A Beaver Habitat Enhancement Proposal for Sapp Road Park

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Executive Summary

Sapp Road Park is an open space in Tumwater, Washington featuring restored forest and open wetlands along Percival Creek. Although the site supports a variety of native plants and animals, significant portions of the wetland are dominated by invasive reed canary grass (*Phalaris arundinacea*) and yellow flag iris (*Iris pseudacorus*). These species outcompete native wetland plants and limit the habitat available to native animals, resulting in lower biodiversity (Molofsky 2004, King County 2020). This habitat enhancement plan proposes to increase biodiversity and improve wetland functions at Sapp Road Park by focusing on enhancing habitat for one very impactful species, the American beaver (*Castor canadensis*). A resident dam-building beaver population and its associated pond and wetlands could bring numerous ecological benefits:

- Beaver ponds have **higher biodiversity** than non-beaver ponds or streams (Nummi et al. 2019)
- Beaver dams help **improve water quality** while dampening the effects of climate warming induced hydrologic changes (Dewey et al. 2022)
- Beaver dams attenuate stream flow, **decreasing flash-flooding** (Puttock et al. 2020)
- Natural beaver dams and beaver dam analogs (BDAs) can **benefit anadromous fish, such as salmon** (Bouwes et al. 2016)
- Prolonged inundation (which a consistently maintained beaver dam or series of dams may cause) can **decrease a population of reed canary grass** (Jenkins 2008)

The approach proposed in this paper is to plant beaver-favored native plant species in a way that is ecologically appropriate for the site, attracts beavers to take up residence there, and provides a sustainable source of food which makes long-term residence possible. The planting plan focuses on three native tree species: Black cottonwood (*Populus balsamifera* subsp. *trichocarpa*), Pacific willow (*Salix lasiandra*), and Sitka willow (*Salix sitchensis*). These species are favored forage for beavers (Vanderhoof 2020) and are already present at Sapp Road Park, but not in great abundance. All three of these species readily re-sprout after cutting, making them ideal renewable sources of food for beavers. To ensure that the plants are not completely eaten before their roots are established, this plan recommends protecting them with fencing, and then gradually removing that fencing over the course of several years. A concurrent experimental approach of planting coppiced trees (trees cut down to a stump and allowed to re-sprout) without protection will also be explored. If effective, this method could be used to plant beaver-favored trees without the need for fencing, which would provide an immediate food source that survives herbivory.

I. Introduction

Sapp Road Park is a publicly accessible but largely undeveloped park owned by the City of Tumwater. It contains emergent and forested wetlands along the banks of Percival Creek, a salmon-bearing stream which flows into Capitol Lake in Olympia. Before its ownership was transferred to the City of Olympia, Sapp Road Park was farmed, and much of the flat land along the banks of Percival Creek was pasture for grazing livestock. Since 1998, the end of farming along with sporadic restoration activities carried out by the City of Tumwater have helped the site become more naturalistic.

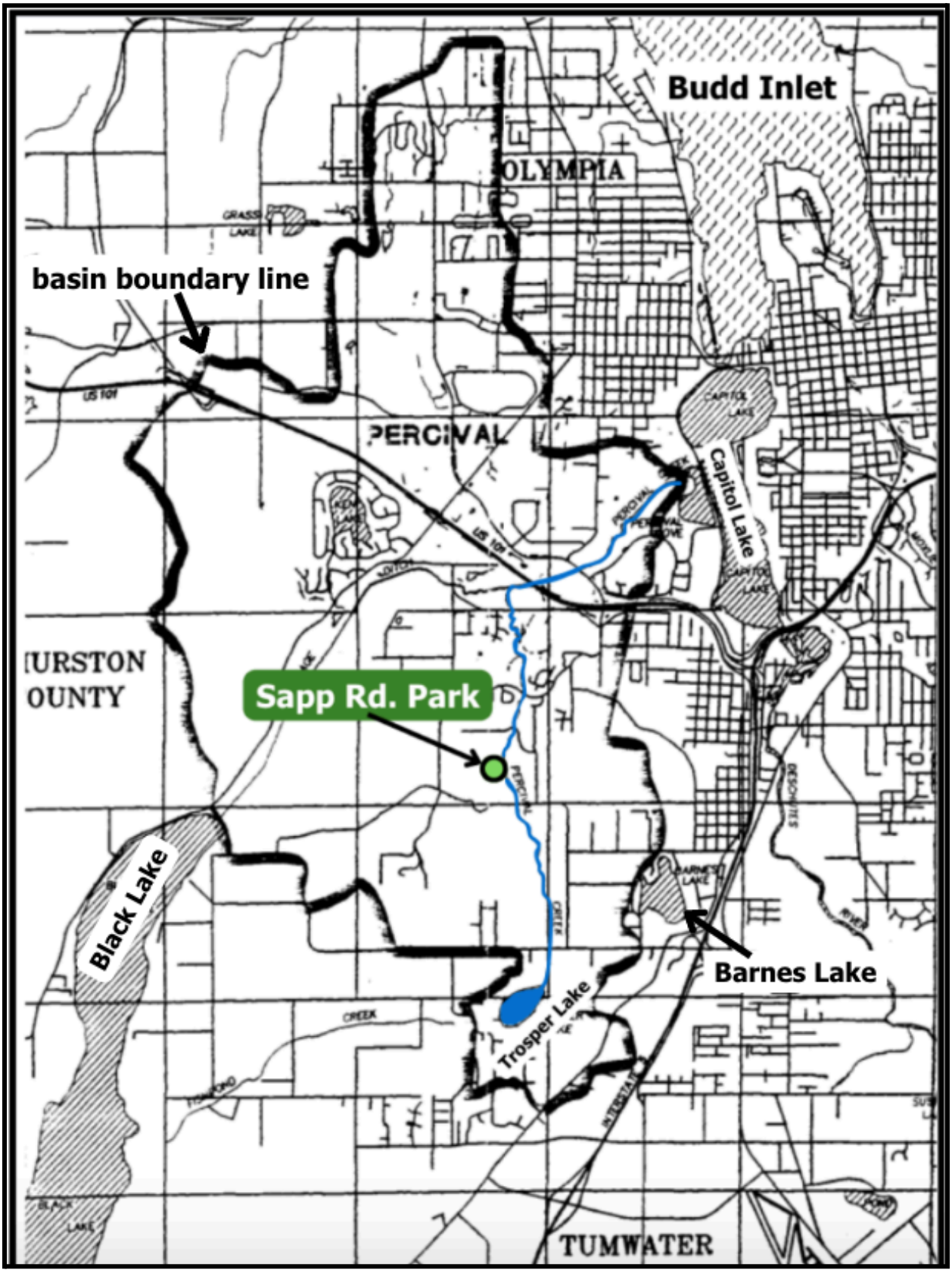
In its current state, the wetland has many beneficial ecological functions. The small forested portions of the wetland (with mature trees which do not seem to have been cleared for pasture) have impressive native plant diversity. The site has decent habitat complexity, with patches of willow scrub-shrub and a few large snags intermixed with emergent wetland. There is a sizable portion of the emergent wetland which is uniquely dominated by native sedges (*Carex spp.*) rather than reed canary grass. However, like many wetlands in western Washington that have been heavily disturbed by human activities, it has a significant invasive plant presence. Reed canary grass (*Phalaris arundinacea*) dominates the great majority of the emergent wetland areas and yellow flag iris (*Iris pseudacorus*) is abundant along the banks of the creek. These invasive plant species can be thought of as ecosystem engineers. They change the shape and composition of streams and wetlands while lowering the diversity of native plant and animal species that can inhabit sites where they predominate (Molofsky 2004, King County 2020). Because of these invasive species, the Sapp Road Park wetland's function as habitat for diverse species is not all that it could be. However, there is another ecosystem engineer, native to North America, which is capable of altering its environment in a way that increases habitat heterogeneity and biodiversity – the American beaver, *Castor canadensis* (Stringer 2015).

There is plenty of evidence that beavers live just upstream of the site, but none are currently building dams or lodges within Sapp Road Park. If beaver habitat can be improved by planting a sustainable source of beaver-favored forage plants, it may encourage beavers to take up residence on the site. A resident, dam-maintaining beaver population with a sustainable food source could not only increase habitat for a more diverse array of native plant and animal species, it may also suppress the growth of reed canary grass through prolonged inundation.

Location: Sapp Road Park is located in Tumwater, Washington; northeast of Black Lake and southwest of Olympia (***see Fig. 1***). It is in the Deschutes River Watershed (WRIA 13), within a sub-basin called the Percival Creek Basin **(*see Fig. 2*).**

Figure 1 - Site Location in WRIA 13 - Deschutes River Watershed

Figure 2 - Percival Creek Basin (*Percival Creek is shown in blue*)



Formation and Geologic History of the Percival Creek Basin

The Percival Creek Basin came into being by the activity of glaciers advancing from and receding back to the Puget Sound area. This glacial activity resulted in the deposition of highly-compacted, low-permeability glacial till as well as more permeable glacial outwash material throughout the basin. (City of Olympia Public Works 1993). When the last glacier retreated out of the area around 16,850 years ago, its meltwaters deposited a highly-permeable layer of sandy outwash which underlies the Sapp Road Park wetland today. (WA DNR 2003).

II. Methods

The following methods were used to characterize the Sapp Road Park wetland, determine its boundary, and assess its quality as habitat for beavers.

Pre-field Methods

Before making a field visit to Sapp Road Park, the following resources were used to gain an initial understanding of the potential wetland boundaries, soils, and historical land changes on the site:

- National Wetlands Inventory (NWI) Wetlands Mapper (NFWS 2023)
- Thurston Geodata - Thurston Wetlands Map (Thurston County 2023)
- Web Soil Survey (NRCS 2023)
- Google Earth Pro Historical Aerial Photos (Google Earth 2023)

Field Methods for Wetland Determination

The first field investigation was conducted on December 15, 2023 by the author (Phil Harris), Nick Baker, Dash Paulson, Chaz Hastings, and Grant Gilmore. The wetland boundary was determined following the protocol outlined in the *U.S. Army Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (Environmental Laboratory 2010). The continuous boundary line for the whole site was extrapolated from the combined observations of the location of hydrophytic and upland vegetation, topography, and visible indicators of hydrology during a perimeter walk of the wetland. The site was visited several more times in March and April 2024 to observe plant species when they are more definitively identifiable during leaf-out and flowering.

Wetland Rating

The wetland within Sapp Road Park was rated using the Washington Tool for Online Rating (WATOR), which is based on the Washington State Wetland Rating System (Ecology 2024). Wetland areas along Percival Creek south of the Sapp Road culvert and north of the park boundary were not included in this rating.

Beaver Habitat Assessment

The guiding document used to determine Sapp Road Park's suitability as beaver habitat (in terms of geomorphology and vegetation) was King County's *Planning for Beavers Manual: Anticipating Beavers when Designing Restoration Projects* (Vanderhoof 2022)

How Geomorphology Conducive to Beaver Dam Construction Was Measured

- The **stream gradient** of Percival Creek within Sapp Road Park was calculated using the Thurston 2ft elevation contours map layer and the measuring tool in ArcGIS Online. The highest elevation of the stream within the park was subtracted from the lowest elevation (rise). This change in elevation was then divided by the length of the stream (run) in this section of the creek (this length was determined by tracing the stream's path in a recent aerial photo with the ArcGIS Online measuring tool).
- **Stream width** was measured with a tape measure in several spots along the creek's course within the park by Dash Paulson during a field visit.
- **Valley width** was measured as the distance between points of highest elevation running parallel to the creek. The points of highest elevation on either side of the creek were determined from the ArcGIS Online topographic base map and the distance was measured using the measuring tool.

Vegetation Suitability for Beavers and Signs of Beaver Activity

The site was visited by the author (Phil Harris) on March 16 and April 19, 2024 to observe the location and abundance of beaver-favored plants in Sapp Road Park, as well as signs of current and past beaver activity.

III. Results

Wetland Characteristics

Hydrogeomorphic (HGM) Class

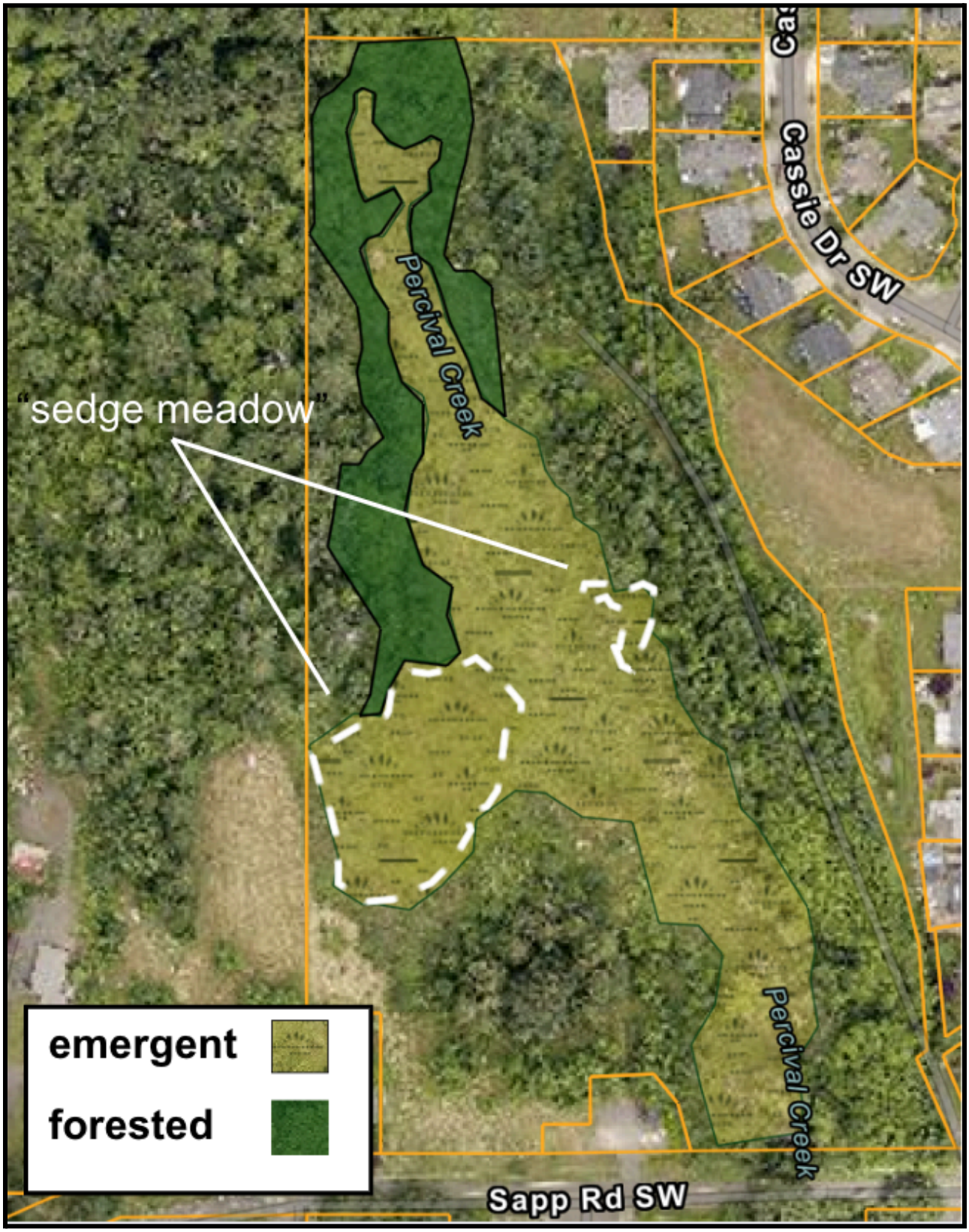
The main source of hydrology for the Sapp Road Park wetland is Percival Creek, and as such, it would be classified as **riverine** in the Hydrogeomorphic (HGM) system (Brinson 1993).

Hydrophytic Vegetation

Sapp Road Park contains two Cowardin wetland classes: **palustrine emergent** and **palustrine forested** (Cowardin 1979). A swath of **emergent** wetland follows the general course of Percival Creek, and this portion of the wetland is dominated by invasive reed canary grass (*Phalaris arundinacea*). Clusters of invasive yellow flag iris (*Iris pseudacorus*) line the banks of the creek. There are two sections of the emergent wetland which are dominated by native slough sedge (*Carex obnupta*) instead of reed canary grass, and these will be called the “sedge meadows”. The largest sedge meadow sits in a circular depression to the west of the creek. Near the north end of the parcel, the wetland is **forested**. (***see Fig. 3***)

*(For a full list of plant species observed throughout the site see **Appendix A - Plant List.** For vegetation observed around the wetland and upland soil pits dug during site visits, see **Appendix C - Wetland Determination Forms.**)*

Figure 3 - Cowardin Classes and Sedge Meadow Locations at Sapp Road Park



Soils

Web Soil Survey

The NRCS Web Soil Survey (NRCS 2024) maps the following soil types in the Sapp Road Park parcel:

- **Giles silt loam**

  Typical profile:

  H1 - 0 to 10 inches: silt loam
  H2 - 10 to 48 inches: silt loam

- **McKenna gravelly silt loam**

  Typical profile:

  H1 - 0 to 9 inches: gravelly silt loam
  H2 - 9 to 13 inches: gravelly silt loam
  H3 - 13 to 36 inches: very gravelly loam

In Web Soil Survey, **Giles silt loam** is described as **well-drained** and **non-hydric** while the **McKenna gravelly silt loam** is classed as **poorly drained** and **hydric**. Within the parcel, the reed canary grass -dominated emergent wetland beside the creek is mostly underlain by the well-drained **Giles silt loam**, while the native plant -dominated forested wetland and the large sedge meadow are almost coterminous with the poorly drained **McKenna gravelly silt loam.** (***see Appendix C, Map 1 - Soils***)

Field Observations of Soils

During a site visit on December 15, 2023, the author (Phil Harris) and Nick Baker dug two soil pits, **one in the emergent wetland**, and **one in the nearby upland.** (***see Appendix B, Map 2 - Soil Pit Locations***)

Soil characteristics observed in pits

(***see Appendix C: Wetland Determination Forms for more detailed information***)

Pit 1 - Wetland
Surface to 7" depth: Dark gray-brown sandy loam
7" to 12" depth: Lighter gray-brown loamy sand with redox features (iron concentrations)
12" to 15" depth: Light gray silt loam with redox features (pore linings)

Hydric soil indicators: Depleted Matrix (USDA 2016)

Pit 2 - Upland
Dark yellowish-brown silty loam from the surface to a depth of 12 inches

No hydric soil indicators present

Hydrology

The primary source of hydrology for the Sapp Road Park wetland is Percival Creek. Percival Creek originates at Trosper Lake and flows north through the Percival Creek Basin. After the creek passes through the Sapp Road Park wetland, it meets with Black Lake Ditch, and the combined waters flow into Capitol Lake in Olympia. (***see Fig. 2 above***)

Field Observations of Hydrology

Free water was observed at a depth of 11 inches in the **wetland soil pit 1,** indicating a **high water table. (*see Appendix B, Map 2 for Soil Pit 1 location*)**

Other noteworthy hydrological characteristics

- This wetland is mapped by Thurston County as a **Critical Aquifer Recharge Area.** (Thurston GeoData 2024)
- The southernmost portion of Sapp Road Park, where Percival Creek meets the Sapp Road culvert, is identified as a **High Groundwater Flood Hazard Area**, meaning that "flooding occurs as a result of subsurface geologic conditions that prevent recharging water from moving downward or laterally as fast as it enters the groundwater system.The result is a rise in the ground water table and accumulation of surfacing ground water…" (Thurston County 2024)

  (***see Appendix B, Map 3 - High Groundwater Flood Hazard Areas***)

Land Use

Current land use

Sapp Road Park itself is set aside by the City of Tumwater as open space, but is surrounded by residential areas. These residential areas are zoned as “Residential / Sensitive Resource” which means the area is meant to have low-density housing (a maximum of four dwelling-units per acre) compatible with the area’s open-space character and environmental sensitivity. (Tumwater Municipal Code Chapter 18.08.)

Historical land use

Before it was owned by the City of Tumwater, this land was used for agriculture. Historical aerial photos show uniform fields of grass on the site before the 1990s, and old barbed wire fences can be found along the edges of the property.

Wetland Rating

The Sapp Road Park wetland was determined to be a **Category II wetland**. It has a high ability to improve water quality on a landscape scale, and this water quality improvement is valuable to humans. It has a middling ability to improve water quality on-site. Its hydrologic functions (such as flood attenuation) are high on the landscape scale, medium on-site, but these hydrologic functions score low in terms of value specifically to humans. Although on-site habitat function is relatively low, the wetland adds to overall habitat connectivity in the landscape and is mapped as priority habitat for several species of bats (WDFW 2024). Percival Creek is also mapped as habitat for threatened Puget Chinook salmon (*Oncorhynchus tshawytscha*) (NOAA 2024), and this wetland is within the known range of the threatened Oregon Spotted Frog (*Rana pretiosa*) (USFWS 2024).

Figure 4 - Wetland Function Scores

FUNCTION	Improving Water Quality	Hydrologic	Habitat	
Site Potential	**M**	**M**	**L**	
Landscape Potential	**H**	**H**	**M**	
Value	**H**	**L**	**H**	**Total**
Score Based on Ratings	**8**	**6**	**6**	**20**

*Detailed **wetland rating forms** can be found in **Appendix E***
Maps** associated with wetland ratings can be found in **Appendix F

Regulatory Setting

Federal Regulations

The subject wetland has a continuous surface connection with Percival Creek, a relatively permanent water which flows into Capitol Lake, which is itself connected to the navigable Budd Inlet by a small outlet at the 5th Avenue dam (US EPA 2024). For this reason, the wetland would likely be regulated by the **United States Army Corps of Engineers** as a Water of The United States (WOTUS), as per the **Clean Water Act - Section 404** (33 U.S.C. § 404)

Several species protected by the **Endangered Species Act** (16 U.S.C. §§1531-1544) could potentially inhabit or otherwise depend on the Sapp Road Park wetland. The site is within the known range of the threatened Oregon spotted frog (*Rana pretiosa*) which is regulated by the **United States Fish & Wildlife Service** (USFWS 2024). The Deschutes River watershed, which contains the subject wetland and Percival Creek, is mapped by NOAA Fisheries' Essential Fish Habitat Mapper as **Essential Fish Habitat** (EFH) for the Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) (NOAA 2024). Chinook salmon (*O. tshawytscha*) is a threatened species whose habitat is protected by the Endangered Species Act, and coho salmon (*O. kisutch*) is a "harvestable" species whose habitat is protected by the the **Magnuson-Stevens Act** (16 U.S.C. §§ 1801-1884). Both of these anadromous fish species are regulated by the **National Marine Fisheries Service** (NMFS).

State Regulations

As the wetland would likely be federally regulated as a WOTUS, activities on this site would require a **Clean Water Act Section 401** (33 U.S.C. § 401) **Water Quality Certification** from the **Washington State Department of Ecology**. Any state or local government action or decision would need an environmental review in accordance with the **State Environmental Policy Act** (RCW 43.21c). If the wetland was not under federal jurisdiction, it would still be regulated by the state via the **Water Pollution Control Act** (RCW 90.48.030). As Thurston County is a coastal county, a federal permit for activity in the wetland would have to be certified consistent with the **Coastal Zone Management Act** (16 U.S.C. §§ 1451 et seq.) by **Ecology**. If a modification was to be made to Percival Creek– **such as the installation of a pond leveler or the notching of a beaver dam**, a **Hydraulic Project Approval** (RCW 77.55) would need to be obtained from the **Washington Department of Fish and Wildlife**.

State Statutes Related to Local Regulations

The upper reaches of Percival Creek and the Sapp Road Park wetland are not considered “shoreline environment” (City of Tumwater, 2019, Appendix A), so it is not regulated under the **Shoreline Management Act** (RCW 90.58). The City of Tumwater is one of the fast-growing municipalities required by the **Growth Management Act** (RCW 36.70a) to regulate wetlands within its jurisdiction.

Local Regulations

City of Tumwater Municipal Code Regulations Pertaining To This Site

- **Title 16 - Environment**
    - **Chapter 16.28 - Wetland Protection Standards**
    - **Chapter 16.32 - Fish and Wildlife Habitat Protection**
    - **Chapter 16.24 - Aquifer Protection Standards**

Wetland Rating and Buffer

According to **Tumwater Municipal Code 16.28.090**, “Wetlands shall be rated according to: (A) the Washington State Wetland Rating System for Western Washington: 2014 Update…”

Following the protocol for the Washington State Wetland Rating System for Western Washington: 2014 Update (Hruby 2014), the subject wetland was determined to have a rating of **Category II**, with an **overall score of 20** and a **habitat score of 6**. In the City of Tumwater, a wetland with these scores is required to have a buffer width dependent on the impact of planned land use: Low - 75 ft; Moderate - 110 ft; High - 150 ft. (TMC 16.28.170) This is in full agreement with the buffer widths recommended by Ecology (Ecology 2014).

Permit Summary

Permit / Approval	Implementing Agency	Applicability
FEDERAL		
Clean Water Act - Section 404 Permit	U.S. Army Corps of Engineers	If WOTUS, dredging or filling a wetland will require a permit
STATE		
Clean Water Act - Section 401 Water Quality Certification	Washington State Department of **Ecology**	If WOTUS, activities will require Section 401 Water Quality Certification
Hydraulic Project Approval (HPA)	Washington Department of **Fish and Wildlife**	If a modification is to be made to Percival Creek, HPA is needed
Construction Stormwater General Permit	Washington State Department of **Ecology**	If the project disturbs one or more acres of land
Coastal Zone Management Act (CZMA)	Washington State Department of **Ecology**	A federally permitted activity would need to be certified consistent with CZMA
Water Pollution Control Act (WPCA)	Washington State Department of **Ecology**	If the project discharges waste into waters of the state
LOCAL		
City of Tumwater Wetland Permit	**City of Tumwater**	"A permit shall be obtained from the city prior to undertaking the following activities in a regulated wetland or its buffer unless authorized by TMC 16.28.110..." (TMC 16.28.100)
SEPA Environmental Checklist	**City of Tumwater**	"Any person proposing to develop in the incorporated limits of the City of Tumwater is required to submit an environmental checklist unless the project is exempt as specified in WAC 197-11-800 (Categorical Exemptions) of the State Environmental Policy Act" (City of Tumwater, 2023)
Fish and Wildlife Habitat Protection Approval	**City of Tumwater**	"No person, corporation, or other legal entity shall engage in construction on a site which supports a protected fish and wildlife habitat area as defined by this chapter without having received approval for proper protection or mitigation by the city through the environmental review process and/or applicable discretionary permit(s) and construction permit(s)." (TMC 16.32.040)

Beaver Habitat Suitability

These are the results of the author's assessment of Sapp Road Park's quality as beaver habitat in terms of geomorphology, vegetation, and evidence of beaver activity:

Geomorphology

Stream parameters conducive to beaver dam construction:	**Percival Creek section in Sapp Road Park**	**Suitable for Beaver dam-building?**
Stream gradient < 4%	Stream gradient: **0.5%**	**Yes**
Stream width: < 30 ft.	Stream width: **~ 5 - 8 ft.**	**Yes**
Valley width > 100 ft.	Valley width: **~ 200 - 300 ft.**	**Yes**

**stream parameters from "Planning for Beavers Manual…" (Vanderhoof 2020)*

Vegetation

According to the "*Planning for Beavers Manual…*" (Vanderhoof 2020), the following woody plant species are considered to be the most favored by beavers in Western Washington (meaning beavers generally seem to "prefer" these species, choosing them over others when given the chance):

- **Aspen (***Populus* spp. - ex: *Populus tremuloides***)**
- **Cottonwood (***Populus* spp. - ex: *Populus balsamifera* subsp. *trichocarpa***)**
- **Willows (***Salix* spp. - ex: *Salix lasiandra*, *Salix sitchensis***)**

Plant species known to be favored beaver forage are present on-site. Clusters of **Sitka willow** (*Salix sitchensis*) are concentrated at the north end of the site, very close to, and sometimes laying across Percival Creek (***see Fig. 5***). Almost every Sitka willow observed at Sapp Road Park has old chew marks from beavers on it. Many of the Sitka willows have a shrubby, multi-stemmed form, at the center of which is the distinctive rough-hewn cone created when a beaver cuts down a tree's mainstem. Several large **Pacific willows** (*Salix lasiandra*) dot the east side of the creek, further from its bank than the Sitka willows (***see Fig. 5***) What could possibly be old beaver-dug channels lead from the creek to some of the large Pacific willows. There is a single, small **black cottonwood** (*Populus balsamifera* subsp. *trichocarpa*) at the south end of the site, up a slope, about 100 ft. away from the creek (***see Fig. 6***). The cottonwood has not been cut or chewed by beavers at the time of this writing.

Figure 5 - “North Section” Beaver-related Habitat Features

Figure 6 - “Middle & South Section” Beaver-related Habitat Features

Other Evidence of Beaver Habitat Suitability - Past and Current Beaver Activity

Woody plant species cut by beavers

The following woody plant species showed signs of cutting by beavers at Sapp Road Park (presumably used as food or if not food, then building material), and is being considered another form of evidence for habitat suitability and information on what plant species beavers utilize in this area:

- Sitka willow (*Salix sitchensis*)
- Pacific willow (*Salix lasiandra*)
- Red-osier dogwood (*Cornus stolonifera*)
- Red alder (*Alnus rubra*)
- Oregon ash (*Fraxinus latifolia*)
- Bigleaf maple (*Acer macrophyllum*)

Signs of Former Beaver Residence

There are several piles of weathered, beaver-chewed wood near the north end of the site which may have been part of old dams or lodges. The location of the largest of these is shown in ***Fig. 5***. Throughout the site there are a number of what will be called “coppiced groves”. The coppiced groves are collections of willows (and a few red osier dogwoods) which all have the growth form of a tree which has been coppiced. A coppiced tree is one in which the main stem has been cut down to a stump, and new shoots have sprouted from that stump, giving it a shrubby, multi-stemmed form. In this case it was beavers rather than humans that “coppiced” these trees, as evidenced by their distinctive chew marks. See ***Fig. 6*** for the location of one of these “coppiced groves”.

Signs of Current Beaver Activity

In April 2024, **fresh / recent beaver chew was observed on red alder stumps** near the Sapp Road culvert (***see Fig. 6***). This suggests that beavers likely occupy the wetland upstream of the culvert, and come into the south end of Sapp Road Park for foraging. No fresh chew has been observed further north of the area right around the culvert. As of April 2024, **there are no known active beaver dams or lodges within Sapp Road Park.**

IV. Discussion

How would a resident dam-building beaver population at Sapp Road Park enhance wetland functions?

Habitat functions

- **Biodiversity** - The way beavers create habitat heterogeneity and complexity through dam-building, pond creation, inundation, and herbivory has an "**overwhelmingly positive influence on biodiversity**" overall (Stringer 2015).
- **Salmon habitat** - Percival Creek is a salmon-bearing stream and research has shown that the habitat complexity created by beaver dams can lead to an increase the production and survival of juvenile anadromous fish, without impeding their migration upstream and downstream (Bouwes 2016).
- **Oregon spotted frog habitat** - Thurston County is one of the few places in Washington where populations of threatened Oregon spotted frogs (*Rana pretiosa*) still exist. According to the Washington Department of Fish and Wildlife "Beaver impounded systems appear to provide many of the habitat requirements of this species." (WDFW 2024)
- **Bat habitat** - Sapp Road Park's wetland areas are mapped by WDFW as priority habitat for several sensitive bat species: the little brown bat (*Myotis lucifugus* - listed as endangered in Canada and several other US states), big brown bat (*Eptesicus fuscus*), and Yuma myotis (*Myotis yumanensis*). High production of aquatic invertebrates, snags, and structural complexity make beaver ponds particularly good habitat for bats. One study showed bat use of beaver ponds to be 8 times higher than that of non-beaver ponds (Nummi 2011).

Hydrologic functions

- Beaver dams can **increase surface water storage** (Dittbrenner 2022). This can make riparian areas around beaver ponds more resilient in times of drought.
- Beaver dams attenuate stream flow, **decreasing peak flows and flash-flooding**. (Puttock et al. 2020)
- Beaver dams **increase water quality** - especially through denitrification. (Dewey 2022)

Invasive Plant Suppression

- Deep flooding and/or prolonged inundation can **reduce the population of reed canary grass** (*Phalaris arundinacea*), and allow a native plant community to take its place**.** (Jenkins 2008). Reed canary grass dominates the vast majority of the emergent wetland at Sapp Road Park. A beaver pond may suppress reed canary grass in this way, enhancing the wetland's biodiversity and habitat functions.

V. Beaver Habitat Enhancement Plan

Goal: The goal of this plan is to enhance habitat at Sapp Road Park for beavers to the degree that a population could continually inhabit the site.

Objective: Establish native plants on the site which are favored forage for beavers.

Plant Species Chosen for Beaver Habitat Enhancement

Three species were chosen for beaver habitat enhancement planting due to their **favorability** to beavers, **ecological appropriateness** for the site, **ease and speed of propagation**, and their **ability to re-sprout** after herbivory:

- **Pacific willow** (*Salix lasiandra*)
  - Beaver-favored forage
  - Already present on-site
  - Propagates easily from cuttings, can be planted as live stakes
  - Re-sprouts after being cut and can be coppiced
  - Is a facultative wetland plant (FACW)
  - **"The most water tolerant of our willow species"** (Vanderhoof 2022)
- **Sitka willow** (*Salix sitchensis*)
  - Beaver-favored forage
  - Already present and the most abundant willow species on-site
  - Propagates easily from cuttings, can be planted as live stakes
  - Re-sprouts after being cut and can be coppiced
  - Is a facultative wetland plant (FACW)
  - **Alongside Pacific willow, adds to willow species and growth-habit diversity in the planting palette**
- **Black cottonwood** (*Populus balsamifera ssp. trichocarpa*)
  - **Particularly favored beaver forage**
  - Already present on-site (although currently only one individual)
  - Propagates easily from cuttings, can be planted as live stakes
  - Re-sprouts after being cut and can be coppiced
  - **Is a facultative plant (FAC), and more conducive to planting in upland / drier areas as long as it can access the water table**
  - Fast-growing tree that propagates itself vigorously in the right conditions
  - Unlike the willows, can potentially grow into a very large tree, which would add to the diversity of growth-habits in the planting

Planting Design Principles

1. Supplement the current plant community

This approach assumes that the occurrence of particular plant species in particular locations indicates that area's suitability for planting more of the same species.

Willows (*Salix lasiandra* and *Salix sitchensis*)

- Cluster willow live stake plantings near current individual willows or stands of willows.
- Concentrate most of the willow plantings at the north end of the parcel, expanding the small "willow groves" which are currently there.

Black cottonwood (*Populus balsamifera* subsp. *trichocarpa*)

- Cluster black cottonwood plantings near the individual cottonwood on site, on the upland slope and down into the wetland patch of reed canary grass below

2. Plant in the appropriate soil, sunlight, and hydrological conditions

- **Pacific willow** can be planted in **wetter areas** with less well-draining soils, and in those areas where inundation by beaver activity is anticipated.
- **Sitka willow** can be planted in **fairly wet areas** but aim for the edges of anticipated inundation areas, using the locations of current Sitka willows as a guide. Sitka willows on this site seem successful in well-drained soil beside the creek, and some even grow inside the creek bed.
- **Black cottonwood** should be planted outside areas of anticipated continuous inundation if possible, **ideally on well-drained soils with a high water table**, such as the Giles silt loam sections beside Percival Creek which is currently dominated by reed canary grass. These reed canary grass -dominated areas also receive the most sunlight, which is important for black cottonwood. When planting black cottonwood live stakes, try to ensure it reaches the water table. An augur can be used to drill down to the water table.

3. Plan for herbivory

- The proposed approach is to fence clumps of plantings which will remain fenced for several years so that their roots can fully establish before they're eaten. Fencing would be gradually removed in phases to make the plantings available to beavers.

4. Plant to suppress reed canary grass

- **Willow live stakes are to be planted at 2 ft apart from each other on-center**: According to “Controlling *Phalaris arundinacea* (reed canarygrass) with live willow stakes: a density-dependent response.”, willow live stakes placed densely at 2 ft centers from one another decreased the biomass of reed canary grass growing beneath them by 68% by the second year. (Kim et al 2006)
- Experimental approach: Plant black cottonwood live stakes with the same dense spacing as has proven successful with willows in reed canary grass suppression.

5. Plan to mitigate conflict with humans

- The topography of Sapp Road Park is such that a typically-sized beaver dam would not likely cause backwater flooding that reaches adjacent properties if it is built in the northern half of the parcel. However, the closer a dam is to the Sapp Road culvert, the more likely it would be to flood properties upstream. To encourage dam building near the northern half, all of the willow planting will be concentrated there.

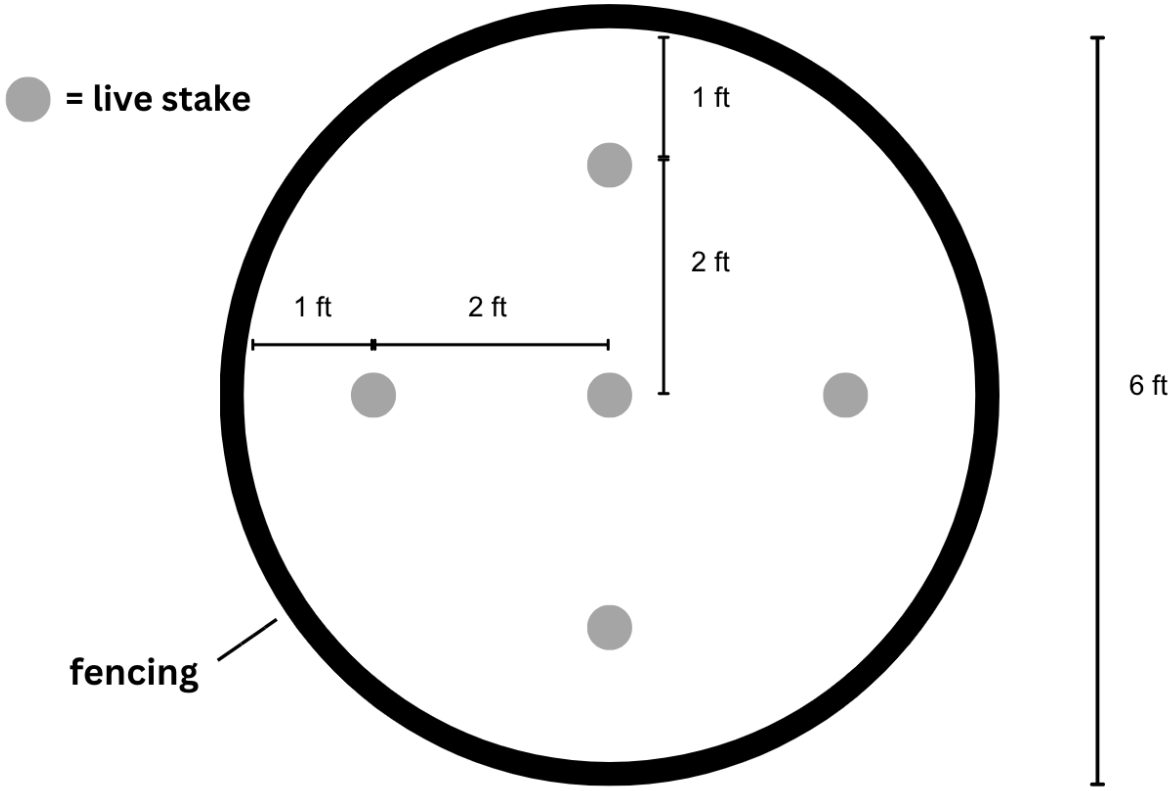
Planting Plan

Fence clusters of 5 live stakes at 2 ft centers (***see Fig. 7***)

Rationale:

- 2 ft centers is the recommended planting density to suppress reed canary grass
- A large fenced area could be breached once and all of the stakes could be eaten, fencing in smaller clusters means only a few get eaten for each breach of fence.
- 5 live stakes per cluster could make monitoring and noticing patterns of mortality easier, and the smaller planting units could be done gradually over time, such as during sporadic restoration events.

Figure 7 - Fenced clusters of 5 live stakes at 2 ft centers



Conceptual Planting Plan Maps

The following maps present one possible way to plant in accordance with the principles outlined above. In reality, planting would likely need to be able to adapt to beaver behavior and hydrological changes as they manifest. The installation of beaver dam analogues (BDAs) could also change where the most appropriate sites for plantings are.

Note: the areas/lines of anticipated inundation are based on a theoretically “optimal” 4ft tall beaver dam built near the old beaver structure on the north end of the site. This location is considered optimal because it would flood a large amount of reed canary grass while preserving an unflooded area of willows, and no backwater flooding would occur outside of Sapp Road Park’s boundaries. (***see Appendix B, Map 4***)

Figure 8: Black Cottonwood Planting - "South Section" of Sapp Road Park

Percival Creek is shown in blue, it flows from the culvert in the south (bottom) to the north (top)

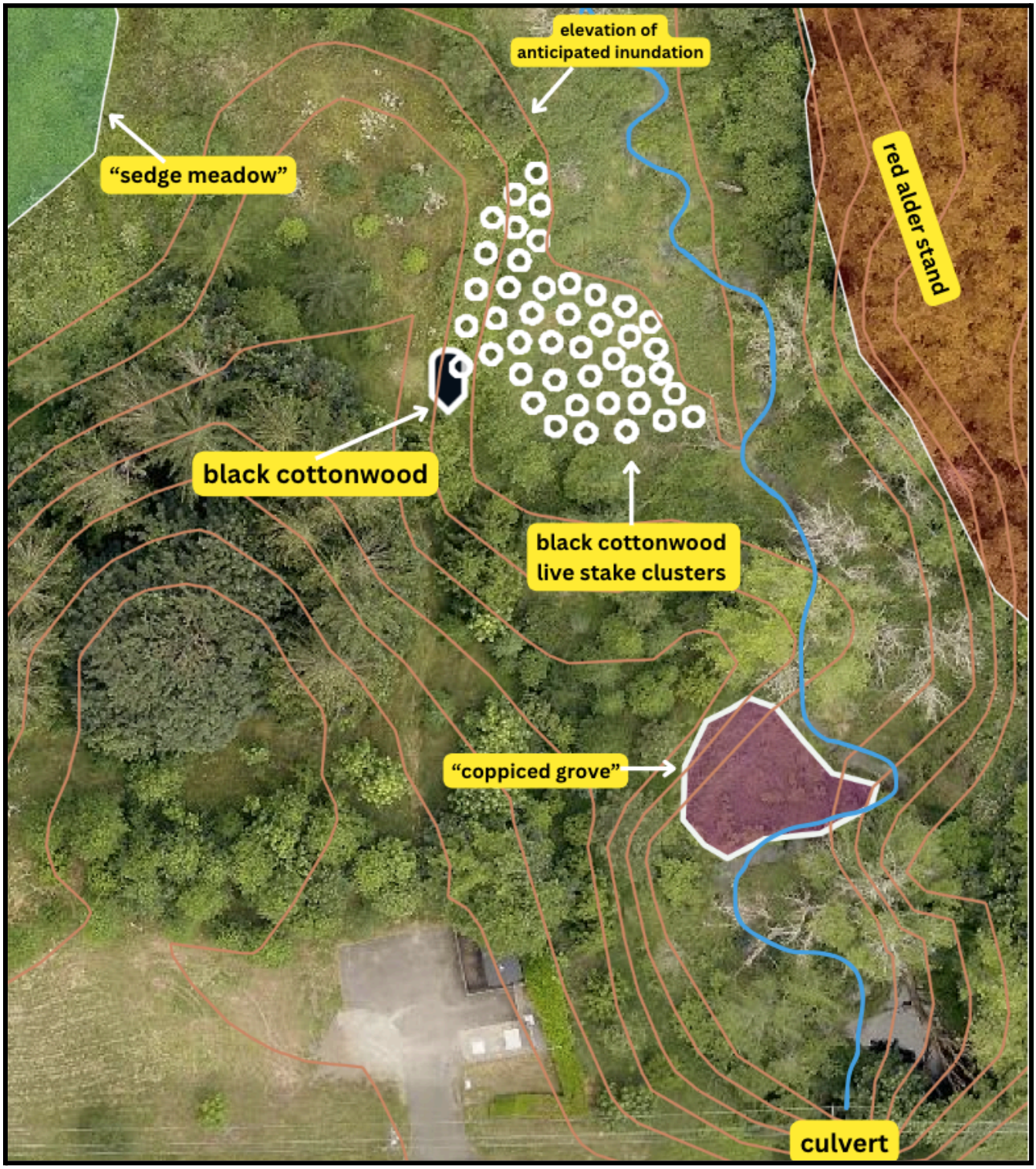


Figure 9: Pacific Willow Planting - "Middle Section" of Sapp Road Park

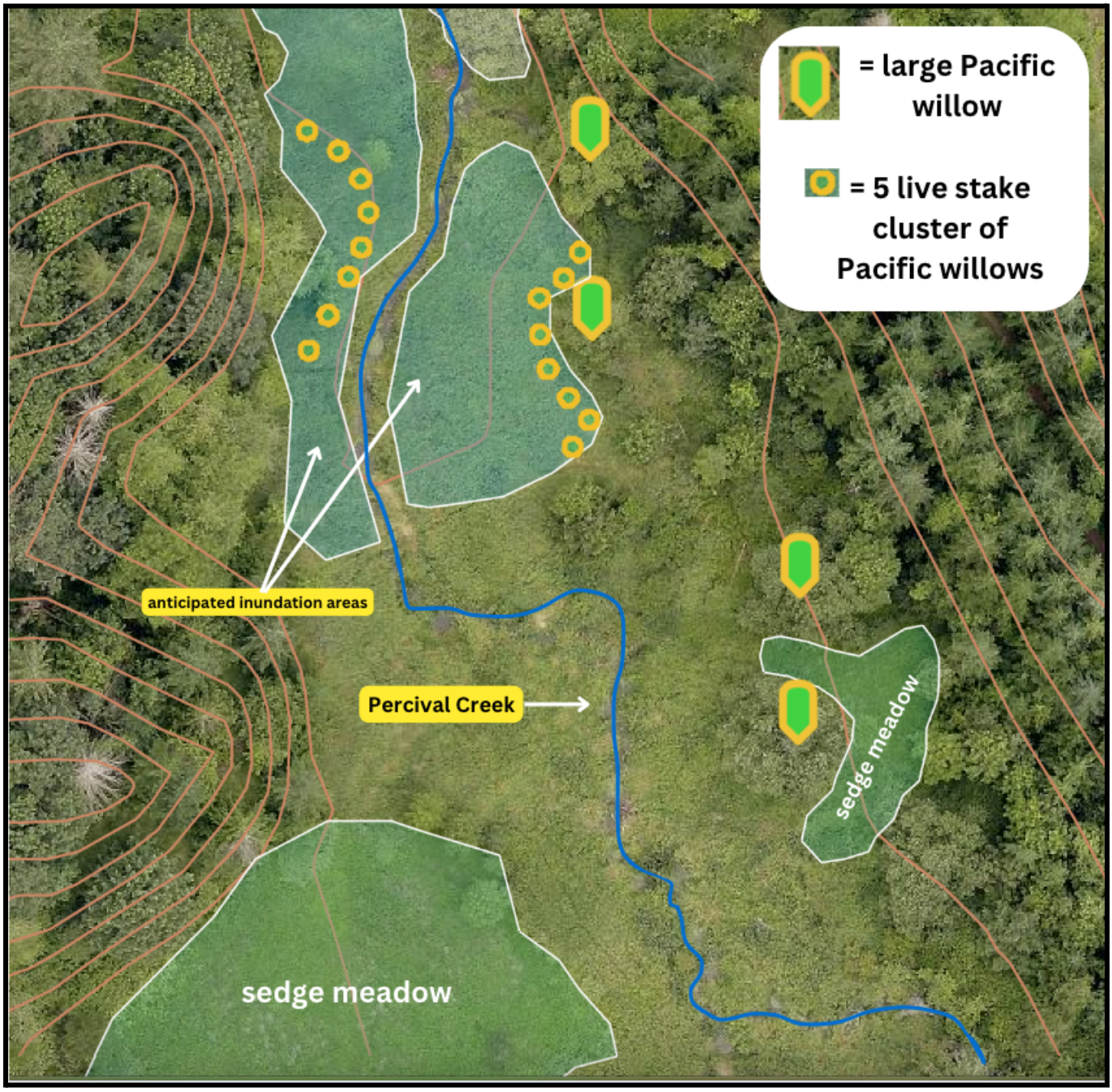
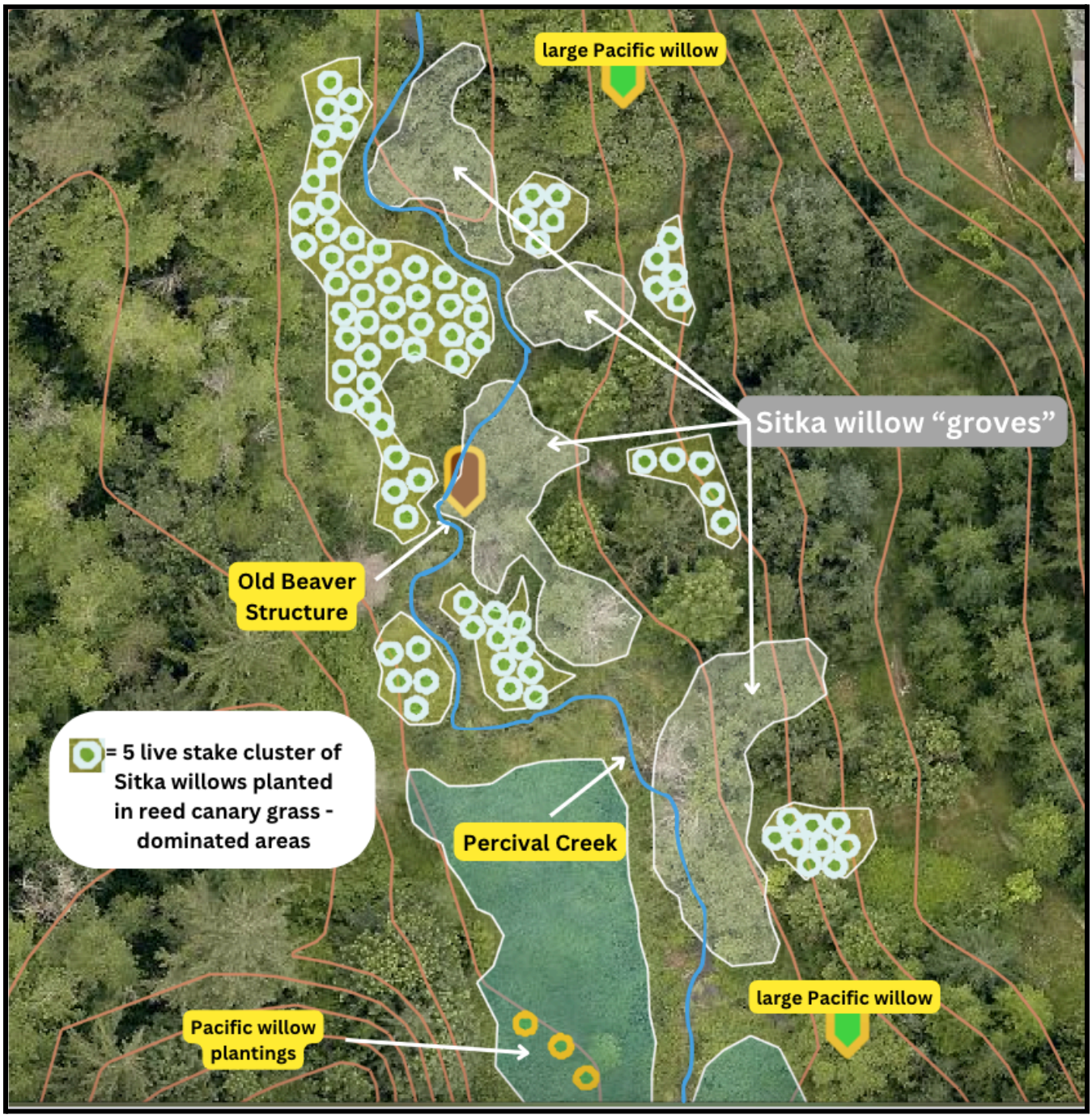


Figure 10: Sitka Willow Planting - "North Section" of Sapp Road Park



Experimental Approach

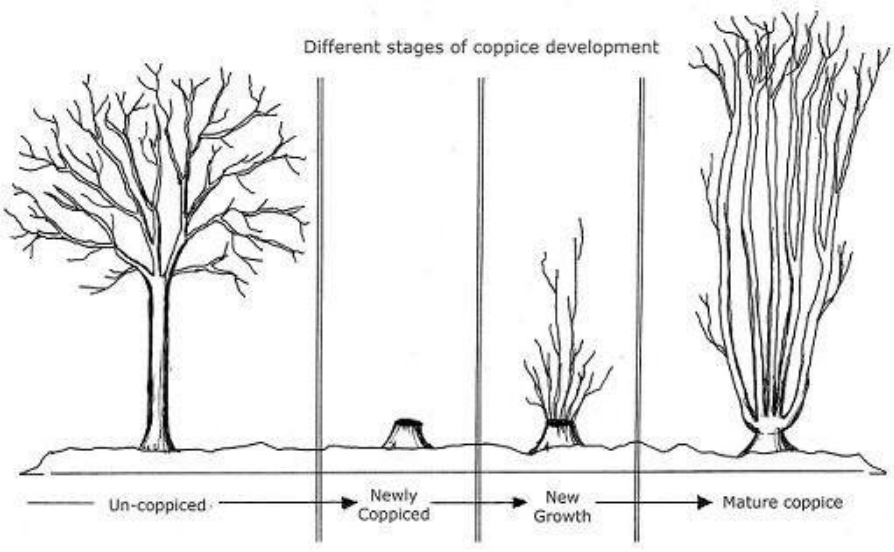
Coppicing Trees Before Planting

This is an untested approach which applies the concept of “beaver mimicry” to planting technique. Beaver cut and heavily favor re-sprouting tree and shrub species, and there are many “beaver-coppiced” trees at Sapp Road Park. Copying this behavior may help produce trees and shrubs which can both **provide food for beavers** first moving into the site but also **allow the plants to survive herbivory** because they have a well-established root system. If effective, this could provide an alternative to fencing or otherwise protecting plantings, which requires maintenance and management.

A Method For Pre-Coppicing Trees

1. Grow live stakes of willows or cottonwoods (or use older developed saplings if available) in the relative safety of a nursery, and grow them up for at least a year (more years in this initial stage would of course produce a larger tree to be coppiced, which could be advantageous)
2. In the winter after the first year, while the plant is dormant, the main stem is cut, leaving only 6 inches of stem above the roots, encouraging the development of side-shoots. An advantage to this process happening in the nursery is that the cut main stem and branches could then be used to propagate even more plant materials.
3. When a whole growing season has passed after the main stem has been cut, and the coppiced willows and cottonwoods have developed many side-shoots, they can be planted in the field in their appropriate sites. To see if this pre-coppicing method is a viable technique to balance the needs of feeding beaver and plant survival, it is suggested to not cage or fence these plantings.

Figure 11: Stages of Coppice Development (*Source: centralcoastwilds.com*)



Proposed Planting Schedule and Monitoring

Year 1 - Plant and live stakes on-site, root cuttings in the nursery

- Plant and willow and cottonwood live stakes in clusters near sites of current willows and cottonwoods in late winter / early spring - **fence 100% of live stakes**
- Begin rooting live stakes in a nursery

Year 2 - One-fourth of fencing to be removed, coppice nursery trees

- Assess plant conditions, fence conditions, record survival rate of plantings
- Adjust or supplement plantings as necessary, maintain or repair fencing
- **Remove 25% of fencing** from plantings furthest from the water's edge (least likely to be eaten by beavers), these are hopefully well rooted and established, may possibly become accessible beaver forage
- **Cut back nursery willows and cottonwoods** to 6 inches when dormant (late winter)
- Use cut stem and branches to propagate more plant materials which can be planted when roots are well developed, installed as additional live stakes, or used to continue a coppicing cycle

Year 3 - One half of fencing to be removed, allow side-shoot development

- Assess plant conditions, fence conditions, record survival rate of plantings
- Adjust or supplement plantings as necessary, repair or maintain fencing
- Remove 25% more fencing from plants (**now half is unfenced**)
- **Allow side shoot development of cut back willows and cottonwoods** during the growing season this year

Year 4 - Three fourths of fencing to be removed, install coppiced trees

- Assess plant conditions, fence conditions, record survival rate of plantings
- Adjust or supplement plantings as necessary, repair or maintain fencing
- Remove 25% more fencing from plants (now **three fourths is unfenced**)
- **Install coppiced trees** near their appropriate clusters where naturalistic, a middling distance from the water

Year 5 - All fencing to be removed, assess coppiced tree survival and growth

- Assess plant conditions, record survival rate of plantings, including the coppiced trees
- Adjust or supplement plantings as necessary
- **Remove all fencing from plants**

VI. Recommendations

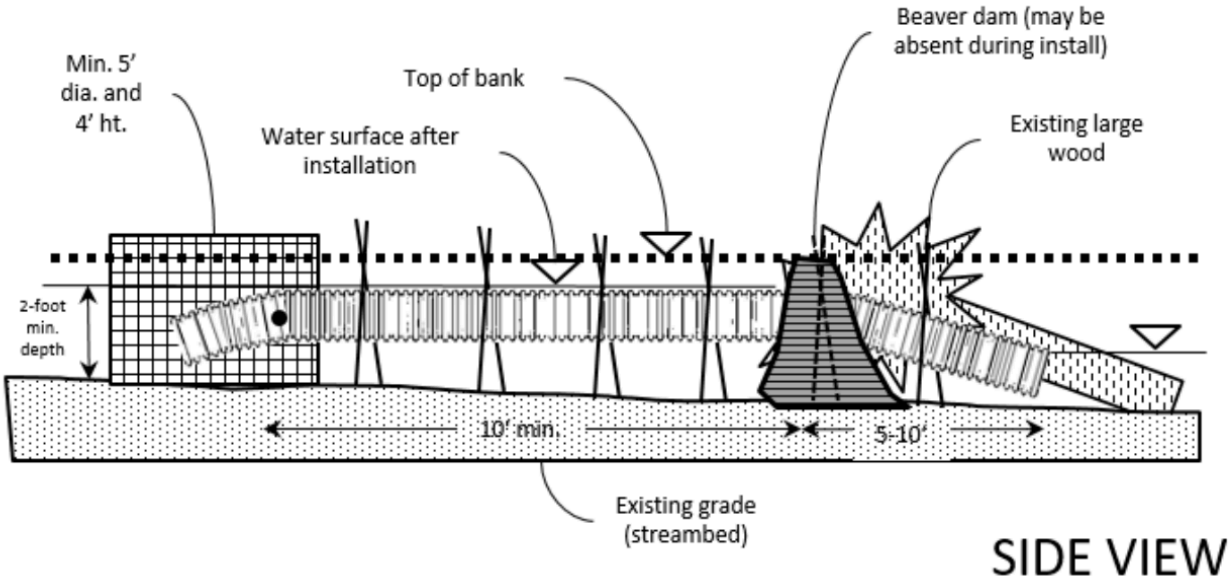
Preservation of sedge meadow areas

It is recommended that any restoration or habitat enhancement activities carried out at Sapp Road Park take care not to disturb the “sedge meadow” portions of the wetland or convert them to another wetland type, such as scrub-shrub. They are unique in their quality of being able to persist as native plant -dominated emergent wetlands in spite of being surrounded by reed canary grass. These areas could be **particularly valuable for Oregon spotted frogs** (*Rana pretiosa*), which require low-vegetation emergent wetlands and cannot thrive where reed canary grass predominates. (Pearl 2004)

Adaptive Management

Denser planting of willows at the north end of the site is intended to encourage beavers to build a dam in that area. In theory, a dam at the north end has a lower risk of causing backwater flooding that reaches beyond the parcel boundaries and onto adjacent property. If the water level is raised beyond the 138 ft elevation contour on the site, it will cause flooding on the property just on the other side of the Sapp Road culvert. If beavers do end up constructing a dam on the south end of the site which causes backwater flooding beyond Sapp Road Park, a pond leveler device can be used to maintain the water level below the 138 ft elevation.

Figure 12: Flexible Pond Leveler Diagram



Source: King County Beaver Management Technical Paper #1

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