Madrona Woods
2006 Baseline Vegetation Survey and Monitoring Protocols

Prepared For: Friends of Madrona Woods

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I. INTRODUCTION

Madrona Woods is a nine acre open space on the northern boundary of Madrona Park, located on the eastern side of central Seattle (Map 1). The main landscape feature in Madrona Woods is a forested ravine, which includes a stream and surrounding wetlands throughout most of this topographical feature. The Friends of Madrona Woods have been active in restoring this ravine for over 10 years. As part of their monthly work parties, they have removed many invasive species, replanted native species, created and maintained trails and involved other community groups in their efforts. In 2006, the Friends of Madrona Woods received grants from the Seattle Public Utilities Aquatic Habitat Matching Grant Program, King County Waterworks, the National Oceanic and Atmospheric Administration, and the King County Council to daylight a creek that surfaces between 37th Avenue and 38th Avenue and currently drains into Seattle's storm system (Map 2). Another seep surfaces east of 38th Avenue and flows east for approximately 350 feet, at which point it also enters a storm drain (Map 2). The project will re-connect the stream to its headwaters, restore the stream bed and allow it to once again flow into Lake Washington. The mouth of the newly diverted creek, currently a grass lawn abutting a row of weeds along the shoreline, will be transformed into a nearshore estuary. This wetland cove will create a rare pocket of cold-water fish and wildlife habitat in an otherwise urbanized setting.

To monitor progress and meet grant requirements, Seattle Urban Nature (SUN) was contracted to collect baseline vegetation information on the site prior to project construction and installation. SUN was also asked to create a long-term monitoring plan for the Friends of Madrona Woods that would be implemented by members of the group in conjunction with high school students and other community members. These efforts will provide the Friends of Madrona Woods with the means to compare and evaluate the changes to vegetation in the project area during and after the daylighting process.

II. ASSESSMENT METHODOLOGY

The project area, as identified by the Friends of Madrona Woods, consists of approximately six acres of riparian, wetland and upland habitats within a forested ravine in the northern section of Madrona Park (Map 2). Habitat types in the park are based on data from the 1999-2000 survey by Seattle Urban Nature (SUN 2000). These habitat types were updated by Seattle Urban Nature staff for the project area during the course of this survey (Map 2). Seattle Urban Nature ecologists further separated the project area into 11 different zones based on vegetation and topography (Map 3).

To sample vegetation in each zone, SUN established linear transects stratified across each zone to capture the full variability of conditions present. The point-intercept method was used to evaluate vegetation conditions in forested Zones 4-11 (Map 3). A baseline was established running east to west across the entire length of the project area. Linear transects were established at set intervals along the baseline, running from north to south and spanning the entire zone (Map 4). Table 1 lists the number of transects established in each surveyed zone, distance between transects and transect bearing of each transect. For each transect, all species of trees, shrubs, vines and groundcover were recorded where they intersected the transect tape. This data was converted to percent cover for each surveyed transect, and averaged to provide percent cover information for the entire zone. Tree cover and species composition was measured for overstory (greater than 45 feet in height), midstory (15-45 feet tall) and regenerating (under 15 feet tall) layers within each zone. Sampling was conducted in September, 2006.

Zones 1-3 were not located in the forested part of the park and transects were not established to measure vegetation in these three zones due to lack of vegetative diversity. Ocular estimates of percent cover of all present vegetation species were recorded. Large trees present in the lawn area (Zone 2) were separately identified and their diameters at breast height (dbh) were measured.

Table 1. Transect layout in eight sampled zones in Madrona Woods

Zone	Number of Transects	Transect Bearing	Distance Between Transects	Total Length of Measured Transects
4	2	180°	20 meters	100 meters
5	6	180°	20 meters	174 meters
6	6	180°	20 meters	85 meters
7	1	225°	20 meters	29 meters
8	6	180°	20 meters	35 meters
9	4	180°	20 meters	63 meters
10	3	180°	20 meters	42 meters
11	1	180°	20 meters	23 meters

Map 1

E SPRING ST

MADRONA PLAYGROUND

MADRONA RAVINE

38TH AV

NEWPORT WY

GRAND AV

E SPRING ST

38TH AV

RANDOLPH AV

MADRONA PARK

E MARION ST

MADRONA PARK

LAKE WASHINGTON BV

35TH AV

36TH AV

37TH AV

Lake Washington

33RD AV

34TH AV

E COLUMBIA ST

RANDOLPH PL

NORWOOD PL

39TH AV

LAKE WASHINGTON BOULEVARD

MADRONA PARK

MADRONA PARK

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Madrona Woods

Creek Daylighting Project Location

Legend

- Project Boundary
- Park Properties
- Existing Stream

N

1:2,000

0 125 250 500 Feet

Seattle Urban Nature Project

Friends of Madrona Woods

Madrona Woods

Habitat Types

Legend

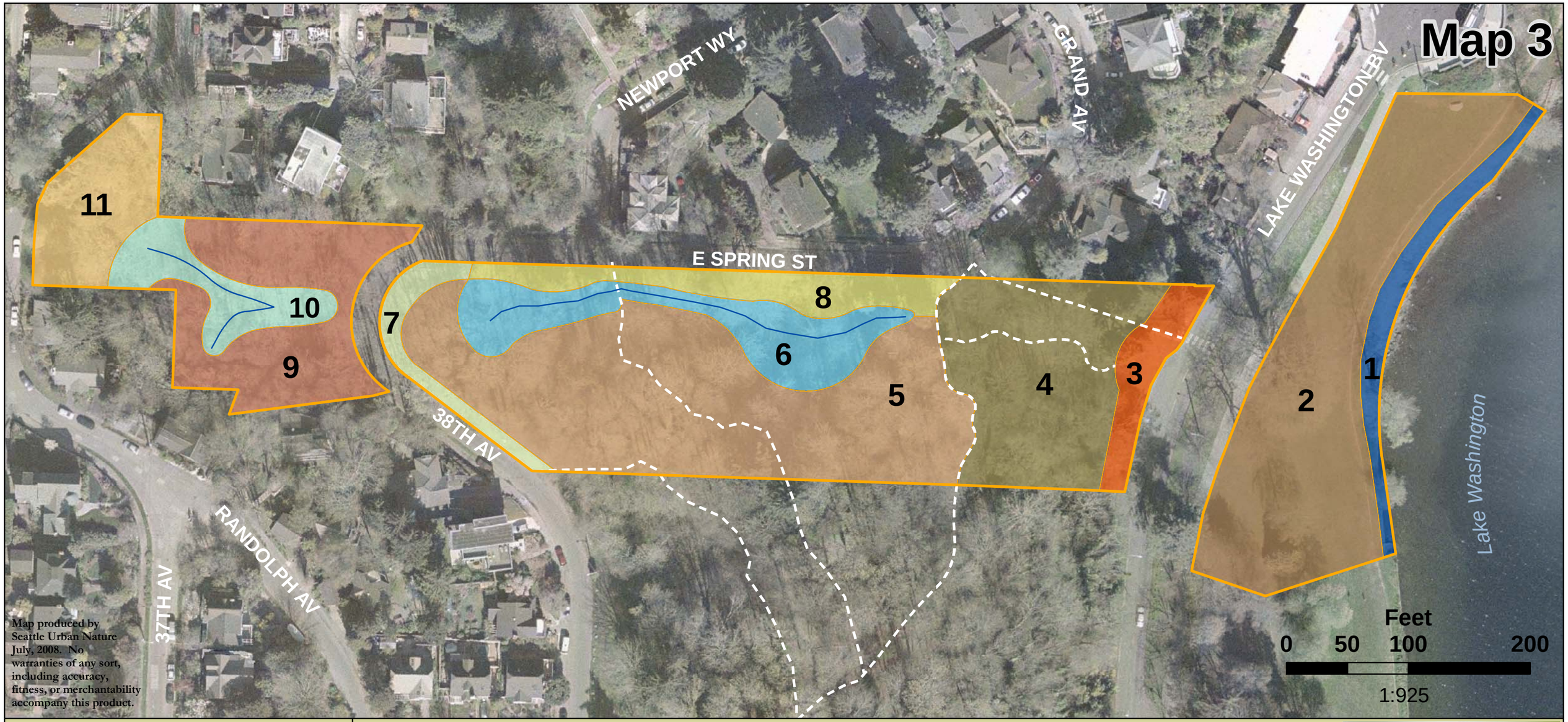
Habitat Types (2006)

- Trails
- Existing Stream
- Intake Drain
- Deciduous Forest
- Palustrine Forested Wetland
- Landscaped Forest
- Landscaped Grassland
- Shrubland

N

Friends of Madrona Woods

Seattle Urban Nature



Madrona Woods Management Zone Locations

Legend

- Project Boundary
- Trails
- Existing Stream

Management Zones (2006)

Zone					
1	4	8
2	5	9
3	6	10
	7	11

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Madrona Woods

Locations of vegetation sampling line-transects

Legend

- Project Boundary
- Parcels
- 11 Management Zones
- Transect Locations (2006)
- Trails

N

Friends of Madrona Woods

Seattle Urban Nature Project

III. RESULTS AND FINDINGS

Zone 1

Zone 1 is a small strip of vegetation, approximately 8-15 feet in width, located along the shore of Lake Washington and adjacent to the landscaped lawn (Map 3). This zone consists primarily of invasive species and is dominated by Himalayan blackberry (*Rubus discolor*), which makes up 80% of the shrub layer in the zone (Table 2). Four species of trees are found in the zone, of which two are native and two are invasive. The overstory is dominated by black cottonwood (*Populus trichocarpa*), which was present at a percent cover of 25% (Table 2). The midstory contains a small amount of Oregon ash (*Fraxinus latifolia*) (2% cover), whereas the regenerating layer consists of two invasive species, English holly (*Ilex aquifolium*) (1% cover) and one-seed hawthorn (*Crataegus monogyna*) (1% cover) (Table 2). Both of these species are considered to be invasive and are widely distributed in natural areas in Seattle where seeds are dispersed by birds and other animals. English holly is classified as a Weed of Concern by the King County Noxious Weed Program (King County 2007). These are widespread invasive species which threaten native ecosystems by displacing native vegetation and degrading wildlife and plant habitats. Control and containment of existing populations of these species is recommended (King County 2007).

The shrub layer consists mostly of Himalayan blackberry (80% cover) and Scotch broom (*Cytisus scoparius*) (3% cover) (Table 2). Himalayan blackberry is classified as a Weed of Concern by the King County Noxious Weed Program (King County 2007). Scotch broom is classified as a Non-designated Noxious Weed in King County. This classification refers to widespread invasive species for which control is highly recommended but not required in King County (King County 2007).

The herbaceous layer consists of 11 species, of which three are native and eight are non-native. The understory is dominated by giant horsetail rush (*Equisetum telmateia*), with a percent cover of 45% (Table 2). The second most dominant species is reed canarygrass (*Phalaris arundinacea*) (20% cover), which is classified as a Non-designated Noxious Weed in King County (King County 2007). Small amounts of other invasive species are present in the herbaceous layer, including hedge false bindweed (*Calystegia sepium*) (3% cover), bull thistle (*Cirsium vulgare*) (3% cover) and yellow flag iris (*Iris pseudacorus*) (2% cover) (Table 2). Bull thistle and yellow flag iris are classified as Non-designated Noxious Weeds in King County whereas hedge false bindweed is classified as a Weed of Concern (King County 2007).

Table 2. Tree, shrub and herbaceous species found in Zone 1 in Madrona Woods during the 2006 survey. Values represent percent cover.

Scientific Name[1]	Common Name	2006 Survey Average Percent Cover
OVERSTORY TREES (Percent Cover)		
Populus trichocarpa	black cottonwood	25%
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Crataegus monogyna**	one-seed hawthorn	1%

Table 2. Tree, shrub and herbaceous species found in Zone 1 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover**
Fraxinus latifolia	Oregon ash	2%
Ilex aquifolium*	English holly	1%
SHRUBS (Percent Cover)		
Cytisus scoparius*	scotch broom	3%
Rubus discolor*	Himalayan blackberry	80%
Salix sitchensis	Sitka willow	1%
UNDERSTORY (Percent Cover)		
Agrostis sp.	bentgrass	1%
Athyrium filix-femina	ladyfern	1%
Calystegia sepium*	hedge false bindweed	3%
Cirsium vulgare*	bull thistle	3%
Dactylis glomerata	orchardgrass	1%
Equisetum telmateia	giant horsetail rush	45%
Holcus lanatus	velvetgrass	3%
Iris pseudacorus*	yellow flag iris	2%
	lawn	2%
Phalaris arundinacea*	reed canarygrass	20%
Polystichum munitum	sword fern	1%
Trifolium sp.	clover	3%

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.

Zone 2

Zone 2 is a landscaped area, consisting mainly of lawn, with several large trees scattered throughout the area (Map 3). This zone is bounded by Zone 1 to the east and Lake Washington Boulevard to the west. The southern boundary of the zone is a set of stairs leading to the water and the northern boundary consists of two benches near the bus stop (Map 3).

Six trees were recorded in this zone within the proposed project area. Their species and DBH are listed in Table 3. The understory of the zone consists mostly of lawn (98% cover) (Table 3).

Table 3. Tree and herbaceous species found in Zone 2 in Madrona Woods during the 2006 survey. Values represent percent cover. Values represent percent cover.			
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover**	**DBH**
OVERSTORY TREES (Percent Cover)			
Acer macrophyllum	bigleaf maple	25%	53 and 33 inches
Betula pendula	European weeping	10%	23 inches
Ilex sp.	holly	10%	35 inches

Table 3. Tree and herbaceous species found in Zone 2 in Madrona Woods during the 2006 survey. Values represent percent cover. Values represent percent cover.			
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover**	**DBH**
Populus trichocarpa	black cottonwood	15%	86 inches
Thuja plicata	western red cedar	10%	24 inches
UNDERSTORY (Percent Cover)			
	bare dirt	2%	
	lawn	98%	

[1] Species in bold are non-native species.

Zone 3

Zone 3 consists of a landscaped area bounded by Lake Washington Boulevard to the east and the beginning of the forested ravine to the west (Map 3). This zone consists of approximately half mowed lawn and half invasive species that are located at the forest boundary (Table 4).

Two overstory species are found in this zone: big-leaf maple (*Acer macrophyllum*) and Norway maple (*Acer platanoides*), both with percent covers of 40% (Table 4). Norway maple is an invasive species in natural areas but does not have a legal designation at this time. Five species of trees are present in the regenerating layer in the zone of which two are native and three are non-native. Douglas fir (*Pseudotsuga menziesii*) and Western red cedar (*Thuja plicata*) are present at 2% cover each. Invasive trees include English holly (2% cover), sweet cherry (*Prunus avium*) (2% cover) and cherry laurel (*Prunus laurocerasus*) (1% cover), which are all invasive tree species spread by birds dropping seeds in natural areas. English holly and cherry laurel are classified as Noxious Weeds of Concern, whereas sweet cherry does not have a legal designation at this time.

Six species of shrubs are present in this zone of which five are native and one is non-native. The shrub layer is quite sparse and makes up only 8% cover (Table 4). Native species recorded include: tall Oregon grape (*Mahonia aquifolium*) (2% cover), red-flowering currant (*Ribes sanguineum*) (1% cover), salmonberry (*Rubus spectabilis*) (2% cover), red elderberry (*Sambucus racemosa*) (1% cover) and snowberry (*Symphoricarpos albus*) (1% cover). A small amount of Himalayan blackberry is also present (1% cover) (Table 4).

Seven species of herbaceous plants were recorded in this zone, of which two are native and five are non-native. Half of the understory vegetation consists of lawn (Table 4). A considerable amount of English ivy (*Hedera helix*) (30% cover), hedge false bindweed (10% cover), wild clematis (*Clematis vitalba*) (1% cover) and deadly nightshade (*Solanum dulcamara*) (1% cover) are also present. Hedge false bindweed and deadly nightshade are classified as Weeds of Concern, whereas English ivy and wild clematis are classified as Non-designated Noxious Weeds in King County (King County 2007).

Table 4. Tree, shrub and herbaceous species found in Zone 3 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover**
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	40%
Acer platanoides**	Norway maple	40%
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Ilex aquifolium*	English holly	2%
Prunus avium**	sweet cherry	2%
Prunus laurocerasus*	cherry laurel	1%
Pseudotsuga menziesii	Douglas fir	2%
Thuja plicata	Western red cedar	2%
SHRUBS (Percent Cover)		
Mahonia aquifolium	tall Oregon grape	2%
Ribes sanguineum	red-flowering currant	1%
Rubus discolor*	Himalayan blackberry	1%
Rubus spectabilis	salmonberry	2%
Sambucus racemosa	red elderberry	1%
Symphoricarpos albus	snowberry	1%
UNDERSTORY (Percent Cover)		
Calystegia sepium*	hedge false bindweed	10%
Clematis vitalba*	wild clematis	1%
Equisetum telmateia	giant horsetail rush	3%
Hedera helix*	English ivy	30%
	lawn	50%
Plantago major	broad-leaved plantain	10%
Prunella vulgaris	common self heal	10%
Solanum dulcamara*	deadly nightshade	1%

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.

Zone 4

Zone 4 is located on the eastern part of the ravine, bordered by Zone 3 to the east and a trail to the west (Map 3). The northern boundary is a paved path leading from a set of stairs separating the park from private property. The southern boundary is the top of the ridge, directly west of a large redwood tree located in Zone 2. A considerable amount of restoration has occurred in this zone over the past 10 years.

The overstory is dominated by big-leaf maple, with a percent cover of 80%. A smaller amount of black locust (*Robinia pseudoacacia*) is also present (11%) (Table 5). Black locust is considered to be an invasive species in the Pacific Northwest by the Plant Conservation Alliance's Alien Plant Working Group (2007). This species invades natural areas and spreads through root suckers and stump sprouts, forming dense thickets and excluding native plants.

The midstory and regenerating layer has eight species of trees, of which four are native and four are non-native. Native species include Oregon ash (6.5%), Western red cedar (6%), Western yew (*Taxus brevifolia*) (2%) and big-leaf maple (<1%). Three invasive species are found in the regenerating layer, which include English holly (2%), cherry laurel (2%) and European mountain ash (*Sorbus aucuparia*) (<1%). European mountain ash is an invasive species which does not have a legal designation at this time. It spreads through birds dropping seeds in natural areas and has the ability to form thickets in forested areas and exclude native species.

A total of 10 species were recorded in the shrub layer, of which eight are native, one is non-native and one is undetermined (horticultural Rhododendron species) (Table 5). The shrub layer provides a cover of 34% in this zone. Due to past restoration activities, considerable native diversity exists in this zone, which is dominated by beaked hazelnut (*Corylus cornuta*) with 19% cover (Table 5). Smaller amounts of Indian plum (*Oemleria cerasiformis*) (4%), snowberry (*Symphoricarpos albus*) (4%) and low Oregon grape (*Mahonia nervosa*) (2%) are also present. No invasive species were found in the shrub layer in this zone.

Eleven herbaceous species were recorded in Zone 4. Of these species, four are native and seven are non-native (Table 5). Sword fern (*Polystichum munitum*) is the most abundant species in this zone with a percent cover of 42%. However, there is also a considerable component of invasive species including English ivy (33% cover), herb Robert (*Geranium robertianum*) (5% cover), wild clematis (2%), wall-lettuce (*Mycelis muralis*) (1.5%), creeping buttercup (*Ranunculus repens*) (1%) and deadly nightshade (1%) (Table 5). Herb Robert is a Non-designated Noxious Weed in King County (King County 2007). Creeping buttercup and wall-lettuce do not have legal designations at this time, but are considered to be invasive species in natural areas in the Pacific Northwest. Creeping buttercup is often present in wetlands and riparian areas. Wall-lettuce is a weedy species that is usually found in small quantities. However, this species has aggressively spread throughout Madrona Woods and is present in large amounts particularly in the western portion of the ravine by the stream headwaters (Zone 9).

Table 5. Tree, shrub and herbaceous species found in Zone 4 in Madrona Woods during the 2006 survey. Values represent percent cover.

Scientific Name[1]	Common Name	2006 Survey Average Percent Cover[2]
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	80%
Alnus rubra	red alder	3%
Robinia pseudoacacia**	black locust	11%
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	T
Fraxinus latifolia	Oregon ash	6.5%
Ilex aquifolium*	English holly	2%
Malus sp.	horticultural apple species	T
Prunus laurocerasus*	cherry laurel	2%
Sorbus aucuparia**	European mountain ash	T
Taxus brevifolia	Western yew	2%
Thuja plicata	Western red cedar	6%

Table 5. Tree, shrub and herbaceous species found in Zone 4 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover[2]**
SHRUBS (Percent Cover)		
Buxus sempervirens	common box	2%
Corylus cornuta	beaked hazelnut	19%
Holodiscus discolor	oceanspray	1%
Mahonia aquifolium	tall Oregon grape	T
Mahonia nervosa	low Oregon grape	2%
Oemleria cerasiformis	Indian plum	4%
Philadelphus lewisii	mock-orange	T
Rhododendron sp.	horticultural rhododendron varieties	T
Symphoricarpos albus	snowberry	4%
Vaccinium parvifolium	red huckleberry	1%
UNDERSTORY (Percent Cover)		
Adiantum pedatum	maidenhair fern	1%
	bare dirt	8%
Clematis vitalba*	wild clematis	2%
	coarse woody debris	4%
Equisetum telmateia	giant horsetail rush	1%
Geranium robertianum*	herb Robert	5%
Hedera helix*	English ivy	33%
Lapsana communis	nipplewort	T
	litter	11%
Maianthemum dilatatum	false lily-of-the-valley	T
	mulch	9.5%
Mycelis muralis**	wall-lettuce	1.5%
Polystichum munitum	sword fern	42%
Ranunculus repens**	creeping buttercup	1%
Solanum dulcamara*	deadly nightshade	1%

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.
[2] T = Trace presence of species (less than 1%).

Zone 5

Zone 5 encompasses the south-central portion of the ravine, bounded by the ridge on the south side, the main trail bordering zone 4 on the east side, the riparian corridor on the north side, and a landscaped area adjacent to 37th Avenue on the west side (Map 3). This zone corresponds to the upland forested area of the ravine.

The overstory in this zone is dominated by big-leaf maple, which has 86% cover. Douglas-fir (*Pseudotsuga menziesii*), Western red cedar and red alder (*Alnus rubra*) are present in small

amounts of less than 5% each (Table 6). One invasive species, black locust, was present in this zone at a cover of less than 1%.

A total of seven species were recorded in the regenerating layer of the zone. Native species include big-leaf maple (6% cover), Pacific madrone (*Arbutus menziesii*) (2% cover), Western red cedar (2% cover) and Douglas-fir (less than 1% cover). Three invasive species are present including English holly (3.5% cover), sweet cherry (6.5% cover) and cherry laurel (1.5% cover) (Table 6). These species make up slightly more than half of the cover in this layer (a total of 11.5% cover of invasive species compared to 10% cover for native species).

Nine species of shrubs were found in the zone, all of which are native. The total percent cover provided by the shrub layer is 44% in this zone. Beaked hazelnut is the most prevalent species in the shrub layer with an average percent cover of 36%. Additional species present at less than 5% cover include: salal (*Gaultheria shallon*), oceanspray (*Holodiscus discolor*), low Oregon grape, Indian plum and thimbleberry (*Rubus parviflorus*) (Table 6).

The herbaceous layer consists of 12 plant species, of which seven are native and five are non-native (Table 6). The understory is dominated by sword fern which has a percent cover of 65%. The second most prevalent species is English ivy with a cover of 34%. Four other invasive species are present at a cover of less than 1%. These species include hedge false bindweed, wild clematis, wall-lettuce and deadly nightshade (Table 6).

Table 6. Tree, shrub and herbaceous species found in Zone 5 in Madrona Woods during the 2006 survey. Values represent percent cover.

Scientific Name[1]	Common Name	2006 Survey Average Percent Cover[2]
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	86%
Alnus rubra	red alder	2%
Pseudotsuga menziesii	Douglas-fir	4%
Robinia pseudoacacia	black locust	T
Thuja plicata	Western red cedar	2.5%
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	6%
Arbutus menziesii	Pacific madrone	2%
Ilex aquifolium*	English holly	3.5%
Prunus avium*	sweet cherry	6.5%
Prunus laurocerasus*	cherry laurel	1.5%
Pseudotsuga menziesii	Douglas fir	T
Thuja plicata	Western red cedar	2%
SHRUBS (Percent Cover)		
Corylus cornuta	beaked hazelnut	36%
Crataegus douglasii	Pacific hawthorn	T
Gaultheria shallon	salal	3%
Holodiscus discolor	oceanspray	1%
Mahonia nervosa	low Oregon grape	1%

Table 6. Tree, shrub and herbaceous species found in Zone 5 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover[2]**
Oemleria cerasiformis	indian plum	1%
Rubus parviflorus	thimbleberry	1%
Rubus spectabilis	salmonberry	T
Symphoricarpos albus	snowberry	T
UNDERSTORY (Percent Cover)		
Athyrium filix-femina	Ladyfern	2%
	bare dirt	6%
Bromus vulgaris	Columbia brome	T
Calystegia sepium*	hedge false bindweed	T
Clematis vitalba*	wild clematis	T
	coarse woody debris	1%
Equisetum telmateia	giant horsetail rush	1%
Hedera helix*	English ivy	34%
	litter	3%
	mulch	4.5%
Mycelis muralis*	wall-lettuce	T
Osmorhiza berteroi	sweet cicely	T
Oxalis oregana	redwood sorrel	1%
Polystichum munitum	sword fern	65%
Pteridium aquilinum	bracken fern	T
Solanum dulcamara*	deadly nightshade	T

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.
[2] T = Trace presence of species (less than 1%).

Zone 6

Zone 6 consists of the riparian area in the north of the ravine between 38th Avenue on the western side, the main trail on the eastern side, and zone 8 to the north. (Map 3). Water currently seeps from the slopes of the western portion of the zone and flows into a drain near the eastern trail.

The overstory is dominated by big-leaf maple (78% cover) with a smaller amount of red alder (12%) and Pacific madrone (3.5%). One horticultural species, beech, was also recorded in the zone (Table 7).

The regenerating layer in the zone consists of Western red cedar (6.5% cover), big-leaf maple (4% cover) and Pacific madrone (3.5% cover). Two invasive species, cherry laurel and European mountain ash, are also present at average percent covers of 2% and 3% respectively (Table 7).

The shrub layer contains nine species, of which one is non-native (Table 7). The shrub layer provides 43% cover in the zone and is composed of a mixture of salmonberry (*Rubus spectabilis*) (12% cover), red elderberry (*Sambucus racemosa*) (12% cover) and beaked hazelnut (10% cover). Smaller amounts of snowberry (*Symphoricarpos albus*) (5% cover) and creeping blackberry (*Rubus ursinus*) are also present. One invasive species, Himalayan blackberry, was recorded at an average percent cover of 1% (Table 7).

Fifteen herbaceous species were recorded, of which nine are native and six are non-native. The most dominant native species include ladyfern (*Athyrium filix-femina*) (32% cover), giant horsetail rush (*Equisetum telmateia*) (16% cover), sword fern (8.5%) and slough sedge (*Carex obnupta*) (7%). Invasive species make up a great deal of the percent cover in this zone. Six invasive species were recorded, with a total percent cover of 64%. These species are, in order of dominance: English ivy (31%), hedge false bindweed (18%), deadly nightshade (12.5%), creeping buttercup (2%), herb Robert (less than 1%) and common periwinkle (*Vinca minor*) (less than 1%).

Table 7. Tree, shrub and herbaceous species found in Zone 6 in Madrona Woods during the 2006 survey. Values represent percent cover.

Scientific Name[1]	Common Name	2006 Survey Average Percent Cover[2]
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	78%
Alnus rubra	red alder	12%
Arbutus menziesii	Pacific madrone	3.5%
Fagus sp.	beech	8%
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	4%
Arbutus menziesii	Pacific madrone	3.5%
Prunus laurocerasus*	cherry laurel	2%
Sorbus aucuparia*	European mountain ash	3%
Thuja plicata	Western red cedar	6.5%
SHRUBS (Percent Cover)		
Corylus cornuta	beaked hazelnut	10%
Lonicera involucrata	twinberry	1%
Oemleria cerasiformis	indian plum	T
Rosa gymnocarpa	baldhip rose	T
Rubus discolor*	Himalayan blackberry	1%
Rubus spectabilis	salmonberry	12%
Rubus ursinus	creeping blackberry	2%
Sambucus racemosa	red elderberry	12%
Symphoricarpos albus	snowberry	5%
UNDERSTORY (Percent Cover)		
Athyrium filix-femina	ladyfern	32%
	bare dirt	6%
Blechnum spicant	deerfern	2%

Table 7. Tree, shrub and herbaceous species found in Zone 6 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover[2]**
Carex obnupta	slough sedge	7%
Calystegia sepium*	hedge false bindweed	18%
	coarse woody debris	2%
Equisetum telmateia	giant horsetail rush	16%
Geranium robertianum*	herb Robert	T
Glyceria striata	tall mannagrass	T
Hedera helix*	English ivy	31%
	litter	6%
Lysichitum americanus	skunk cabbage	4%
	mulch	3%
	open water	3%
Polypodium glycyrrhiza	licorice fern	T
Polystichum munitum	sword fern	8.5%
Ranunculus repens*	creeping buttercup	2%
Solanum dulcamara*	deadly nightshade	12.5%
Stachys cooleyae	hedgenettle	1%
Vinca minor*	common periwinkle	T

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.
[2] T = Trace presence of species (less than 1%).

Zone 7

Zone 7 is a small semi-horticultural restoration area on the east side of 38th Avenue (Map 3). Most of the plant material present has been planted as a result of restoration activities in this zone.

The overstory in the zone is composed entirely of big-leaf maple (Table 8). No regenerating trees were recorded in this zone. Five species of shrubs were recorded in the zone of which four are native and one is non-native. Thimbleberry is the most abundant shrub with a percent cover of 10%. Other native shrubs include oceanspray (3.5%), mock-orange (*Philadelphus lewisii*) (3%) and red-flowering currant (*Ribes sanguineum*) (2%). One invasive species, Himalayan blackberry, was recorded at a percent cover of 7% (Table 8).

The understory in this zone is composed primarily of mulch (51% cover). Nine species of herbaceous plants were recorded, of which four are native and five are non-native (Table 8). The most common native species are sword fern (13% cover) and ladyfern (5% cover). Small amounts of deerfern (*Blechnum spicant*) (2%) and Canada goldenrod (*Salidago canadensis*) (2%) are also present. Three invasive species are present in this area with a combined percent cover of 23.5%. These species include English ivy (14.5%), wild clematis (8%) and hedge false bindweed (1%) (Table 8).

Table 8. Tree, shrub and herbaceous species found in Zone 7 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover[2]**
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	100%
SHRUBS (Percent Cover)		
Holodiscus discolor	oceanspray	3.5%
Philadelphus lewisii	mock-orange	3%
Ribes sanguineum	red-flowering currant	2%
Rubus discolor*	Himalayan blackberry	7%
Rubus parviflorus	thimbleberry	10%
UNDERSTORY (Percent Cover)		
Athyrium filix-femina	ladyfern	5%
	bare dirt	2%
Blechnum spicant	deerfern	2%
Calystegia sepium*	hedge false bindweed	1%
Clematis vitalba*	wild clematis	8%
	coarse woody debris	2%
Hedera helix*	English ivy	14.5%
Hemerocallis sp.	daylilly	3%
Lapsana communis	nipplewort	T
	mulch	51%
Polystichum munitum	sword fern	13%
Salidago canadensis	Canada goldenrod	2%

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.
[2] T = Trace presence of species (less than 1%).

Zone 8

Zone 8 is also a small horticultural strip, extending along the southern side of East Spring Street on the northern border of the ravine (Map 3). This zone is located directly to the north of the riparian forest (Zone 6).

The overstory in this zone is a mix of native and horticultural species planted along the border of Madrona Woods. Native species consist of big-leaf maple (46% cover) and Western red cedar (14% cover). Horticultural species include beech (*Fagus sp.)* (28.5%) and Port Orford cedar (*Chamaecyparis lawsoniana*) (12.5%) (Table 9). Four species were recorded in the regeneration layer (Table 9). Cherry laurel has the highest percent cover of all regenerating species in this zone and twice that of all the native species combined (10% as opposed to 5% for native species) (Table 9).

Nine species of shrubs are present in this zone, of which one is non-native. The shrub layer provides a total percent cover of 68%. The shrub layer is dominated by red elderberry (24%

cover), oceanspray (12.5% cover), snowberry (10% cover) and tall Oregon grape (9% cover). Smaller amounts of other shrubs include Nootka rose (*Rosa nutkana*) (5%), low Oregon grape (2%), red-flowering currant (1%) and vine maple (*Acer circinatum*) (1%) (Table 9).

The understory in this zone has a substantial amount of mulch (16%). Of the 10 recorded herbaceous species, five are native and five are non-native. Sword fern (10% cover), ladyfern (9% cover) and giant horsetail rush (7% cover) are the most prevalent native species. Invasive species present include a considerable amount of hedge false bindweed (17%), English ivy (5%), creeping buttercup (3%) and herb Robert (2%). The average percent cover of invasive species in this zone totals 27% (Table 9).

Table 9. Tree, shrub and herbaceous species found in Zone 8 in Madrona Woods during the 2006 survey. Values represent percent cover.

Scientific Name[1]	Common Name	2006 Survey Average Percent Cover[2]
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	46%
Chamaecyparis lawsoniana	Port Orford cedar	12.5%
Fagus sp.	beech	28.5%
Thuja plicata	Western red cedar	14%
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	T
Alnus rubra	red alder	4%
Fraxinus latifolia	Oregon ash	1%
Prunus laurocerasus*	cherry laurel	10%
SHRUBS (Percent Cover)		
Acer circinatum	vine maple	1%
Holodiscus discolor	oceanspray	12.5%
Ligustrum sp.	privet hedge	3%
Mahonia aquifolium	tall Oregon grape	9%
Mahonia nervosa	low Oregon grape	2%
Ribes sanguineum	red-flowering currant	1%
Rosa nutkana	Nootka rose	5%
Sambucus racemosa	red elderberry	24%
Symphoricarpos albus	snowberry	10%
UNDERSTORY (Percent Cover)		
Athyrium filix-femina	ladyfern	9%
Calystegia sepium*	hedge false bindweed	17%
	coarse woody debris	3%
Equisetum telmateia	giant horsetail rush	7%
Fragaria vesca	woodland strawberry	3%
Geranium robertianum*	herb Robert	2%
Hedera helix*	English ivy	5%
Lapsana communis	nipplewort	7%
	litter	8.5%

Table 9. Tree, shrub and herbaceous species found in Zone 8 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover[2]**
	mulch	16%
Polystichum munitum	sword fern	10%
Ranunculus repens	creeping buttercup	3%
Thalictrum occidentale	Western meadow-rue	T

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.
[2] T = Trace presence of species (less than 1%).

Zone 9

Zone 9 is adjacent to the west side of 38th Avenue and consists of an upland forest, transitioning into a wetland habitat. The eastern side of the zone is bounded by 38th Avenue, the north and south sides are bounded by private property and the western side is bounded by a wetland (Map 3).

The overstory is dominated by big-leaf maple with 100% cover and a small amount of red alder (10% cover) (Table 10). Of the four species present in the regeneration layer, three are native and one is non-native. Big-leaf maple is the most prevalent native species in the regeneration layer (15% cover), followed by Douglas-fir (4% cover) and Sitka spruce (less than 1% cover). A considerable amount of cherry laurel is also present, with 12% cover in this zone (Table 10).

Seven species of shrubs were recorded in this zone, of which six are native and one is non-native. The total percent cover provided by the shrub layer is 55%. The shrub layer is dominated by red elderberry with an average cover of 33%. Smaller amounts of Indian plum (11% cover), snowberry (3% cover), beaked hazelnut (3% cover), salal (1% cover) and low Oregon grape (less than 1% cover) are also present. One invasive species, Himalayan blackberry, was recorded at an average cover of 4% in this zone (Table 10).

Seven herbaceous species were recorded in the understory, of which three are native and four are non-native. The understory is dominated by sword fern (45% cover). Four invasive species were recorded in this zone and make up an average of 33% percent cover combined. These species include English ivy (17.5% cover), wild clematis (7% cover), wall-lettuce (7% cover) and deadly nightshade (1% cover). Wall-lettuce is very prevalent in this zone and a substantial infestation of it is present on the southern slope, adjacent to the private property boundary.

Table 10. Tree, shrub and herbaceous species found in Zone 9 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover[2]**
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	100%
Alnus rubra	red alder	10%

Table 10. Tree, shrub and herbaceous species found in Zone 9 in Madrona Woods during the 2006 survey. Values represent percent cover.		
Scientific Name[1]	**Common Name**	**2006 Survey Average Percent Cover[2]**
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	15%
Picea sitchensis	Sitka spruce	T
Prunus laurocerasus*	bay laurel, cherry laurel	12%
Pseudotsuga menziesii	Douglas-fir	4%
SHRUBS (Percent Cover)		
Corylus cornuta	beaked hazelnut	3%
Gaultheria shallon	salal	1%
Mahonia nervosa	low Oregon grape	T
Oemleria cerasiformis	Indian plum	11%
Rubus discolor*	Himalayan blackberry	4%
Sambucus racemosa	red elderberry	33%
Symphoricarpos albus	snowberry	3%
UNDERSTORY (Percent Cover)		
Athyrium filix-femina	ladyfern	4%
	bare dirt	7%
Clematis vitalba*	wild clematis	7.5%
Hedera helix*	English ivy	17.5%
Juncus effusus	soft rush	1%
	litter	7%
Mycelis muralis **	wall-lettuce	7%
Polystichum munitum	sword fern	45%
Solanum dulcamara*	deadly nightshade	1%

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.
[2] T = Trace presence of species (less than 1%).

Zone 10

This zone encompasses the wetland area between Zones 9 and 11, which includes the headwaters of the stream (Map 3).

The overstory is similar to that of Zone 9 and is dominated by big-leaf maple (100% cover) with a red alder component (12%) (Table 11). A small amount of Western red cedar is present in the regenerating layer (2.5% cover), along with a small amount of cherry laurel (1% cover).

The shrub layer is dominated by red elderberry (25% cover), salmonberry (21% cover) and red-osier dogwood (*Cornus stolonifera*) (13% cover). A small amount of Himalayan blackberry was recorded (1% cover).

Seven species were recorded in the herbaceous layer, of which four are native and three are non-native. Ladyfern is the most prevalent species in the understory with an average percent cover of 25%. Other native species include sword fern (7%), Western touch-me-not (*Impatiens noli-tangere*) (5%) and skunk cabbage (*Lysichitum americanus*) (2%). Invasive species found include deadly nightshade (4.5%) and English ivy (4%). A large stand of deadly nightshade is present on the north side of the wetland, where it is covering a population of giant horsetail rush and skunk cabbage.

Table 11. Tree, shrub and herbaceous species found in Zone 10 in Madrona Woods during the 2006 survey. Values represent percent cover.

Scientific Name[1]	Common Name	2006 Survey Average Percent Cover[2]
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	100%
Alnus rubra	red alder	12%
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Prunus laurocerasus*	cherry laurel	1%
Thuja plicata	Western red cedar	2.5%
SHRUBS (Percent Cover)		
Cornus stolonifera	red-osier dogwood	13%
Oemleria cerasiformis	Indian plum	2%
Ribes hudsonianum	Western black currant	1%
Rubus discolor*	Himalayan blackberry	1%
Rubus spectabilis	salmonberry	21%
Sambucus racemosa	red elderberry	25%
UNDERSTORY (Percent Cover)		
Athyrium filix-femina	ladyfern	25%
	bare dirt	11.5%
Cardamine hirsuta	hairy bittercress	T
	coarse woody debris	3%
Hedera helix*	English ivy	4%
Impatiens noli-tangere	Western touch-me-not	5%
	litter	3%
Lysichitum americanus	skunk cabbage	2%
	open water	2%
Polystichum munitum	sword fern	7%
	rock	1%
Solanum dulcamara*	deadly nightshade	4.5%

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.
[2] T = Trace presence of species (less than 1%).

Zone 11

Zone 11 is the western-most zone in Madrona Woods, bordered by 37th Avenue on the west and north sides, private property on the south side, and a wetland (Zone 10) on the east side (Map 3). This zone consists of an upland forest with a transition zone from the wetland area. This zone has the highest amount of invasive species in the project area and will require a considerable amount of restoration.

The overstory in this zone is composed entirely of big-leaf maple (100% cover). The midstory of the zone is mostly composed of sycamore maple (*Acer pseudoplatanus*) (54% cover), which has the potential to become invasive in the park. This species should be regularly monitored and/or removed if it appears to be spreading. There is also a considerable stand of cherry laurel in this section of the park (17% cover) (Table 12).

The only shrub species recorded in this zone is Himalayan blackberry at a cover of 8% (Table 12). Of the four herbaceous species recorded, the two native species make up a very small amount of cover in the zone. Giant horsetail rush and sword fern together make up 9% cover (Table 12). English ivy had 100% cover on the forest floor. In addition, a large stand of Japanese knotweed (*Polygonum cuspidatum*) is present on the north side of the wetland, although only a small portion of that population was picked up in this transect (6% cover) (Table 12).

Table 12. Tree, shrub and herbaceous species found in Zone 11 in Madrona Woods during the 2006 survey. Values represent percent cover.

Scientific Name[1]	Common Name	2006 Survey Average Percent Cover
OVERSTORY TREES (Percent Cover)		
Acer macrophyllum	big-leaf maple	100%
MIDSTORY AND REGENERATING TREES (Percent Cover)		
Acer pseudoplatanus*	sycamore maple	54%
Prunus laurocerasus*	cherry laurel	17%
SHRUBS (Percent Cover)		
Rubus discolor*	Himalayan blackberry	8%
UNDERSTORY (Percent Cover)		
	coarse woody debris	1%
Equisetum telmateia	giant horsetail rush	6%
Hedera helix*	English ivy	100%
Polygonum cuspidatum*	Japanese knotweed	6%
Polystichum munitum	sword fern	3%

[1] Species in bold are non-native species. Species denoted by * are non-native invasive species which have been given a legal designation by the King County Noxious Weed Program (King County 2006). Species denoted by ** are non-native invasive species which have not been given a legal designation at this time.

IV. RECOMMENDATIONS

The daylighting project in Madrona Woods is an ambitious restoration project which will transform and improve the riparian, wetland and upland habitats in a large portion of Madrona Park.

The 2006 baseline survey shows that a considerable amount of restoration has already occurred in the Woods, as is evidenced by the native species diversity present and the low amounts of invasive species present in the shrub layer in most areas. Specific recommendations for the project area include removing invasive tree species, adding a conifer component to the regeneration layer, and removing invasive species such as English ivy, Japanese knotweed, deadly nightshade and wall-lettuce. These recommendations are discussed below:

Invasive tree species

Seven species of known invasive trees and one species that is potentially invasive were found during the course of the baseline survey. These species include: European mountain ash, English holly, Norway maple, cherry laurel, sweet cherry, one-seed hawthorn and black locust. Cherry laurel and English holly were the most commonly found invasive tree species, present in the regeneration layer in 72% and 36% respectively of all 11 zones. Table 13 describes specific locations of all invasive tree species found in the park.

One horticultural maple species was found in Zone 11 and appears to be spreading throughout this area. This species should be identified, monitored, and potentially removed if substantial increases in seedling and sapling density are noticed.

All of these species have the capacity to sprout from stumps or roots once they have been cut. Therefore, more complete control can be achieved by applying herbicide directly to cut or frilled plants and monitored over a period of several years.

Table 13. Invasive tree species found in Madrona Woods.

Scientific Name[1]	Common Name	Zone Number
Acer pseudoplatanus	sycamore maple	11
Acer platanoides	Norway maple	3
Crataegus monogyna	one-seed hawthorn	1
Ilex aquifolium	English holly	widespread
Prunus avium	sweet cherry	3 and 5
Prunus laurocerasus	cherry laurel	widespread
Robinia pseudoacacia	black locust	4
Sorbus aucuparia	European mountain ash	4 and 6

Conifers

The overstory in Madrona Woods is mostly deciduous, with very few conifers present. Restoration activities have increased conifer densities by planting conifers in the understory. However, no conifer regeneration is currently present in 45% of surveyed zones. Increasing the diversity and density of conifers during restoration activities will help to re-establish a conifer component in the park. Particular attention should be directed to zones 1, 2, 7, 8 and 9 which do not have any conifer regeneration present at this time. Appropriate species of conifers include Western red cedar, Douglas-fir and Sitka spruce which are already present in the park. Other species such as Western hemlock (*Tsuga heterophylla*) and grand fir (*Abies grandis*) can be added to increase species diversity.

Invasive herbaceous species

Invasive herbaceous species pose the most significant problem in Madrona Woods at this time. Two of these species, Japanese knotweed and deadly nightshade, are present only in wetland and riparian areas in zones 6 and 10. Wall-lettuce is present in considerable quantities on the southern slope of zone 9. Three other species, English ivy, hedge false bindweed and wild clematis are more widespread throughout the project area. In particular, English ivy is present in all forested zones at an average percent cover of 30% across all zones. Hedge false bindweed is most heavily infesting zones 6 and 8, whereas wild clematis is found is zones 7 and 9.

Information about removal of some of these species is found below:

Deadly nightshade and hedge false bindweed

These two species are similar in growing habit and are often found in similar habitats, i.e. disturbed wetland and riparian areas. Both species easily re-sprout from roots and root fragments and require similar management techniques. Manual control involves removing as much of the root as possible either by pulling or digging. Because the plants can re-root if they are left lying on the soil, it is important to remove the plant material from the site. It is unlikely that a single treatment will control the population entirely, and therefore additional removal will be necessary over several years. If the site is not too wet, cardboard or mulch can be applied to suppress further growth (King County 2000). For information about chemical control, please see the specific “Bittersweet Nightshade” and “Field Bindweed” information in Appendix A.

Japanese knotweed

A large patch of Japanese knotweed is present in the northern portion of Zone 10. As this appears to be an isolated population, control at this time will prevent further infestation of the wetland. This species spreads by rhizomes, which can resprout from small fragments in the soil. Manual control involves digging out the root mass as completely as possible and then removing re-sprouts over the next several years. An additional method is cutting the knotweed to the ground and placing a tarp or heavy black fabric over the area, thus cutting off light to the plants. If this method is used, the fabric has to be tightly staked to the ground. Chemical control of this plant is very effective using the stem injection method, where a special injector gun is used to

apply herbicide directly into each plant stem (King County 2005). More information about this plant is provided in Appendix A.

Wall-lettuce

A large infestation of this species is present on the south slope of Zone 9. This species is often present in open areas or forest edges. It reproduces almost entirely by seed and is not rhizomatous (Clabby and Osborne 1999). Although not much information is available for control methods for this plant, recommendations include removal by pulling as much of the root as possible, followed by replanting of native species and an application of cardboard or mulch to suppress regrowth. Plants should be removed prior to flowering where possible.

Slope stabilization

Much of the ravine in Madrona Woods has very steep slopes, which have a high cover of English ivy. On-going restoration efforts have been removing the ivy and replanting the area with native plants. Slope stability has been an issue on some of the steeper slopes both due to difficulty of access and erosion potential while native vegetation becomes established. Several slope stabilization options are discussed below, but a consultation with EarthCorps or other consulting firm with experience in slope stabilization is highly recommended.

Available slope stabilization methods include:

- Using jute, burlap or a similar material to cover the denuded area and planting an understory layer with species such as sword fern in addition to trees and shrubs through the jute to establish a root system to hold the soil in place. The jute or burlap will decompose after several years (Florineth and Gerstgraser, 1996).
- Creating terraces using anchored or buried logs to hold soil. This technique has the added advantage of adding coarse woody debris (CWD) to the soil, and providing a platform to stand on the slope.
- Fascines are live willow stakes which are tied together with at least 2 mm thick wire. These bundles are then placed in a shallow dug ditch, covered with soil and allowed to root, thus creating rows of vegetated barriers (Florineth and Gerstgraser, 1996). Unfortunately, this technique works best on wet sites where willows can grow, and is not appropriate to the steep upland slopes in Madrona Woods.

More information can be found in the Florineth and Gerstgraser article, which can be found online at: http://www.fao.org/docrep/X0622E/x0622e0s.htm

V. MONITORING

Monitoring of the project site will take place for at least three growing seasons after project installation. Monitoring targets include:

1. Minimum 80% survival rate of new native plantings (trees and shrubs) after 3 growing seasons.
2. 10% or less invasive species cover after 3 growing seasons.

In July of 2008, following the majority of project construction and planting, fourteen 5 meter x 5 meter monitoring plots were established throughout restored areas of Madrona Woods (Map 5). Five of the plots were located in restored areas adjacent but outside of the project area described in this report. Complete monitoring protocols are found in Appendix B. Data sheets are found in Appendix C. A training session was conducted for Friends of Madrona Woods volunteers covering all aspects of the monitoring protocols.

The following parameters will be collected:

- Density information for all trees growing within the monitoring plot including height, diameter, health condition and species.
- Density and vigor information for all shrubs growing within the monitoring plot including height, number of stems, health condition and species.
- Percent cover within the monitoring plot for all shrubs, vines and herbaceous species.

Plots will be separated into one of three general sections as described in Table 14 and illustrated on Map 5.

Table 14. Monitoring zones in Madrona Woods

Section Number	Section Name	Monitoring Plot Numbers	Number of Plots
1	Shoreline	1,2,3,4,5	5
2	Riparian Corridor	6,7,8,9	4
3	Forested Upland	10,11,12,13,14	5

Data for each zone will be averaged, and will allow the group to track survival of planted species and the presence of invasive species. These data can also be compared with data collected during the baseline survey to track general trends in the overall progress of the habitat restoration occurring in Madrona Woods.

Table 15 summarizes pertinent data for each zone that can be used for comparison and to track project success.

Map 5

E SPRING ST

LAKE WASHINGTON BV

38TH AV

Lake Washington

9 8 7 6 5 4 3 2 1 11 10 12 13 14

Feet
0 50 100 200
1:760

Map produced by Seattle Urban Nature July, 2008. No warranties of any sort, including accuracy, fitness, or merchantability accompany this product.

Madrona Woods
Monitoring Plot Locations

Legend

- Park Property
- Parcel
- Trails

Monitoring Plots (2006)

- Shoreline
- Riparian
- Upland

N

Friends of Madrona Woods

Seattle Urban Nature

Table 15. Native and invasive cover of tree, shrub and herbaceous species found in Madrona Woods during the 2006 survey. Total percent cover refers to the total cover of native, non-native and invasive species present in the park and can total greater than 100% due to overlapping species.

Zone	Total % Cover	Native Cover	Invasive Cover	Number of Native Species
OVERSTORY TREES				
1	25%	25%	0%	1
2	70%	50%	0%	3
3	80%	40%	40%	1
4	94%	83%	11%	2
5	95%	95%	0%	4
6	102%	94%	0%	3
7	100%	100%	0%	1
8	101%	60%	0%	2
9	110%	110%	0%	2
10	112%	112%	0%	2
11	100%	100%	0%	1
MIDSTORY AND REGENERATING TREES				
1	4%	2%	2%	1
2	0%	0%	0%	0
3	9%	4%	5%	2
4	19%	15%	4%	4
5	22%	10%	12%	4
6	19%	14%	5%	3
7	0%	0%	0%	0
8	15%	5%	10%	3
9	31%	19%	12%	3
10	4%	3%	1%	1
11	71%	0%	71%	0
SHRUBS				
1	84%	1%	83%	1
2	0%	0%	0%	0
3	8%	7%	1%	5
4	33%	31%	0%	9
5	43%	43%	0%	9
6	43%	42%	1%	8
7	26%	19%	7%	4
8	68%	65%	0%	8
9	55%	51%	4%	6
10	63%	62%	1%	5
11	8%	0%	8%	0
HERBACEOUS				
1	85%	47%	28%	3

Table 15. Native and invasive cover of tree, shrub and herbaceous species found in Madrona Woods during the 2006 survey. Total percent cover refers to the total cover of native, non-native and invasive species present in the park and can total greater than 100% due to overlapping species.

Zone	Total % Cover	Native Cover	Invasive Cover	Number of Native Species
2	100%	0%	0%	0
3	65%	13%	42%	2
4	88%	44%	44%	4
5	103%	69%	34%	7
6	134%	71%	63%	9
7	49%	22%	27%	4
8	63%	29%	27%	5
9	83%	50%	33%	3
10	48%	39%	9%	4
11	115%	9%	106%	2

References

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Appendix A. Best Management Practice information for selected invasive species present in Madrona Woods

1. Bittersweet nightshade (*Solanum dulcamara*)
   http://dnr.metrokc.gov/wlr/lands/weeds/nightshade.pdf

2. Field bindweed (*Convolvulus arvensis*)
   http://dnr.metrokc.gov/wlr/lands/weeds/field_bindweed.pdf

3. Invasive Knotweeds: *Polygonum bohemicum, P.cuspidatum, P. polystachyum, P. sachalinense*
   http://dnr.metrokc.gov/wlr/lands/weeds/pdf/Knotweed.pdf

Appendix B. Friends of Madrona Woods Monitoring Protocols

Equipment List

- Field forms
- Pencil
- Camera
- Diameter tape or caliper
- 50 foot (or meter) measuring tape (optional)
- Plant ID or reference book

Sampling Plot Locations

14 sampling plots are located throughout the restored area of Madrona Woods (Map 5). These plots are 5 meters x 5 meters in size and have been marked with a wooden stake and a bright green pin flag in each corner of the plot. The plot number (1-14) is marked on each wooden stake and green pin flag. In addition, an aluminum tag with the plot number is stapled to one of the wooden stakes. Plot locations were recorded with a GPS unit.

Photo Documentation

Standing at one corner of the sampling plot and facing into the plot, take a photograph of as much of the plot area as possible. Always take photographs from the same stake and height. It may be necessary to move backwards away from the plot to capture the entire area. If this is the case, keep the distance and direction of movement constant across all plots. It is also important to complete photo documentation during the same season each year to get an accurate assessment of growth.

Monitoring Priorities

There is an order of monitoring that should be observed: monitor percent cover first, then do the tree and shrub density, DBH and height estimates. This order is necessary to maintain the monitoring site in the best condition to obtain the best observations and data.

A. Estimating Percent Cover in Rectangular Plots

1. Estimating cover will involve focused attention and teamwork. The first step is to get a clear idea of the plot boundaries. Locate all four stakes marking the boundaries of the plot. It may be helpful to run a meter tape along the boundary to mark the boundary clearly. If another tape is available, it may be helpful to further subdivide the plot into quarters to make cover estimation easier.

2. Develop a plant list of all species in the plot. The list can be augmented if additional species are located during monitoring. The list should contain the scientific and common names of

native and invasive shrubs, herbaceous plants and vines. Use the **cover data form** to record all estimates.

3. Once the species list is established, position monitors at opposite ends of the plot, and one in the middle if possible. People should be stationed on the outside of the plot if possible to minimize trampling.

4. Vegetation in the plot will be estimated out of 100%. Each layer is evaluated independently and therefore the total for the plot can add up to greater than 100%. For example, it is possible to have 50% sword fern on the ground, 80% snowberry in a low shrub layer and 40% beaked hazelnut in a high shrub layer.

5. Once positioned, cover estimates are made systematically one species at a time. The recorder calls a species and each observer makes a visual estimate of what he or she estimates the area of the species covers in the sector and makes an estimate of the percent that species covers in the sector sampled. Only parts of the plant species that are within or overhanging the sector are included; deductions for gaps between leaves and stems are not made. **Think bird's eye view. Draw an imaginary line around the canopy of individual or groups of the target species, visualize the amount of foliage loosely pushed together in a mass within the sector and make an estimate of the <u>percent of the sector that foliage covers</u>. For large amounts of foliage, think in units of 10-25%; for smaller amounts of foliage, think in units of 1-5%. If there is only one small plant, use a minimum of 0.1% so the species is recognized as a trace. Once each observer makes an estimate for the first species, the recorder will ask each observer to give their estimate and the group will decide which is the best estimate to record for the species. Repeat this process for each species in the sector. As a point of reference, 0.5m x 0.5m = 1%; 0.7m x 0.7m = 2%; 1m x 1m = 4%; 1m x 2m = 8%, 2m x 2m=16%, 3m x 2m=24%.**

6. A word about plant identification. If you do not know the species or are not confident in your identification, take a picture or draw and describe the dominant features of the plant in your field notebook. Use an alias name (unknown composite #1, etc.) to record all occurrences of the same species until the plant can be identified. Remember the 1 in 20 rule: do not pick plant specimens unless you see at least 20 other similar plants in the immediate area.

B. Estimating Plant Survival, Growth and Vigor of Installed and Naturally Recruited Shrubs and Trees

1**. Plant survival** is determined by the presence/absence and number of trees and shrubs observed by species within each plot. In most cases, survival estimates apply only to the sample plot and cannot be extrapolated to the entire site. Beginning at one corner of the plot, count and tally each species of installed tree or shrub encountered. Count only those plants that are <u>rooted within</u> the sample plot. Note dead plants by species if possible, otherwise record as "dead tree" or "dead shrub". Also note any tree or shrub seedlings that you believe may have been naturally recruited to the site (e.g., English holly, European mountain ash, black cottonwood, red alder, Douglas fir, salmonberry, etc.).

2. **Growth** of installed and naturally recruited trees and shrubs is determined by measuring the height, diameter and number of stems produced by the plant. Measure the height, diameter and stem count data as you record information for each plant. You will have one record for every individual tree and shrub that is rooted in the plot.

2a. **Heights-** shrub and tree heights are measured and recorded (in situ=as it appears without lifting leaders or straightening the tree) to the nearest inch if less than 6 feet tall, or the nearest foot or half meter if taller. Measure or visually estimate the heights of all trees and shrubs measured in the plot.

2b. **Diameters**- Measure and record the **diameter at breast height** (dbh breast height is defined as 4.5 feet from the ground surface) for each tree using a diameter tape or calipers. For trees smaller than 4.5 feet in height, measure and record the average stem diameter 4" (fist width) above the ground to the nearest inch. A seedling is usually recorded as 0.1 inches.

2c. **Stem counts-** count the number of distinct stems that emerge 4" or less (fist width) above the ground for each plant, only counting stems that occur within the sample plot. If a shrub with 10 stems is straddling the perimeter plot line with 5 stems inside the line and 5 stems outside the line, only the 5 stems inside the line are counted and recorded.

3. **Vigor** is a measure of the state of health of the plant. As each installed tree or shrub is measured, its state of health should be recorded. These are subjective measures that become easier to determine with experience. The options are "dead", "poor", "fair" and "good". "Dead" means there is no evidence of a green cambium (use your thumb nail to scratch the base and upper portion of the stem; if no green layer is observed, the plant is dead); "poor" means no evidence of new growth (epicormic branches, flowers, fruits), stressed, infested, wilted and anemic appearance; "fair" means the plant is green, erect without exhibiting new growth, little if any infestations; and "good" means the plant exhibits lots of new growth, flowers, fruits, vegetative growth.

4. **Colonization by English ivy** is assessed and recorded for each tree, if present.

5. **Snags** are recorded in the same way as live trees, with "snag" as the species code. A snag is any dead tree greater than 5 feet in height and greater than 5 inches in diameter. DBH and height are recorded for each snag.

6. **Coarse Woody Debris (CWD)** refers to any downed wood or standing wood shorter than 5 feet in height in the case of stumps. CWD must be larger than 5 inches in diameter to be recorded. If a piece of CWD has a portion that is larger than 5 inches in diameter but then decreases in size, record the length of the portion that is inside the plot and larger than 5 inches. Only record the lengths of wood that lie within the plot boundaries. The length of the CWD piece should be measured to the nearest foot or half meter and entered in the height column. Measure the diameter at a point halfway along the log to get an average diameter.

Appendix C. Field forms for monitoring data collection

Herbaceous Cover Data Sheet for Shrubs, Herbaceous Plants and Vines

Date______________________ Observers______________________________

Plot Number_______________ Zone Number____________________

Data Entered: ______

Species Name	Common Name	Percent Cover
Mulch		
Bare		
Lawn		
Impervious		

Density Data Sheet for Trees and Shrubs

Data Entered: _______

Date_____________ Observers_________________

Plot Number________ Zone Number_______ Canopy Cover________

Species Name	Common Name	Height (ft)	Diameter (in or cm)	# of stems	Health*	Ivy (check if present)

Tree Health*: **Good; Fair; Poor; Dead**