uplands likely provides habitat for many mammals, birds, reptiles, and amphibians commonly found in western Washington.

Results of the reconnaissance investigations done on the site were used to develop enhancement and restoration plans within the different communities. Proposed plantings of shrubs and trees were selected for their compatibility with existing vegetation and based on existing site conditions. In addition, plant species also were selected based on their ability to contribute to habitat diversity and complexity.

ENHANCEMENT AND RESTORATION PLAN

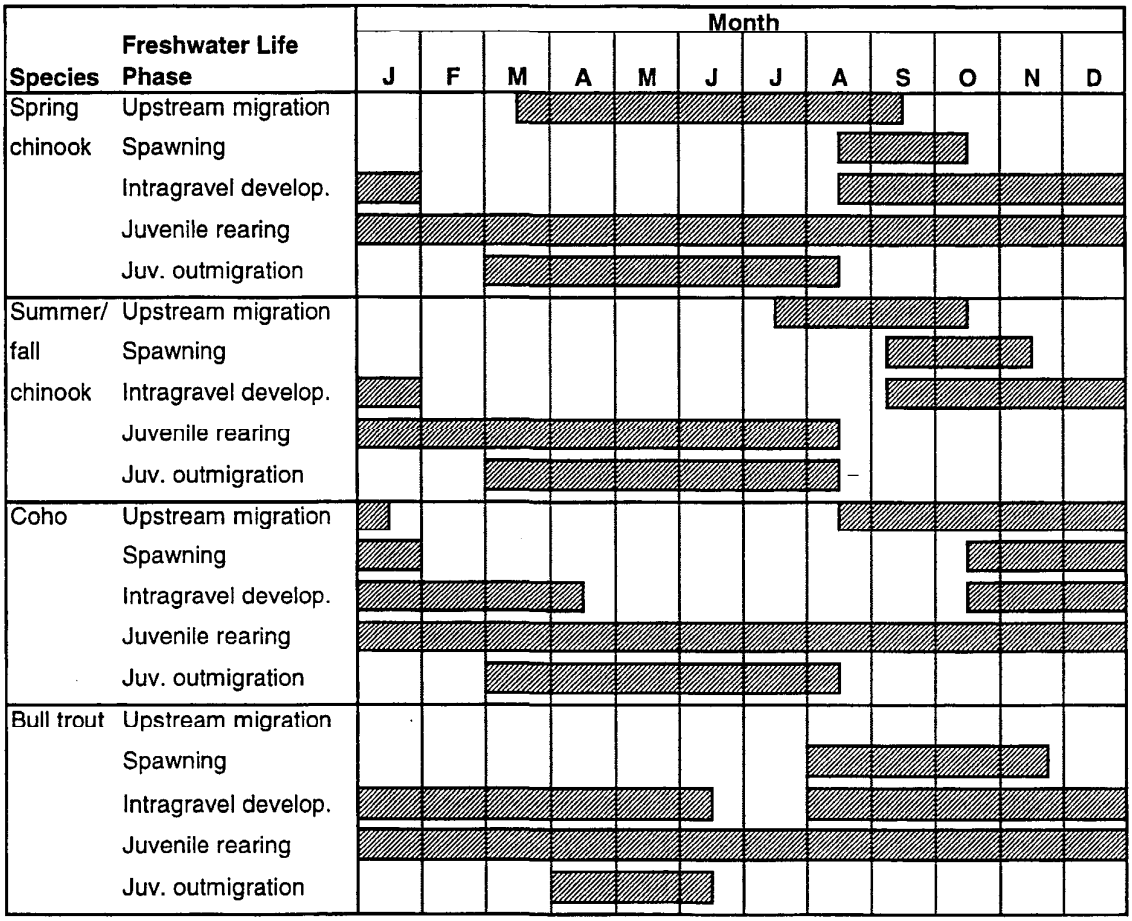
FISH HABITAT

Coho salmon and steelhead (*O. mykiss*) and cutthroat trout are the anadromous salmonid species found in Swan Creek (WDFW and WWTIT 1994, Williams et al. 1975). The timing and life history phases of each of these species are shown in Figure 4. These three species rear in fresh water for at least 1 year before migrating to saltwater; therefore, adequate summer and winter habitat is needed to ensure the survival of these salmonids. Additionally, resident cuthroat and rainbow trout may inhabit this portion of Swan creek and would benefit from enhanced, restored, and created fish habitat.

The objectives of the fish enhancement plan are as follows:

- Increase the coho and cutthroat trout spawning habitat in the Swan Creek drainage.
- Provide off-channel rearing habitat for coho salmon and cutthroat and rainbow/steelhead trout, and amphibian and invertebrate species.
- Provide increased and enhanced wetland habitat for salmonids inhabiting the lower Puyallup River system and estuary.
- Increase invertebrate production and salmonid spawning habitat in the lower reach of Swan Creek.

Figure 4 Puyallup River salmonid life history stages.



Sources: PNRBC 1970, WDFW and WWTIT 1994, City of Tacoma 1998.

- Increase public awareness of the importance of diverse salmonid habitat in stream systems by providing stewardship and educational opportunities for city and county residents.

To achieve these objectives, a meandering stream channel (Channel A) will be designed and created to provide salmonids with summer and winter rearing habitat and, potentially, spawning habitat for coho salmon and cutthroat trout in the Swan Creek drainage. Channel A will connect

the Swan Creek to the Haire Wetland, to allow fish access into this habitat. The Haire Wetland will then be connected to the lower reach of Swan Creek by a second channel (Channel B).

Enhancement work is also planned for the lower reach of Swan Creek: Two log sill structures will be installed to increase invertebrate production and provide potential spawning habitat for coho and cutthroat, and two flow-constrictor structures will be installed to flush out sediment in this section.

HYDROLOGICAL AND BIOLOGICAL CRITERIA

The proposed stream channel will be designed to provide diverse habitat for summer- and winter-rearing juvenile coho salmon and cutthroat trout. Large woody debris structures and boulder structures will be placed in the stream to provide cover. The design of Channels A and B will satisfy hydrological criteria to tolerate 100-year flood events and biological criteria necessary to facilitate fish passage and encourage the use of the channels for salmonid rearing and spawning. Based on the species of fish present in Swan Creek and the existing habitat in the Swan Creek drainage, the habitat created will most favor coho salmon and cutthroat trout. For this reason, channel design will be directed toward optimizing habitat features desirable to these species.

Included in the design elements for the fluvial fish habitat are (1) channel gradient, (2) cross-sectional area, (3) substrate (size, amount, sorting), (4) residual pool depth, (5) habitat structures, (6) velocity (estimated maximum and minimum), (7) weir heights, and (8) riparian coverage. Included in the controlling variables for these designs are (1) discharge (maximum and minimum estimated flows), (2) sediment load, and (3) topography and space. The goals of the fish habitat design include (1) maintaining an appropriate temperature range, (2) providing diverse and complex habitat, (3) maintaining sufficient flow in Swan Creek, and (3) accounting for interspecies interactions. Table 4 details criteria necessary to achieve a functional channel for spawning and rearing.

Table 4 Criteria to achieve functionality of stream channel for salmonid spawning (adults) or rearing (juveniles).

Channel Criteria	Juvenile Coho	Adult Coho	Juvenile Trout	Adult Trout
Minimum depth[1] (inches)	~ 9	~ 7.1 migration[2] ~ 7.1 spawning[2]	~ 12	~ 4.7 (migration)[2] ~ 2.4 (spawning)[2]
Maximum velocity[2] (fps)	< 1	8.04 (migration) 1 - 3 (spawning)	< 0.7	4.02 (migration) 0.25 - 2.4 (spawning)
Substrate preference[2]	Gravel to boulders (0.25 > 12 inch), size and age dependent	0.5 - 4 inch (spawning)	Gravel to boulders (0.25 > 12 inch), size and age dependent	0.24 - 4 inch (spawning)
Temperature (°C)[2]	1.7 (lower lethal) 12-14 (preferred) 26-29 (upper lethal)	7.2 - 15.6 migration 4.4 - 9.4 spawning 4.4 - 13.3 incubation	0.6 (lower lethal) 12-16 (preferred) 22.8 (upper lethal)	6.1 - 17.2 (spawning)
Dissolved oxygen (mg/liter)	> 7.75 (optimum) ≤ 6 (stressful) ≤ 3.5 (lethal)	> 5 migration and spawning[2]	> 7.75 (optimum) ≤ 6 (stressful) ≤ 3.5 (lethal)	> 5 migration and spawning[2]
Max. mean gradient (in reach length of 525 ft)	No data	7%[3]	No data	12%[3]
Cover	Standing crop linked to amount and diversity	Maximum redd distance from cover ≤ 10 ft	Standing crop linked to amount and diversity	Maximum distance of redd from cover ≤ 10 ft
Ratio of scour pool depth (SPD) to jump height (H)	SPD ≥ 1.25 x H	SPD ≥ 1.25 x H	SPD ≥ 1.25 x H	SPD ≥ 1.25 x H
Barrier height (jump at 90° angle)	0.5 ft	7.22 ft (maximum)[2] ≤ 2 ft (optimum)[4]	0.5 ft	2 ft[2] ≤ 1 ft (optimum)[4]

1 In general, channel depth to support migration and spawning must be adequate to cover the maximum body width of the migrating salmonid and is therefore highly size-dependent.

2 Bjornn and Reiser (1991).

3 SSHEAR Program 1997, as found in Thurston County barrier inventory (WDFW 1997).

4 Protocols for assessing fish passage at culverts (Burton, unpublished).

CHANNEL DESIGN AND EXCAVATION

Channel A will be excavated entirely on the former Walter Wetland (see Appendix C Sheet 3). This new channel will be excavated from Swan Creek at approximately 146 ft downstream of the Pioneer Way culvert to the inlet of the Haire Wetland, which is approximately 300 ft north and 250 ft west of the mouth of the new channel. This new channel will be designed to have a water depth of 6 to 12 inches. A weir will be installed in Swan Creek downstream

from the inlet to Channel A to ensure there is adequate flow through Swan Creek during the summer months.

The water elevation at the mouth of the channel is 13.3 ft (vertical datum is 1929 NGVD) and a weir will control water flow into the channel. The water elevation at the inlet to the Haire Wetland will be 12.5 ft and controlled by a weir. Channel B will be excavated between the Haire Wetland and Swan Creek at approximately 980 ft downstream of the Pioneer Way culvert. The elevation of this channel at the outlet of the Haire Wetland is 12.5 ft and the elevation of the inlet to Swan Creek is 10.0 ft.

Sideslopes in Channel A and B will be shaped at 3.0H:1V (see Appendix C, Sheet 4 [A]) The total length of Channel A is projected to be 530 ft, with a watershed length of 453 ft, thereby achieving a sinuosity of 1.17 (Table 5). The total length of Channel B is 43 ft, with a watershed length of 35 ft, thereby achieving a sinuosity of 1.22 (Table 5). Instream structures and habitat will be placed as described in the subsequent section.

Table 5 Channel specification summary.

	Channel A Swan Creek to Haire Wetland	Channel B Haire Wetland to Lower Swan Creek
Beginning elevation (ft)	13.3	12.5
Ending elevation (ft)	12.5	10.0
Total elevation change (ft)	0.8	2.5
Total length of channel	530 ft	43 ft
Lineal distance of channel	453 ft	35 ft
Channel slope	0.21 percent	5.8 percent
Channel sinuosity	1.17	1.22

IN-CHANNEL HABITAT DEVELOPMENT

Habitat features installed within Channel A will include six deflector log structures, five logjam structures, six rootwads, and ten large boulders (see Appendix C, Sheet 8 [1 and 3] and Sheet 9 [5]). A 1-ft-thick gravel and cobble substrate will be used in this channel and a brush mattress with an optional rock toe will be used to stabilize the banks along the channel (Figure 5). The deflector log and logjam structures and boulders are proposed along the stream at 25- to 35-ft intervals in order to provide lateral pools and cover, thereby diversifying the instream habitat (see Appendix C, Sheet 3).

Appropriately sorted spawning gravel will be placed in the streambed to create interstitial habitat for invertebrates and potential spawning and rearing habitat for cutthroat trout and coho salmon (see Appendix C, Sheet 4 [A]). It must be noted that the elevations provided in Table 5 refer to the final elevation of the channel bottom, after the channel has been filled with gravel. Gravels in the 0.25- to 3-inch size range will be used to line the bottom of all channel segments to an average depth of 1 ft (see Appendix C, Sheet 4 [A]). This depth is necessary to ensure that the gravels are usable by cutthroat and coho for spawning.

An evaluation of sediment transport capacity of the channel demonstrates that the normal range of expected flows (1 to 10 cubic feet per second [cfs]) will flush out silt and sand from the pools while leaving the spawning gravel unmodified. Ordinary high flows of 5 cfs would be sufficient to flush out 2-mm sediment and smaller (sands, silt, and clay) from the spawning gravel. An extreme flow of 50 cfs within Channel A would transport sediments up to 12 mm in diameter; thus, gravels placed within the channel would not be dislodged over the range of flows anticipated through the channel.

Habitat features installed within Channel B will include three rootwads, three weirs, and cobble and gravel substrate. Rootwads will be placed in the bank at approximately 25-ft intervals on opposite sides of the bank (see Appendix C, Sheet 3 and 8 [1]). The weirs will be made of log sections that will be 9 ft long and secured into the excavated channel by footer rocks underlying the downstream end of each log, and by backfilling over the outer 2 ft of each log (see Appendix C, Sheet 8 [2]). Log placement will create a series of step pools designed to maintain a minimum water depth of 6 to 12 inches at low-flow conditions (see Appendix C,

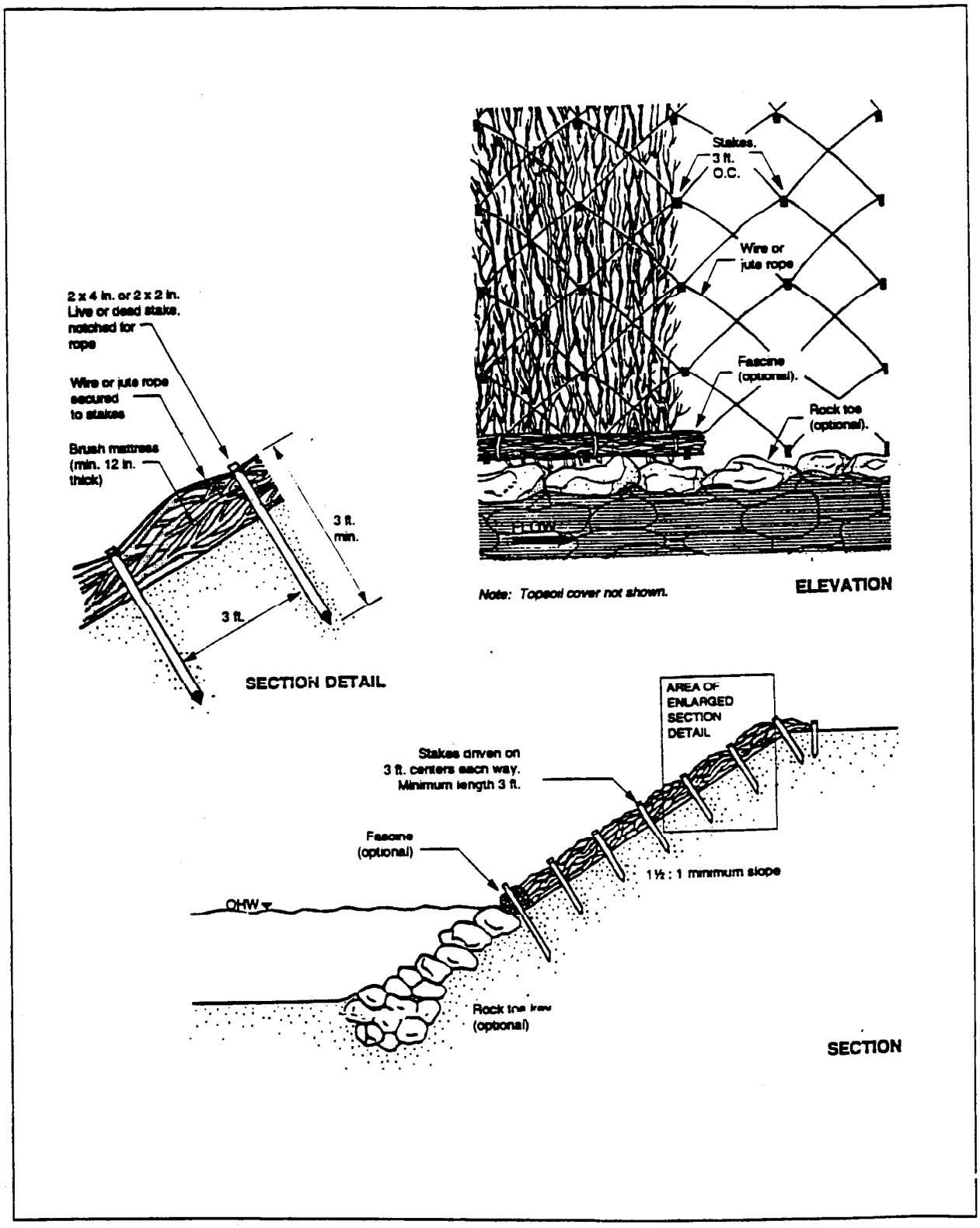


Figure 5 Installation of a brush mattress shown with an optional fascine and rock toe. (Adapted from Gray and Leiser 1982.) (From Johnson and Stypula 1993.)

Sheet 4 [D]). The logs will be placed every 10.5 ft for a total of 3 weirs. This arrangement will limit the maximum drop to approximately 4.8 inches, ensuring that none of the log structures limits fish passage for salmonid fingerlings and fry. A single layer of cobble (3 to 6 inches) will also line each step pool to provide for rearing habitat and to minimize scour. Given the necessity for cobble lining in these areas and the desire to maintain a pool depth that exceeds the mean channel depth, the initial lining with gravel in each step pool (i.e., immediately downstream of each log) will not exceed a thickness of 3 inches; the cobble will thus overlie the gravel in these areas.

Two flow-constrictor log structures will be installed in Swan Creek between 1,050 ft and 1,150 ft (distance measured from the Pioneer Way culvert) (see Appendix C, Sheet 8 [4]). These structures are designed to increase flow velocity in this reach and therefore flush out sediment. Additionally, rock of diameter 0.25 to 4 inches will be placed in the streambed to create interstitial habitat for invertebrates and potential spawning and rearing habitat for cutthroat trout and coho salmon (see Appendix CB, Sheet 9 [6]).

RIPARIAN, WETLAND, AND UPLAND HABITAT PLANTING PLAN

The goal of the proposed planting plan is to enhance the structural complexity and diversity of existing plant communities. This goal will be achieved by removing and replacing invasive species with native plants typically and historically found in palustrine wetlands and adjacent forested uplands in the Pacific Northwest region. Enhancing and restoring native plant communities will improve the natural biological support functions of both wetland and upland plant communities. In addition, the existing and created wetland complex will improve the water quality protection and flood storage and attenuation functions compared to existing conditions. Furthermore, the native plant communities are expected to provide instream and overhead cover and a source of terrestrial insects to salmonids and other fishes that use Swan Creek.

Plant Material

All material to be used will be plants native to the Northwest. Much of the native plant material will be obtained from plant nurseries. If season, weather, and soil conditions allow, bare-root plants may be used. Bare-root stock is recommended only for riparian restoration areas, including planting zones 2, 3, 4, 5, and 6. Otherwise, containerized plants will be used, except where willow, black twinberry (*Lonicera involucrata*), black cottonwood, and red-osier

dogwood live stakes are specified. To the maximum extent practicable, black cottonwood, Sitka willow, black twinberry, and red-osier dogwood cuttings will be obtained on site from locations where mature plants of these species are abundant. Collections of cuttings from on-site sources will be done by a consulting biologist or mitigation specialist to ensure that not more than one-fifth of the stems for any plant are taken and donor plants are not adversely affected. Plant substitutions may be allowed based on the recommendation of a project biologist or mitigation specialist, or by permitting agency. Substitutions also may be based in part on plant availability.

All species selected for planting are well-adapted to anticipated moisture and climate conditions, and are expected to thrive following successful establishment. Typical planting details and plant schedules (Appendix C, Sheet 6 and 7 and Appendix D) have been developed for each plant community identified in the field investigation that will be restored or enhanced. Many of the different sizes and types of plants specified in these areas have been selected because they were observed on the site or appear to be well-suited to conditions and project goals and objectives. Others were selected as species that naturally occur in native plant communities characteristic of the Puget Lowland region.

Planting Density

Spacing of trees and shrubs varies depending on planting location, vegetation zone, plant type (tree or shrub), and growth habit. Higher planting densities will be used in Zones 1, 2, and 3, which are expected to be cleared of most existing vegetation to construct the proposed off-channel habitat. Lowest densities are specified for dense, second-growth, deciduous, upland forest communities (Zones 4, 5, and portions of 6). See the typical planting details and plant schedules (Appendix C, Sheets 6 and 7 and Appendix D) for specific densities and species of plants to be used in each community.

Site Preparation

Soils within each community will be modified where necessary to maximize native plant establishment success. Decisions on whether soil amendments will be required will be determined at the time of planting by the City's consulting biologist or mitigation specialist based on whether or not the soils meet the proposed soil specification. If during excavation, it becomes apparent that soil organic matter content in any of the enhancement or restoration areas is unfavorable to native plant establishment, soils in the immediate vicinity of all bare-root,

container-stock, and rooted-cutting plantings will be amended with topsoil and mulch, as specified by the City's consulting biologist or mitigation specialist to promote successful establishment and growth. It is assumed that soil in the immediate vicinity of live-stake plantings will not need amending based on preliminary reconnaissance investigations for communities in which live stakes have been specified (see plant schedules in Appendix D).

In the new channel and reforestation areas, it may be possible to salvage some of the existing fill for use as topsoil. The City's consulting biologist or mitigation specialist will evaluate the suitability of use of fill material for topsoil during clearing and excavation. At that time, detailed evaluation of soil texture and other physical and biological characteristics of existing fill its potential use can be determined. Based on evaluation of fill material characteristics, it may be necessary to amend the existing fill material with topsoil, compost, or a mixture of the two to create a suitable medium for successful establishment of proposed plantings. Under no circumstances shall the retained or amended fill material contain large clods, rocks, litter or construction debris after it has been placed, and final grade completed. All large clods, rocks, litter, and construction debris shall be removed and disposed of off site by the contractor.

Clearing, grading, and any soil amendments of the offchannel and wetland enhancement areas (Zones 1, 2 and 7) shall not occur when the ground is frozen or excessively wet. Following installation of bare root or containerized plants, a 3- to 4-inch layer of medium-fine bark mulch, compost, or equivalent material will be applied within a 2- to 4-ft radius of each shrub and tree, respectively. This material shall be layered and placed around each plant so that a shallow well is created and no mulch touches the stem of the plant. This will prevent root crown and stem rot that may occur when mulch material is in direct contact with the stem. Mulch will also improve soil moisture retention capacity and help control establishment or regrowth of invasive species.

Trees and shrubs in all proposed planting zones will be planted as indicated in planting details. If necessary, based on the determination of the City's consulting biologist or mitigation specialist, soil in which trees and shrubs will be planted shall be amended as specified. At a minimum, the soil to a depth of 4 to 6 inches below the rootball of the bare-root, container-stock, and rooted-cutting plantings will be scarified and loosened.

Unless otherwise specified by the City's consulting biologist or mitigation specialist at the time of plant installation, fertilizer use in the offchannel and wetland enhancement areas in

Zones 1, 2, and 7 shall be avoided to prevent potential eutrophication problems in Swan Creek and the Puyallup River. In the upland areas (Zones 3, 4, 5, and 6) potential fertilizer use, such as tablets or time release granules may be used based on the recommendation of the City's consulting biologist or mitigation specialist as determined during plant installation. In all cases, any such fertilizer use will conform to the manufacturer's directions and specifications. Under no circumstances will fertilizer be broadcast onto the soil surface in any of the habitat restoration areas.

Non-Native and Invasive Plant Species Control

Non-native and invasive species, including Himalayan blackberry and reed canarygrass, will be removed by hand or a combination of hand-removal and spot herbicide application. If herbicides are used, only a glyphosate-based herbicide approved for use in aquatic environments by the Washington State Department of Ecology will be used and only in accordance with all applicable manufacturer specifications and with proper approvals. Wherever possible, hand-shoveling will be used, to remove above- and below-ground portions of non-native and invasive plants, especially for rhizomatous species like reed canarygrass and Himalayan blackberry. This method more effectively suppresses re-establishment or regrowth by removing rhizomes that otherwise will resprout to form new above-ground biomass. Non-native plants, including roots, rhizomes, and attached soil, shall be disposed of off-site at a licensed sanitary landfill or composting facility. Native trees and shrubs will be planted where non-native and invasive species have been removed. Establishment of native trees and shrubs will help to further prevent the re-establishment of non-native species. English ivy shall be removed or the stems cut on any of the black cottonwoods that are saved.

Proposed Native Plant Community Enhancements

Below are the descriptions of the proposed enhancement within each community to be enhanced. The general limits of the enhancement and restoration within each community are shown in Appendix C, Sheets 6 and 7. Limited enhancement is proposed within Community E, as described below. No enhancement is proposed in Communities B and F. As indicated in the sections below, detailed plans for each community are shown in the typical planting details, typical sections, and plant schedules (Appendix C, Sheets 6 and 7).

Community A

Prior to introducing native plants, all invasive species will be removed, including cherry laurel, Scot's broom, Himalayan blackberry, one-seeded hawthorn, and English ivy. A bulldozer or other excavator will be used to remove most of these species. To the maximum extent practicable, mature black cottonwoods and existing snags will be saved. English ivy will be removed (or a section of the stems removed to kill the plant) from all of the infested black cottonwoods that can be saved. Those snags and trees that cannot be saved will be used as habitat features in Community B, the constructed channel, or other communities on the site.

Zones 1, 2, 3, 4 and 6 are located upslope of the constructed channel in adjacent uplands. Shrubs, arborescent shrubs, and trees will be planted in these zones, including Pacific ninebark (*Physocarpus capitatus*), Pacific willow, Western crabapple (*Malus fusca*), Oregon ash (*Fraxinus latifolia*), black cottonwood, Sitka spruce (*Picea sitchensis*) and western red cedar (*Thuja plicata*). Pacific willow, Pacific ninebark, and Oregon ash will be planted in wetter areas along the constructed channel in Zones 1 and 2, which are expected to remain relatively moist as a result of capillary action. A three-tiered structure will be created as follows: shrubs will generally be placed in Zone 1 near the toe of the slope. Deciduous trees, including Oregon ash and Pacific willow will be planted at and near the border of Zones 1 and 2 as shown in the planting detail and typical section. Cottonwood and conifers will be planted in upslope areas in Zones 2, 3, and 4 to provide shading and bank stability (see planting detail for Communities A, C, and D and these zones). Together these plantings will create a more structurally diverse assemblage of native plants that provide breeding, feeding, and resting opportunities to many species of wildlife typically found in the western Washington. All of the species specified in these planting details are typically found in lowland wetland and upland plant communities in western Washington. Spacing and densities of plants specified in the planting schedules for Community A are typical of those observed in plant communities within the Puget Sound region.

Constructed Stream Channel Zones (1 and 2)—As shown in Appendix C, Sheet 5, the channel will be constructed to connect Swan Creek and the Haire Wetland. Two planting zones will be established in the constructed channel (Zone 1 and Zone 2). Zone 1 will extend from the OHWM upslope to about midbank. Zone 2 will extend from near the middle of the streambank to the top of bank as shown in the planting detail and typical section for Zones 1 and 2. A combination of shrubs and trees will be used to create a mosaic of shrub and forest communities

in these zones. Shrubs and trees often associated with streams and wetlands that are widely recognized for their rapid growth and bank stabilization characteristics have been selected for Zone 1, including red-osier dogwood, black twinberry, Pacific ninebark, Hooker willow (*Salix hookerina*), and Pacific willow. These species will provide bank stability and overhead cover relatively rapidly. Shrubs and trees selected for Zone 2 were selected in part for their rapid growth characteristics, as well as their tolerance of summer drought and growth forms. Snowberry, red elderberry (*Sambucus racemosa*), and vine maple (*Acer circinatum*) will form three tiers of shrub vegetation beneath the mixed deciduous and coniferous forest canopy formed by red alder, Oregon ash, Sitka spruce, Douglas fir, and western hemlock (*Tsuga heterophylla*). Berries and seeds of these species will provide food for a variety of wildlife and the vegetation will provide cover. Trees in Zone 2 will provide a future potential source of LWD to the channel.

South of the Constructed Channel—An approximately 1-acre upland area (Zone 6) will be converted from primarily driveways, existing deciduous forest, and invasive species to a mixed deciduous and evergreen riparian forest. It is assumed that about one-third of this area will be totally cleared and may be used to stockpile construction materials and equipment and as a staging area for constructing the new channel, and about two-thirds of this area will remain covered by the existing deciduous forest of black cottonwood. Prior to using this area for these purposes, all invasive vegetation will be removed. Mature black cottonwoods will be saved wherever possible in this area.

Because much of the area south of the new channel will be cleared of vegetation, it will have to be more densely planted to prevent regrowth and spread of invasive species. The forest stand structure has been built around retention of existing black cottonwood trees. A mixture of deciduous and evergreen trees will be used to establish a multiple layered forest canopy. Douglas fir, western red cedar, big-leaf maple, and western hemlock will be used in the more open areas now occupied by buildings, meadow vegetation, and driveways. Areas in between trees will be planted with a mixture of hazelnut (*Corylus cornuta*), salal (*Gaultheria shallon*), and oceanspray (*Holodiscus discolor*) as shown in the typical sun planting detail for this area. A more shade-tolerant community will be created beneath the existing black cottonwood canopy. Shade-tolerant trees, including western red cedar, western hemlock, madrone (*Arbutus menziesii*), and big-leaf maple, will be planted beneath the cottonwood canopy. In addition, a mixture of evergreen huckleberry (*Vaccinium ovatum*), salal, vine maple, and swordfern

(*Polystichum munitum*)will be planted around and in between groups of evergreen trees as shown in the typical shade planting detail for this area. As shown in the plant schedule for Zone 6, a variety of ages (sizes) of trees will be used to create a more diverse stand structure and habitat.

Zone 3 (Public Access Zone)—This community will border the public access trail, the mixed deciduous and coniferous forest in Zone 6, and Swan Creek. The assemblage of plants selected for this community provides different food and cover opportunities to wildlife than other community types, is aesthetically pleasing, and will deter people from trampling the banks of Swan Creek. Several species of trees and shrubs produce fruit eaten by wildlife commonly found in the Puget Sound region. Armed species, including Nootka rose (*Rosa nutkana*), Douglas hawthorn (*Crataegus douglasii*), and western crabapple, form dense thickets that will deter access to the newly constructed channel and west bank of Swan Creek. As with other communities, a mixture of different sizes of trees and shrubs will be used to create greater habitat and structural diversity (see Plant Material Schedule Community A – Zone 3). These species also will enhance existing overhead cover, provide better shade, and more breeding, feeding, and rearing opportunities of fish and wildlife than now exist along this reach of the creek.

Community B

No enhancement is proposed in this area, which contains dense shrub and deciduous forest communities around its perimeter. This area is a good source of willow, red-osier dogwood, black twinberry, and cottonwood cuttings that will be used for enhancing vegetation in Communities E and G (Zone 7) as well as in the Constructed Stream Channel (Zones 1 and 2).

Although no plantings will be done in this community, large logs or stumps with rootwads attached may be placed in selected locations. Black cottonwoods and other trees cleared to constructed the public access and constructed channel may be salvaged and placed in the Haire Wetland or used for LWD in the constructed channel. Logs will be installed by either mechanized equipment through areas in either Communities C or D cleared of invasive species (e.g., Himalayan blackberry), or possibly lowered in by helicopter. In no circumstances will access roads to the wetland be constructed so that track hoes or other equipment can place logs in the wetland. The logs and stumps will enhance habitat quality by providing resting areas and foraging habitat for frogs, reptiles, birds, and small mammals. As these features decompose,

they also may provide breeding habitat for various species of wildlife, including woodpeckers, mice and voles, salamanders, and garter snakes.

Communities C and D

Reforestation will occur in Zones 3, 4, 5, and 6 within Communities A, C and D. Following removal of dense thickets of Himalayan blackberry, coniferous trees, including Douglas fir, Western hemlock, grand fir, western red cedar, and Sitka spruce, will be planted within the existing deciduous forest. Zone 4 is the area adjacent to the wetland and extends upslope to approximately the 20-ft contour (see Figure 2). This zone is expected to be somewhat more mesic (wetter) habitat than Zone 5, which is located upslope. Sitka spruce and western red cedar, which are shade-tolerant and will tolerate moister soil conditions, will be placed in Zone 4. Douglas fir, western hemlock, and grand fir (*Abies grandis*) will be planted in Zone 5. Douglas fir, which is shade-intolerant, will be planted only in areas where the deciduous forest canopy is more open. Western hemlock and grand fir, which are shade-tolerant will be planted in areas beneath the denser deciduous forest canopy. Conifers will be planted in both zones in small groups and as scattered individuals. To simulate the multiple-tiered and age structures of naturally regenerated forests, different ages and sizes of conifers will be planted as specified in the plant schedules for Zones 4 and 5 (see Appendix D, Plant Materials Schedule). This will contribute to greater habitat diversity in forest stand structure by creating small stands of conifers of mixed ages and heights as well individual conifers amidst stands of deciduous trees. In addition, the shade that the conifer stands will provide will help control the spread of invasive species, particularly Himalayan blackberry and Scot's broom, which are generally shade-intolerant.

Community E

A limited amount of enhancement will occur in Community E. Cuttings of shrubs collected on site will be planted on both banks of Swan Creek near to where it exits the property. Prior to planting these areas, similar to that shown in the typical detail for Constructed Stream Channel Zone 1, the reed canarygrass will be removed by hand. Where reed canarygrass has been removed, groups of live stakes of Sitka willow, red-osier dogwood, and black cottonwood will be planted to create a dense scrub-shrub and forested wetland community that will shade out the reed canarygrass. Sources of cuttings will include plants from Communities B and F.

Community F

No enhancement is proposed in this area, which contains dense scrub-shrub and deciduous forest vegetation. This area is a good source of willow, red-osier dogwood, black twinberry, and cottonwood cuttings.

Community G

Sitka willow, black cottonwood, red-osier dogwoods, and Oregon ash will be installed in this community. Plants will be in the form of both cuttings and container stock as shown in the typical planting detail for Zone 7. Above- and below-ground portions of reed canarygrass will be removed entirely within 4-ft-diameter circles evenly distributed across the community. Removal will be achieved by hand-shoveling. The intent of this planting method is to grow trees and shrubs that will eventually shade out the reed canarygrass.

SUMMARY

This project will provide approximately 2,249 ft^2 of instream rearing habitat for all species of juvenile salmonids, and spawning habitat for adult coho and cutthroat trout. A detailed list of materials required for construction of the two new channels is shown in Table 6.

The combined enhancement and restoration activities will improve over 5.8 acres of fish and wildlife habitat, including the following:

- 4.3 acres of riparian forest will be restored or enhanced.
- Provide access to 3 acres of existing wetlands for salmonid rearing habitat.

Table 6 Summary of construction materials.

Item Description	Approximate Quantity	Units
Earth work	6,200	Yd^3
Streambed gravel (0.25- to 3-inch-diameter stone)	65	Yd^3
Cobbles (3- to 6-inch-diameter stone)	10	Yd^3
Boulders (12- to 18-inch-diameter stone)	10	Each
Logs for log weirs (9-ft length x 16-18-inch diameter)	6	Each
Logs for log sill, deflector log and channel constrictor structures (10- to 20-ft length x 12- to 18-inch diameter)	30	Each
Logs for log jam and deflector log structures (5-ft length x 10- to 12-inch diameter)	16	Each
Logs for log jam and deflector log structures (3-ft length x 10-to12-inch diameter)	10	Each
Rootwads 6-ft length x 12- to 18-inch diameter	6	Each
Jute matting	11,460	Ft^2
Hydroseed	0.50	Acres
Live stakes	100	Each

The project includes removal and control of over 1.8 acres of invasive species in five different areas that now provide limited habitat value. In addition, about 0.5 acre of habitat will be created where very little or no habitat currently exists. Proposed restoration activities will remove about 0.5 acre of existing driveways, buildings, and invasive or ornamental plants in previously filled areas of the site.

REFERENCES

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