 15% *R. spectabilis*. For the understory, a solid 50-70% of the coverage is invasive *R. armeniacus.* It is overcrowding the *P. munitum* which is covering about 25-30%. The only other invasive species, which is barely present, is *S. dulcamara*. There is not a lot of variation in structure and species in this polygon.

Site Preparation Activities

Polygon 1 is a deciduous forest on a slight slope of less than 5 degrees that faces west. This section also borders the park, causing it to receive more sunlight from the east than from other areas. Modifications will include removal of non-native vegetation, planting of native conifers and native shrubs, and mulching. This site is on a slope but erosion is not an issue. The slope is very gradual, so mulch should not be swept away by runoff. In this site, mulch plays a critical role in reducing non-native encroachment from the eastern side of the site, which is completely non-native.

Polygon 2 is distinguished by the street runoff that drains into the section from the north. First, non-natives species will be removed. The northern 1/3 of this polygon becomes heavily saturated, so live stakes will be planted in order to stabilize sediment. Mulch will be added to the entire polygon except for areas that become saturated. These areas include the saturated area in the northern third and the area down the center where there is a seasonal creek.

Polygon 3 has dense top canopy and sub-canopy layers, making it slightly more shaded than other polygons. Due to presence of shade, the invasive *R. armeniacus* is not as prominent (Figure 6). Site preparation activities for this polygon will mainly include the removal of non-native species; however, this polygon contains the least amount of non-natives so this will be limited. Live stakes will be planted along the stream to promote stream bank stability and prevent erosion. Mulch will be spread, excluding 2 feet away from the stream on both sides.

Polygon 4 is a deciduous forest, with an average of 12.5% upper canopy cover, compared to an average of 62.5% upper canopy cover in the other sections (Figure 7). As a result of more sunlight, there is a higher density of *R. armeniacus* found here. More extensive removal of this non-native will be required for this polygon (Figure 6). Afterwards, we will create a few micro-sites, by constructing mounds in a triangular configuration using existing soil in the Polygon 4. The height of the mounds will be no more than four inches tall. Clustered plantings will also be utilized. Mulch will then be added throughout the site, especially in the areas between the mounds and islands.

Logistical Considerations

Potential Area Disturbance

A trail runs through the park from the south to north and splits into two trails, which run to the east and west. The trail to the west runs adjacent to the south border of Crestwood Park before connecting with Kirkland Junior High School. This trail receives a significant amount of recreational use by students, residents and visitors. Moreover, this trail represents the only point of access to our project site, as the rest of it is inaccessible due to the high density of *R. armeniacus* and other constraints from the native vegetation. To minimize disturbance, disruption, and impact to the area and adjoining community, one primary pathway will be utilized to enter the site from the north from this main trail. Volunteer parking will be available along the park side of 110th Ave NE across from the residential dwellings and will be supervised in order to retain as minimal damage as possible to the strip of lawn that runs along east boundary of our site and southward towards the end of the park (Figure 8).

Mulch

Mulch will be staged near the trail head and adjacent to the point of entry into our site (Figure 8). This area was chosen because it is the most accessible and can serve as a convenient location for vehicle delivery. Additionally, by staging mulch in this location we will not interfere with the trail utilization by everyday users. For cold composting, we have decided to use Polygon 4 as it holds the highest density of *R. armeniacus,* thus providing the shortest carrying distance of the removed invasive materials onto the compost pile. Other restoration materials may also be kept in this location.

Entry Points

Our main entry point is located to the north of our site, where the pathway leads through the adjacent previous restoration site into Polygon 4, at our site (Figure 8). This is the only entry point we can realistically use, due to the high density of *R. armeniacus*, native vegetation and landscape features. However, there are potential problems with using this path. Human traffic may compromise the integrity of a freshly restored site by damaging recently planted native species. In order to help avoid this, we will temporarily mark the best fitting pathway with mulch and woody debris to prevent trampling and disturbance. To further discourage human traffic, we will be planting in mounds and islands. There will not be one singular pathway through the site once restoration is complete: there will simply be enough space for volunteers to perform maintenance.

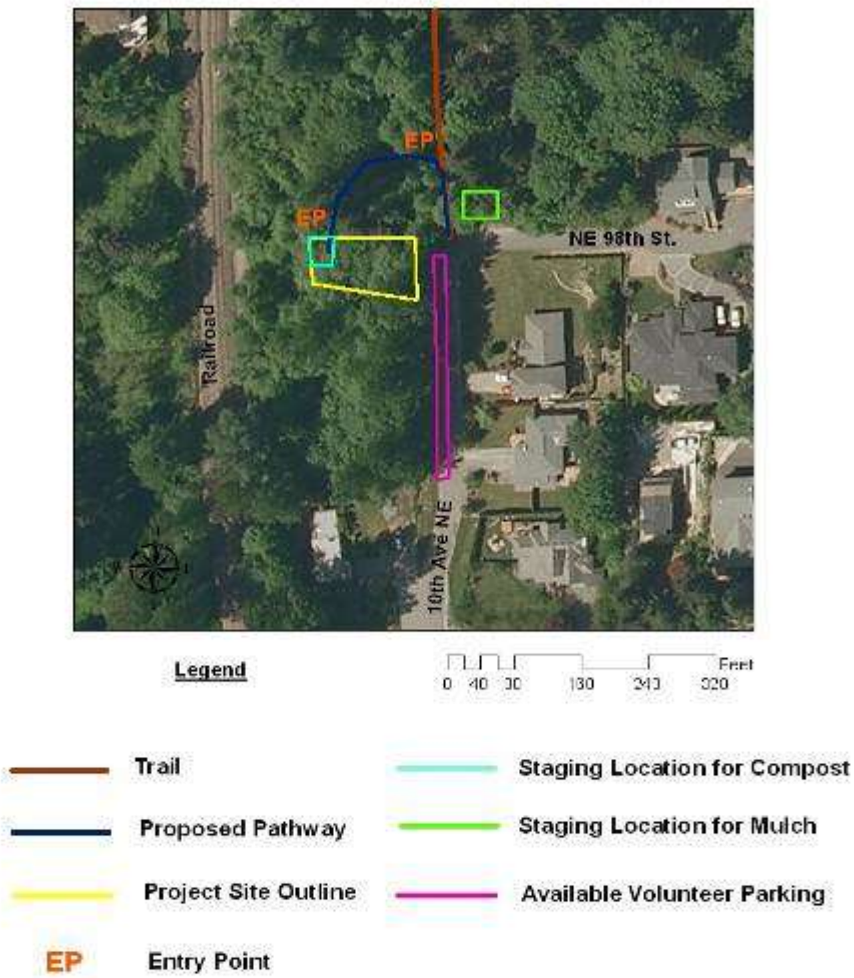

Figure 8: Logistical Places

Planting Plan

Polygon 1

The long-term goal of this polygon is to establish a conifer-deciduous mixed forest. Polygon 1 already contains established adult *A. rubra* and *P. balsamifera* trees, which will provide some shade throughout the site. There will still be some direct sunlight from the east. 2 *P. menziesii* will be planted along this eastern edge, where there is more sunlight and also where the soil is sandier and drains more efficiently. One will be planted in the northern section along the edge, and the second towards the middle along the edge (Figure 9). The recommended distance for this species is 10-foot centers (Plant Selection Guide). 2 *T. heterophylla*, which are more shade tolerant, will be planted in the middle of the polygon, at suggested 6-foot centers (Figure 9) (Nursery Trees 2011). They will thrive in the shadier areas on the west side, enabling them to grow tall and help shade out invasive species in the future (Objective 1-1). These species provide cover and habitat for many wildlife species and small mammals (Objective 2-1). Both will be planted as 12 inch plugs. 3 *Fraxinus latifolia*, which establishes well in wet soils, will be planted on the western side of the polygon in the form of 1 gallon containers (Objective 2-1) (USDA Forest Service). 3 *P. sitchensis* will be planted under gaps in the canopy at 10-foot centers (Nursery Trees 2011).

AD6: The citation for Nursery Trees should be "Ornamental & Landscape Trees."

Holodiscus discolor does well on slopes and at the edge of deciduous forests of alder, making this an ideal option to plant near the *A. rubra* on the edge of the site (Leigh 1998). There is sufficient sunlight along the edge of the polygon for this species to do well in. 6 will be placed along the edge, at 2-foot centers, to incorporate more diversity (Figure 9) (Objective 1-3) (Plant Selection Guide). *C. sericea* prefers moist soils and is easily established, even in disturbed areas (Stevens and Dozier 2002). It will grow quickly and will provide food and cover for various small mammals, birds, as well as browse for larger wildlife (Objective 2-1) (Crane 1989). There would be 6 planted along the border between polygon 1 and polygon 2. *R. nutkana* is a thorny plant, which will help prevent people from accessing the park through this area (Objective 4-1). 9 will be planted at 3-foot centers because of our desire to have dense cover. *Symphoricarpos albus* is highly adaptable in terms of sunlight and soil conditions and will also add to the diversity plant communities (Favorite 2002). We will plant about 6 in bare root form, at 2-foot centers (Figure 9) (Plant Selection Guide). *Oemleria cerasiformis* like moist or wet soils, and can tolerate shade or partial shade, making them good choices for the wet sub-polygon (Plant Selection Guide). Two will be planted in the form of 12-18 inch bare roots.

P. munitum does well in moist soils or partial shade, and can also tolerate sunny and dry conditions once it becomes established (Native Plant Guide). It will be used as a structural element as well as ground cover and is able to persist through canopy development. They provide excellent amphibian habitat around their base as older fronds die (Objective 2-2) (Native Plant Guide). We will plant about 16 plants in 4" pots, or larger salvages if we can obtain them. The recommended distance for this species is 3-foot centers (Figure 9) (Plant Selection Guide). We will try to get the majority of these species as salvaged materials.

AD7: The Native Plant Guide citation should be "Guide for Using Willamette Valley Native Plants."

AD8: Beaked hazelnut, vine maple, serviceberry, salal, Pacific ninebark, deer fern and lady fern were added to this polygon (Figure 10).

Polygon 2

Polygon 2 has the most issues with hydrological functioning. The wet area, which is the top half of the polygon, has more saturated soil. Stream bank stability and water filtration are the main objectives for this polygon. *S. sitchensis*, *C. obnupta*, *C. sericea*, and *L. involucrata* are the plant species we chose to help with strengthening the stability of the stream bank. *C. sericea* has extensive root systems that are helpful in binding soils that have already been damaged (Stevens and Dozier 2002). For the seasonal creek at the bottom here are many *A. rubra* trees already, so we are focusing on providing a mid-canopy cover using species such as *A. circinatum*, which already exists on site, as well as valuable shrubs such as *C. sericea* and *L. involucrata* for stream bank stability. These species will still allow some light to filter through the canopy.

We will plant 4 *S. sitchensis* in the wetter areas of the polygon, using live stakes. The recommended distance is 2-foot centers (Plant Selection Guide). They grow quickly and possess soil binding qualities (Objective 3-1) (Moore 2002). 6 *C. sericea* and 4 *A. circinatum* will also be planted here, at 4-foot centers (Figure 9) (Plant Selection Guide). These will help provide food and cover for wildlife, as well as adding to the diversity of the site (Objective 2-1; Objective 1-3) (Stevens and Dozier 2002; Favorite 2006). *C. sericea* will be planted using live stakes, and *A. circinatum* will be planted using 12 to 18 inch bare roots. *L. involucrata* is a valuable shrub for stream bank stability and restoration of riparian areas (Objective 3-1) (Darris 2011). We will plant 6 in the wetter areas of the polygon. The recommendation for this species is 3-foot centers (Figure 9) (Plant Selection Guide). We will be planting 6 *P. capitatus* in this area, since it is another species that thrives in wet soil (Figure 9). The suggested distance is 2-foot centers (Plant Selection Guide).

We will plant 15 10-inch plugs of *C. obnupta*, at 6-inch centers (Figure 9). It will help improve hydrological functions by providing storm water abatement and strengthening stream bank stability (Objective 3-1) (emswcd.org). *S. microcarpus* will be planted in two dense clusters of 10 plants each in order to help with stream bank stabilization. We also will be planting 14 *P. munitum* in 4 inch pots because of the qualities stated previously (Figure 9) (Native Plant Guide). *B. spicant* is another ground cover that we will be using. It is a native fern that thrives in shade, moisture, and in the presence of organic matter. We will be planting about 9 around the shadier areas containing more organic matter, at a suggested distance of 2-foot centers (Figure 9) (Nursery Trees 2011). *A. filix-femina* does well in both shady and sunny regions, so we can plant 15 of them throughout the polygon in clusters of 3-4.

AD9: The Native Plant Guide citation should be "Guide for Using Willamette Valley Native Plants."

AD10: The citation for Nursery Trees should be "Ornamental & Landscape Trees."

AD11: Oregon ash and snowberry were added to this polygon (Figure 10).

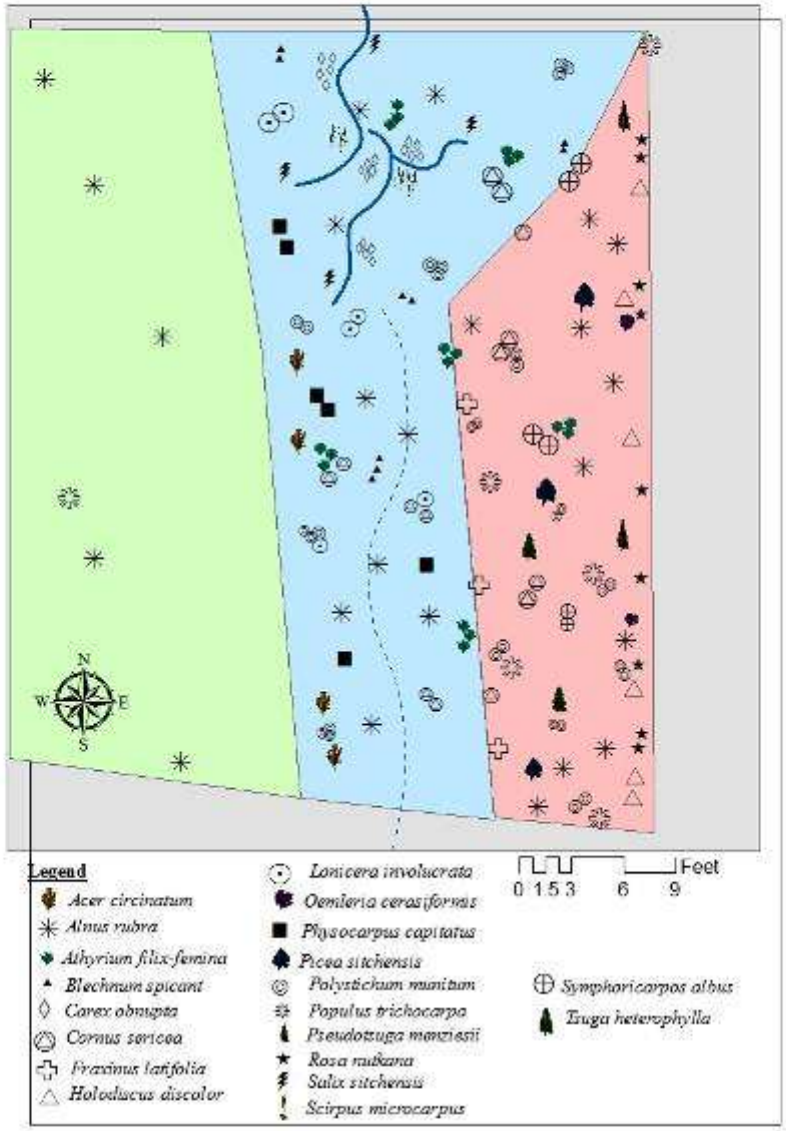

Figure 9: Original Planting Plan For Polygons 1 and 21

[1] *Alnus rubra* and *Populus trichocarpa are pre-existing vegetation.*

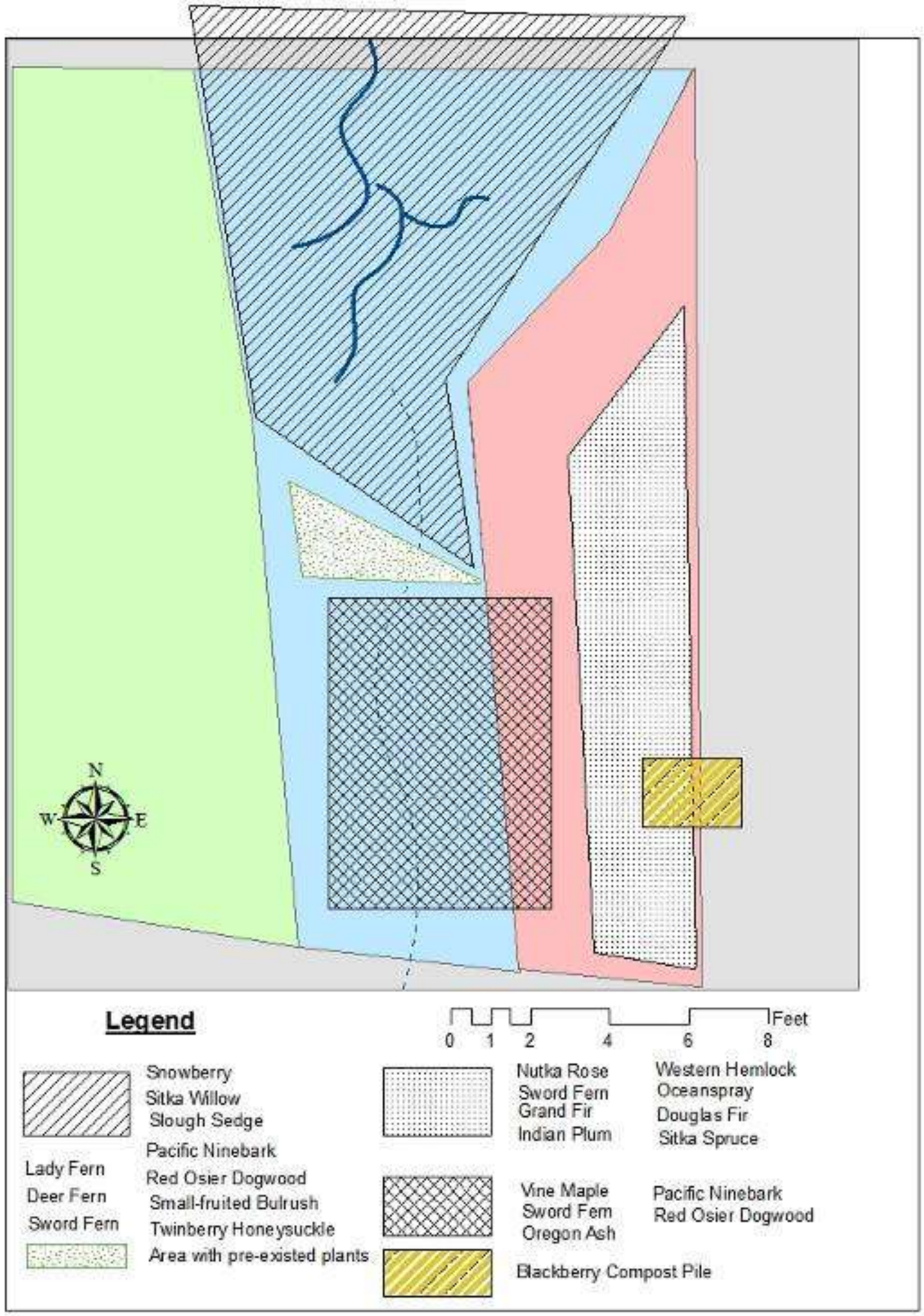

Figure 10: As-Built Map For Polygons 1 and 2

Polygon 3

A stream runs through this polygon, causing the soils to be moist and saturated. Species that thrive near streams will be planted alongside it, while the remaining plants will be planted in elliptical island configurations (Figure 11). This polygon is the most shaded.

AD12: Island configurations were only utilized on the west side of the stream in this polygon. Due to prevalence of native vegetation on the east side of the stream, it was not possible to plant in island configurations there (Figure 12).

AD13: The elliptical shape of islands was not used. Instead islands were framed around existing vegetation and are irregularly shaped.

S. sitchensis and *C. sericea* will be planted along both sides of the stream, because they possess soil binding qualities which will help control erosion, and will promote amphibian habitat (Objective 2-2; 3-1) (Moore 2002; Stevens and Dozier 2002). Both species will also provide habitat for many bird, mammal, and insect species (Objective 2-1) (Table 1). *S. sitchensis* will be planted using live stakes, which will come from hardwood cuttings at Yesler Swamp (Plant Selection Guide). There will be 10 live stakes planted at 2-foot centers (Figure 11). *S. sitchensis* also acts as a filtering agent to promote cleansing of the stream (Jurries 2003) (Objective 3-2). There will be 4 *C. sericea* planted in 12 to 18 inch bare root form, along each side of the stream at 3-foot centers, as well as in the shadier part of the polygon. 5 more can be planted in the more open area adjacent to Polygon 4 (Figure 11). Additionally, 15 *C. obnupta* will be planted along the stream at 2-foot centers, because it does well under shady and wet conditions (Plant Selection Guide).

AD14: Small-fruited bulrush, red-osier dogwood, slough sedge, lady fern and Sitka willow were used in the area added north of Polygon 3, in the section that is closer to polygon 2, across the stream (Figure 12).

P. capitatus and *R. spectabilis* are also good species to use on stream banks due to their soil binding qualities (Objective 3-1) (Leigh 1999). *R. spectabilis* is already prevalent in Polygon 2, so hardwood cuttings will be taken from existing plants, if needed. There will be 9 plants placed along the stream (Figure 11). It is recommended that they be planted at 4-foot centers (Plant Selection Guide). *P. capitatus* will be purchased in 12 to 18 inch bare root form, and will be planted at 4-foot centers (Plant Selection Guide). This amounts to 3 plants on each side of the stream (Figure 11). *S. albus* and *Corylus cornuta* were chosen due to their tendency to form dense thickets and for their valuable foraging qualities: they will be planted at the section closer to the Polygon 4, where there is higher sun availability (Plant Selection Guide). Both of these species will be acquired in the form of 12-18 inch bare roots, and will be planted at a recommended distance of 4-foot centers (Plant Selection Guide). This amounts to 4 *S. albus* and 4 *C. cornuta* plants being used in this polygon (Figure 11). Additionally, we will employ *B. spicant* and *A. filix-femina* as ground cover throughout this polygon, as these species thrive in the conditions this polygon provides (Plant Guide). We will acquire *B. spicant* and *A. filix-femina* in the form of 4 inch pots, utilizing about 24 and 15 respectively (Figure 11).

AD15: Salmonberry was not utilized in this polygon, because we became aware of its already abundant presence (Figure 12)(Table 7).

AD16: Pacific Ninebark was planted in live stake form throughout this polygon instead of bare root form (Figure 12)(Table 7).

AD17: Beaked hazelnut was planted mainly in the added area to the south of the polygon 3 (Figure 12).

With deciduous species already established on the site, *T. heterophylla* and *T. plicata* would likely thrive due to their shade tolerance. Planting these would satisfy our main goal of promoting succession towards a natural mixed conifer stand, as well as add diversity to the plant community (Goal 1; Objective 1-3). They will also help shade out invasive species once they become established and grow taller (Objective 1-1). Both would be acquired in 12 inch plug form. The recommended planting density for *T. heterophylla* is a minimum of 6-foot centers, resulting in 5 trees on the railway side of the Polygon 3 (Figure 11) (Plant Selection Guide). There would be 4 *T. plicata* trees planted, at recommended 6 to 10-foot centers (Figure 11) (Plant Selection Guide). *Rhamnus purshiana* is shade tolerant, does well in moist soils, and is commonly found near *A. rubra*, making it a good choice to plant in this polygon (Habeck 1992). It can be acquired in a 12 to 18 inch bare root form. There will be 4 plants placed at a recommended planting density of 4-foot centers (Figure 11) (Plant Guide Selection).

AD18: Sitka spruce was planted throughout this polygon, as it thrives under moist soil conditions (Figure 12).

AD19: Douglas fir was planted in one of the islands that is closer to the open canopy section of Polygon 4 with higher light availability (Figure 12).

AD20: Indian plum was utilized throughout the western side of the stream in this polygon, in each island configuration (Figure 12).

AD21: Oregon ash was added to the island configurations in this polygon, as well as in the area added to the south (Figure 12).

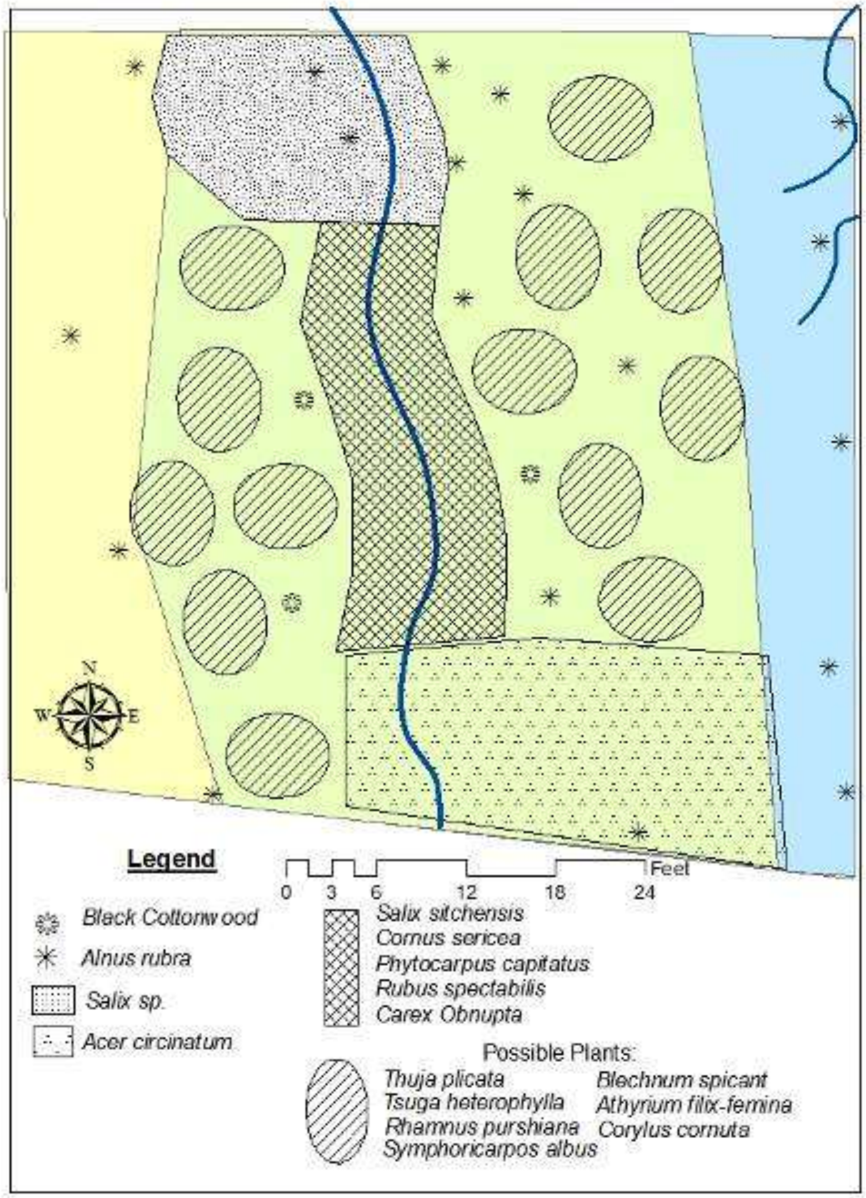

Figure 11: Original Planting Plan For Polygon 3[2]

[2] *Alnus rubra* and *Populus trichocarpa are pre-existing vegetation*

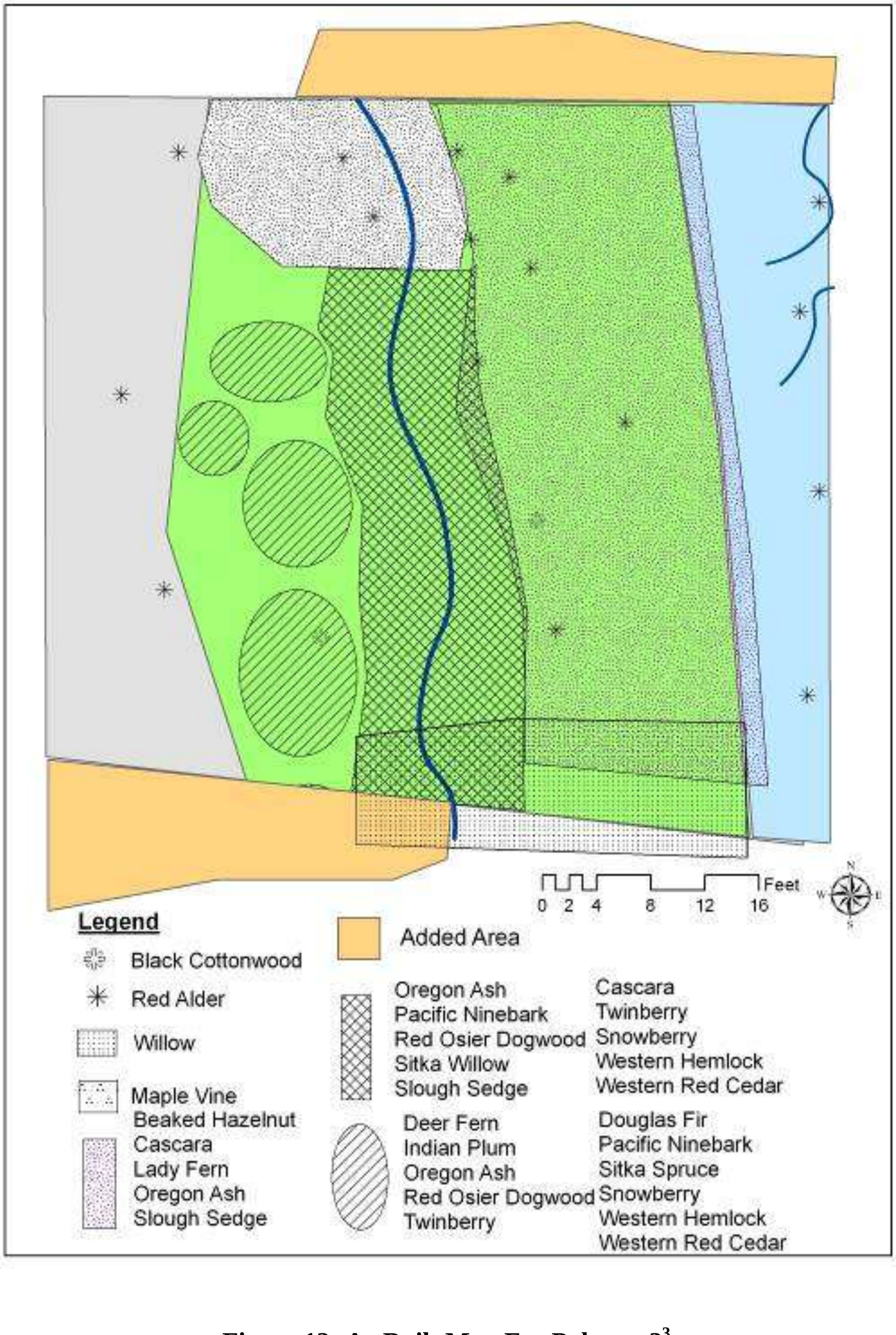

Figure 12: As-Built Map For Polygon 3[3]

[3] *Alnus rubra* and *Populus trichocarpa are pre-existing vegetation*

Polygon 4

Polygon 4 will be divided into two sub-polygons, with one being more shaded and wet, towards the south side of the polygon, and one being less shaded and drier. The wetter sub-polygon contains all *A. rubra* currently growing in the polygon. These adult trees shade this sub-polygon, enabling shade-tolerant species to potentially grow here. This area will contain triangular mounds, six feet long on each side (Figure 13). Due to the tendency of these mounds to dry out, we will be constructing only three of them in shaded areas. They will contain species that have a higher tolerance for decreased amounts of moisture. For the rest of the polygon (both dry and wet), we will be planting in "islands," or clusters of plants. These will be elliptical in shape, to make it easier to weed. They will not end up being perfectly elliptical, but we are aiming for 8 feet across and 6 feet wide (Figure 13). These islands will be planted a little more densely than the mounds, to help prevent the return of *R. armeniacus* (Figure 13) (Objective 1-1). However, if possible, more inexpensive plant materials will be used in these islands, due to the chance of higher mortality rates in the future. Planting in mounds and islands will help satisfy the wishes of the CP, who wants volunteers to be able to walk around and perform maintenance without stepping on plants (Objective 4-1). However, there will not be a single continuous pathway through the site, as this could encourage unwanted pedestrian traffic through. Instead, the islands and mounds will be spaced far enough apart (two feet, perhaps) that volunteers can walk around them, while still having a somewhat natural look. The sizes of the mounds and islands were chosen with maintenance in mind: volunteers should be able to weed from the edges of the islands and mounds, without having to go into them (Objective 4-1). The space between the islands and mounds cannot be too large, or *R. armeniacus* will likely have an increased chance of returning. To prevent this, mulching will likely have to be done in these more open areas (Objective 1-1). There will be approximately 15 elliptical islands and 3 triangular mounds in the wet sub-polygon, and 7 elliptical islands in the dry sub-polygon (Figure 13).

AD22: Instead of planting in uniform elliptical islands, islands were formed around pre-existing vegetation, primarily western sword fern: they are of many different shapes and sizes (Figure 14).

A. grandis will be planted in the mounds, due to its broader tolerance to changes in moisture. Water supply may become an issue in the mounds, during the drier months (Howard 2000). It also does well in shade, which is good due to the existing canopy formed by *A. rubra*. It also provides cover and nesting sites for a variety of small mammals and birds (Objective 2-1) (Howard 2000). There will be one planted per mound, in the form of 1 gallon containers, for a total of 3 trees. It is suggested that this species be planted on 6-foot centers (Plant Selection Guide). There are already existing *P. munitum* throughout the polygons, so no new ones will be planted. *G. shallon* does well in dry to moist soils, and can survive in shade or partial shade. This makes it a good choice to plant in the mounds, because it can tolerate the lower amounts of moisture, while still growing in shade (Plant Selection Guide). *S. albus* is another species that can be utilized in either the islands or the mounds. It does well in dry to moist soils, and likes full, partial, or no shade (Plant Selection Guide). There will be 2 of each of these species planted per mound, for a total of 6 per species. *G. shallon* will be planted in the form of plugs, and *S. albus* will be planted in bare root form.

AD23: Sitka spruce was planted in some of the mounds, because they were still in wet areas and in shade (Figure 13).

T. heterophylla and *T. plicata* were the tree species chosen for the islands in the wet sub-polygon. They are shade-tolerant and grow well in moist to wet soils, and will be planted in 12 inch plugs (Tesky 1992). The shade provided by existing *A. rubra* will enable these trees to grow and eventually add to the canopy cover, helping to shade out invasive species (Objective 1-1). It is suggested that they be planted at 6-foot centers (Figure 13) (Plant Selection Guide). They would not be good choices for the mounds because they might easily dry out: therefore these two species will be planted in the islands throughout the polygon. There will likely be one of each species planted per island, for a total of 15 each. *P. sitchensis* is also a good species for these islands, because it likes moist soils. However, it is not very shade tolerant, and therefore will be planted away from the existing *A. rubra*, so that it receives some sunlight (Griffith 1992). We will plant the *T. heterophylla* and *T. plicata* closer to the *A. rubra* if possible, since they do well in shade. There will be one of each planted in each island, at 10-foot centers (Nursery Trees 2011). *C. sericea, P. capitatus, L. involucrata, Amelanchier alnifolia, S. albus, O. cerasiformis, G. shallon,* and *A. filix-femina* will also be planted in the islands in the wetter sub-polygon. They all like moist or wet soils, and can tolerate shade or partial shade, making them good choices for the wet sub-polygon (Plant Selection Guide). All of these will be planted in the form of 12-18 inch bare roots, except for *L. involucrata*, which will be planted with live stakes, at 2 to 4-foot centers (Plant Selection Guide). One individual from each of these species will be planted in each island for a total of 15 each (Figure 13). These islands will be planted more densely than the suggested distances, which assume no mortality. We do expect some plants to die during the restoration process, hence the denser planting. However, they will not be planted so densely as to have too high of an initial mortality rate.

AD24: The numbers of species per island was altered, due to existing vegetation and variation in island size and shape (Figure 14).

AD25: The citation for Nursery Trees should be "Ornamental & Landscape Trees."

AD26: Serviceberry was not utilized in the very wet areas of Polygon 4, as suggested by Professor Gold (Figure 14).

The drier sub-polygon contains no *A. rubra*. Species that can prosper in drier soils and sun will be planted here. *P. menziesii* was chosen for this sub-polygon, since it survives better in sunny, dry areas (Uchytil 1991). Like the tree species in the wet sub-polygon, it will eventually grow taller and help to shade out invasive species (Objective 1-1). There will be no mounds used here, since the soil already has less water than the other parts of the polygon. To keep the polygon uniform, as well as keeping volunteer maintenance in mind, we will be planting in islands here as well. There will be 7 *P. menziesii* trees planted, in 12'' plugs, at 10-foot centers (Figure 13) (Plant Selection Guide). Each island will contain one *P. menziesii*, as well as *C. sericea*, *A. alnifolia*, and *S. albus*. There will be two of each of these species in each island, resulting in one tree and 6 shrubs per island. These will be planted less densely than the islands in the wet sub-polygon, because of the decreased amounts of moisture in the soil.

AD27: The numbers of species per island was altered here as well, for the same reasons (Figure 14). The number of individuals planted was reduced for most species (Table 7).

Planting a variety of trees, shrubs, and herbaceous species will help make the plant and wildlife community more diverse (Objective 1-3 and Objective 2-1). *T. plicata* provides browse for larger animals, and cover for smaller animals (Tirmenstein 1989a; Tirmenstein 1989b; Uchytil 1989a; Uchytil 1989b). The seeds of *T. heterophylla* and *T. menziesii* are eaten by birds and mammals, and their foliage provides a food source for many insects and larvae (Tirmenstein 1989a; Tirmenstein 1989b; Uchytil 1989a; Uchytil 1989b). They also provide cover and nesting habitat. The berries / fruit of *O. cerasiformis, A. alnifolia*, *C. sericea*, *L. involucrata*, *S. albus*, and *P. capitatus* are eaten by birds and other wildlife (Tirmenstein 1989a; Tirmenstein 1989b; Uchytil 1989a; Uchytil 1989b). Hummingbirds and other pollinators enjoy the nectar from these species (Tirmenstein 1989a; Tirmenstein 1989b; Uchytil 1989a; Uchytil 1989b). See Table 6 for specifics.

Note: It is important to note that the distances in the previous narratives for all of the polygons are all *suggested* densities at which to plant. In actuality, the plants at this restoration site may be planted more closely together, because there will be some mortality. The increased density will help account for plants lost during the restoration process.

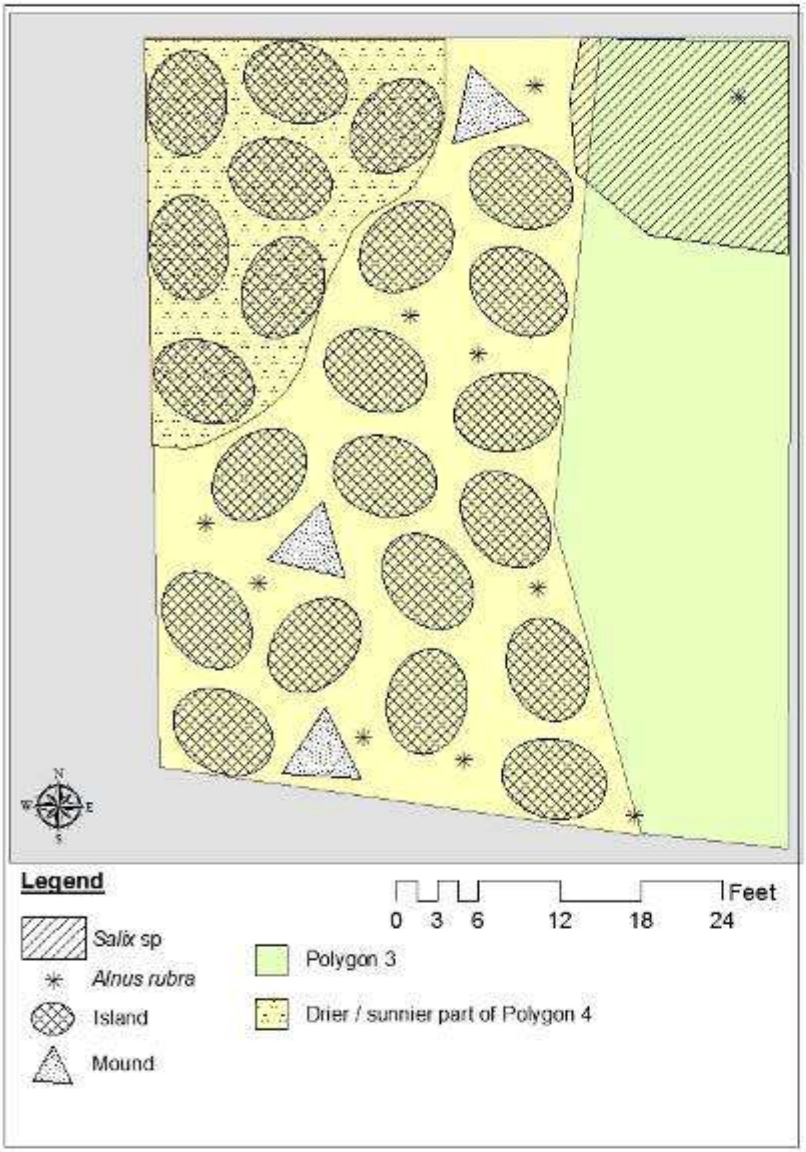

Figure 13: Original Planting Plan For Polygon 4[4]

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[4] *Alnus rubra* is pre-existing vegetation.

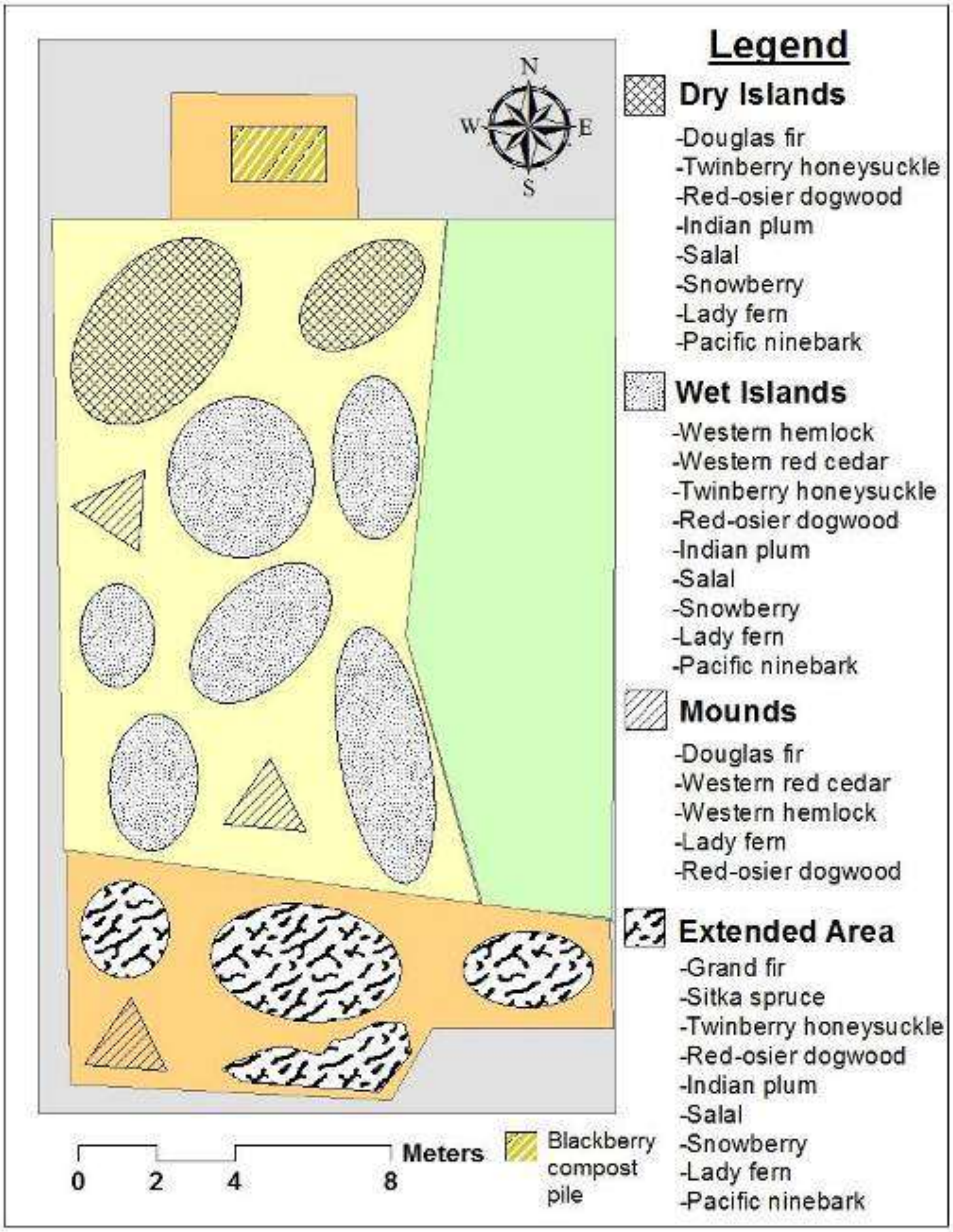


Figure 14: As-Built Map For Polygon 4

Table Revisions

Table 1: General Materials List

Task	Material	Qty	Source		Task	Tools	Qty	Source
~~1-1a~~	~~Trash bags~~	~~30~~	~~Us~~		1-1a	Shovels	22	CP
1-1a	Tarp	1	CP		1-1a	Loppers	40	CP
					1-1a	Gloves	50	CP /Self-brought
1-1b	**Mulch**	**27 yards**	**City of Kirkland**		1-1b	Shoves	22	CP
					1-1b	Gloves	50	CP /Self-brought
					1-1b	**Wheelbarrows**	**3**	**CP**
1-1c	**Plants**	**163**	**Various**		1-1c	Shovels	22	CP
1-1c	Marking tape	1	Us		1-1c	Gloves	50	CP /Self-brought
					1-1c	**Wheelbarrows**	**3**	**CP**
					1-2a	Shovels	22	CP
					1-2a	Gloves	50	CP /Self-brought
1-3a	Plugs	**142**	Various		1-3a	Shovels	22	CP
1-3a	Pots	**77**	Various		1-3a	Gloves	50	CP / Self-brought
1-3a	Live stakes	**92**	Various					
1-3a	Bare roots	**78**	Various					
2-1a	Plants	**98**	Various		2-1a	Shovels	22	CP
2-1a	Marking tape	1	CP		2-1a	Gloves	50	CP /Self-brought
					2-1a	**Wheelbarrows**	**3**	**CP**
2-2a	Plants	**161**	Various		2-2a	Shovels	22	CP
2-2a	Marking tape	1	CP		2-2a	Gloves	50	CP /Self-brought
					2-2a	**Wheelbarrows**	**3**	**CP**

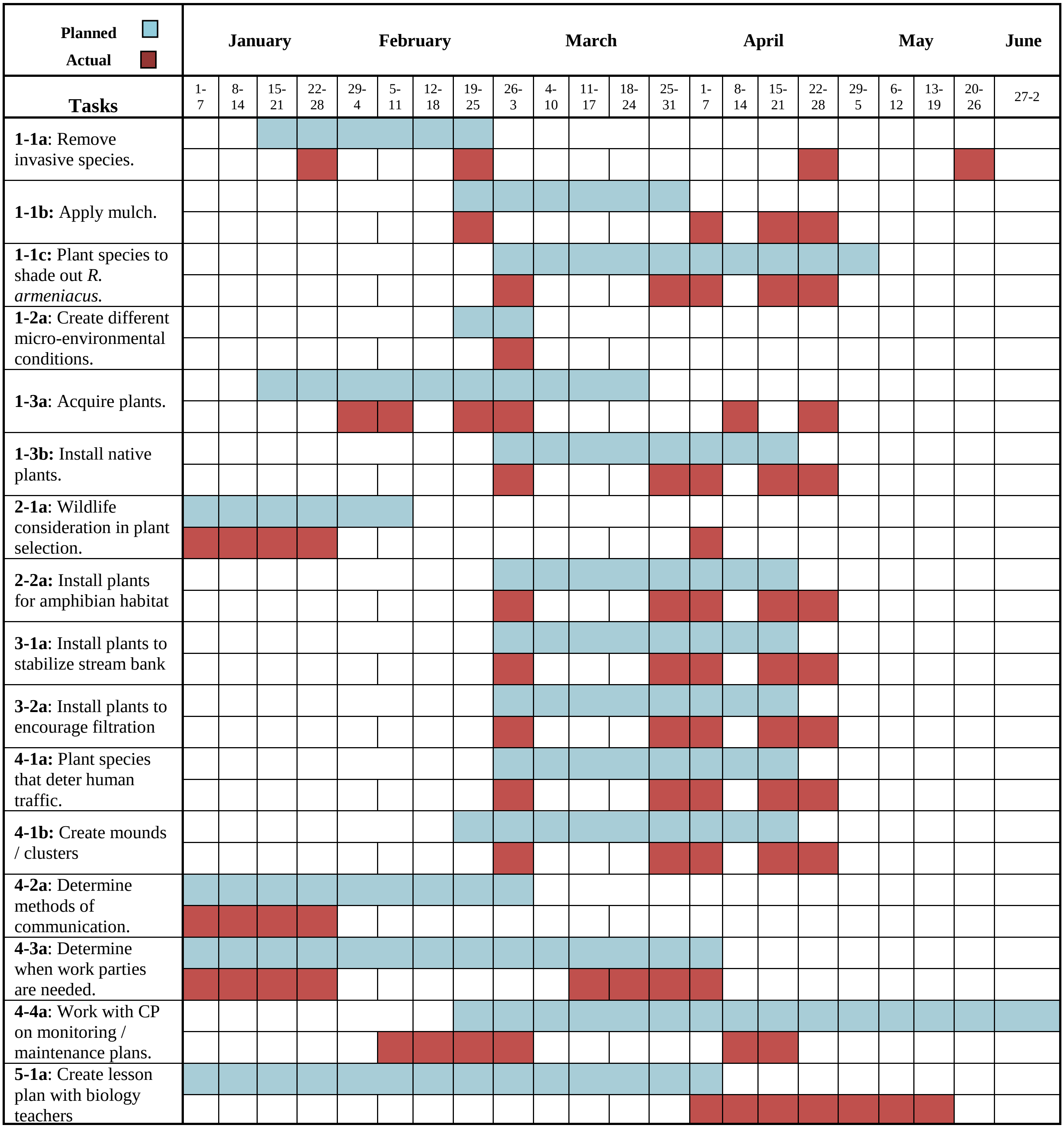
3-1a	Plants	**94**	Various		3-1a	Shovels	22	CP
3-1a	Markers	30	Us		3-1a	Gloves	50	CP /Self-brought
					3-1a	**Wheelbarrows**	**5**	**CP**
3-2a	Plants	**99**	Various		3-2a	Shovels	22	CP
3-2a	Marking tape	1	CP		3-2a	Gloves	50	CP /Self-brought
					3-2a	**Wheelbarrows**	**3**	**CP**
4-1a	Barrier Plants	**10**	Plant Sales		4-1a	Shovels	22	
					4-1a	Gloves	50	CP /Self-brought
					4-1a	**Wheelbarrows**	**5**	**CP**
					4-1b	**Wheelbarrows**	**5**	**CP**
					4-1b	Shovels	22	CP
					4-1b	**Soil**	**1/2 yards**	**City of Kirkland**
					4-1b	Gloves	50	CP
~~4-2a~~	~~Flyers~~	~~30~~	~~Us~~					
~~4-2a~~	~~Ads~~	~~TBD~~	~~Us~~					
					4-3a	Shovels	22	CP
					4-3a	Gloves	50	CP /Self-brought
					4-3a	**Wheelbarrows**	**5**	**CP**
5-1a	Lesson Plans	1	Us / Teachers					

Table 2: Plant List

	Polygon 1			Polygon 2			Polygon 3			Polygon 4		
Species	**#**	**ft**	**Form**	**#**	**ft**	**Form**	**#**	**ft**	**Form**	**#**	**ft**	**Form**
Abies grandis										~~3~~ 4	6	1 gal
Acer circinatum	2	4	12-18’’ BR	4	4	12-18’’ BR	2	4	12-18’’ BR	2	4	12-18’’ BR
Amelanchier alnifolia				2	3	12-18" BR	6	3	12-18" BR	~~20~~	3	12-18’’ BR
Athyrium filix-femina	3	3	4”pots	~~15~~ 7	3	4” pots	4	3	4'' pot	~~15~~ 11	3	4'' pots
Blechnum spicant	2	2	4" pot	9	2	4” pot	~~12~~ 9	2	4" pot			
Carex obnupta				~~15~~ 13	6’’	10" plug	15	6"	10" plug			
Corylus cornuta	1	2	12'' plug				~~4~~ 3	2	12'' plug			
Cornus sericea	6	3	Live stake	8	4	Live stake	~~8~~ 6	3	12-18” BR	~~29~~ 10	3	12-18’’ BR
Fraxinus latifolia	3	4	1 gal.	1	4	1 gal.	~~15~~ 6	4	1 gal			
Gaultheria shallon	3	3	plugs				8	3	plugs	~~21~~ 10	3	plugs
Holodiscus discolor	~~6~~ 5	4	6-12’’ BR									
Lonicera involucrata				6	4	Live stake	~~4~~ 10	4	Live stake	~~15~~ 11	4	Live stake
Oemleria cerasiformis	~~2~~ 3	6	6-12” BR				3	6	6-12" BR	~~15~~ 4	4	12-18’’ BR
Physocarpus capitatus	1	2	Live stake	~~6~~ 10	2	12” BR	~~4~~ 8	2	~~12” BR~~ Live stake	~~15~~ 8	2	12-18’’ BR
Picea sitchensis	3	10	12"+ Plug				5	10	12"+ plug	~~15~~ 7	10	12"+ Plug
Polystichum munitum	~~16~~ 4	3	4’’ Pot	~~14~~ 3	3	4’’ Pot	5	3	4" pot	8	3	4" pot
Pseudotsuga menziesii	2	10	12”+ plug				2	10	12"+ plug	~~7~~ 3	10	12”+ plug
Rhamnus purshiana							~~4~~ 5	4	12-18” BR			
Rosa nutkana	~~9~~ 10	3	Pot/salv.									
Rubus spectabilis							~~8~~	~~4~~	~~Live stake~~			
Salix sitchensis				~~4~~ 9	4	Live stake	~~8~~ 5	2	Live stake			
Scirpus microcarpus				~~20~~ 24	8”	10” plug	6	8”	10” plug			
Symphoricarpos albus	6	2	6-18’’ BR	8	4	12-18” BR	8	4	~~12-18” BR~~ Live stake	~~35~~ 20	2	~~6-18’’ BR~~ Live stake
Thuja plicata	2	6	12” plug				~~4~~ 8	6	12” plug	~~15~~ 13	6	12” plug
Tsuga heterophylla	2	6	12” plug				5	6	12” plug	~~15~~ 7	6	12” plug
Totals:	55			104			129			130		
Grand Total: 418												

Timeline Revisions

Table 3: Timeline



Lessons Learned

Financial Budget

With our expenditures, we were under the financial budget that was originally planned in our work plan document. Many plants were donated by the Highlands Neighborhood Association.

Table 4: Plant Budget Sources

	Order #	Date	Cost
SCD Plant Sale	331	03/08/2012	$266.62
Sound Native Plants	12-51	03/13/2012	$146.80
King Conservation District Plant Sale	100000522	03/17/2012	$72.27
Sound Native Plants	12-91	04/23/2012	$56.69
Total			**$542.38**

One financial lesson we learned was the importance of salvaging and live-staking. When we were ordering the plants, we had not yet attended any salvage events or confirmed the sources of live-stake sites, so we were not sure what we would be able to obtain. There was a specific county district that our CP preferred we buy from, and the deadline occurred before we had confirmation of the sites. Our second salvage option was not at a site where there were not enough plants that we were looking for, and the money saved from acquiring plants that were present would not make the gas spent on the traveling worth it. For future projects, it would be best to salvage and get live-stakes before plant buying deadlines, so that we have a better idea of what we will be able to get for free and what we will need to spend money on. If we had confirmed the sites earlier, we might have been able to save more money and could have given it to other restoration groups in the class that needed it.

A second lesson we learned involved not ordering exact amounts of every single plant we wanted. In fact, we only ordered approximately 75% of the total plants we thought we wanted. This ended up being beneficial, because changes were made to the work once installation begam. The reason we did not order everything was because we were worried about the budget and wanted to make sure that we remained within the limits of it. Also, once plants began to leaf out, we were aware that some plants were already present in more abundance than previously anticipated. Skunk cabbage, lady fern, salmonberry and native field horsetail cropped up everywhere. Thus, it was not necessary to plant in as many places as planned, because native vegetation already existed on the site. Some of it was just not as visible at the time the work plan was made. Western sword fern was probably not necessary to order, because it is in a higher abundance than we had originally thought. These lessons could help save money for future projects, if kept in mind.

Table 5: Financial Expenditures

Expenditures by Major Category	Cost
Plants	
Conifer Trees	~~$57.80~~ **$35.82**
Deciduous Trees	~~$116.90~~ **$58.01**
Shrubs	~~$518.70~~ **$168.26**
~~Sedges~~ Groundcover	~~$66.00~~ **$280.29**
Subtotal plants + tax	~~$759.40~~ **$542.38**
Mulch	0
Subtotal Mulch	0
Tool Rental	0
Subtotal Tool Rental	0
Transportation	0
Subtotal Transportation	0
Printing	~~$25~~
~~Subtotal for printing~~	~~$25~~
Project Total	~~$784.40~~ **$542.38**

Table 6: Revenue Sources

Revenue by Fund Source	
Course Fee Allotment	~~$594.40~~ **$485.69**
Cash Donations	
Cash donations by CP	~~$190.00~~ **$56.69**
Subtotal Cash Donations	~~$190.00~~ **$56.69**
Project Total	~~$784.40~~ **$542.38**

Labor Budget

Overall, less volunteer labor was used than was anticipated. This is primarily attributed to overestimations on how many volunteers would be present at the second, third and fourth work parties and the fact that the length of work parties was modified to last 2 hours instead of 3. The first work party drew around 50 people, while the next work parties drew between 10 - 20 people. This was not an issue, however. The first work party required many volunteers, because of the sheer amount of Himalayan blackberry growing on the site. For later parties, it was actually more beneficial to have fewer people on site. The site gets crowded, native plants are trampled and it is more difficult to instruct a large amount of people on proper planting methods. It can become too chaotic for the volunteer party to still be efficient at accomplishing with a high level of quality. We learned that decreased levels of human-caused disturbance occurred when volunteers had more space and when there were fewer volunteers per group member to supervise. A good strategy employed was for group members to spend the majority of the work parties supervising volunteers to reduce accidental disturbance and to ensure proper planting strategies. For similar reasons group members did most of the planting in sensitive areas on days when volunteers were not present.

The opposite trend held true in terms of group member hours: in almost every task, group members worked more hours than expected. The primarily lesson we learned here was that these tasks will likely take longer than originally estimated. After our first group planting party we were able to better estimate future planting parties. There are many factors that were not always accounted for in the planning side of implementation, which sometimes made the work take more time than it could have. As this project went on, we became more capable of accounting for these details ahead of time, which is an important lesson for any project.

Table 7: Labor By Activity

	Team Hours	Volunteer Hours	Total
Site Assessment			
Expected	12	0	12
Actual	12	0	12
R. armeniacus Removal			
Expected	45	240	285
Actual	**31**	**170**	**201**
Mulching			
Expected	18	90	108
Actual	**24**	**28**	**52**
Plant Acquisition			
Planning			
Expected	7	0	7
Actual	**16**	0	**16**
Salvages			
Expected	23	0	23
Actual	**0**	0	**0**
Live stake acquisition			
Expected	20	0	20
Actual	**12**	0	**12**
Planting			
Expected	30	120	150
Actual	**75**	**60**	**135**
Stewardship Plan			
Expected	27	0	27
Actual	**40**	0	40
Educational Events			
Expected	25	0	25
Actual	**50**	**22**	**72**
Total Hours			
Expected	207	450	657
Actual	**260**	**280**	**540**

Planting Plan Lessons

In the original planting plan, we had planned to plant in islands in Polygons 3 and 4, with the addition of mounds in Polygon 4. These islands were supposed to be uniform in shape (elliptical) and the same size across the polygons. We kept this main idea from the planting plan, but ended up creating islands around pre-existing native vegetation, primarily western sword fern. One of the main lessons learned is that designing a planting plan on paper is very different than going to the site and performing the actual installation of the plants. It is difficult to record the placement of every plant on paper and with accurate distances from one another. During the site assessment, the number of red alder trees and their locations was noted, but individual plants such as western sword fern were hard to keep track of, because there were many spread throughout the site, and some were not easily visible, because they were smothered by Himalayan blackberry when we visited the site during the fall. This is the primary reason we did not think to include already existing plants within the islands: we were treating the plan as though the site was empty aside from red alder, when in actuality there were many species that could be found growing on it.

Returning to the site multiple times after the Work Plan was designed and the Himalayan blackberry was removed helped give a better idea of how the plan could be designed more successfully. As an example, Polygon 4 ended up having 2 dry islands and 6 wet islands, rather than 7 dry islands and 15 wet islands. We also added 4 more islands in the southern extended area. This occurred because of changes to island shapes, as explained above and because we were able to evaluate the soil better once the blackberry was removed. The dry islands were supposed to contain one tree and six species of plants, and the wet islands were supposed to contain 2 to 3 trees and 8 plants. However, since the shapes and sizes of the islands were not uniform, many ended up with less or more species, depending on the size and the amount of native vegetation already in the island. Ultimately this made the layout look more natural, however, and was probably a better choice in terms of design.

Unfortunately, changing the design also changed the densities and such of the plants. This brings up a second lesson learned: ordering plants before finalizing the planting plan may lead to deficiencies or excess numbers of plants. Due to the fact that we ordered plants after the initial planting plan draft, but before the work plan final, the numbers of plants required changed. The numbers then changed again due to changes in island layout, as described above. Spacing also varied somewhat, because we had to take into account the distance from existing plants as well. For example, some islands contained only 5 plant species instead of 11, which meant that the numbers needed were lower. Examples included red-osier dogwood going from 51 required to 30 needed, western sword fern from 30 to 20, western hemlock from 22 to 14, etc (Table 2). Many other species numbers also changed during the time from the work plan to the time of actual installation of plants. To fix this in the future, we might want to order plants after the work plan is finalized and approved, and ideally, after the removal of Himalayan blackberry. Luckily, we ended up with extra plants rather than not having enough, while still staying under budget and allowed up to extend the borders of our restoration site. This lesson relates to the lessons learned in terms of finances, mentioned earlier.

During parts of the actual planting process, we had volunteer help. We had allocated volunteers to a variety of jobs, including labeling plants, planting, mulching, etc. It rained throughout the duration of the first volunteer planting party. As a result, many of the written labels got washed off, making them unreadable. This made identifying the plants more difficult later on, when inventory of the polygons were taken. To prevent this, we should have labeled the tape beforehand, or in a dry area. Also, it was noticed later on that some of the labels were incorrect. For example, some labels read “9 berry” which seems to be a combination of Pacific ninebark and twinberry. Unfortunately, some plants tend to look very similar without leaves, which can easily lead to incorrect identification. It is hard to keep track of every volunteer, but for future reference, team members should try and keep a close eye on people who are labeling plants, so as not to end up with labels that do not make sense. Incorrect labels can cause incorrect inventory numbers.

Lastly, many native plants that were already present on sites were compromised by having large volunteer work parties. There were instances where volunteers were cutting down native vegetation, despite having been shown what to remove and what to leave alone. Other times, native vegetation was trampled by people who were not watching where they were walking. Volunteers are extremely helpful overall in helping accomplish restoration projects and it is crucial to include communities in the process of restoration to ensure continued stewardship after installation. However, we learned that strong supervision is imperative during work parties, so as to create as little disturbance as possible.

Other Plans

We worked together with Susan Buyarski-Crauer and Kathy Colombo, two teachers from Kirkland Junior High School, to create a lesson plan for their biology classes. Because the teachers begin to introduce ecology into their lesson plans in the spring, we wanted our own plan coincide with the curriculum while incorporating the work we were doing on-site in an informative way.

Past lesson plans from previous capstone groups had focused on teaching the basics of ecosystems and the many interactions between living and non-living organisms that exist. Instead, we chose to use an ecosystem as a subtopic to ecological succession and restoration, both of which are important to providing a healthy and functioning ecosystem for wildlife and vegetation.

Two days of instruction were given to each set (Susan and Kathy's) of classes. The first day served as an introduction using a PowerPoint presentation. This PowerPoint consisted of:

- The 20-Year Forest Restoration Plan
- Invasive species and their effects
- Ecological succession
- Ecological restoration - UW-REN Capstone project

A brief tour of our restoration site followed. This was done in order for students to: 1) familiarize themselves with the site and vegetation present; 2) distinguish between native and non-native and/or invasive species; 3) become aware of their surrounding environment which influences the conditions on-site; and 4) begin to recognize what the vegetation and other factors onsite could indicate in terms of succession and restoration.

Day Two allowed for the students to actively interact with nature. Five different activities took place onsite at the same time: ecology art, bee pollinator-building, nature sketching, picture-taking, and plant identification. Ecology art consisted of gathering natural materials, such as branches, stems, leaves, flowers, etc. that were not intact and creating an art-piece of any kind. Bee pollinator-building involved putting together a bee pollinator set which included instructions. For nature sketching and picture taking the students were allowed to choose what plants to sketch or take pictures of. Plant identification was to help students differentiate between native and invasive species as well as learn the commonly-known important plants existent at the earlier stages of succession as our site at Cotton Hill Park is in the earlier stages. Prior to this outside-activity day, students had signed up to be in a particular group with teachers allowing for about a maximum of six students to a group.

By involving and giving students activities to do both in and outside the classroom, we were more likely to get them interested in our site and in restoration in general. This was also an opportunity to spread awareness and spur a more personal connection between the students and nature as many students often use the park on a daily basis as a means of going to and from school. We see this involvement as a strong way to promote long-term stewardship in the restoration project (Objective 5-1).

Design for the Future

Our vision for the site in the future is to have a mature conifer-dominated forested riparian and wetland area that provides urban wildlife habitat, filtration of storm water runoff, and community services such as park aesthetics and a site for education. Frequent volunteer maintenance will likely be necessary in the months and years directly after restoration, when planted trees are still growing. In 50 years, there will be a mixed deciduous-conifer forested area with a diverse understory of native trees, shrubs and herbaceous plants. In 100 years, the forest should be a mature conifer-dominated forest with a diverse understory. As time goes on, the site should require less maintenance and will become more self-sustaining. In each phase, the diversity in plant species and structure will provide a variety of shelter and food sources for wildlife. Moreover, anyone passing through the park will enjoy its natural aesthetics. We would like to see continuous involvement from the local community in terms of volunteer maintenance, as well as using the park as an educational tool for students to take part in and learn about. Having an involved community is important for the park’s future and the continued success of the restoration.

The goals, objectives and the basic approach will enhance the chance for the long-term success of this project. The eventual formation of a more covered canopy, through the planting of coniferous trees, will help to shade-out of the invasive species and allow for native species to grow and become more dominant. These understory plants will provide a food source, as well as cover for a variety of wildlife. Having a variety of species at different heights in the canopy and the understory will form diverse habitats for a wider array of animal species. Encouraging structural diversity in the stream may aid the return of native amphibians. Storm water runoff will be filtered better before entering Thorton Creek with a more abundant growth of appropriate wetland species. Prolonged enhancement of wildlife habitat and healthy ecosystem functions connects the surrounding greenbelt which includes Crestwood Park and Juanita Bay Park (Figure 2) and sets an example for public space land managers.

A long-term maintenance and monitoring plan was created for the CP, in order to aid in the site's successful restoration. This addressed what kind of maintenance needs to be performed, as well as how often. Maintenance will need to be done on the site long after this particular restoration project is complete, and the plans will help ensure that the site will be monitored and maintained carefully in the future (Objective 4-4).

Frequent maintenance will likely be needed in the time directly following restoration, to ensure that invasives do not interfere with the growth of new plantings. Heavy mulching should suppress many weeds and will need to be reapplied periodically (Chalker-Scott 2007). Our intention is that native plants will propagate on their own, but replanting of native trees, shrubs, and ground cover may be necessary. Long-term monitoring and maintenance will be needed to achieve our vision for success.

The challenges that we anticipate beyond completion of our project are maintenance, reducing disturbance during volunteer events, and harsh site conditions. The maintenance and monitoring described above is crucial to the future of our site. Natural barriers planted will deter people and pets from crushing vegetation, and decrease the number of invasive species seeds transferred into planting areas. Through active community and volunteer engagement and involvement, the chances of success for a self-sustaining native plant community will be higher because there will be ongoing efforts of removing and suppressing invasive species. Providing educational opportunities about native ecosystems and restoration projects in places such as the local junior high school will encourage future stewards of Cotton Hill Park.

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Appendix A

Table 8: How plants benefit wildlife.

Species	Benefits for Wildlife
*Thuja plicata**	May provide browse for some larger wildlife, and cover for smaller wildlife.
*Tsuga heterophylla**	Seeds: Eaten by birds and mammals. Shelter: For birds, mammals and insects.
*Pseudotsuga menziesii**	Seeds: Eaten by many birds and small mammals. Foliage: Eaten by many insects and larvae. Insects: Eaten by many birds. Shelter: Cavity-nesting birds, insects, small mammals.
*Rhamnus purshiana**	Berries: Birds and mammals. Foliage: Foraged by butterfly larvae. Insects: Eaten by birds.
*Oemleria cerasiformis**	Berries: Variety of birds, foxes, coyotes. Nectar: Hummingbird.
*Amelanchier alnifolia**	Berries: Eaten by variety of birds and mammals. Nectar: hummingbirds, butterfly. Foliage: eaten by butterfly larvae
*Cornus sericea**	Berries: Eaten by variety of birds and mammals. Nectar: Butterflies. Leaves: Butterfly larvae. Thickets and shelter.
*Acer circinatum**	Seeds: grosbeaks, woodpeckers, nuthatches, finches, quail, grouse. Larvae plant brown tissue moth, Polyphemus moth. Nectar: bees
*Lonicera involucrata**	Fruits: Eaten by birds. Nectar: Food for hummingbirds
*Salix sitchensis***	Shelter: For birds, mammals and insects. Forage: Eaten by many small mammals.
*Symphoricarpos albus***	Fruits/Seeds: Birds and mammals. Shelter: Birds and mammals.
*Physocarpus capitatus***	Fruits: Eaten by many birds.
*Holodiscus discolor**	Foliage: Browsed by variety of insects. Insects: Eaten by birds. Shelter: Songbird protection, insects. Nectar: Swallowtail, butterflies.
*Rubus spectabilis**	Fruits: Eaten by birds and small mammals. Insects: Food for bumblebees. Nectar: One of the first blooming plants visited by hummingbirds.
*Blechnum spicant***	Shelter: Amphibians and reptiles.
*Rosa nutkana**	Hips: Eaten by several birds and mammals. Seeds: Birds. Leaves: Butterfly larvae and leaf-cutter bee. Thickets: Shelter for birds and mammals.
*Carex obnupta***	Shelter: Amphibians and reptiles.

* Reference: Starflower Foundation

** Reference: Stinson and Fisher