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EXECUTIVE SUMMARY

The Duwamish Greenbelts include the predominantly forested areas that are perched on the hills on either side of the Duwamish River Valley in south Seattle. The greenbelts comprise the largest area of native forest in Seattle, totaling about 800 acres. The Seattle Department of Parks and Recreation (DPR) owns and manages over 500 acres within the greenbelts. In order to develop effective strategies for managing these lands, it was decided by DPR staff in 1997 to undertake a project that would include:

- Inventory of the vegetation on all greenbelt lands owned by DPR;
- Research of social and environmental information and planning documents for the greater Duwamish corridor;
- Notification and involvement of community constituents in the research and inventory process;
- Definition of DPR's goals and objectives for managing this resource;
- Analysis of the existing resource through the framework of the goals and objectives and within the context of the historical trends, the greater ecosystem's functions, the neighborhood context and the political/regulatory environment; and
- Development of management strategies to address the general resource, specific resource types and specific management issues.

This management plan describes the components of the project, summarizes and analyzes the results of the inventory, and recommends management actions and guidelines that address the identified problems with the vegetation resource. The goals for the Duwamish Greenbelt vegetation are:

1. **Conserve wildlife habitat** – Greenbelt vegetation will be managed to preserve and enhance wildlife habitat in conjunction with the Urban Wildlife and Habitat Management Plan (DPR 1994, updated 2000).
2. **Maintain buffering and aesthetic value** – Greenbelt vegetation will provide visual screening between land uses and function as an attractive border to the neighborhoods that surround it.
3. **Mitigate urban pollution**– Greenbelt vegetation will trap air pollutants, provide biofiltration of water, screen excessive noise, and buffer urban microclimates.
4. **Provide natural drainage** – Greenbelt vegetation will be managed to preserve and increase the land's ability to buffer and direct storm water.
5. **Protect soil and water quality** – Greenbelt vegetation will be managed to preserve riparian corridors and hillsides by preventing erosion and maintaining vegetative cover.
6. **Protect public safety** – Greenbelt vegetation will be managed to reduce the risk of hazards from trees.

The inventory of vegetation on the DPR-owned greenbelts was completed by volunteers and DPR staff between February and December of 1998. Data were collected for a total of 530 plots, which were located using a differential Geographic Positioning System (GPS). The sample plot size was $1/10^{th}$ acre, thus about 10 percent of the approximately 500 acres of DPR-owned lands was sampled.

The following data were collected at each sample plot:

- Team and plot identifiers
- plot location
- dominant overstory & understory plant species
- percent cover of invasive plant species
- rating of tree health
- occurrence of tree seedlings or saplings indicating regeneration
- slope and aspect
- occurrence of saturated soils or standing water

- number of trees in each plot and average trunk diameter
- occurrence of special features – powerlines, slides, encampments, creeks, gully erosion, refuse, huge trees, snags, down logs, seeps

To facilitate analysis of the data and development of management prescriptions, the greenbelts were divided into seven assessment units. These sub-units include Duwamish Head, Puget Park, Westcrest Park, West Marginal Hillside, North Beacon Hill, South Beacon Hill, and Carkeek Drive.

The data from the inventory show that the Duwamish Greenbelts are mostly forested areas that are dominated primarily by deciduous species (about two-thirds of all plots are deciduous). Only 17 percent of plots are evergreen or mixed forest. In deciduous plots, the most overstory common association is big leaf maple/red alder, and in evergreen plots Douglas fir and Pacific madrone are the dominant trees. While deciduous forest occurs throughout the greenbelts, many of the evergreen plots are concentrated in only a few areas, including Westcrest Park and Duwamish Head.

When compared to the more rural forests of the Puget Lowlands, the Duwamish forests have relatively low forest density and small tree size. About two-thirds of all plots have trees that average 20 inches in diameter or less, and about one-half of those plots have 10 trees or fewer. About half of all plots were rated "fair" for tree health, with over one-quarter rating poor. Tree regeneration, another indicator of forest health, was found to be quite low, and was noted primarily for deciduous species; coniferous regeneration was minimal.

Invasive exotic plants were found to be widespread in the greenbelts, with several species accounting for very high coverage in many plots. Over half of all plots have greater than 25 percent total cover by invasive species, and over one-quarter have greater than 75 percent cover. Himalayan blackberry is the most wide-spread and has the highest cover of all the invasive species; it is followed closely by English ivy. Cherry laurel and English holly were also found to occur frequently in the greenbelts.

Data were collected on a variety of landscape features. Steep slopes in excess of 40 percent were found in 18 percent of the plots. Refuse, slides, seeps, and powerlines were the most commonly noted features that would necessitate special management actions.

In analyzing the data, a total of five major problems were identified for the Duwamish Greenbelts. Each problem is described in the plan, along with lists of questions that identify the primary management issues. The major problems identified are as follows:

- Lack of forest complexity
- Low forest age and density
- Low native plant diversity/high invasive plant occurrence
- Common occurrence of slides
- High level of human intrusion

In addition to sub-unit assessment areas, the greenbelts were divided into seven land form types: wetlands, riparian corridors/ravines, non-forested areas, upland forests, slides, powerlines, and viewpoints. These categories were developed for the purpose of identifying common areas to which to apply general management guidelines and prescriptions. Where applicable, land form types are prioritized for each management prescription.

The management prescriptions described in the plan are intended to address at least one of the five major problems identified above. Information is provided for each prescription or task regarding the reasons for doing them, the major elements of the task, the sub-unit areas and land form types that are prioritized for the task, and the specific problems that are addressed. In general, the main factors that are used in prioritizing areas for prescriptive actions in this plan are as follows:

- high visibility and/or high level of public use,
- risk to public safety,
- reasonable accessibility,
- good probability of involvement by neighborhood or community group volunteers,
- moderate biological condition with respect to specific problem under consideration
- area is "front" for specific problem under consideration (area of good to moderate quality adjacent to area of poor quality), and/or
- riparian corridor in which management action would contribute to improved aquatic habitats.

Using these criteria, it is likely that the West Duwamish areas will generally be prioritized over the East Duwamish areas due to greater visibility, higher level of public use, better access, the presence of more riparian corridors, and better biological condition. Areas on steep slopes will typically receive lower priority due to accessibility issues unless they pose a slide risk, and therefore are threats to public safety. Areas with high cover of invasive plants will generally receive lower priority than areas with moderate cover, because the latter are considered more recoverable. In general, this plan takes the approach that tasks with a higher probability of success should be prioritized, and that areas that are not yet severely disturbed should be saved from further degradation before those areas that are already in worse shape.

The plan proposes 13 prescriptions or tasks for managing the vegetation of the Duwamish Greenbelts. They are as follows:

1. Manage hazard trees
2. Thin dense forest stands
3. Identify/create canopy gaps
4. Plant non-forested areas
5. Plant conifers
6. Plant broadleaf evergreen and deciduous species
7. Convert vegetation to lower canopy at viewpoints and powerlines
8. Revegetate slide areas
9. Increase snags and down logs
10. Control problematic invasive species
11. Conduct trail inventory
12. Reduce human disturbance
13. Inspect and delineate boundaries

Duwamish Greenbelts Management Plan
Seattle Department of Parks and Recreation

1. INTRODUCTION

The Duwamish Greenbelts include the predominantly forested areas that are perched on the hills on either side of the Duwamish River Valley in south Seattle. The greenbelts comprise the largest area of native forest in Seattle, totaling about 800 acres. The Seattle Department of Parks and Recreation (DPR) owns and manages over 500 acres within the greenbelts. These lands include various park lands, viewpoints and undeveloped open space. The DPR owns all or part of the following: Belvedere Viewpoint, Fairmount Park, Hamilton Viewpoint, José Rizal Park, Lewis Park, Puget Park, Sturgus Park, Westcrest Park and 12th Avenue South Viewpoint. Other agencies and private interests also own substantial lands within the Duwamish Greenbelts.

1.1 Benefits of Greenbelt Lands

These properties were acquired by the DPR because of the multiple public benefits they provide. The mass of trees and vegetation, as well as the soils on these sites are reservoirs that detain rainfall, thereby reducing runoff and assisting the City's drainage functions. The soils and plants also provide biofiltration to maintain water quality. The foliage traps particulate pollution in significant amounts, especially along the I-5 corridor.

The greenbelts represent significant wildlife habitat. The forests foster wildlife populations that are rare or non-existent elsewhere in the City. Where streams pass through the greenbelts, the vegetation helps stabilize the streambanks and keeps the water cool through shading and evaporative cooling. The cool clean water that comes out of the greenbelts contributes positively to the water quality of the Duwamish estuary.

Humans also benefit from their direct experience of the greenbelts. These are places where residents can take a walk and find a tranquil forest in the midst of the City. They are a destination for groups and individuals learning about the environment. The greenbelts provide screening and greenery that add character to the neighborhood and value to adjacent properties. Visually, the greenbelts soften the edges of the industrial corridor south of downtown.

1.2 Management Challenges

These properties present a number of management challenges for the City. The fragmented ownership of the greenbelts, which includes significant private holdings, makes management actions difficult to effectively implement at a large scale. For example, long-term success rates for managing invasive weeds on DPR lands are lowered due to the inability to manage weeds encroaching from adjacent private lands. Similar difficulties arise from a fragmented ownership with regards to encampments and the problem of refuse dumping. Other fragmentation problems arise in areas of powerline corridors and undeveloped street right-of-ways.

Much of the greenbelt areas occur on steep slopes that are prone to sliding, requiring significant investigation prior to planting trees or clearing invasive species. Many of these areas are too steep to safely use volunteer labor in carrying out management actions. The greenbelt areas lie between the industrial complexes in the bottom of the Duwamish Valley and the residential areas on the hill crests. As steep-sloped transitional areas, they are not well integrated into the adjacent neighborhoods. Finally, there is no stable funding source for managing the DPR greenbelt lands; priority typically goes to management of high-use, high-visibility recreational park facilities.

1.3 Purpose and Scope of Project

In order to develop effective strategies to address these types of challenges, it was decided by DPR staff in 1997 to undertake a project that would result in a management plan for the vegetation on DPR-owned lands. The project included:

- inventory of the vegetation on all greenbelt lands owned by DPR;
- research of social and environmental information and planning documents for the greater Duwamish corridor;
- notification and involvement of community constituents in the research and inventory process;
- definition of DPR's goals and objectives for managing this resource;
- analysis of the existing resource through the framework of the goals and objectives and within the context of the historical trends, the greater ecosystem's functions, the neighborhood context and the political/regulatory environment; and
- development of management strategies to address the general resource, specific resource types and specific management issues.

This management plan describes the components of the project, summarizes and analyzes the results of the inventory, and recommends management actions and guidelines that address the identified problems with the vegetation resource. The plan does not propose changes of use for these park properties, nor does it seek to change the forested nature of the greenbelts. The plan was developed to address primarily the vegetation resource. We recognize that there are other management issues that relate to the vegetation, and these are addressed in this plan only to the extent that they affect or are affected by vegetation.

2. GOALS FOR GREENBELT VEGETATION

Many of the properties within the Duwamish Greenbelts were acquired by Parks and Recreation between 1989 and 1998 as part of the Open Space Bond passed by King County in 1989. The purposes of the acquisitions were articulated in the City's Greenspaces Policy (1993). In summary, they were:

1. Help preserve areas of natural landscape and habitat for wildlife
2. Provide natural buffers between land uses of different intensity or areas of distinct character or identity
3. Help mitigate the effects of noise and air pollution
4. Help reduce the necessity for constructed storm water systems
5. Help preserve the quality of natural drainage systems and enhance the stability of the land.

The goals for this plan were developed with a focus on these purposes. The plan adds another goal for safety, recognizing that the well being of the greenbelts is closely linked to the well-being of the surrounding community. Together, the goals for the Duwamish Greenbelt vegetation are:

1. **Conserve wildlife habitat –** Greenbelt vegetation will be managed to preserve and enhance wildlife habitat in conjunction with the Urban Wildlife and Habitat Management Plan (DPR 1994, updated 2000).
2. **Maintain buffering and aesthetic value –** Greenbelt vegetation will provide visual screening between land uses and function as an attractive border to the neighborhoods that surround it.
3. **Mitigate urban pollution**– Greenbelt vegetation will trap air pollutants, provide biofiltration of water, screen excessive noise, and buffer urban microclimates.
4. **Provide natural drainage** – Greenbelt vegetation will be managed to preserve and increase the land's ability to buffer and direct storm water.
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6. **Protect public safety** – Greenbelt vegetation will be managed to reduce the risk of hazards from trees.

3. STRATEGY FOR ACHIEVING HEALTHY GREENBELT FORESTS

It is our professional opinion that the best way to achieve the goals of this plan is to work toward a "sustainable" urban forest consisting primarily of native plant associations through strategic interventions that emulate existing ecological processes. By "sustainable" we refer to "A Model of Urban Forest Sustainability" (Clark 19XX) which identifies three essential components of a sustainable urban forest:

- The Vegetation Resource
- The Community Framework
- The Resource Management

Simply put, this model states that the welfare of the forest is inextricably linked with the way that it is managed and with the support and involvement that the community provides. While this plan focuses primarily on management of the vegetation resource, it is intended to be a resource management tool to enhance the community framework in support of the vegetation resource. The following sections expand on the vision for the Duwamish Greenbelts for each of these components.

3.1 Maintain a Healthy Forest Ecosystem

With a healthy forest ecosystem, the best balance of the above goals can be realized. A healthy forest ecosystem contains complexity in terms of structure and function, providing habitat to many diverse populations of native flora and fauna. At the same time, the forest is sufficiently continuous to favor species that need "interior" forest conditions. Likewise, forest stands are connected so that populations are continually replenished by migration.

A healthy forest ecosystem maintains buffering and aesthetic value. A mixture of tree species featuring conifers provides more effective screening year-round. The complexity of the vegetation provides interest and depth to the forest edge. A vigorous forest rapidly fills in any vegetation gaps that appear.

A healthy forest ecosystem mitigates urban pollution. Carbon dioxide is sequestered in a forest that is growing rapidly. A multi-layered canopy presents the maximal leaf area to trap particulate matter. Living soils with abundant organic matter break down or bind up waterborne pollutants.

A healthy forest ecosystem provides a natural drainage utility. Rainfall is trapped in the high volume of leaf surface area before it ever reaches the ground. Significant amounts of evergreen vegetation provide this cover even in winter months. The high levels of organic matter in the soil and its well-developed structure, act as a sponge to detain water during peak storm events.

A healthy forest ecosystem keeps soil in place by limiting the movement of water over the ground surface. The leaf litter acts as mulch, while multi-layered root systems strengthen the soil matrix. In the event of soil disturbance, native soil fertility insures that surrounding plants rapidly recolonize any soil that is exposed. As a result, very little of the soil ends up in our streams.

A healthy forest ecosystem is also healthy for the community. Healthy trees are less likely to be hazardous. When they grow vigorously they are able to fend off disease and insect threats. Proactive management helps promote this. Stands of mature or stagnant trees may need thinning and/or underplanting. Edges and high-traffic areas may need inspection routinely so potential hazard situations can be identified. Hazardous trees may be converted to habitat features such as snags or downed logs to promote the above goals as well.

Soil is the key to promoting all of these benefits. Like wildlife, native vegetation needs appropriate habitat to survive, thrive, and reproduce. In the urban environment, soil is often the habitat component that is compromised. In comparison to mature, undisturbed forest soils, Duwamish Greenbelt soils lack the structure and the dynamic nutrient exchange needed to sustain a competitive native ecosystem. Native plant species are dependent on a vigorous "rhizosphere" to give them a competitive advantage over invasive exotic species. The abundant organic matter found in native forests has typically been lost to erosion and burning during historic logging and excavation events. Sporadic attempts to "clean up" the greenbelts have also robbed the soil of new organic matter. Soil compaction is a less critical impact on soil health, but can be locally significant. With compaction, not only is plant growth inhibited, but the "sponge" for rainfall absorption is also diminished.

3.2 Involve Local Residents in the Greenbelts

The involvement of local residents in the greenbelts is essential to promoting the goals of this plan. Where local residents have taken a constructive interest in the greenbelt, multiple benefits have followed. Residents have reported problems and issues such as illegal dumping, hazardous trees, encampments, and so on, and have acted as a repository of site-specific information, such as history and wildlife inventories. Local residents have joined the Adopt-a-Park program to control exotic invasive weeds and plant trees. They have advocated for the greenbelt in their community councils and with the Parks Department. In some areas, local residents have developed management plans for their part of the greenbelt (e.g., Westcrest Park, Fairmount Ravine, Hamilton Viewpoint).

On the other hand, local residents who are not constructively engaged in the greenbelts may view them as nuisances or safety problems. They may not understand all the benefits a healthy forest provides. They may inadvertently compromise forest health when they walk off-trail, collect plants, or dump yard waste, and they may not perceive the impacts of their actions on the greenbelts. In some cases, there are even incidents of unauthorized tree cutting, clearing and other actions that entirely disregard the interests of the greater public.

Several conditions contribute to lack of constructive participation in the greenbelts. Much of the Duwamish Greenbelt property has come into public ownership since the 1989 Open Space Bond Issue. Many local residents may still not perceive these areas as "parks". Furthermore, the lack of developed trails makes accessing and enjoying these open spaces difficult. Evidence of illegal activities creates a perception that they are unsafe places to go. The location of the greenbelts on the borders of the neighborhood leave them lacking neighborhood identity. There is no critical mass of people who claim the greenbelts as "their" park.

Part of achieving a sustainable, healthy forest is engaging the neighborhood in the greenbelts by addressing these conditions. While this plan only identifies action steps specific to vegetation, these steps must be integrated with a campaign to involve and educate the surrounding neighborhoods about the greenbelts. This plan may be used as one tool to accomplish this end.

3.3 Integrate Resource Management Priorities with Community Interest

The Department of Parks and Recreation does not have a maintenance budget for the Duwamish Greenbelts. This is typical of all the department's open space, which historically was left "natural", meaning unmanaged. The need for management is now recognized, hence this management plan. This plan provides a framework for addressing management issues in the absence of routine maintenance. It does so by identifying project types and guidelines for how to apply them.

Some project resources may be available through capital funding or the Pro-Parks Levy. However, available resources are meager compared to the large body of work this plan identifies. The primary resource required for implementing this plan will be citizen participation. This makes the need to involve local residents in their greenbelts even more central to achieving the plan goals.

In contrast to the approach used in a developed landscape, the project approaches here may not fit the public's image of "neat" vegetation typical of more formal park landscapes. In keeping with the goals of this plan and the limitation on resources, most project approaches use native ecosystem processes to influence forest composition. These may look "random" or "messy" in certain phases. Two processes – disturbance and competition – are the fundamental ways that the vegetation can be manipulated.

Management either seeks to limit disturbance in healthy areas or to increase disturbance in unhealthy areas. In healthy areas, gentle techniques to manage competition without causing disturbance are called for. Once an area is disturbed, however, competition needs to be aggressively managed. Weeds need to be repeatedly controlled, and installed plants need water, mulch and other treatments to boost their competitive advantage. The management objectives focus primarily on achieving mature native vegetation. To promote the strategy of involving local residents, good interpretive campaigns should be built into all projects so that temporary "messes" can be understood in the context of the long-term goals.

4. PLAN DEVELOPMENT

The Duwamish Greenbelts Reforestation Project was initiated by Seattle DPR in 1997. DPR contracted with Sheldon & Associates, a private environmental consulting firm, to assist in all aspects of the project, including inventory organization, volunteer training, data quality control, data analysis, and management plan preparation. DPR also solicited assistance from TREEmendous Seattle, a non-profit environmental organization, in finding and organizing the volunteer base. Volunteers that participated in collecting inventory data included private individuals and the following organizations: Tree Stewards, TREEmendous Seattle, Big Brothers of Seattle, Americorps, North Seattle Community College students, Environmental Explorer Post at Franklin High School, and the Environmental Explorer Post at Rainier Beach High School.

4.1 Inventory Methods

The inventory of DPR-owned lands in the Duwamish Greenbelts was designed to be carried out by trained volunteers using a differential Geographic Positioning System (GPS) to locate sample plots in the field and to record the data. Hand-written data forms were also used as a backup in case the GPS system malfunctioned. The electronically-stored sample plot locations and data entries were later transferred into a GIS database system by DPR staff. The data were analyzed by staff from Sheldon & Associates.

Data Collection

Sample plot locations within DPR-owned lands were pre-assigned by DPR staff using the existing GIS database that contains the mapped boundaries of the various parcels. The pre-assigned sample plot coordinates were then stored in a Trimble TDC2 Datalogger™ GPS. Volunteers were trained to locate these plots in the field using the GPS, and to then record the data for each plot electronically into the GPS data entry system. The typical estimated error in locating plots using the differential GPS is about one meter.

Volunteers were trained in the use of the GPS and in data collection methods in February 1998. Some supervision was provided to volunteers by DPR staff during the early period of data collection. Data were collected by volunteers during late winter and spring of 1998. As volunteer availability waned, DPR staff completed the inventory data collection through the summer and fall of 1998. The entire period of data collection lasted from late-February 1998 through early-December 1998. Volunteers completed approximately half of the 530 plots that were sampled, with DPR staff completing the remainder.

The sample plot size selected for the inventory was 1/10th acre, each plot having a diameter of 74.4 feet (22.7 meters). The total number of plots was based on the goal of sampling roughly 10 percent of the total DPR-owned land of about 500 acres. Since each plot represents 1/10th acre, 500 plots would cover roughly 50 acres, or 10 percent of the 500 acres. Plots were located to sample representatively across the parcel, including parcel edges. Plot location selection was not biased by topography, vegetation, accessibility or other factors.

To be able to identify on-the-ground the exact area in which to sample, field teams would locate the center of the sample plot using the GPS, stretch out a pre-measured rope from this central point (37.2 foot radius), and then hang several flags at the edges of their sample plot. One team member would typically walk through the plot, while the other stood near the center, recording data called out by the observer.

The following data were collected at each sample plot (see Appendix A for example data form):

- Team and plot identifiers
- plot location
- dominant overstory and understory plant species
- percent cover of invasive plant species
- number of trees in each plot and average trunk diameter
- rating of tree health
- occurrence of tree seedlings or saplings indicating regeneration
- slope and aspect
- occurrence of saturated soils or standing water
- occurrence of special features – powerlines, slides, encampments, creeks, gully erosion, refuse, huge trees, snags, down logs, seeps

Visual estimates were used for determining dominant plant species and percent cover of invasive exotics. The range for the average tree diameter was determined by either visual estimates or by measuring and averaging diameters using a forester's cruise stick (Biltmore stick). The range for percent slope was visually estimated using a simple geometric method of the difference in height between the two team members standing a certain distance apart. Tree health was based on a subjective assessment of extent of canopy cover and any evidence of tree decay.

Data Management and Analysis

Data that were recorded in the field using the GPS data entry system, and were electronically transferred by DPR staff into a GIS database, based in the UNIX system. Data that were hand-written on paper forms were later manually entered into the GIS database. Quality control of a portion of the data was completed by biologists who revisited sample plots and confirmed or corrected the original observations. A number of duplicate data sets were inadvertently collected by volunteers, and these were used as part of the quality control effort.

Maps were plotted using the GIS to represent data trends in the various DPR lands in the study area, and to identify areas targeted for management actions. The data were also made available in a Microsoft Excel™ spreadsheet, which was used to sort the data and to develop summarizing tables and charts that aided in the analysis.

4.2 Past Management of Duwamish Greenbelts

In the mid-1990's public interest was focused on reversing the impacts of urbanization on the Duwamish/Green River ecosystem. In 1994, the King County Council lead the formation of the Duwamish Coalition to bring stakeholders together to find ways to initiate environmental restoration of the watershed while fostering industrial redevelopment of the corridor. The Green/Duwamish Ecosystem Restoration Study, commissioned in 1995 as a joint project of King County and the Army Corps of Engineers, focused primarily on the riparian environment of the entire watershed. The Lower Duwamish Watershed Habitat Restoration Plan, completed in late 1996, also focused on the riparian habitats, this time mainly in the Seattle area. This plan did include Puget Creek as one of the tributary creeks, and it indicates upland areas as “Connector/Pocket Habitat” for riparian corridors.

Several Neighborhood Plans list priorities and projects for the Duwamish Greenbelts. Some plans make general statements, such as: “maintain and upgrade existing parks, playgrounds, and open spaces” (North Beacon Hill Plan) or “Preserve and extend the neighborhood’s tree canopy” (Admiral Plan).

Specific references to the greenbelt include:

- “…potential street vacations or closures to create street-end parks or view points…” (North Beacon Hill)
- “North/south walking trails along…Puget Park/Riverview Trail; Duwamish Hillside Trail.” (Delridge)

Westcrest Park was developed under a master plan completed by Rich Haag in the 1970s, and a management plan is currently being completed by a neighborhood coalition in partnership with DPR. Other citizen-initiated plans have been completed for Fairmont Ravine and Hamilton Viewpoint. To our knowledge, no other plans address the management of the Duwamish Greenbelts.

Several agencies have jurisdictions on or adjacent to DPR-owned greenbelts. Seattle City Light manages power and transmission lines on right-of-ways adjacent to Park property. SEATRAN has regulatory jurisdiction over trees in the right-of-way adjacent to Park property. Seattle Public Utilities manages several utilities that pass through Park property, including creeks that fall under their drainage and wastewater utility. Department of Design, Construction and Land Use regulates activities in many parts of the greenbelt as Environmentally Critical Areas (ECAs). Washington State Department of Fish and Wildlife has jurisdiction over the fish and wildlife in the greenbelts.

In addition to these government entities, there are many citizen groups that have interests in the greenbelts. There are numerous Adopt-a-Park groups involved with parks along the greenbelts, including Fairmount Ravine, Puget Park, Riverview Playfield, and Westcrest Park. Some of these groups are supported by or affiliated with their local community councils. Examples of active groups include:

- The Green/Duwamish Watershed Alliance is a citizen non-profit group dedicated to restoring the entire watershed.
- I’M A PAL is a foundation working in the lower Duwamish watershed on a variety of restoration and environmental justice projects.
- The Environmental Coalition of South Seattle works on economic development and pollution prevention.
- The Greater Duwamish District Council represents the area of SODO South Park, Georgetown and Beacon Hill.
- Duwamish Valley Neighborhood Preservation Coalition is a community group concerned with the liveability of its neighborhoods.

Beyond these groups there are numerous businesses and residents located next to Park property. Groups of Park neighbors may periodically work together to address a local issue that involves the Park property.

5. OVERVIEW OF GREENBELT CONDITIONS

This section summarizes the data that were collected for this project. It provides an overview of existing conditions in the greenbelts with regards to forest type, common plant associations, forest distribution and density, forest health, invasive species coverage, and occurrence of various landscape features. An analysis of these data is presented in Section 6. The raw data in the database is presented in spreadsheet form in Appendix B. Figure 5-1 shows the location of the greenbelts and the sub-unit assessment areas. The DPR-owned lands in the greenbelts were divided into seven sub-units to aid in the data analysis. These include Duwamish Head, Puget Park, Westcrest Park, West Marginal Hillside, North Beacon Hill, South Beacon Hill, and Carkeek Drive. Data for each sub-unit area are summarized in Appendix C.

5.1 Forest Type and Common Plant Associations

The Duwamish Greenbelts are mostly forested areas that are dominated primarily by deciduous species. Of all the plots sampled, 85 percent are forested, with only 15 percent dominated by shrubs or grasses and herbaceous species. About 68 percent of all plots are dominated by deciduous forest, 8 percent are evergreen (conifers plus Pacific madrone), and 9 percent are mixed forest. As can be seen in Table 5.1, the four most commonly occurring overstory associations are deciduous, with the big leaf maple/ red alder association accounting for one-fourth of all plots. Douglas fir and Pacific madrone, a common evergreen association in forested nearshore areas in the Puget Trough accounts for only 2 percent of all plots. Other evergreen associations are similarly low in representation in the Duwamish Greenbelts. Note that western hemlock/ western red cedar, an association that is common in many lowland areas in the Puget Trough, is not on the list in Table 5.1. A lack of forest complexity in the study area is reflected in the large percentage of plots that have only one dominant overstory species.

Table 5.1. Dominant Overstory Associations

Overstory Associations*	Forest Type			Percent of Plots*
	Deciduous	Evergreen	Mixed	
Big leaf maple/ Red alder	X			25
Big leaf maple	X			23
Red alder	X			13
Big leaf maple/ Black cottonwood	X			3
Douglas fir		X		3
Douglas fir/ Pacific madrone		X		2
Black cottonwood	X			2
Big leaf maple/ Douglas fir			X	2
Douglas fir/ Western red cedar		X		2
Douglas fir/ Red alder			X	2

*Dominant overstory associations that account for less than 2 percent of plots are not shown.

The data on dominant tree species in the study area mirrors the overstory association data. Bigleaf maple is either the sole dominant overstory species or it is a co-dominant with another species in 55 percent of all plots (Table 5.2). Similarly, red alder is dominant in 44 percent of plots. Black

Figure 5-1. DPR-Owned Portions of Duwamish Greenbelts & Sub-Unit Boundaries

cottonwood is the third most commonly occurring deciduous tree. Evergreen species are much less common: Douglas fir is dominant in 10 percent of plots, Pacific madrone in 6 percent, and western red cedar in only 4 percent.

Table 5.2. Dominant Tree Species in Forest Overstory

Common Name	Scientific Name	Type of Tree		Percent of Plots in Which Species is Dominant*
		Deciduous	Evergreen	
Big leaf maple	*Acer macrophyllum*	X		55
Red alder	*Alnus rubra*	X		44
Douglas fir	*Pseudotsuga menziesii*		X	10
Black cottonwood	*Populus balsamifera*	X		7
Pacific madrone	*Arbutus menziesii*		X	6
Western red cedar	*Thuja plicata*		X	4
Western hemlock	*Tsuga heterophylla*		X	1
Bitter cherry	*Prunus emarginata*	X		1
Willow	*Salix sp.*	X		<1
No tree cover	---			15

* The percent of plots in this column exceeds 100%, as many plots have two co-dominant species.

Bringing in the understory species to complete the picture, Table 5.3 lists the common overall plant associations for each forest type, as well as the most common understory associations found in each forest type. In deciduous forests, Himalayan blackberry, Indian plum, English ivy, hazelnut, and sword fern are the most common understory species, and English ivy/Himalayan blackberry is the most common association. One or both of these non-native vines were noted as dominant species in about 60 percent of all plots. Native shrubs dominated far fewer plots. Sword fern is the only native herbaceous species that occurs as a common dominant in the study area. A total of 29 dominant understory species were observed in deciduous forest plots, 21 of which species are native. This apparent diversity, however, is misleading because many of these species occur in only a small number of plots. For this reason, most of these species are not listed among the common associations in Table 5.3. For all plots in the study area, 36 percent have an understory dominated by only native species.

In evergreen forests in the Duwamish area, there is generally less disturbance and less cover by invasive species. The data show that salal, red elderberry, and sword fern are most common in the understory of evergreen forests in the study area. Evergreen plots have a total of 11 understory dominants, with 7 of those being native. For mixed forests, Indian plum, Himalayan blackberry, and salal were most commonly noted. Mixed forest plots have a total of 19 understory dominants, with 16 of those being native species. As with the deciduous plots, this is a misleading number in that most of the native species dominate in only a few plots. The 15 percent of plots that have no forest cover occur primarily in disturbed areas that are vegetated with non-native grasses or Himalayan blackberry. Some of these non-forested plots occur in managed lawn grass areas.

Table 5.3. Most Common Plant Associations

Plant Association	Percent of Total Plots	Percent of Plots of Each Forest Type
Deciduous Forest Associations		**% of Decid. Plots**
Big leaf maple/ Red alder/ Indian plum/ Sword fern	2	3
Big leaf maple/ English ivy/ Himalayan blackberry	2	3
Big leaf maple/ Hazelnut/ Sword fern	2	3
Red alder/ English ivy/ Himalayan blackberry	2	3
Big leaf maple/ Himalayan blackberry/ Sword fern	2	3
Big leaf maple/ Red alder/ English ivy/ Himalayan blackberry	1	2
Big leaf maple/ Red alder/ Indian plum/ Red elderberry	1	2
Big leaf maple/ Red alder/ Salmonberry/ Himalayan blackberry	1	2
Big leaf maple/ English ivy/ Indian plum	1	2
Big leaf maple/ English ivy/ Sword fern	1	2
Red alder/ Hazelnut/ Himalayan blackberry	1	2
Most Common Understory Associations in all Deciduous Forest Plots		**% of Decid. Plots**
English ivy/ Himalayan blackberry	6	9
Himalayan blackberry	3	5
Indian plum/ Sword fern	3	5
Hazelnut/ Himalayan blackberry	3	4
Hazelnut/ Sword fern	3	4
Indian plum/ English ivy	3	4
Evergreen Forest Associations		**% of Evergreen Plots**
Douglas fir/ Western red cedar/ Salal/ Red elderberry	<1	9
Douglas fir/ Pacific madrone/ Salal/ Dewberry	<1	9
Douglas fir/ Salal	<1	7
Douglas fir/ Salal/ Red elderberry	<1	7
Douglas fir/ Pacific madrone/ Salal	<1	7
Most Common Understory Associations in all Evergreen Forest Plots		**% of Evergreen Plots**
Salal	2	21
Salal/ Red elderberry	1	16
Salal/ Sword fern	1	14
Salal/ Dewberry	1	12
Salal/ Himalayan blackberry	<1	7
Mixed Forest Associations		**% of Mixed Forest Plots**
Bigleaf maple/ Douglas fir	2	20
Red alder/ Douglas fir	2	20
Red alder/ Pacific madrone	1	15
Bigleaf maple/ Western red cedar	1	13
Red alder/ Western red cedar	1	11
Bigleaf maple/ Western hemlock	<1	7
Bigleaf maple/ Pacific madrone	<1	4
Pacific madrone/ Bitter cherry	<1	4
Red alder/ Western hemlock	<1	2
Black cottonwood/ Douglas fir	<1	2
Most Common Understory Associations in all Mixed Forest Plots		**% of Mixed Forest Plots**
Himalayan blackberry	<1	9
Himalayan blackberry/ Indian plum	<1	7
Salal	<1	7
Hazelnut/ Sword fern	<1	4
Salmonberry/ Sword fern	<1	4
Hazelnut/ Oregon grape	<1	4
Most Common Associations with no Forest Cover		**% of No Forest Plots**
Grass	5	36
No vegetative cover	2	13

Plant Association	Percent of Total Plots	Percent of Plots of Each Forest Type
Deciduous Forest Associations		**% of Decid. Plots**
Himalayan blackberry/ Grass	1	10
Himalayan blackberry	1	10
Himalayan blackberry/ Field horsetail	<1	4

5.2 Forest Distribution, Density & Health

The data indicate that roughly two-thirds of the area in the Duwamish Greenbelts is dominated by deciduous forest. Given this prevalence, it is not surprising that deciduous forest is not concentrated in certain locales, but occurs throughout the study area. Evergreen forest, which accounts for 8 percent of all sample plots, is concentrated primarily in Westcrest Park (86 percent of all evergreen plots in the study occur in this Park), with a small component of evergreen forest in the Duwamish Head area. There are no evergreen plots in the entire eastern Duwamish Greenbelt. Mixed forest, which accounts for 9 percent of all plots, occurs scattered throughout both sides of the Duwamish Valley. Mixed forest dominates in 18 percent of the plots in the Duwamish Head area, and 20 percent of plots in Westcrest Park. Other areas in the greenbelts have fewer, more localized occurrences of mixed forest, with the exception of North Beacon Hill, which has only deciduous plots.

Forest density is determined by the number of trees in a given area. Typically, the dynamics of plant physiology result in a decrease in density of trees as tree size increases. Therefore, a low count of trees per plot does not necessarily reflect low canopy cover or an unhealthy forest; both tree count and size must be considered together to determine whether an area is lacking in canopy cover. Table 5.4 shows the percent of plots that fall into each diameter and tree count range.

Table 5.4. Percent of Plots by Number and Diameter of Trees

Number of Trees Counted in Plot	Tree Diameter Range (inches)					Percent of Plots in Each Tree Count Range
	4-12	>12-20	>20-30	>30-50	>50	
1-5	11	19	11	3		43
6-10	10	10	1.5			22
11-15	6	4	<1		<1	11
16-20	2	1	<1			4
21-30	<1	1				2
31-50	<1					<1
>50	<1					<1
Total Percent of Plots	31	36	14	3	<1	

When compared to the more rural forests of the Puget Lowlands, which have fewer disturbance indicators than urban forests, the Duwamish forests have relatively low forest density. About 67 percent of all sample plots have trees that average 20 inches in diameter or less, and of those plots, 50 percent have 10 trees or fewer. This means that both tree size and numbers of trees are generally quite low. The sample plots were 0.1 acre in size, so 10 trees per plot translates to 100 trees per acre. Based on the data collected, only 2 percent of the Duwamish Greenbelts has greater than 200 trees per acre, and these fall in the two smallest size classes (Table 5.4). Where trees range in diameter of 4-12 inches, the data indicate that the tree counts range from 10 to 650 trees per acre, with a median of 70 trees per acre (Table 5.5). For areas with trees in the >12-20 inch class size, the median tree count is around 50 trees per acre. The tree density decreases with increased tree size, with the exception of one plot that had a surprisingly high count of very large trees. Though this inverse relationship is typical for all forests, tree density is low in the Duwamish Greenbelt forests for all tree size classes when compared with more rural, less disturbed forests.

Table 5.5. Range and Average of Tree Count by Size Class

Tree Size Class	Range in No. of Trees Per Acre	Median No. of Trees Per Acre
4-12	10-650	70
>12-20	10-280	50
>20-30	10-200	30
>30-50	10-50	10
>50	No range	120*

*Only plot sampled with >50 inch trees had count of 12 trees.

Data collectors were asked to make a relatively subjective determination of forest health for the forested plots. Table 5.6 summarizes the tree health data by diameter class. Only 7 percent of all plots were judged to have "good" tree health. While the majority of forested plots rated fair for tree health, over ¼ of all plots rated poor. There is not any discernible pattern where tree health either increases or decreases with tree size. However, the data do reflect a trend where plots with the lowest tree counts more often rated poor in tree health. Table 5.7 shows how tree health varies with the number of trees per plot. Just over half of the plots with 5 or fewer trees rated poor for tree health, but this number drops to 17 percent for those plots with 6-10 trees. The vast majority of plots with 6 or more trees rated fair.

Table 5.6. Forest Health by Tree Size Class

Tree Diameter Range (inches)	Percent of Total Plots	Percent of Total Plots with Good Tree Health	Percent of Total Plots with Fair Tree Health	Percent of Total Plots with Poor Tree Health
4-12	31	4	18	10
>12-20	36	2	22	11
>20-30	14	<1	7	6
>30-50	3	0	1	1
>50-100	<1	<1	0	0
Total Percent of all Plots in Each Tree Health Rating:		7	48	28

Table 5.7. Percent of Plots in Each Tree Count Range by Tree Health

Trees Per Plot	Tree Health Rating			Total Number of Plots in Each Tree Count Range
	Good	Fair	Poor	
1-5	53%	42%	5%	216
6-10	17	73	10	121
11-15	22	68	10	59
16-20	5	71	24	21
21-30	10	90	0	10
30-65	0	100	0	2

Another component of forest health that was measured as part of this study is tree regeneration. Forests with few tree seedlings are in danger of dying out over time because there are no replacements for the aging trees. In the Duwamish Greenbelts, the study shows that there is little tree regeneration, and that most of this is deciduous. Of the forested plots, about 60 percent show no regeneration, 35 percent show regeneration by deciduous trees, and only 5 percent have coniferous regeneration. This low number for conifers is reflective of the lack of mature conifer forest in the area, but it is lower than expected given that at least one evergreen species dominates in 17 percent of all plots.

5.3 Invasive Plant Coverage

Invasive plants are known to be a severe problem in the Duwamish Greenbelts, but the data from this study are alarming in showing how pervasive is the invasive coverage. Over one half of all plots have greater than 25 percent total cover by invasive species, and over one quarter have greater than 75 percent cover (Table 5.8). Only 13 percent of all plots have no cover by invasive species, and these are mostly evergreen-dominated plots.

Table 5.8. Total Percent Cover for All Invasive Species

Total Percent Cover by Invasives	No. of Plots	Percent of Plots
No cover	71	13
Trace-5	86	16
>5-25	79	15
>25-50	57	11
>50-75	90	17
>75-100	147	28

Broken down by species, Himalayan blackberry is the most wide-spread and has the highest cover of all the invasives; it is followed closely by English ivy (Tables 5.9 and 5.10). These are both creeping, woody vines that spread readily and grow up and over other plant species, thus choking out competitors for space and sunlight. About 69 percent of all plots have some blackberry present, and 31 percent of all plots have over 50 percent cover by this one species. English ivy is present in 43 percent of all plots and has over 50 percent cover in 15 percent of plots. The remaining invasive species are not nearly as widespread, and occur primarily in smaller, isolated clumps. Cherry laurel and English holly occur mostly at relatively low cover levels, although a small number of plots show higher coverage. When present, clematis can dominate much of the ground cover as well as creeping up into the tree canopy, but it is generally not widespread throughout the study area.

The distribution of invasive plant species in the Duwamish Greenbelts is widespread. We see the lowest percent cover by invasives in Westcrest Park where the forest is less disturbed and a greater percentage of the area (38%) is dominated by evergreen species. In this area, 62 percent of all plots have less than 25 percent cover by invasive species. Areas that have very high percent cover of invasive species (over half of all plots in an area having greater than 50 percent cover) include Duwamish Head, North Beacon Hill, South Beacon Hill, and Carkeek Drive.

Table 5.9. Occurrence of Invasive Plant Species

	Percent of All Plots in Which Each Species Occurs in Each Cover Class						
Range of Percent Cover	**Himalayan Blackberry**	**English Ivy**	**Cherry Laurel/Holly**	**Giant Knotweed**	**Clematis**	**Reed Canary-grass**	**Scot's Broom**
None	31	57	67	98	94	99	94
1-5	16	13	23	<1	2	<1	4
>5-25	13	8	7	<1	2	<1	1
>25-50	8	6	2	<1	1	0	<1
>50-75	11	8	<1	0	<1	0	0
>75-100	20	7	0	0	0	0	<1

Table 5.10. Summary of Invasive Plant Cover by Species

Invasive Plant Species	Percent of Plots With Species Present	Percent of Plots in Which Species Covers >25%	Percent of Plots in Which Species Covers >50%
Himalayan Blackberry	69	40	31
English Ivy	43	21	15
Cherry Laurel/Holly	33	2	<1
Giant Knotweed	2	<1	<1
Clematis	6	2	<1
Reed Canarygrass	<1	0	<1
Scot's Broom	6	1	<1

5.4 Landscape Features

The Duwamish Greenbelts include both relatively flat areas as well as very steep slopes. Steep slopes in excess of 40 percent were found in 18 percent of the plots. Half of the plots were in areas of 15 percent slope or less, with a portion of those in flat or depressional areas. Table 5.11 shows the breakdown for percent of plots by slope.

Table 5.11. Percent of Plots in Each Slope Range

	Slope (percent)		
	0-15	**>15-40**	**>40**
% of Total Plots	50	32	18

Data collectors were asked to estimate the general compass direction toward which the majority of the plot was sloping. In addition to the eight cardinal directions, flat and depressional plots were noted. About 52 percent of plots face easterly (E, SE, NE) and 23 percent face westerly (W, NW, SW) (Table 5.12). Very small percentages are due north or south. A total of 17 percent are essentially flat or slightly concave.

Table 5.12. Percent of Plots by Aspect

	Aspect									
% of Total	N	NW	W	SW	S	SE	E	NE	FLAT	DEPRESS.
Plots	5	8	10	5	1	9	29	14	15	2

Data were collected on the occurrence of specific features, both natural and manmade, within the sample plots to provide information on areas that may need special attention, that may have exceptional habitat features, or that may present specific challenges when planning and implementing restoration actions. Table 5.13 shows the percent of plots in which each feature occurs. A number of plots have refuse (8%) of some type or portions of decrepit buildings (<1%) that will likely need to be cleaned up. The presence of water in plots will need to be considered in restoration plans wherever there are creeks (4%), gully erosion areas (3%), or seeps (8%). Snags and down logs, important wildlife habitat features, were found to occur in about 25% of all plots, a significantly lower occurrence than one might expect in a healthy, multi-aged forest ecosystem.

Table 5.13. Frequency of Occurrence of Special Features

Special Feature	Percent of Total Plots in Which Feature Occurs
Powerline	3
Slide	3
Encampment	1
Creek	4
Gully erosion	3
Refuse	8
Huge tree	5
Snag	24
Down log	26
Seep	8
Old Buildings	<1
Fences	1

6. DATA ANALYSIS AND MANAGEMENT ISSUES

The Duwamish Greenbelts are dominated by second- and third-growth forest that was logged presumably through the late 1800s and early 1900s. The general condition of this area indicates that it has received no large-scale forest management over the years (e.g., extensive replanting or thinning), and that the regrowth of the forest has been strongly influenced by the urban setting. Because these forests occur in an area that has undergone rapid and extensive urban development since logging, regrowth has been shaped by factors that include:

- soil erosion and loss of organic matter during and following logging;
- fragmentation into small forest blocks;
- restriction of remaining forest remnants to erosion-prone slopes;
- disturbance along forest edges for construction of roads, housing, ballfields, etc.;
- invasion of non-native plants progressing from the disturbed edges into forest interiors; and
- tree clearing for utility corridors and views with accompanying invasion of non-native plants.

As areas in the greenbelts were logged, and the debris burned or removed, this interrupted the normally continuous process of the forest contributing organic matter to the soils. With the significantly lowered input of organics, the extent of bacterial and fungal breakdown of organic debris into useable nutrients was substantially reduced. Soils became deficient in the microbes that are essential to the nutrient-cycling processes on which plants depend. As soils became more sterile, plant vigor and plant species diversity decreased. In areas where dying trees created canopy gaps, the more adaptive and opportunistic invasive species could out-compete native species that were lacking for nutrients. Tree seedlings in the understory that would normally shoot up into new canopy gaps given the increase in sunlight, were stunted by the lack of microbes, mycorrhizae (symbiotic fungi/tree root association) and nutrients.

As urban development spread in the Duwamish area, forest fragmentation and the extent of forest edges increased. All forest edges differ in common ways from the forest interior: increased potential for windthrow, more open tree canopy, decreased shading, decreased moisture in soil and microclimate, and encroachment by non-native plants. Forest edges in urban areas tend to have an even greater extent of disturbance, the effects of which are seen further into the forest interior than in more rural areas. Types of urban-related disturbances may include selective tree clearing, planting or encroachment of non-native species from landscaped areas, encroachment of invasive weeds from disturbed areas, extensive networks of social paths, predation of wildlife by domestic pets, piping creeks underground or diverting flows thus eliminating or decreasing riparian corridors, increased storm water flows resulting in slides of steep slopes, and so on. This higher level of disturbance, when combined with the extensive fragmentation and smaller forest blocks of urban areas, results in the degraded condition of the forest edge extending further into the forest and greatly reducing the effective forest interior. Thus we see in the Duwamish Greenbelt forests, for example, invasive plant species not just limited to the more disturbed forest edges, but occurring in and even dominating the understory throughout forest stands.

Most of these problems are evidenced in the data collected for this project. Table 6.1 provides a summary of the problems or constraints in the Duwamish Greenbelts that were identified by the data. Ratings for each constraint are listed by sub-unit area. They are rated by severity: severe, moderate, or low, or by presence or absence. The severity of the ratings was gauged in part by comparing the sub-unit areas, but primarily the ratings were determined by quantitative standards. For example, small tree size was rated a severe constraint for a sub-unit area when more than one-half of the plots averaged 4-12 inch diameter trees. A moderate rating was assigned for areas with greater than one-third of plots at 4-12 inch diameter trees, and less than 15 percent of plots with trees greater than 20 inches in diameter. Areas with less than two-thirds of plots with trees greater than 12 inches were rated low. For a complete guide to how the other severity ratings in Table 6.1 were determined, see table footnotes.

Table 6.1. Summary of Severity of Identified Problems by Sub-unit Area

	Sub-unit Areas						
Constraints	**Duwamish**	**Puget Park**	**W. Marginal**	**Westcrest**	**N. Beacon**	**S. Beacon**	**Carkeek Dr.**
Small Tree Size[1]	L	L	L	M	M	S	S
Low Density[2]	S	S	S	M	S	S	S
Low Conifer Cover[3]	M	S	S	L	S	S	S
Low Overall Regeneration[4]	S	S	S	M	M	L	M
Low Conifer Regeneration[5]	S	S	S	M	S	S	S
Poor Tree Health[6]	S	S	M	L	M	L	M
Low Native Understry. Domin.[7]	M	S	M	M	S	S	S
High Invasive Cover[8]	S	S	S	M	S	S	S
High Blackberry Cover[8]	M	M	M	M	S	S	S
High Ivy Cover[8]	M	L	M	L	S	M	S
Frequent Laurel/ Holly Occurrence[9]	M	M	M	M	S	L	S
Frequent Clematis Occurrence[9]	L	L	L	L	M	L	L
Steep Slopes[10]	S	L	M	L	M	M	L
Slides[11]	S	L	M	L	S	L	L
Seeps[12]	S	L	M	M	L	M	S
Gully Erosion[12]	M	L	L	M	L	L	L
Creeks	P	P	P	P	NP	NP	P
Refuse[12]	M	L	M	S	M	S	M
Powerlines	P	P	P	P	P	P	NP

S – Severe, M – Moderate, L – Low, P – Present, NP – Not Present

1 S=>50% of plots have 4-12" trees, M=>33% of plots have 4-12" trees & <15% of plots have >20" trees, L=<67% of plots have >12" trees
2 S=>50% of plots have 10 or fewer trees, M=>50% of plots have 10 or more trees, L=>30% of plots have >20 trees
3 S=<10% of plots dominated by evergreen or mixed forest, M=10-30% of plots dom. By evergreen or mixed, L=>30% plots are evergreen/mixed
4 S=<30% of plots have regeneration, M=30-60% of plots have regeneration, L=>60% of plots have regeneration
5 S=<15% of plots have conifer regeneration, M=15-40% of plots have conifer regeneration, L=>40% of plots have conifer regeneration
6 S=<50% rated fair or better, M=50-70% rated fair or better, L=>70% rated fair or better
7 S=<6 dominant native understory species, M=6-15 dominant understory species, L=>15 dominant understory species
8 S= 40% or more of plots have >25% cover, M=15-<40% of plots have >25% cover, L=<15% of plots have >25% cover
9 S= present in >40% of plots, present in 20-40% of plots, present in <20% of plots
10 S= >25% of plots have >40% slopes, M=10-25% of plots have >40% slopes, <10% of plots have >40% slopes
11 S=>5% of plots have slides, M=2-5% of plots have slides, L=<2% of plots have slides
12 S=>10% of plots have constraint, M=5-10% of plots have constraint, L=<5% of plots have constraint

The following sub-sections analyze the major trends in the data that were identified in Section 5 of this report. The analysis focuses on problems posed by the degraded condition of the forest and identifies the major management issues that will need to be addressed in efforts to enhance the forests of the Duwamish Greenbelts.

6.1 Lack of Forest Complexity

The lack of complexity in the Duwamish Greenbelt forests is evidenced by low species diversity, an overwhelming dominance by deciduous trees, low tree regeneration, and low structural complexity in both the tree canopy and in the dead or decaying wood component. Over two-thirds of the study area is dominated by deciduous trees only, and this is limited primarily to two species, red alder and bigleaf maple. Many areas were noted that had only one of these species as a dominant tree. While evergreen species are dominants or co-dominants in 17 percent of all plots, most of the area that is dominated primarily by conifers is concentrated in Westcrest Park. There are a number of very large areas within the greenbelts that have no dominance by coniferous species. These occur primarily in the West Marginal Hillside, North Beacon Hill, and South Beacon Hill areas. Puget Park and Carkeek Drive are smaller areas that have some mixed forest, but are predominantly deciduous. Douglas fir and Pacific madrone are the only common dominants in evergreen plots throughout the study area.

Because the forests in the area are relatively young (<100 years old), one would expect Douglas fir to dominate over cedar and hemlock in previously logged areas. However, a healthy forest should have a significant component of regenerating seedlings, saplings, and mid-canopy specimens of these climax species; we do not see this evidenced in the majority of the Duwamish Greenbelt forests. Westcrest Park is the exception to this, having the highest percentages of evergreen forest (38% evergreen, 19% mixed forest) and conifer regeneration (17% of plots) of any of the seven assessment areas.

In addition to the lack of tree species diversity, there is a uniformity of size and age in most stands in the study area that results in a lack of canopy complexity. There is little mid-canopy structure in these forests, as most trees in a stand are of similar height. With the low species diversity, there is also a paucity in the mid-canopy of tall shrubs (e.g., vine maple, red elderberry, oceanspray) and trees that stay relatively small to maturity (e.g., hazelnut, hawthorn, crabapple, Pacific dogwood). Thus, a view of a typical older stand in the area might show tall bigleaf maple of 12-20 inches in diameter, with a very open understory of scattered red elderberry and a dense carpet of English ivy. Views of typical younger stands in the study area may show a shorter, even-aged alder forest with an open canopy, very little shrub layer, and dense thickets of Himalayan blackberry.

Contributing to this lack of complexity is the minimal occurrence of regeneration among both deciduous and evergreen species. This means that there are few tree seedlings or saplings in the understory to be replacement trees that will eventually fill gaps in the canopy caused by the death of overstory trees. Regeneration was noted in only one-third of all plots in the study area, and it was primarily comprised of deciduous species. Conifer regeneration was observed in only 22 (4%) of 530 plots. The lack of conifer seedlings is easily explained by the general lack of a seed source in mature coniferous trees. Clearly, conifer regeneration was significantly higher in Westcrest Park than in other greenbelt areas due to the more extensive dominance of Douglas fir in the Park. What remains difficult to explain is the relatively low level of deciduous regeneration that was observed.

Red alder are known for readily spreading by seed and big leaf maple by seed and stump or root sprouting. This could be a factor of canopy closure in some areas, where deep shade prevents establishment of seedlings, but many areas were noted with relatively open canopies and little regeneration. In these areas, seedlings may be out-competed or choked out by invasive species such as blackberry and ivy.

This lack of forest complexity is explained in the history of forest practices and urbanization in the area. The Duwamish area was once covered by old growth lowland forests that were likely dominated by western red cedar and western hemlock. In areas where trees had fallen, the space in the canopy might have allowed Douglas fir seedlings to grow up to maturity. These would eventually be outlasted by Cedar and hemlock, which have much longer life spans than Douglas fir, and thus eventually come to dominate in the oldest forest stands in the Pacific Northwest. Where slides or burns occurred, pioneer species of herbs and shrubs would give way to early successional tree species such as red alder. Red alder is a rapidly growing and relatively short-lived seral species that enriches the soil by fixing nitrogen and provides shade for conifer seedlings to establish. The alder in the slide or burn areas would have eventually died out and the stands transitioned toward the coniferous species.

This natural process of succession, maturation, death and disturbance that once occurred in this area was interrupted when the forests were logged, primarily by clearcutting. Following the stage of pioneer species, the sun-loving, easily sprouting, opportunistic early seral species of red alder readily established dominance in this area. However, most of the Duwamish forest never matured to the coniferous stage. With urban development speeding along in surrounding areas, there was little seed source for coniferous species and little protection from the sun for the more shade-loving cedar and hemlock to become established. Bigleaf maple is now so common in the area probably because it is sun-loving, sprouts very easily, and had an abundant seed source in that it was left in remnant forested areas in the built environment such as on vacant lots and steep slopes.

Management Issues:

- In planting conifers, what factors should be considered, what areas prioritized or avoided?
- What species should be planted to increase mid-canopy cover and where?
- Should habitat structures (snags, down logs, brush piles, nesting boxed) be imported or created in a specific area? If so, what should be targeted wildlife species?
- Should deciduous tree species be planted to increase overall diversity? If so, what species and where?
- What should be planted on open west or south-facing slope?
- How can light gaps be created in areas of dense deciduous canopy without increasing invasive species cover?
- What areas should be targeted for conifer under-planting?
- Is it desirable to increase deciduous regeneration?
- How will invasives be managed in areas targeted for under-planting conifers?

6.2 Low Forest Age and Density

The forests in the greenbelts are generally comprised of relatively small trees in stands of relatively low density. The trees in two-thirds of the area average less than 20 inches in diameter, and two-thirds of the study area has 100 or fewer trees per acre (10 trees per plot). For areas with the smallest tree size class (4-12 inches), in which you would expect to see the highest densities, the data show a median of only 70 trees per acre. In more rural conifer forests, a typical density range might be XX to XX trees per acre when the average diameter is less than 12 inches. At a diameter range of 20-30 inches, where we would expect to see XX to XX trees per acre, the data for the Duwamish show 50 trees or less per acre. Based on the data collected, only 2 percent of the study area has greater than 200 trees per acre, and this is entirely accounted for by the two smallest tree size classes. Low forest density is a severe problem in all areas within the Duwamish Greenbelts with the exception of Westcrest Park. Small tree size is a severe problem in South Beacon Hill and Carkeek Drive. These latter areas occur along the eastern portion of the Duwamish Greenbelts.

The low density of trees observed in the study area is probably related to low organic input and a related lack of nutrients, a lack of overall regeneration, and competition for limited light and nutrients by invasive species such as blackberry and ivy. It is likely that logging and development-related disturbances initially depleted the nutrient reservoir in the soil and biota, thus limiting availability of nitrogen and other important nutrients. The lack of variety in age class is related to low input of organic matter, and therefore lower levels being recycled in the forest system. If there were large amounts of organic matter being cycled into the soils of the greenbelt areas, we would be seeing rapid invasion and revegetation by native pioneer species every time a disturbance created an opening. But much more commonly, we see disturbed areas being invaded by non-native species, and/or showing little or very slow growth of plants overall.

The uniformity of age that characterizes these forests is accompanied by a lack of recruitment of dead and decaying wood. Old growth forests have so many snags and decaying down logs because there are always older trees dying. The lack of older trees in the Duwamish means fewer trees are dying and becoming snags or down logs. This means fewer habitat structures for wildlife, and a lack of nurse logs, a common source of new trees in healthy forests.

Management Issues:

- What are appropriate target densities for the forests in the Duwamish Greenbelts, given their urban setting?
- Is it desirable to plant mostly conifers to increase density, or should deciduous trees be planted as well?
- Are there management actions that could effectively increase tree growth rates that would be appropriate for the Duwamish forests (e.g., thinning deciduous trees to benefit conifers, thinning in doghair alder stands)? What areas should be prioritized?
- Should soil organic matter be increased to promote rhizosphere development?
- Does the high proportion of poor tree health ratings in this study suggest the need for a comprehensive survey of areas of diseased or dying trees by a qualified forester?

6.3 Low Native Plant Diversity/ High Invasive Occurrence

The data show that low native plant diversity is a moderate to severe problem throughout the study area. A fairly wide variety (29 species) of native shrubs and herbs were observed during the study, but only a handful of these were noted to be common dominants. The under-representation of coniferous forest and the lack of complexity in forest communities in the area results in a scarcity of the native understory species that are common in lowland forests. Shrub species that are notably absent or scarce in the Duwamish forests include Oregon grape (*Mahonia nervosa*), evergreen huckleberry (*Vaccinium ovatum*), red huckleberry (*Vaccinium parviflorum*), vine maple (*Acer circinatum*), snowberry (*Symphoricarpos albus*), roses (*Rosa* spp.), and currants (*Ribes* spp.). Herbaceous species that are absent or under-represented include false lily-of-the-valley (*Maianthemum dilatatum*), foamflower (*Tiarella trifoliata*), bleeding heart (*Dicentra formosa*), western trillium (*Trillium ovatum*), deer fern (*Blechnum spicant*) and wood fern (*Dryopteris spp.*). The lack of these species is surprising and should be considered as a major indicator of the lack of forest complexity and the degraded forest health in the Duwamish Greenbelts. While this lack of diversity has been confirmed by experienced botanists, the apparent under-representation of native herbs may be exaggerated by the data due to an unintended bias by the volunteer data collectors toward the more familiar and easier-to-identify trees and shrubs. In addition, many of the plots were sampled during late fall and winter when herbs die back and are generally not visible.

The low diversity that was observed in understory associations is likely directly related to the widespread occurrence and extensive coverage by invasive non-native species. Only 13 percent of all plots have no occurrence of invasive species, and over half of the plots show greater than 25 percent total cover by invasives. Himalayan blackberry was noted in over two-thirds of the plots, and either English ivy, cherry laurel or English holly are problematic in over one-third of all plots.

Blackberry and ivy, by far the most prevalent non-native species in the Duwamish Greenbelts, are highly invasive and opportunistic. Blackberry readily establishes in disturbed areas where low canopy cover allows for more light and more space. The species thrives in dry or saturated soils and out-competes other understory plants by growing over them and forming dense thickets that allow little light penetration during the growing season and leave virtually no rooting space for other species. Blackberry thrives on steep slopes where other species may have difficulty establishing. Blackberry is capable of spreading by seed, rhizome, and tip-sprouting and is probably the most successful invasive species ever introduced to the Pacific Northwest. English ivy is capable of spreading by seed, but more commonly spreads by rhizome to form dense, monotypic carpets that choke out native groundcover and spreads extensively into the tree canopy. Ivy is so insidious in urban forests because it can thrive even under dense canopy cover and is almost impossible to eradicate once it establishes in an area.

Himalayan blackberry was commonly observed in non-forested areas and in the understory of deciduous forest areas, especially where canopy cover was low. There was less extensive cover of blackberry found in evergreen forest areas. Blackberry was noted to have particularly high coverage in North Beacon Hill, South Beacon Hill, and Carkeek Drive areas. The North Beacon Hill area has a higher proportion of steep slopes and slide areas where canopy cover is relatively low and blackberry has ample opportunity to establish. South Beacon Hill and Carkeek Drive areas are generally not as steep, but there is no evergreen forest in either, little mixed forest, and relatively low tree densities, allowing for more canopy openings.

English ivy probably first moved into the disturbed, more open areas within the Duwamish Greenbelts, and then crept on into less disturbed areas of deciduous forest with denser canopy cover. There are few plots in the evergreen and mixed forest areas that have greater than 25 percent cover of ivy.

Cherry laurel and English holly do not show extensive coverage in many plots (less than 3% of plots have greater than 25% cover), but they were noted to occur relatively frequently (one-third of all plots). The lack of extensive coverage is most likely a factor of the growth habits of these species. They spread mostly by seed and so do not form the rhizomatous, monotypic thickets seen with blackberry or ivy. However, the high frequency of occurrence would indicate that these species have been spreading throughout many areas in the Duwamish Greenbelts, and that there is ample potential for invasion of additional areas.

Management Issues:

- Since it is not feasible to eliminate all invasive plants from the greenbelt areas, what is the best approach to managing them?
- Is it preferable to begin with targeting areas of high invasive cover or "invasive fronts" where an area of little invasive cover is adjacent to areas of significantly higher cover?
- What is the best approach to use on steep slopes that are dominated by invasive species? How do we increase native diversity while maintaining slope stability?
- Should the long-term goal for areas with very high blackberry cover be to minimize the spread of such areas, or to eventually try and eliminate them?
- What native understory species are desirable for the Duwamish forests, but also are capable of growing fast and fighting invasive species for space?
- How should vegetation at viewpoints be managed to maintain views?

6.4 Common Occurrence of Slides

Large portions of the Duwamish Greenbelts are perched on the slopes that define the eastern and western walls of the Duwamish Valley, or on the headland slopes of the Duwamish Head. Steep slopes (areas that exceed 40 percent in slope) account for 18 percent of all plots, while one-third of plots occur on slopes ranging from 15 to 40 percent. A large proportion of the steep slopes occurs in the Duwamish Head, West Marginal Hillside and North and South Beacon Hill areas. Particularly in North Beacon Hill, there are a number of plots that could not be safely accessed due to the steepness of the slope (data were collected by viewing these plots from above). All but one of the slide areas that were observed during the study are on moderate to steep slopes. About 37 percent of the identified slide areas occur on slopes in excess of 40% and over half are on slopes of 15-40%.

Seeps are commonly found on steep slopes in Western Washington, and are often related to the occurrence of slides. Seeps were noted in 8 percent of the plots in the study, and about one-fifth of all plots with seeps occur on steep slopes. One-third of plots with seeps occur on slopes of 15-40%. Curiously, only a few plots that occur on steep slopes had both seeps and slides noted. Regardless of whether all three features coincided in specific plots, one would expect that areas with high proportions of seeps and steep slopes would have greater occurrence of slides. This study supports this assumption, as can be seen in the data for Duwamish Head, West Marginal Hillside, and North

Beacon Hill areas where steep slopes, seeps and slides are all common. For areas that have a high proportion of seeps but do not have significant areas of steep slopes, no slides were observed. These include South Beacon Hill, which has 9 percent of its plots in seeps, and Carkeek Drive, which has 15 percent of plots in seeps. These areas have 10 percent of plots, and no plots on steep slopes, respectively.

Slides typically result in clearing most trees from an area, thus making them more susceptible to additional erosion, and to colonization by invasive plants. Slides also threaten the built environment that surrounds the greenbelt parcels, thus presenting a potentially serious threat to public safety. Because slide-prone areas typically occur on steep slopes, access for assessing and stabilizing these areas is difficult.

Management Issues:

- How do we manage the forests and enhance cover and diversity without destabilizing slopes and causing new slides?
- How will management practices differ in recent slide areas vs. historic slide areas?
- How do we deal with the safety and access issues in working in slide-prone areas?

6.5 High Level of Human Intrusion

Urban forests are generally characterized by a high level of ongoing human intrusion. In the Duwamish Greenbelts, the forests are surrounded mostly by residential areas or occur in public parks. They are criss-crossed by utility corridors and by trails, both formalized and social. People camp out, and some neighbors and other users of the greenbelts dump yard waste and garbage. The private use of public park property for driveways, yards and other encroachments is also a problem in the greenbelts, although data on the occurrence of encroachments were not collected during this study. Other unauthorized uses are known to occur as well.

A total of seven encampments were observed in or near plots; one in the West Marginal Hillside area, two in Westcrest Park, and four in the North Beacon Hill area. There are almost certainly a number of encampments that were not observed during the study. The City of Seattle has adopted a policy of zero tolerance for encampments on City-owned lands, but this is not consistently enforced. It is generally the goal of DPR staff to remove camp structures and restore forest areas that have been disturbed by camping activities. For those implementing this goal, approaching and cleaning up encampments raises safety and social service issues where a coordinated effort among City departments may be needed.

Powerlines were observed in or near about 16 plots, but one cannot discern from the data how many separate powerlines this represents. It is likely that there are some powerlines crossing the greenbelts that are not accounted for in the database. Powerlines pose unique problems in the greenbelts because the vegetation under them is managed so that it does not grow high enough to interfere with the overhead lines. This precludes planting trees and tall shrubs in these areas. The open canopy that results makes the powerlines and adjacent areas more susceptible to intrusion by invasive plants. Selection of species that will not grow into the powerlines at maturity is critical in these areas.

The extent of refuse that was noted in plots in the study area reflects typical dumping practices in undeveloped urban areas. Refuse was observed in a total of 8 percent of plots, or about 42 plots. Very few plots with refuse were observed in the Duwamish Head and Puget Park areas. The most frequent occurrence of refuse was noted in Westcrest Park and South Beacon Hill, with 12 percent of plots in each area. The data do not differentiate between big piles of yard waste, large tire dumps or small bits of litter, so the severity of the problem is somewhat masked. Refuse in the urban setting is most commonly dumped along the edges of undeveloped areas, commonly where pullouts or parking lots occur alongside the road. It is also common to see yard waste dumped directly over the fences of neighboring residential lots.

Management issues:

- What plant species should be selected for planting under powerlines?
- What is the best approach for managing vegetation and minimizing invasive spread in areas adjacent to powerline corridors?
- How can DPR discourage future dumping of refuse in greenbelt areas?
- What is a workable strategy for dealing with encampments that achieves cleanup goals without risking worker's safety?
- How can reforestation efforts be integrated with areas of informal, social trails? Are there social trails that should be eliminated? Is there a need for a thorough mapping of all trails?

7. LAND FORM DESCRIPTIONS

Within the Duwamish Greenbelts, land forms can be divided into seven basic types: wetlands, riparian corridors/ravines, non-forested areas, upland forests, slides, powerlines, and viewpoints. These land forms are defined and described below. The categories are used for this study for the purpose of identifying common areas to which to apply general management guidelines and prescriptions. For example, more water-tolerant plants will be recommended for installation in wetlands, and low-growing plant species will be targeted for powerline corridors and viewpoints. Specific land form types are prioritized in Section 8 for implementation of various management prescriptions.

7.1 Wetlands

According to the City of Seattle Environmentally Critical Areas (ECA) ordinance:

> "Wetlands are those areas that are inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

The data collection effort in the Duwamish Greenbelts did not include a comprehensive survey for wetlands. Volunteer data collectors were not trained in wetland identification and were largely not qualified to make field wetland determinations. DPR's general database for the greenbelts does include some information on wetland locations; the information is primarily based on the National Wetlands Inventory maps (see Figure 7-1). In addition, the data collected as part of the Duwamish Greenbelts study provides information that can be used to locate potential wetland areas. This includes information on standing water and saturated soils, presence of seeps and creeks, and identification of dominant understory plant species. Potential wetlands were identified in all of the sub-units based on the following criteria:

- ♦ Presence of soft soils or standing water
- ♦ Presence of creeks or seeps
- ♦ Presence of hydrophytic (water-loving) vegetation with a rating of facultative or wetter (>50% probability of occurring in wetlands) in the understory

If any one of the above criteria were met in any plot, it was considered a potential wetland. Based on these parameters, 25 percent of the total plots surveyed in the Duwamish Greenbelts met at least one of the criteria for potential wetlands listed above. This number probably reflects a much higher estimate of wetland occurrence than what actually exists because the presence of any single criterion by itself does not necessarily indicate wetland. Even though it is likely that there were wetlands in the study area that were overlooked, it is very unlikely that the actual wetland area in the greenbelts is as high as the 25 percent indicated above.

Identifying these potential wetland areas simply provides guidance for finding those sites that may present opportunities for wetland enhancement. However, implementation of vegetation management strategies that specifically target wetlands will depend on a more accurate field survey of the study area to identify and map their location. Rather than the uniform distribution of sample plots used for the overall greenbelt survey, a wetland survey should focus on areas likely to support wetland habitat. In addition to further field assessment of all sample plots that had soft soils,

Figure 7-1. Known Wetlands, Streams, Slides, and Powerlines in Greenbelts

standing water, seeps, or slides, field crews should focus on toes of slopes, low topographic depressions, known ravines and creeks, and presence of hydrophytic vegetation (Facultative or wetter). These detailed survey areas can be identified using aerial photographs and DPR staff's knowledge of the greenbelts.

7.2 Riparian Corridors/Ravines

Riparian corridors are wetland and terrestrial areas within the influence area of the adjacent stream. They are technically defined in the City of Seattle ECA as:

> "…all areas within 100 feet measured horizontally from the top of the bank, or if that cannot be determined, from the ordinary high water mark of the watercourse and water body, or a 100 year flood plain as mapped by FEMA, as regulated by the Seattle Floodplain Development ordinance, whichever is greater."

The data collection effort in the Duwamish Greenbelts did not include a comprehensive survey for streams and riparian corridors. In instances where these features did occur in a plot, they were noted. Streams previously mapped by the City of Seattle are indicated on DPR base maps used for this project (Figure 7-1). Riparian corridors and/or streams were identified in, but not limited to, the following areas: all four of the West Duwamish Greenbelt sub-units (Duwamish Head, Puget Park, West Marginal Hillside, Westcrest Park), and the Carkeek Drive sub-unit in the East Duwamish Greenbelt.

7.3 Non-forested areas

Non-forested areas have no tree cover and are divided into three categories

- Meadow (grasses and forbs)
- Blackberry thickets with native shrub species
- Blackberry thickets with other invasive species or grass

Eighty-one plots (15%) in the study area have no overstory (Table 7.1). Of these 81 plots, 43 have no shrubs in the understory and would be considered meadow areas. Of the remaining 38 plots, 35 were blackberry thickets with other invasive species or grass, and 3 were blackberry with native shrubs. The high percentage of non-forested plots in Puget Park reflects the large areas of meadow that were included in the sampling area for that sub-unit. Thus 78 of the 81 non-forested plots are either maintained grass playfields, meadow in the unmaintained portions of the greenbelts that is vulnerable to invasion by non-natives, or already invaded meadow. The number of plots located in maintained grass playfields could be calculated using the aerial photos depicting plot locations.

Table 7.1 Occurrence of Non-forested Areas by Sub-Unit

Sub-unit	No. of Non-forested Plots	% of Total Plots in Sub-unit
Duwamish Head	17	20%
Puget Park	28	42%
West Marginal Hillside	21	13%
Westcrest Park	6	6%
North Beacon Hill	8	13%
South Beacon Hill	1	2%
Carkeek Drive	0	0%
TOTAL	**81**	**15%**

7.4 Upland Forests

Upland forests are undeveloped landscapes that do not fall into one of the previous classifications. They are forested areas that have been divided into two categories based on slope steepness.

Forests on Steep Slopes

These are forested areas that occur on slopes of 40 percent or greater. There are a total of 85 plots (16%) in the study area in this landscape category (Table 7.2).

Table 7.2 Occurrence of Forested Areas on Steep Slopes by Sub-Unit

Sub-unit	# of Forested Area/Steep Slope Plots	% of Total Plots in Sub-unit
Duwamish Head	28	32%
Puget Park	2	3%
West Marginal Hillside	35	23%
Westcrest Park	3	3%
North Beacon Hill	13	20%
South Beacon Hill	4	10%
Carkeek Drive	0	0%
TOTAL	**85**	**16%**

Forests on Less than 40% Slopes

These are forested areas that occur on slopes of less than 40 percent. There are a total of 364 plots (69%) in the study area in this landscape category (Table 7.3).

Table 7.3 Occurrence of Forested Areas on <40% Slopes by Sub-Unit

Sub-unit	# of Forested Areas/<40% Slope Plots	% of Total Plots in Sub-unit
Duwamish Head	42	48%
Puget Park	36	55%
West Marginal Hillside	101	64%
Westcrest Park	85	90%
North Beacon Hill	43	67%
South Beacon Hill	37	88%
Carkeek Drive	20	100%
TOTAL	**364**	**69%**

7.5 Slides

Slides are areas where the soil surface and vegetation have slid downhill and the exposed soil surface is bare and steep. A total of 18 slides were noted in the sampled plots (Table 7.4). Slides in the study area have been mapped fairly extensively by the City and are identified in Figure 7-1.

Table 7.4 Occurrence of Slides by Sub-Unit

Sub-unit	# of Plots with Slides	% of Total Plots in Sub-unit
Duwamish Head	8	9%
Puget Park	1	2%
West Marginal Hillside	4	3%
Westcrest Park	1	1%
North Beacon Hill	4	6%
South Beacon Hill	0	0%
Carkeek Drive	0	0%
TOTAL	**18**	**3%**

7.6 Powerlines

Powerline areas are defined by the presence of overhead transmission lines under which the vegetation has been altered, including powerlines that run along edges of roads or provide power to buildings within parks. Powerlines were noted in a total of 16 plots, 13 of which were in the West Marginal Hillside and Westcrest Park. A more accurate estimate of the total acreage of powerline areas and specific locations has been made using aerial photographs of the study area (Figure 7-1).

7.7 Viewpoints

There are four City of Seattle SEPA-designated viewpoints that occur in the study area (Table 7.5). These viewpoints are owned by Seattle DPR and are managed for low canopy height to provide scenic vistas and panoramic views.

Table 7.5. Designated Viewpoints in the Duwamish Greenbelts

Sub-unit	Name/Location	View
North Beacon Hill	12 Ave. S.	Duwamish Valley
North Beacon Hill	Jose Rizal Park/ 12 Ave. S. and Judkins St.	Elliot Bay, Downtown Seattle, Olympic Mountains
Duwamish Head	Hamilton View Park/ California Way SW	Elliot Bay, Downtown Seattle
Duwamish Head	Belvedere Viewpoint Park/ Admiral Way SW	Elliot Bay, Downtown Seattle

8. MANAGEMENT PRESCRIPTIONS

This section includes management prescriptions that are intended to address at least one of the problems identified in Section 6. Information is provided for each task regarding the reasons for doing them, the elements of the task, the areas or land form types that are prioritized for that task, and the specific problems that are addressed. The tasks are not ordered by priority, but do occur in a logical sequence where the first tasks listed would need to be undertaken earlier than the others. The task descriptions are followed by a summary table listing the tasks and the major features for each one.

In general, the main factors that are used in prioritizing areas for prescriptive actions in this plan are as follows:

- high visibility and/or high level of public use,
- risk to public safety,
- reasonable accessibility,
- good probability of involvement by neighborhood or community group volunteers,
- moderate biological condition with respect to specific problem under consideration (general approach is to begin with areas of moderate condition rather than severe, as defined in Table 8.1),
- area is "front" for specific problem under consideration (area of good to moderate quality adjacent to area of poor quality), and/or
- riparian corridor in which management action would contribute to improved aquatic habitats.

Using these criteria, it is likely that the West Duwamish areas will generally be prioritized over the East Duwamish areas due to greater visibility, higher level of public use, better access, the presence of more riparian corridors, and better biological condition. Areas on steep slopes will typically receive lower priority due to accessibility issues unless they pose a slide risk, and therefore are threats to public safety. Areas with high cover of invasive plants will generally receive lower priority than areas with moderate cover, because the latter are considered more recoverable. In general, this plan takes the approach that tasks with a higher probability of success should be prioritized, and that areas that are not yet severely disturbed should be saved from further degradation before those areas that are already in worse shape.

8.1 Manage Hazard Trees

Defective trees can be dangerous. Limbs can break off, or whole trees can fall over. If the tree is near a house, street or trail, injury or damage can result. Fortunately, the chance of this occurring can be anticipated based on visual inspection of the tree.

Trees can be inspected any time of year. Inspection requires training in one of the standard hazard evaluation formats. The DPR uses *Evaluating Tree Defects* by Ed Hayes (XxdateXX) for preliminary hazard analysis. Visible defects that are considered in hazard evaluation include, but may not be limited to, cracks in limbs and/or trunk, seams in limbs and/or trunk, spiral cracks in limbs and/or trunk, rib cracks, weak branch unions (V crotches), decay in limbs and/or trunk, cankers in limbs and/or trunk, deadwood, root problems, and poor tree architecture or form. Aggravating factors in hazard evaluation may include fast-growing species, sprouting from topping cuts, weak branch attachments, heavy end-weight of branches, included bark, evidence of past branch/trunk failure, saturated soil, frequent irrigation, more than 30 percent of buttress roots decayed and/or disturbed, evidence of excessive mechanical bark damage, large dense crown, lack of basal trunk flare (poor taper), recent construction activity, willow soil, and mushrooms visible at base or in root zone. A combination of any of these factors may greatly elevate the hazard rating.

Trees must be assessed within the limits of available fiscal and human resources. Therefore, priority should be given to inspecting locations and situations with high probability of failure and high potential of damage or injury. This typically means property boundaries near streets, buildings and parking lots. In these locations, several conditions may make failure more likely. Mature alder and cottonwood are more likely to fail catastrophically. Trees that have been previously topped or are resprouted from a stump are more likely to fail, and forest edges with wind exposure may also be more prone to failure. Orthophotos and other available geographic information can be used to predict some of these conditions.

Trees that rate a high hazard should be considered an imminent risk and should be scheduled for immediate remediation. Trees that are rated a moderate risk may be reevaluated at a specific interval or scheduled for immediate remediation. In cases where the hazard rating of a tree or trees is in dispute, the International Society of Arboriculture Tree Hazard Evaluation Form can be used to perform a more in-depth evaluation. Corrective action for high hazard rated trees should be reasonable and prudent and may include:

- moving any at-risk structures, equipment, fixtures or recreational sites;
- correcting the defect by pruning, cabling and bracing, or tree removal; and
- closure of the area.

Trees targeted for removal could be topped and girdled for snag creation, or felled and left on the ground to provide more downed wood. Openings in the tree canopy created by removal of hazard trees should be prioritized for planting (see Sections 8.3, 8.5, and 8.6).

8.2 Thin Dense Forest Stands

Thinning even-aged and overly-dense stands of trees in the greenbelts will improve forest health by increasing the growth rates of remaining trees and creating space and light for young tree seedlings and understory shrubs and herbs. Stands of dog-hair alder and young dense stands of Douglas fir should be prioritized for thinning. Areas with a severe invasive problem should not be thinned unless they can be immediately and densely planted, as the increased light will spur growth of invasives. Erosion or slide-prone areas should be evaluated for slope stability prior to thinning. Thinning can be done uniformly throughout targeted areas, or in patches to create specific gaps.

To implement this action, DPR foresters should conduct a forest survey in which they identify appropriate areas for thinning. The tree count and size data that were collected for this study can be used to help guide foresters to areas with dense stands of young trees. Appropriate thinning rates or densities should be identified for each targeted area as part of the survey. Areas selected for thinning which have low tree regeneration and/or high invasive cover should be prioritized for planting (see Sections 8.5 and 8.6).

8.3 Identify/Create Canopy Gaps

While related to forest thinning, creation of canopy gaps is a more site-specific process that need not occur only in young dense forest stands. Selective removal or girdling of trees is recommended in areas where a very dense tree canopy does not allow enough light to promote good tree seedling growth, but where tree trunk density does not justify widespread thinning. This condition is common in the more mature stands of bigleaf maple or Douglas fir where the removal of large numbers of trees to create openings cannot be justified. In urban forests such as the Duwamish Greenbelts where non-native plants are widely distributed, a site may be quickly colonized by invasive species if existing seedlings or newly planted trees do not rapidly close the canopy of the forest after a tree has died or been removed. Removing or thinning too much canopy, only to have it be replaced by invasives in the shrub layer, does not achieve the desired goal of improving forest health. Therefore, a slower approach that has maintainable and ultimately self-sustaining results is recommended.

To take advantage of existing crown openings and create additional canopy gaps the following methods are recommended:

1. Identify canopy openings. Openings in the crown can be found by walking the trails and forest of the greenbelts and looking for gaps in the overhead canopy that have the following characteristics:
    a. The opening is wider then the width of the canopy of the closest overstory trees.
    b. The distance from the center of the gap to any canopy tree trunk is a minimum of 40 feet.
    c. The opening is not on a north-facing slope - the closer the gap faces south, the better.

2. Remove nearby diseased trees. Survey the trees surrounding the canopy gap for health and remove or top any diseased trees that may fall on the new plantings that will be installed.

3. Remove invasive plants in the canopy opening. Apply an appropriate method of controlling the regrowth of invasive plants as described in Section 8.9. Remove competitive shrub species a minimum of three feet around each planting location.

4. Plant the canopy opening. Install plants at irregular spacing to simulate small natural groupings of like species of Douglas fir, western hemlock, western redcedar, grand fir and western yew. All trees should be spaced 10 feet apart at a minimum. Site-specific plans should be established through DPR's foresters and the groups responsible for the planting of the trees. Understory species should be included in the planting of areas that require clearing of invasives.

5. Monitor remaining trees for health. As decline is noted in large-canopy dominant trees, begin the introduction of shade-tolerant cedar and hemlock along the northern side of the declining tree. Plant Douglas fir and shade-intolerant species south of the dying tree. Space all trees a minimum of 10 feet from the dying tree. To more actively create canopy gaps, trees in decline are good candidates for cutting for down wood or girdling for snag creation.

Areas to prioritize for canopy gap identification and/or creation are those sub-units that are prioritized for conifer planting because of their comparatively good overall health: Duwamish Head and Westcrest Park. Within these sub-units, areas that have good access, are highly visible to the public, and have low levels of invasive coverage (require little site preparation and follow-up maintenance) are good places to target for initial planting in existing or created canopy gaps. Creating canopy gaps should be done in concert with efforts to create snags and down wood in the forest. That is, trees that are targeted for removal could be girdled or topped rather than cutting them down. This will result in standing dead wood (snags) as well as the crown and limbs littering the forest floor over time (down wood).

8.4 Plant Non-forested Areas

Where canopy is non-existent, restoration of native forest is a process of establishing a diverse canopy and understory of well-adapted native plants and their ecological allies. The product is a vigorous conifer-dominated forest that can best provide the functions defined in the goals of this plan. Many of the areas targeted for this process are currently blackberry thickets. These areas have little habitat diversity, nor do they achieve the optimal levels of erosion control, storm water detention and neighborhood buffering that a healthy native forest can provide.

In urban areas, reforestation is a very different project from the tree planting that timber companies practice. It is highly dependent on managing competition from exotic weeds and disturbance from urban influences. It also requires conserving or rebuilding forest soils that may have been lost during deforestation. Work proceeds in phases so that appropriate plants are placed in an ecological niche where they can effectively compete. Shrub landscapes without forest canopy have a high maintenance cost per square foot because they require mostly hand labor to weed. Forested landscapes with conifer canopy are lower cost to maintain if competition and disturbance are properly managed. Shading and root competition from the trees reduces weed competition substantially. Therefore, making a rapid transition from a non-forested shrub landscape to a forested shrub landscape should minimize long-term costs while achieving restoration goals.

The initial phase of planting consists of establishing conifer overstory and managing invasive weed competition. Groundcover is mostly seeded grasses and native forbs which can be mowed several times each growing season. A second phase of planting deciduous tall shrubs (e.g. hazelnut, vine maple) then hastens canopy closure once competition has been controlled. Final ground layer shrub planting is delayed until canopy closure is imminent.

This may take 7-10 years or more, depending on site conditions. While this may seem undesirable at first, this delay can be functional. First, establishing canopy creates the shade conditions that allow forest shrubs to effectively compete. Second, waiting allows the site manager to control any exotic weeds on the site that might interfere with the restoration. Finally, it delays the higher costs of the shrub restoration phase for at least five years. Costs are spread out, making the restoration more affordable.

All non-forested areas that are not maintained as lawn grass should be planted. These occur scattered throughout the various sub-units. For recommended species lists, see Sections 8.5 and 8.6.

8.5 Plant Conifers

Planting conifers in the greenbelts will increase forest complexity (structural and species diversity), increase regeneration and tree age over time, increase tree density, reduce invasion and dominance by non-native invasive species, and improve wildlife habitat to increase the number and diversity of wildlife in the greenbelt forest. The introduction of conifer species throughout the greenbelts can help the largely deciduous forest move towards a more balanced mixed age deciduous and coniferous forest. Active planting in the greenbelts will accelerate forest succession and will establish a seed source, which currently does not exist, for the future regeneration of the forest. The lack of conifers is a ubiquitous problem in the Duwamish Greenbelts. In some areas the problem is more severe than in others, but all landform types except for powerline corridors, and viewpoints need to be planted with conifers. It may not be advisable to plant large–growing trees on extremely steep slopes (greater than 1.5:1 or 60%) because of the potential for large-scale disturbance caused by large trees sliding or toppling on slopes that steep.

Table 8.1 lists conifer species that are native to the Puget lowland forest according to their relative soil moisture and light requirements. This table can be used to determine which species are best suited for different microclimates found within the landform types in the study area. Wetlands, for example, should be planted with conifers that tolerate moist or saturated soil conditions, such as Sitka spruce or red cedar. Riparian corridors and ravines in the Duwamish Greenbelts generally exhibit plant communities that tolerate moist soil conditions and at least partial shade, and should accordingly be planted with conifers that prefer these conditions. Non-forested areas are characterized by lack of overstory and are therefore exposed to high light conditions, and have drier and more nutrient-poor soils that favor early successional colonizers such as Douglas fir and grand fir. Native conifers should not be planted in powerline corridors or viewpoints and their viewsheds because of vegetation height restrictions. Vegetation in these areas is to be managed for low canopy, which would not include tall-growing conifers. Phased planting is the preferred strategy to increase diversity of species selections and age classes of plantings for all areas.

Priority areas for planting conifers include those that presently have some conifers (at least 10% of the plots are dominated by evergreen or mixed forest), and would be nicely supplemented by the addition of more individuals, species, and age classes of conifers. Areas that have some natural conifer regeneration occurring and that have somewhat intact habitat and plant diversity already are more likely to improve in overall habitat quality with relatively low levels of intervention and follow-up care. Comparative ratings of problem severity are shown in Table 6.1. Attentive stewardship and intervention is recommended to keep the healthiest greenbelt areas functioning and improving. The sub-units to prioritize based on these criteria are Westcrest Park and Duwamish Head, where the lack of conifer cover is of low or moderate severity. Lack of conifer regeneration is a severe problem in all the sub-units except for Westcrest Park. Westcrest, therefore, may be a good starting point to focus initial conifer planting efforts in order to maintain and improve an area that is currently in comparatively good shape. Within these sub-units, areas that have good access, are highly visible to the public, and have low levels of invasive coverage (require little site preparation and follow-up maintenance) should be targeted for initial planting.

Table 8.1 Species Selection for Native Conifer Planting

		Light		
		Low	Moderate	High
Soil Moisture	6. Low	*Tsuga heterophylla*	*Abies grandis* *Pseudotsuga menziesii* *Tsuga heterophylla*	*Abies grandis* *Pinus contorta* *Pseudotsuga menziesii*
	Moderate	*Taxus brevifolia* *Thuja plicata* *Tsuga heterophylla*	*Abies grandis* *Pseudotsuga menziesii* *Taxus brevifolia* *Thuja plicata* *Tsuga heterophylla*	*Abies grandis* *Pinus contorta* *Pseudotsuga menziesii*
	High	*Thuja plicata*	*Picea sitchensis* *Thuja plicata*	*Picea sitchensis* *Pinus contorta*

8.6 Plant Broadleaf Evergreen and Deciduous Species

Planting broadleaf evergreen and deciduous trees and shrubs in the greenbelts will increase forest complexity (structural and species diversity) by creating a diverse mid-canopy and shrub layer and increasing regeneration and tree age over time. It will also increase tree density, reduce invasion and dominance by non-native invasive species, and improve wildlife habitat thus increasing the number and diversity of wildlife in the greenbelt forest.

Although the Duwamish Greenbelts are characterized by deciduous trees, the age and species diversity of the forest is very low. Red alder and/or bigleaf maple dominate the canopy layer in almost 70 percent of all the plots surveyed. The shrub layer lacks diversity as well with only five native species commonly found throughout the study area. Tree regeneration is generally very low, and mid-canopy tree and shrub species are rare in the greenbelts. Understory species form an important and integral layer in the overall structure of healthy forests, and therefore should be planted in every landform type described in Section 7. In powerline corridors and at viewpoints, species selection should favor shrubs and small trees that will reach mature heights consistent with required height clearances and vegetation management goals for these landform types. As with planting of conifers, phased planting is the preferred strategy to increase diversity of species selections and age classes of plantings in all areas.

Tables 8.2 and 8.3 list broadleaf evergreen and deciduous tree and shrub species that are native to the Puget lowland forest according to their relative soil moisture and light requirements. Wetlands, for example, should be planted with species that are listed in the moderate to high soil moisture columns (e.g. salmonberry, red osier dogwood). Riparian corridors and ravines in the Duwamish Greenbelts generally exhibit plant communities that tolerate moist soil conditions and at least partial shade, and should accordingly be planted with species that prefer these conditions. Non-forested areas are characterized by lack of overstory and are therefore exposed to high light conditions and have drier, more nutrient-poor soils that favor early successional colonizers such as chokecherry, serviceberry, oceanspray, and madrone.

It is recommended to develop a planting strategy that initially focuses on keeping the healthier greenbelt areas functioning and improving. Priority areas for planting broadleaf evergreen and deciduous trees and shrubs are those that presently have moderate to low understory diversity and density, or have moderate to low invasive coverage, or are being cleared of dense infestations of invasives and must be re-planted. Powerline corridors should be prioritized in order to establish a dense shrub layer that will prevent invasives from colonizing and spreading into these non-forested areas that are to be managed for low canopy.

Areas with low understory diversity are found in all the sub-units, but those with only moderately low diversity (6-15 dominant native understory species found) are Duwamish Head, West Marginal Hillside, and Westcrest Park. High invasive coverage is a severe problem (40% or more of plots have at least 25% cover of invasives) in all sub-units except Westcrest Park. With regard to specific invasive species (blackberry, ivy, laurel/holly), sub-units in the West Duwamish appear to have less of a severe problem than the East Duwamish sub-units, which favors prioritizing West Duwamish sub-units (Table 6.1).

Table 8.2 Species Selection for Broadleaf and Deciduous Tree Planting

		Light		
		Low	**Moderate**	**High**
Soil Moisture	**7. Low**		*Arbutus menziesii* *Prunus virginiana* *Quercus garryana*	*Arbutus menziesii* *Prunus virginiana* *Quercus garryana*
	Moderate	*Acer circinatum* *Cornus nuttalii*	*Acer circinatum* *Cornus nuttalii* *Crataegus douglasii* *Fraxinus latifolia* *Malus fusca* *Populus balsamifera* *Populus tremuloides* *Prunus emarginata* *Rhamnus purshiana*	*Crataegus douglasii* *Fraxinus latifolia* *Malus fusca* *Populus balsamifera* *Populus tremuloides* *Prunus emarginata* *Prunus virginiana* *Rhamnus purshiana*
	High		*Crategus douglasii* *Malus fusca* *Populus balsamifera*	*Crategus douglasii* *Malus fusca* *Populus balsamifera*

Table 8.3 Species Selection for Broadleaf and Deciduous Shrub Planting

		Light		
		Low	**Moderate**	**High**
Soil Moisture	**8. Low**	*Gaultheria shallon* *Mahonia nervosa* *Oemlaria cerasiformis* *Corylus cornuta*	*Amelanchier alnifolia* *Corylus cornuta* *Gaultheria shallon* *Holodiscus discolor* *Mahonia nervosa* *Philadelphus lewisii* *Ribes sanguineum* *Rosa gymnocarpa* *Rubus parviflorus* *Symphoricarpos albus* *Vaccinium ovatum* *Vaccinium parvifolium*	*Amelanchier alnifolia* *Holodiscus discolor*

Soil		Light		
		Low	**Moderate**	**High**
	Moderate	*Acer circinatum* *Cornus nuttalii*	*Cornus sericea* *Corylus cornuta* *Gaultheria shallon* *Holodiscus discolor* *Lonicera involucrata* *Mahonia nervosa* *Oemlaria cerasiformis* *Philadelphus lewisii* *Physocarpus capitatus* *Ribes sanguineum* *Rosa gymnocarpa* *Rosa nutkana* *Rosa pisocarpa* *Rubus parviflorus* *Rubus spectabilis* *Salix scouleriana* *Salix sitchensis* *Sambucus racemosa* *Sorbus sitchensis* *Symphoricarpos albus* *Vaccinium ovatum* *Vaccinium parvifolium*	*Amelanchier alnifolia* *Cornus sericea* *Holodiscus discolor* *Lonicera involucrata* *Philadelphus lewisii* *Physocarpus capitatus* *Ribes sanguineum* *Rosa gymnocarpa* *Rosa nutkana* *Rubus parviflorus* *Rubus spectabilis* *Salix scouleriana* *Sambucus racemosa* *Sorbus sitchensis* *Symphoricarpos albus*
	High	*Cornus sericea* *Rubus spectabilis*	*Cornus sericea* *Lonicera involucrata* *Physocarpus capitatus* *Rosa nutkana* *Rosa pisocarpa* *Rubus spectabilis* *Salix lucida var. lasiandra* *Salix sitchensis*	*Cornus sericea* *Lonicera involucrata* *Physocarpus capitatus* *Ribes sanguineum* *Rosa nutkana* *Rosa pisocarpa* *Rubus spectabilis* *Salix lucida var. lasiandra* *Salix sitchensis*

8.7 Convert Vegetation to Lower Canopy at Viewpoints and Powerlines

Viewpoints and powerline corridors are currently maintained by cutting vegetation to an acceptable level. This results in repeated, dramatic disturbance that degrades the forest condition. The trees that do regrow are typically stump-sprouted maples, alders or black locust suckers. Blackberry invades many of these areas and crowds out the native flora. Repeated cutting is also costly and unsightly. This plan advocates for conversion of these hillsides to vegetation that will provide forest canopy without violating height restrictions.

This approach is complicated by several factors. One is that it has not yet been successfully demonstrated in Seattle. Another is the cost during the process of conversion. Finally, this approach would probably require utilizing some non-native species to provide canopy at lower heights. Nevertheless, the goals of this plan are best served by utilizing this approach at the four viewpoints in the Duwamish Greenbelts and under powerlines where permissible by City Light.

The task entails removing the trees that are likely to grow too tall, controlling blackberry and other aggressive weeds, and planting densely with species, predominantly evergreen, that can be expected to stay below the clearing limits. Even within the restricted height, it is desirable to plant for multiple canopy layers. However, for some powerline situations, the maximum height may be as low as 8-10 feet, where a multi-layered canopy may be unachievable. Maintenance of any such area is critical to achieving success. Ongoing control of competition is required until canopy closure is reached, which might take 10 years or more. A phased planting similar to that described in Section 8.4 may be necessary to gain control of weeds.

This type of conversion project requires a written plan that can be presented for departmental and public review in compliance with the department's Public Involvement Policy. Such a plan has been completed for Hamilton Viewpoint. Priority should be given to this site and any other site that has potential for neighborhood participation. Viewpoints occur only in the Duwamish Head and North Beacon Hill sub-units. Powerline corridors occur in all of the sub-units except for Carkeek Drive. Determining a priority for these areas would probably require a more detailed walk-through survey of all the corridors to determine which areas are most in need of management. Corridor areas that are presently grassland without much invasive cover, or are in need of immediate conversion to low canopy due to presence of overheight trees might be the top priority for these areas. Within the prioritized sub-units, areas that have good access, are highly visible to the public, and have low levels of invasive coverage (require little site preparation and follow-up maintenance) are places to target for planting.

8.8 Revegetate Slide Areas

Exposed soils on slide areas are prone to erosion and colonization by weed species. Revegetation of slide areas beyond the required hydroseeding is desirable to achieve the goals of this plan. Healthy forest vegetation will inhibit further erosion and protect water quality, while restoring the habitat connectivity and visual buffering that the trees provide.

First, a geotechnical assessment is necessary to determine if the area is still unstable. If it is, revegetation may be harmful or futile until the underlying instability is addressed. This may entail regrading the slope, draining the slope, or other construction projects.

Once a slope is determined to be stable for vegetation, the geotechnical consultant should make recommendations about loading capacity for different areas of the hillside. Areas with high capacity can be fully reforested. Other areas may be destabilized by substantial loading and may require a lower canopy planting similar to those described above in Section 8.7.

Revegetating a slide area is challenging. The exposed soils are usually consolidated glacial till, silt, clay, or sand sublayers. These soils lack fertility and rooting volume. Where the geotechnical assessment will allow, 3 inches of compost should be blown onto the bare soil areas. On slopes of up to 40 percent, it may be feasible to till this in with equipment. Otherwise mulch, or geotextile fabric on steeper slopes may be necessary to hold this unconsolidated material in place. Plants should then be installed through the compost into the subgrade, mixing in as much compost as possible.

Plant selections should favor species that are aggressive growers, root sprouters, and/or are evergreen. A phased planting such as described in Section 8.4 is not recommended because the overriding need is to quickly establish woody vegetation. Also, competing plants are minimal in the freshly exposed soil surfaces. Planting should take place in early fall to give the plants the best possible chance to take root before the next growing season.

On south and southwest slopes, plantings will need regular supplemental watering during the three summers following planting. On large areas, this is often best accomplished by pressure compensating drip irrigation, which avoids widespread saturation and weed growth from overhead irrigation, and also avoids excessive compaction and sloughing that comes from foot traffic during manual watering.

Priority should be given to areas that have been stabilized, or those areas that are known to be stable. Within these sites, newer slides are likely to be more successfully revegetated because any competing vegetation is less established. Slides were noted in all sub-unit areas with the exception of South Beacon Hill and Carkeek Drive.

8.9 Increase Snags and Down Logs

Retaining a mix of snags and dead and downed woody material in forest stands provides for diversity in wildlife habitats and increases the number of wildlife species that can be supported at viable population levels. Snags are totally or partially dead trees that have undergone partial decomposition but that remain standing. Many species of birds and mammals are dependent on cavities excavated in snags by the species themselves or by other species. Over 100 wildlife species in western Washington and Oregon use cavities in snags for nesting and roosting (Brown 1985). Cavities occur as a result of decay or are excavated by birds such as woodpeckers. Some species, such as bald eagle, nest on the tops of snags and broken-off trees. In addition, many birds use snags as perches, especially diurnal birds of prey. Just a few of the species known to use large snags include the pileated woodpecker, wood duck, merganser, marten, fisher, raccoon, and western gray squirrel.

The absence of snags can be a limiting factor for many wildlife species in forested systems. Each forest community has different requirements for the density, species, and size of snags, depending on the types of cavity users associated with that community. Table 8.4 presents examples of snag requirements for several woodpecker species.

Table 8.4. Snag Use in a Mixed Conifer Community by Various Woodpecker Species

Species	Estimated Territory Size (acres)	Max. Pairs/ 100 acres	No. Cavities Excavated per Pair per Year	Min. dbh size of nest tree (in.)	No. Snags Required/ 100 Acres to Support 50% of Max. Pop.	No. Snags Required/ 100 Acres to Support 100% of Max. Pop.
Common flicker	40	2.5	1	12	19	38
Pileated woodpecker	300	0.3	3	20	7	14
Hairy woodpecker	25	4	3	10	90	180
Downy woodpecker	10	10	2	6	150	300

Dbh – diameter at breast height
Source: USDA Forest Service 1979.

Snags and felled trees produce down logs that also provide habitat for many species of insects and for the vertebrates that feed on them. Some wildlife species also use down logs for cover or nesting sites. Down logs provide habitat for such species as the Trowbridge shrew, chickaree, bushy-tailed woodrat, hairy woodpecker, dark-eyed junco, rough-skinned newt, and the Pacific tree frog.

As can be seen in Table 8.4, the number of snags required to support viable populations varies with the species. However, for management purposes, the Washington Department of Natural Resources

(WDNR) has proposed an average for snags in healthy forests in Washington of about two snags per acre. The data from the Duwamish Greenbelts study indicates the average in the study area is ¼ snag per acre, or one snag per four acres. This means that the snag count in the greenbelts would need to be increased by about 8 times to approach the desired number set by WDNR.

To enhance wildlife habitat in the Duwamish Greenbelts, it is recommended to install snags and down logs or woody debris. Snags can either be created from standing live trees that are killed by girdling and left in place, or by importing and installing trees felled from another location. Installing new snags is typically done with heavy machinery as the trees are extremely heavy and deep holes are needed (at least one-third of the length of the tree must be underground to support the aerial portion). Creating snags in place is easier, but is generally only done when there is an accompanying desire to create greater canopy opening in the same location. Both coniferous and deciduous hardwood species are used for snag creation. Created snags are generally a minimum of 12 inches in diameter and 15 feet in height, although larger snags will provide for a greater variety of wildlife species. Trees that are girdled for the purpose of becoming snags are often topped at 20-30 feet above ground to minimize the hazard of falling limbs as the tree dies. Identifying opportunities for snag creation will need to be coordinated with the tasks for creating canopy openings (Section 8.3) and for managing hazard trees (Section 8.1).

Down logs can be placed throughout the greenbelts to create more habitat. If any trees are logged from the Park, they can be cut into 15-30 foot lengths and used for this purpose. When City crews cut hazardous tree branches in the Park; these could be left as woody debris. If trees are topped for snag creation or other reasons, this material can be left in the area. The debris should be diced and scattered (with the exception of brush piles) such that it lies in good contact with the ground. Brush piles offer habitat for birds and small mammals, and can be constructed from the smaller branches from any tree or shrub, with the exception of blackberry vines or other invasive species. Down logs should not block trails, divert drainage, smother desirable vegetation, or otherwise damage the surrounding resources. All logs should be stabilized to prevent rolling or sliding downslope.

Creation of snags should be given highest priority in those areas where existing snag counts are low and where the forest condition is moderate to good. This includes Puget Park, West Marginal Hillside, and Westcrest Park. Creation by girdling will have to coincide with a need for increased canopy opening to justify killing trees. Carkeek Drive and Duwamish Head would be given secondary priority for snag creation as the forest in these areas is not as severely degraded as it is in much of North and South Beacon Hill. Creation of snags is desirable in wetlands, riparian corridors and forested areas on slopes less than 40 percent, but it is not advised on steep slopes, in slide areas, in powerline corridors, or directly in front of viewpoints.

The addition of down logs and brush piles is desirable wherever they can be stabilized, and wherever they will not detract from the aesthetic qualities of an area. Down logs should be placed in wetlands, riparian corridors and forested areas on slopes less than 40 percent. They are not advised on steep slopes or in slide areas unless stabilized. Sub-unit areas with notably low percentage of plots with down logs include Duwamish Head, North Beacon Hill, and Carkeek Drive. These areas also include some of the steepest slopes in the greenbelts. Placement of logs in the flatter portions of these sub-units can be prioritized, but again should be coordinated with tasks that produce woody debris, such as forest thinning, and creation of canopy openings and snags.

8.10 Control Problematic Invasive Species

In controlling invasive plants, the primary goal will be to suppress populations below threshold levels at which damage is caused to the native community. This level varies by species. Eradication of certain weed species, such as Himalayan blackberry and English ivy is not considered feasible or cost-effective. The exception to this is the case of Class A weeds such as tansy ragwort (*Senecio jacobaea*), for which eradication is the directive established by the King County Noxious Weed Board.

The scope and preferred method of removal will depend on the species, the extent of invasion in an area, and the steepness and relative soil moisture of an area. For example, areas that are entirely covered by blackberry with no natives interspersed can be mowed and the roots grubbed out. More selective methods will be required where native species are growing among the invasives, or where landscape constraints occur (e.g., saturated soil, steep slopes). Indiscriminant clearing of areas with both native and invasive species is not advised. Heavy equipment may be an option for use on firm soils on flatter slopes, but on steep or saturated soils, techniques should minimize traction and weight bearing.

8.10.1 Control Blackberry

Himalayan blackberry is capable of propagating by seed and by tip layering. The species thrives best in direct sunlight, but it is tolerant of a wide range of light, soil moisture, and nutrient levels. It aggressively colonizes areas where new canopy gaps result in increased sunlight, and is a very effective competitor, forming dense thickets that grow over and crush or smother native species. The primary goal for this task is to facilitate the growth of native species by controlling the extent and cover of blackberry. It is not feasible to try and eliminate this species from the Duwamish Greenbelts, so the focus will be on limiting its spread and reducing its cover.

Methods that are commonly used for controlling blackberry include repeated cutting of canes, mowing, tilling, and chemical control. When using mechanical control, the canes are cut down to the ground. This method allows control of blackberry so that native species have an opportunity to establish, but it will not eradicate the weed from an area. It is often followed-up by repeated mowing or tilling to achieve longer-term control. Root removal by tilling is probably the most effective long-term control, but this cannot be done in areas where native species are interspersed, near areas of surface water, or on steeper slopes where the disturbed soil surface may present erosion problems. The methods of choice in these areas is usually the chemical cut & dab method, spot spraying, or use of a wiper applicator. Broadcast spraying of herbicide in forested areas should generally not be employed in the Duwamish Greenbelts.

Blackberry was most frequently observed, and achieved the highest coverage, in the North and South Beacon Hill and Carkeek Drive areas. Rather than prioritizing these areas which are severely degraded with respect to blackberry cover, it is recommended to begin in the four sub-units of the West Duwamish Greenbelts, which have only moderate coverage. The priority should be to identify areas with relatively low to moderate cover (<25 percent cover) where there are still native understory species, and to keep these areas from worsening by implementing appropriate removal methods. Second priority should be given to identifying and treating “fronts” or areas with low to moderate blackberry cover that are adjacent to areas with high cover (>50% cover). Areas with low tree canopy cover should be given low priority as it is more difficult to control blackberry in areas of full sunlight. However, where there is moderate tree canopy, a lack of native understory species, and the availability of a good-sized work force, it may be feasible to tackle extensive thickets of blackberry using mechanical cutting and grubbing or tilling of the roots. Areas within riparian corridors with thickets of blackberry should be given high priority due to the potential for use of riparian areas by a wide variety of wildlife species.

Blackberry control efforts must be closely coordinated with planting tasks. Areas that are cleared of blackberry must be densely planted with native species before the blackberry has a chance to come back. Ongoing maintenance of these areas will be required for at least several years to give the natives a chance to compete with the blackberry. For this reason, the total area that is selected for blackberry control over a 3-5 year time span should be limited to that that can be reasonably managed by the expected number of available workers.

8.10.2 Control Ivy

English ivy forms dense mats that completely cover the ground, smother other vegetation, and prevent the establishment of native seedlings. Ivy also climbs readily into trees, stunting tree growth over time and causing tree rot by retaining moisture against the bark. The species spreads very rapidly by runners and by seed dispersed by birds. The primary goal for this task is to facilitate the growth of native species by controlling the extent and cover of ivy. It is not feasible to try and eliminate this species from the Duwamish Greenbelts, so the focus will be on limiting its spread and reducing its cover.

The DPR Urban Forestry Program is conducting a study, in cooperation with the University of Washington, on the effectiveness of methods for controlling English ivy in our area. Several local parks are being used as test sites for the study. Researchers are looking at chemical and mechanical methods, heat treatments, and mulching. Existing and experimental methods are being evaluated to determine the most efficient and effective means of controlling this species.

Pending completion of this study, it is recommended to use existing methods that have proven to be at least somewhat successful in controlling ivy. To kill ivy that is climbing into tree branches, the best method is to sever the vines on the tree trunks first at shoulder height and again at the tree base. This can be done with heavy-duty loppers or with pruning saws. This method usually kills the remaining vines in the tree within a few weeks. For safety reasons, pulling down overhead vines (live or dead) from the trees is not recommended unless one can do so without standing directly under the tree. The next phase of removal is to remove vines on the ground within a 5-10 foot radius of the tree by grubbing and digging to get the surface layer of roots, and then rolling up the mat as you go. The debris should be removed from the site. Clearing ivy from the ground is very laborious and time-consuming. Rather than attempting large clearings, it may be most effective to clear islands of at least 10-15 feet in diameter and then densely plant this cleared area. These islands can then be enlarged as resources become available.

Unlike blackberry, ivy directly threatens the health of established trees. Therefore, the highest priority for ivy control will be to kill the vines that are growing up into trees. In general, this occurs in those areas that have the highest cover of ivy. Areas with greater than 50 percent cover of ivy were observed in all sub-units except Puget Park. Priority should be given to those areas that are accessible, that have tree growth of ivy, and that have forest stands that are still in fair to good condition (i.e., relatively healthy trees, good canopy cover). Areas where the trees are in poorer health or where the canopy is more open should be given lower priority.

Once the vines in the trees are killed, the next phase of control should be to remove vines from the ground adjacent to the tree to minimize growth of vines into the trees. The next phase will be creation of cleared islands for planting. Priority for clearing islands in the ivy should be given to those areas that have been designated as high priority for planting understory species. Ongoing maintenance will be required in these island areas as long as there is ivy in the vicinity. Therefore, the extent of clearing of ivy should match the available labor resources for maintenance. Control of ivy should also be prioritized along riparian corridors where the growth of desirable streamside vegetation may be constrained. Vegetation that overhangs streams is important in that it supplies shade, organic debris, and food for the stream system. Ivy does not provide these functions, but rather it detracts from the health of the native riparian species that do.

8.10.3 Control Laurel & Holly

Cherry laurel and English holly are both evergreen shrubs with similar reproductive and growth habits. They are readily spread by seed, which is distributed widely by birds eating the fruits. Both plants are commonly used as ornamentals in home gardens and therefore have abundant local seed sources. These are aggressive species that can grow into thickets or hedges so dense and tall (20-30 feet high) that all native plants are excluded. In the Duwamish Greenbelts, there are only a small number of plots that have greater than 25 percent cover of these species. These are scattered in all sub-unit areas except Puget Park and Carkeek Drive. Since frequent occurrence is the primary problem with these species, rather than high cover, the primary goal will be to limit their spread by reducing the potential seed source, particularly in areas that do not yet have severe problems with high coverage by these species.

Control methods vary depending on plant size and extent of cover. Smaller plants can be hand-pulled or dug out of the ground. Larger plants can be controlled by repeatedly cutting the shrubs to stump height, stump grinding, and/or chemical methods. Mechanical methods are probably preferable when dealing with extensive thickets of mature plants. Stump grinding results in the complete removal of the plants, thus opening up more room for planting desirable natives. When dealing with smaller groupings and isolated mature plants, chemical methods are advised. The preferred chemical method that was recently worked out by DPR staff conducting informal experiments in Frink Park involves drilling 4-5 holes into the large stems (at approximately the same height on the stem) and injecting about 0.5 cc of a concentrated solution of Roundup® into each hole. The plants then circulate the poison throughout the branches and roots, and eventually die. The dead plants can then be left in place without spreading seed, or removed if and when resources become available.

Priority will be given first to those areas that are in relatively good health, and that have low to moderate frequency of occurrence of laurel or holly (portions of all sub-units except North Beacon Hill and Carkeek Drive), or areas where other work is being done. To eliminate the seed source, highest priority should be given to killing mature plants by use of the chemical method. Secondary priority should be given to pulling out the younger shrubs. To minimize re-colonization of these areas once the plants are killed or removed, the next priority should be on reducing the seed source in those areas where laurel and holly are most highly concentrated. In terms of land forms, there are no reasons to prioritize one above another for control of this species.

8.11 Conduct Trail Inventory

The Duwamish Greenbelts contain networks of trails. Some of these trails are on old road grades, but most are “social” trails that have been created by repeated foot traffic over time. Knowing the location and condition of these trails supports the restoration of the greenbelts by helping project planners to quickly evaluate access to a particular project. A trail survey helps project planners evaluate where trails may be ineffective, redundant, or hazardous. Based on the survey, such trails might be closed, rerouted, or improved to provide safe passage. Additionally, providing trails information to the neighborhood should encourage constructive use of the greenbelts.

Trails will be assessed using the Universal Trail Assessment Process developed by Beneficial Designs, Inc. The process provides quick, uniform assessment of trails and organizes the data into a database format for analyzing and publishing the information. This information can be published in the form of trail markers and users guides to provide better access for trail users.

Trails will be located using a laser rangefinder from an origin with a surveyed location. Survey techniques will measure the following features at each station:

Grade - The average grade between two designated stations along the trail is measured with a clinometer. Short, steep sections are measured with an inclinometer and recorded as maximum grade sections. The inclinometer is 24 inches in length and thus measures the grade experienced over one stride, or by a stroller or wheelchair. Objective information about the average and maximum grade is very useful to all user groups, especially mountain bike riders and persons with mobility limitations.

Cross Slope - Cross slope is measured at designated stations along the trail with a 24-inch inclinometer. These measurements are then used to compute the average cross slope for the entire trail. Similar to maximum grade, steep cross slope sections are measured with an inclinometer and recorded as maximum cross slope sections. Cross slope information is most useful to wheelchair users. Wheelchairs are very difficult to drive or maneuver on steep cross slopes.

Width - A tape measure is used to measure the width of the trail. The minimum tread width, or "beaten path," is measured at each station and is used to calculate the average tread width. The minimum amount of usable passage space between stations, or minimum clearance width, is also measured. If the width of the trail is disclosed, mobility device users will be able to determine before embarking on a trail exactly how far they will be able to hike and whether they will be able to reach their destination.

Surface - A judgment is made regarding the type of surface found in between stations. The type of surface is recorded, as well as a description of its characteristics. Trail surface type is a major influence on the degree of access for all user groups.

Trail Length - The distance from the trailhead is continuously recorded to indicate the total length as well as the position of each measurement site relative to the start of the trail.

Trails survey should be prioritized for areas that are being restored so that access can be directed to minimize site impacts. Trails survey should also be prioritized in areas that are receiving high trail use.

8.12 Reduce Human Disturbance

Reducing human disturbance in the greenbelts can be done by improving degraded conditions along forest edges, restoring interior areas that have been compromised by undesirable uses, and increasing public awareness and stewardship opportunities. Dumping, vandalism and theft of vegetation, encampments, boundary encroachments, domestic pets, and unrestricted access are among the human disturbances that can be prevented, minimized, and mitigated for in the greenbelts. Reducing the further occurrence of these disturbances and performing site repair in areas that have been damaged will improve the overall health of the forest. Site repair may involve removing litter and debris, dismantling encampments, and grading or scarifying compacted soil and seeding or installing plants. Prevention of disturbance might include performing regular site inspections, creating functional access, installing access barriers, identifying and delineating greenbelt boundaries, and doing some public education in adjacent neighborhoods.

Human disturbance in relatively unpatrolled and unmanaged public parks like the greenbelts is difficult to control. More than any regulatory policies, it is the attitude of the public towards the greenbelts that ultimately determines the level and extent of human disturbance. Strong community stewardship of public areas such as the greenbelts often results in a decrease in undesirable human disturbances. This pattern of increased awareness and community involvement leading to better stewardship and understanding of neighborhood parks and natural areas has been observed in other parks in Seattle. Management plans result in work on the ground (planting, invasive removal, etc.) that involves and hopefully inspires neighbors, community groups, and local schools. That attention often is enough to get momentum going and attract interest in the park that did not previously exist. Obviously, a commitment on the part of the Parks Department is also an important part of getting the community involved and participating. Involvement and education of the local community will be the keys to developing neighborhood stewardship of the greenbelts and reducing human disturbances that are detrimental to greenbelt health.

Undesirable human uses can occur in any landform type and should be identified in each of the sub-units. Sample plots that had refuse, which could include encampments, were noted during the survey; this was identified as a moderate or severe problem in all but the Puget Park sub-unit. Refuse and encampments that have already been identified should be located in the field and removed. Future disturbance of this nature will hopefully be diminished with prompt removal of trash and a change in community behavior and attitude. Occurrences of encroachment were not identified in this survey, but would be found along sub-unit edges where private property adjoins the greenbelt; and can be identified with a more comprehensive boundary survey. Preventing encroachments will depend on better boundary delineation and community outreach/education. This issue is discussed in further detail in Section 8.13.

Dumping generally occurs along greenbelt edges where there is vehicle access to a site – along streets, in parking lots, and at street ends. Dumping, particularly of yard waste, may also occur where residential lots (backyards) adjoin greenbelt property. Specific sites that have been problematic in the past should be assessed for modification to prevent future dumping. Problems with dumping by adjacent private property owners could be addressed by distribution of an informational brochure or by appropriate prosecution in the event of large-scale or repeated problems. Reporting of incidents by the citizenry should be encouraged, and clean-up response should be prompt and thorough. Regular inspections or patrols of at-risk areas is also recommended. Again, a shift in community attitude about the greenbelts and a better understanding of their functions and values will help a lot towards solving this disturbance problem.

In contrast to dumping which generally occurs along outer edges of the greenbelt, encampments usually occur in more remote parts of the greenbelts that have walk-in access only. Encampments should be removed as soon as possible after they are reported. Extensive and long-term encampments have been observed at North Beacon Hill and were recorded in 6 percent of the sample plots. Sample plots in Westcrest Park and West Marginal Hillside also had encampments. Social trails that are formed in association with encampments should be closed off and revegetated to help prevent re-use.

Vandalism and theft of vegetation often has to do with greenbelt vegetation that interferes with a private property owner's view, and is removed or altered without DPR permission. Other common actions include collecting plants, harassing wildlife and gathering firewood. All living and non-living resources found in natural areas are the property of the City of Seattle, except the wildlife, which is the property of the State. Cases of vandalism and theft can be prosecuted when sufficient evidence to build a case is available. Subchapter II of the City of Seattle Park Code includes language designed to protect these public assets from vandalism. Section 18.12.070 states, "it is unlawful for any person…to remove, destroy, mutilate or deface any structure…lawn, …shrub, tree…plant, flower…in any Park. Any person convicted of vandalizing park property may be punished by a fine in any sum not to exceed $5,000 or by imprisonment in the City Jail for a term not to exceed one year, or by both fine and imprisonment."

The potential impact of domestic pets is reflected in the City regulation that requires pets in parks to be leashed except for in designated off-leash areas. Dogs can destroy vegetation, while dogs and cats can kill or maim wildlife, particularly small mammals and birds. High nutrient loads and fecal coliform bacteria counts in streams and wetlands can result when scoop laws are not observed. Reducing negative impacts of domestic pets is largely the responsibility of an informed and self-policing public.

Access to and within greenbelt areas should be clearly defined based on predominant use patterns. These routes should be developed and maintained as trails and roads using the best management practices for trails described in Section 8.11. Other access should be restricted to prevent widespread degradation of the natural resources. Unsafe, poorly located, and redundant social trails should be closed and made inaccessible by constructed barriers and plantings. Further greenbelt degradation should be prevented by providing clearly defined access when appropriate, or managing forest edges for dense vegetation to prevent ingress.

8.13 Inspect & Delineate Boundaries

Many of the management issues identified in Section 8 are likely to be more prevalent along Park property boundaries. Where greenbelt properties border residential or commercial property, there is more likelihood of disturbance from neighboring land use. Higher light levels encourage the growth of invasive exotic plants. Trees that might fail and impact buildings or traffic areas are more likely to become hazards as they age. Providing clear marking of property boundary locations will help adjacent property owners recognize where public property begins. Inspecting property boundaries will help Parks staff assess the needs and immediate work items.

Where boundaries of City-owned property are in question, they should be located by a registered surveyor. This provides boundary locations with accuracy that has legal standing. However, for routine inspection, differential GPS can approximate property boundaries with an accuracy within one meter. This level of accuracy is adequate for most issues that this plan addresses. Alternatively, the personnel doing the inspection can be equipped with an orthophoto that has lot lines superimposed. Inspecting staff can estimate the boundary location by referencing other landmarks identified on the orthophoto.

Indistinct or unclear boundaries should be marked with labeled white fiberglass boundary stakes or by other visible and durable means, as approved by the DPR Property Manager. Priority for boundary delineation and inspection should be for areas that are undergoing restoration work, areas that have high potential for hazard trees or high potential for human disturbance.

8.14 Summary of Management Prescriptions

Table 8.5 summarizes the management prescription tasks proposed in this section, the areas or land forms prioritized, and the problems addressed by each task. This is not intended to be a comprehensive list, as the need for additional management actions may arise during the planning and completion of these 13 prescriptions. However, the tasks included in Section 8 should provide sufficient improvement to the greenbelts over time such that major strides will be made towards achieving the plan goals.

Table 8.5. Summary of Tasks, Prioritization, and Problems Addressed

Task	Sub-unit Priorities	Land Form Priorities	Problem Addressed
8.1 Manage Hazard Trees	All Sub-units	Forests near built environment	Lack of Forest Complexity Low Forest Age & Density
8.2 Thin Dense Forest Stands	All Sub-units	Forest on <40% slopes Riparian Corridors	Lack of Forest Complexity Low Native Plants/High Invasive Occurr. Low Forest Age & Density
8.3 Identify/ Create Canopy Gaps	Duwamish Head Westcrest Park	Forest on <40% slopes	Lack of Forest Complexity Low Native Plants/High Invasive Occurr. Low Forest Age & Density
8.4 Plant Non-forested Areas	All Sub-units	Non-forested Areas	Lack of Forest Complexity Low Native Plants/High Invasive Occurr.
8.5 Plant Conifers	Duwamish Head Westcrest Park	Forests on <40% slopes Not in powerlines, viewpoints	Lack of Forest Complexity Low Native Plants/High Invasive Occurr. Low Forest Age & Density
8.6 Plant Broadleaf Evergreen & Deciduous Species	Duwamish Head West Marginal Hill Westcrest Park Puget Park	No Priority	Lack of Forest Complexity Low Native Plants/High Invasive Occurr.
8.7 Convert to Low Canopy	Viewpoints: Duwamish Head N. Beacon Hill Powerlines: All except Carkeek	Viewpoints Powerlines	Low Native Plants/High Invasive Occurr. High Level of Human Intrusion
8.8 Revegetate Slide Areas	All except S.Beacon Hill & Carkeek	Slides	Common Occurrence of Slides Lack of Forest Complexity

Task	Sub-unit Priorities	Land Form Priorities	Problem Addressed
8.9 Increase Snags/ Down Logs	Snags: Puget Park West Marginal Hill Westcrest Park Down Logs: Duwamish Head North Beacon Hill Carkeek Drive	Riparian Corridors Wetlands Forest on <40% slopes	Lack of Forest Complexity
8.10.1 Control Blackberry	Duwamish Head Puget Park West Marginal Hill Westcrest Park	Riparian Corridors Viewpoints Forest on <40% slopes	Lack of Forest Complexity Low Native Plants/High Invasive Occurr.
8.10.2 Control Ivy	Remove Ivy from Trees in All Sub-units	Riparian Corridors Forest on <40% slopes	Lack of Forest Complexity Low Native Plants/High Invasive Occurr.
8.10.3 Control Laurel/ Holly	Duwamish Head Puget Park West Marginal Hill Westcrest Park South Beacon Hill	No Priority	Lack of Forest Complexity Low Native Plants/High Invasive Occurr.
8.11 Conduct Trail Inventory	All Sub-units	No Priority	High Level of Human Intrusion
8.12 Reduce Human Disturbance	All Sub-units	No Priority	Lack of Forest Complexity Low Native Plants/High Invasive Occurr. High Level of Human Intrusion
8.13 Inspect & Delineate Boundaries	All Sub-units	No Priority	High Level of Human Intrusion Low Native Plants/High Invasive Occurr.

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