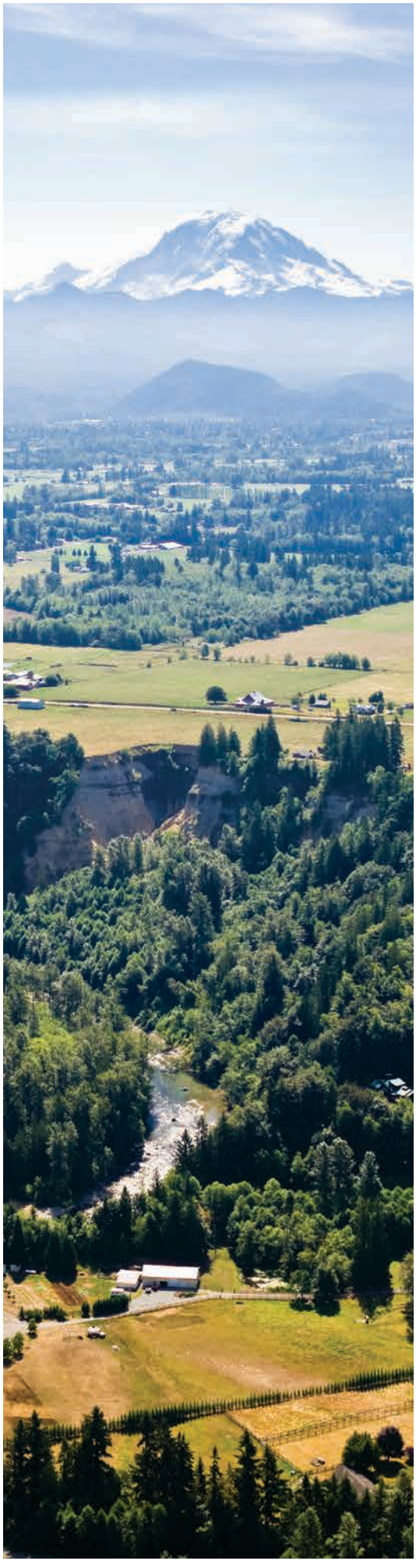

RE-GREEN THE GREEN:

Riparian Revegetation Strategy for the Green/Duwamish and Central Puget Sound Watershed (WRIA 9)

October 14, 2016

GREEN / DUWAMISH AND CENTRAL PUGET SOUND WATERSHED

WRIA 9 Riparian Revegetation Work Group

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October 14, 2016

Written for the WRIA 9 Watershed Ecosystem Forum

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Cover photos:
left: Middle Green River Aerial Image, Ned Ahrens
top right: Lower Green River, eGov photo archives
middle right: Duwamish Planting Party, eGov photo archives
bottom right: Big Spring Creek, June 8, 2012, Elissa Ostergaard

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Executive Summary

Over the last 150 years, the amount of streamside, or riparian, forest cover has been dramatically decreased along the Green/Duwamish River and Central Puget Sound Watershed (WRIA 9) due to human activity and land use. The lack of tall native trees along the banks of the river and its tributaries results in unhealthy and sometimes lethal water temperatures for Chinook and other salmon. In fact, in recent years the Muckleshoot Indian Tribe observed a number of migrating adult Chinook salmon in the Green River die from heat-related diseases and stress. The lack of trees along the Green River results in fewer insects that feed birds, salmon, and other wildlife; and a lack of supply of wood to fall into the river to create a complex of deep and shallow, slow and fast water habitats where fish can hide from predators, feed, take refuge from high flows, and rest.

Shade-producing tree canopies along WRIA 9 riparian areas are needed in order to improve conditions for salmon and to meet water temperature standards. These efforts will help meet the directives of the Endangered Species Act, the Clean Water Act, and Native American fishing rights reserved by federal treaty (the 1974 "Boldt Decision"). There is an urgent need to restore a broad swath of tall trees and other native riparian vegetation on all land use types, urban and rural, along the entire length of the Green River and its tributaries (Figure 1). As part of programmatic action Watershed Wide 5 (WW5), the 2005 Salmon Habitat Plan called for planting trees throughout the basin. However, it did not provide guidance regarding how to prioritize or implement the program. This strategy is intended to guide the scope and priorities for riparian revegetation in the Green/Duwamish River and Central Puget Sound watershed (WRIA 9) for the next 10 years. This will assist the WRIA 9 partners in raising and allocating adequate funding and resources to accelerate the effort.

The goals of this strategy include:

1. Improve water temperature by restoring effective tree shade, especially along the Green River and the Soos and Newaukum Creek drainages; and
2. Improve habitat for threatened Chinook and steelhead.

Secondary benefits of riparian tree planting include:

- Increase climate resiliency;
- Improved public health, equity, and social justice by focusing on adding trees to riparian corridors in urbanized areas and low income ethnically diverse communities;
- Improved public safety; and
- Reduced stormwater runoff volumes and pollution.

Geographic locations with the highest priority for riparian revegetation include areas where water temperature Total Maximum Daily Load (TMDL) clean-up plans have been prepared to address exceedances of state water temperature standards; areas upstream of locations exceeding water temperature standards, which contribute to thermal loading; and the banks of rivers and streams mapped as a high shade priority based on their solar sun angle or aspect. Geographic priorities for revegetation, in order of the most to least important, are: the mainstem Middle Green River and Lower Green River; Soos and Newaukum Creeks and their tributaries; the Duwamish River; tributaries to the

Middle Green River, Lower Green River and the Duwamish; the Upper Green River; and finally, the marine nearshore, and nearshore drainages.

Tall trees along a 165-foot wide swath next to the channel will have the most temperature, habitat and other water quality benefits, especially when the shaded reach is continuous for at least 0.6 miles (1 kilometer). Significant barriers exist to planting trees along levees due to U.S. Army Corps of Engineers and King County Flood Control District rules and practices. Therefore, setbacks and broad planting benches are encouraged in areas affected by levees.

Approximately 86 percent of channels in Agricultural Production Districts and 92 percent of Farmland Preservation Program properties in WRIA 9 are devoid of trees, and are located in areas where temperature TMDL plans are in place or are being developed. Planting buffers on farms is challenging because of agricultural productivity needs and competing King County goals, but numerous options or incentives to offset the impacts of riparian buffers on agricultural landowners exist. In some areas, creative solutions need to be developed to balance recreational needs such as trails for water access and views with the need for dense and wide vegetated buffers.

Key elements of the "Re-Green the Green" strategy include:

- A target of 2,384 acres of newly planted riparian area by 2025 at an estimated cost of $28.3 million. This estimate includes planning, site preparation, planting, maintenance and monitoring, but does not include the cost of purchasing lands for future protection. For the next two years of implementation in 2017-2018, just over $1 million is needed each year.
- WRIA 9 assumes that the $250,000 annual small grant round to award funds from the Cooperative Watershed Management grant program to practitioners that was started in 2015 will continue through 2025, accounting for a total of $2.5 million of the estimated cost noted above. However, because current funding for riparian revegetation is inadequate, WRIA 9 will seek supplemental funding for riparian revegetation, including from the Washington Department of Ecology, U.S. Army Corps of Engineers through the Green/Duwamish Ecosystem Restoration Program, and donations from corporations or others to leverage the WRIA's investments.
- Progress will by tracked by having those planting trees in WRIA 9 enter locations and specific activities related to site preparation and planting onto an interactive web map at http://gismaps.kingcounty.gov/**TreePlantingViewer**/.
- Research is needed to determine the most cost-effective methods for revegetation, water temperatures in the Duwamish, the relative contributions of small tributaries to high temperatures, riparian needs in the Upper Green sub-watershed, and adaptations for climate change.
- Education of public and private streamside landowners and enforcement of existing regulations that protect riparian areas are needed to retain trees in areas that are already forested.

Background

Over time, human activity and land use along much of the Green-Duwamish River has dramatically decreased the amount of streamside or *riparian* forest cover. The removal of tall, native trees from the banks of the river and its tributaries allows too much sunlight to reach the water, leading to unhealthy and sometimes lethal water temperatures for Chinook and other salmon. During a typical summer, temperatures in the Green River and many of its tributaries exceed the water quality standards established by the State of Washington under the federal Clean Water Act to protect salmonids. River temperatures commonly reach 21-22 degrees Celsius (C) or more, well above the water quality standards (16.0-17.5 degrees C). River temperatures above 17.5 degrees cause sublethal effects, including disease outbreaks in adult salmon and poor growth and survival in young salmon. Water temperatures of 22 degrees C or higher are lethal, and cause pre-spawning mortality in adult salmon. Temperatures as high as 24 degrees C (75.2 °Fahrenheit), were measured in the Green River in Tukwila during July of 2015. Air and water temperatures are predicted to rise as the effects of climate change continue.

Figure 1. Tributary to Newaukum Creek, showing a lack of trees along a stream in an agricultural area. Photo courtesy of Department of Ecology.

Not only do trees provide shade, they also provide habitat for insects that feed birds, salmon, and other wildlife. Older trees fall into the river and create pools where fish live, and provide resting and hiding places for fish, so they can get out of fast water and avoid predators. Trees also filter pollutants in air and capture rainfall to reduce stormwater runoff. Separate from ecological benefits, trees provide people with needed shade and fresh air, and contribute to their overall health and sense of well-being.

There is an urgent need to restore a broad swath of tall trees and other native riparian vegetation on all land use types, urban and rural, along the entire length of the Green River and its tributaries (Figure 1). The strategy presented in this report is intended to illuminate the scope and priorities for riparian revegetation in the Green/Duwamish River and Central Puget Sound watershed (WRIA 9) so that adequate funding can be allocated appropriately to accelerate the effort.

The region has an obligation to reestablish shade-producing tree canopies along WRIA 9 riparian areas under a federal treaty with the Native American tribes and two federal laws. These include: Native American fishing rights reserved by federal treaty as affirmed in the court case United States v Washington (the 1974 “Boldt Decision”); the Endangered Species Act, which lists Puget Sound Chinook

and steelhead as threatened and coho as a species of concern; and the Clean Water Act, which requires cool and clean water for people and fish. In Washington, the Clean Water Act is administered by the Washington Department of Ecology (DOE), which sets water quality standards. Recent temperature measurements along the Green River confirmed modeling analyses by DOE that predicted large areas of the Green River system to reach above temperature standards in summer (Coffin et al. 2011). In fact, in 2015, temperatures exceeded levels that are lethal to salmon (Figure 2).

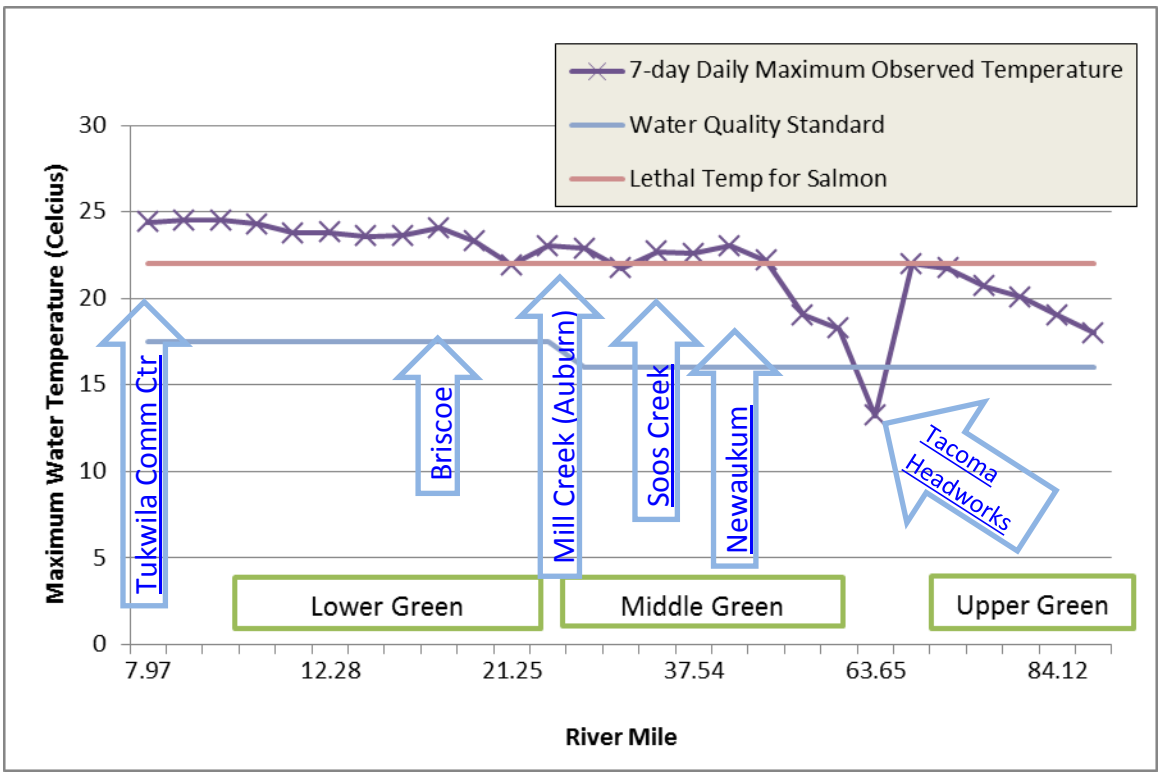

Figure 2. Stream temperatures measured along the length of the Green River from above the Howard Hanson Dam reservoir to Tukwila at River Mile 7.9 on July 4, 2015. Temperatures are well above state temperature standards for the 7-day average daily maximum, and reached lethal levels in all subwatersheds. From King County, unpublished data.

The WRIA 9 Salmon Habitat Plan (Water Resource Inventory Area 9, 2005) was compiled by local governments and other Green/Duwamish watershed stakeholders to prioritize actions to improve survival rates of Chinook and other salmon. The plan, which was ratified by all 17 local governments in WRIA 9, states that riparian revegetation is a priority, and includes the following actions, with the ones most directly related to riparian revegetation in bold:

- Conservation Hypothesis ALL-2 – **Protecting and improving riparian conditions by adding native riparian vegetation** will enhance habitat quality by improving water quality, stabilizing streambanks, providing overhanging vegetation and large woody debris (LWD), and contributing organic matter,

nutrients, and terrestrial prey items, thereby leading to greater juvenile salmon growth and higher survival.

- Program Watershed-wide (WW)-5: **Promote the planting of native trees**
- Program WW-8: **Increase Involvement of Volunteers in Habitat Stewardship**
- Program WW-9: Green/Duwamish **Volunteer Revegetation Program**
- Program WW-16: Develop **Salmon Restoration Tools Consistent with Agricultural Land Uses**
- Project UG-1: Revegetation of Sunday Creek 2.75 Miles up from RM 84.1 (Both Banks)
- **Project MG-6: Newaukum Creek Restoration Between Creek Miles 0.0 and 14.3 (Both Banks)**
- Project MG-16: Ray Creek Restoration at RM 34.2 (Right Bank)
- Project LG-7: Lower Mill Creek, Riverview (Formerly Green River) Park, Hawley Road Levee, and Lower Mullen Slough Restoration Between RM 24 and 21.3 (Both Banks)
- Project LG-8: Schuler Brothers Reach Rehabilitation on Mill Creek Between Creek Miles 0.3 and 2.1
- Project LG-18: Black River Marsh at RM 11.0 (Right Bank)
- **Program N-1: Promote Habitat Restoration on Private Property by Offering a "Toolbox" of Nearshore Habitat Project Designs.**

To date, only some of these recommended actions have been implemented in an organized way; however, many groups are planting trees and removing invasive weeds in WRIA 9. Until this point, no one entity has been coordinating these efforts, and there has been no overall strategy to assure that the highest priority areas are being revegetated first. The purpose of this document is to provide a comprehensive revegetation strategy for the Green/Duwamish and Central Puget Sound watershed that can be used by WRIA 9 funders and practitioners to maximize the outcomes of revegetation efforts by targeting the most important places and the most cost-effective methods, and track progress towards implementation. This strategy is intended to be an easily accessible, online set of working documents, including a smartphone or tablet mobile application, that will be revised as new information becomes available and as conditions, priorities, and opportunities change.

The goals and priorities for riparian revegetation in WRIA 9 stated in this strategy were developed to meet regulatory requirements under the ESA and CWA and improve habitat conditions for salmonids. Revegetation also improves equity and social justice and resiliency in the face of climate change. It will also help King County meet the goal of its 2015 Strategic Climate Action Plan to plant 1,000,000 trees by 2020. This riparian revegetation strategy was developed by a work group convened by WRIA 9, and represents the opinions and experience of the authors; it was not approved specifically by their agencies and tribes. The group met monthly from September 2015 until June 2016, and invited subject matter experts to provide information on the latest conditions and practices. The draft strategy was reviewed and edited by the WRIA 9 Implementation Technical Committee in February and July, 2016. Anyone wishing to provide updates or comments about this riparian revegetation strategy is invited to contact the WRIA 9 staff team (see http://www.govlink.org/watersheds/9/contacts/ for contact information).

Goals

The primary goal of this strategy is to restore healthy native riparian vegetation in order to reduce water temperatures and improve other water quality parameters, improve salmonid health and productivity,

mitigate the effects of land use changes and invasive species, and to improve climate change resiliency along the Green/Duwamish River. This will be accomplished by removing noxious weeds and establishing native plants, including conifers, deciduous trees, willows, and native shrubs where they will have the most immediate benefit to people, salmon and wildlife. Additional goals include:

- **Improve water temperature** in WRIA 9 to levels that are below lethal thresholds for salmon and eventually, to meet state water temperature standards by restoring effective tree shade, especially in the Green River and in Soos and Newaukum creeks, where the Washington Department of Ecology has prepared, or is in the process of preparing, temperature Total Maximum Daily Load (TMDL) water quality improvement reports (Coffin et al. 2011, Lee et al. 2011, and J. Nolan, personal communication). State water quality standards for summer temperatures in the Green River include the following criteria: 16 degrees C (60.8 °F) upstream of Mill Creek (Auburn) and 17.5 degrees C (63.5 °F) downstream as a 7-day average daily maximum temperature;
- **Improve aquatic habitat conditions for ESA-listed Chinook and steelhead,** which are important to tribal treaty rights requiring sustained fishing opportunity.

There will be multiple benefits achieved by planting trees and other native plants along rivers and streams in the Green/Duwamish River watershed, including climate resiliency, public safety, and public health, which is an aspect of equity and social justice. Secondary benefits of this effort include:

- **Improve climate resiliency**
    - Plant native trees to store carbon;
    - Consider planting a variety of species likely to survive and reproduce in a changing climate;
    - Improve habitat for salmon to help mitigate climate changes projected to affect stream flows, water temperatures, and other changes to their habitat.
- **Improve public health, equity, and social justice** by focusing on adding trees to riparian corridors in urbanized areas and low income, ethnically diverse communities.
    - Trees filter air and water pollutants.
    - Living near trees has produced measurable health benefits in a variety of settings and communities (Donovan et al. 2013).
    - Trees cool summer air temperatures locally and counteract “urban heat island” effects.
    - Trees in community spaces have been shown to help reduce stress and promote outdoor activities.
- **Improve public safety** by reducing crime rates (Wolf 2010).*
- **Reduce stormwater runoff volumes and pollution** by planting trees along riparian corridors.

*Exerpts from Kathleen Wolf’s literature review web page on vegetation and crime:

“Those living near a greenway may have concerns about crime. A study examined crime spill-over from a 5-mile greenway in Boston. Police calls regarding personal or property crime adjacent to the trail were compared to calls from houses further away over two years. No significant increase in crime was found for those living next to the corridor. In fact, there was less crime, as compared to houses bordering quiet commercial streets, and significantly less crime than for those buildings abutting a busy arterial street.” (Crewe, K. 2001. Linear Parks and Urban Neighbourhoods: A Study of the Crime Impact of the Boston South-West Corridor. *Journal of Urban Design* 6, 3:245-264.)

"Studies suggest how to design safe yet appealing parks and greenways. The presence of nature, including higher densities of trees, is preferred. A more open understory that provides adequate lines of sight increases perceived safety in urban park settings. This does not require a landscape devoid of understory, but rather suggests that managers should be sensitive to where they place and how they manage vegetation in light of personal safety concerns."

Priorities

Rankings of specific sites for revegetation are based on the WRIA 9 partners' evaluation of current science and the actions most needed to recover salmon species listed as threatened under the Endangered Species Act and increase abundance of salmon in order to sustain tribal treaty fishing opportunities. Science and priorities will change over time, and as they do, the rankings for different areas should be reevaluated and changed to reflect current priorities. These priorities can be used to develop criteria to rank projects for funding in WRIA 9.

Current priorities include:

- **Improve water temperature** by restoring effective tree shade to address temperature TMDLs that have been prepared for Soos and Newaukum creeks, and the mainstem Green River from Howard Hanson Dam to I-405 (Middle and Lower Green subwatersheds). While it is high priority to replant all the banks of river, some areas will have greater shade benefit or quicker benefits in the shorter term. Higher priorities for the mainstem Green River, are locations where the aspect of the river bank in relation to the sun is most important, including those areas marked as critical, high, and medium shade need on riparian aspect priority maps that have been created to support riparian revegetation efforts. Maps showing shade priority can be found on the online interactive map at http://gismaps.kingcounty.gov/**TreePlantingViewer/** . The circles along the bank each represent a 50-foot diameter area, colored by shade priority; darker colors represent places with over 50% trees; lighter colors represent places with less than 50% trees.
- **Improve habitat for threatened Chinook and steelhead**, and coho salmon. A diverse, native riparian corridor provides the following habitat benefits for salmonids:
    - Large woody debris source
    - Filtration of sediments, nutrients, pollutants, and flood debris
    - Nutrient uptake – reduce overabundant nutrients such as nitrogen from agricultural lands
    - Moderation of microclimate effects (humidity, wind speed, soil moisture, air and soil temperatures)
    - Insect/prey fall out
    - Organic inputs of leaf litter increase food sources for insects and nutrients in the channel
    - Shade improves water temperature, which can increase available dissolved oxygen in the water.
    - Overhanging vegetation provides instream cover, complexity, and slower currents
    - Bank stabilization to limit sources of fine sediments that can fill in gravel, reduce spawning and insect productivity

Revegetation Priorities by Area

Geographic priorities were developed and ranked in order to focus efforts for the next ten years (2016-2025) on places that will make the most difference for in-stream habitat. Modeling shows that the benefits are greatest when there is consistent shade in the upper areas of a watershed; areas with

temperature TMDLs issued by DOE are also high priority. Areas lower in the watershed and smaller tributaries were given a lower priority because they would have a smaller overall effect on stream temperature and habitat. Nearshore areas are low in priority because they do not affect stream temperatures, and nearshore tributaries are ranked lowest because they do not have spawning Chinook populations. Table 1 lists areas of importance, from most important least important, in order of ranking:

Table 1. Priority rankings for riparian revegetation of different areas of WRIA 9, from highest to lowest.

Priority Ranking	Location
1	Middle Green (Green River, River Miles 32-64)
1	Lower Green (Green River, River Miles 11-32)
2	Soos and Newaukum Creeks (including tributaries)
3	Duwamish River (River Miles 0-11)
4	Small tributaries to Middle Green – e.g., Burns, Crisp creeks
4	Small tributaries to Lower Green – Mill, Mullen, Springbrook, Brooks creeks
4	Duwamish tributaries (e.g., Hamm Cr, Riverton Cr)
4	Upper Green – this may move higher in priority when more is known about the timing of fish passage improvements through Howard Hanson Dam
5	Nearshore marine shorelines
6	Small streams draining to Puget Sound (e.g., Miller-Walker, Des Moines, Judd, Shinglemill)

In addition to location, the following types of sites should be considered highest priority for revegetation:

- Large parcels or multiple adjacent parcels that will create at least 1000 km (3200 feet) of continuous riparian vegetation along a stream or river;
- Areas that do not already have trees over more than 50% of the site within 165 feet of the stream or channel;
- Areas upstream of areas with high water temperatures;
- Areas identified in the Newaukum, Green River, and Soos temperature TMDL reports/studies; and
- Private lands with willing landowners, with the understanding that when these become scarce, funds will be used to revegetate public lands.

While efforts should primarily focus on those areas of highest priority, it is also recognized that:

- riparian revegetation is worthwhile everywhere;
- revegetation is already being done by many people and groups throughout the watershed, and current efforts need to be continued and encouraged; and
- areas with mature trees with English ivy growing in and under them should be protected by controlling the ivy; and
- revegetation can only happen where there are willing landowners, so all areas should be provided with funding so that efforts can progress.

Specific targets for areas of restoration (in acres) for the different extents of the watershed were developed by the revegetation working group during a series of meetings. We conducted a GIS analysis of the area of buffer within 150 feet of the channel that had less than 50% trees. We then identified the areas of greatest need for revegetation by 2025 based on the priorities listed above for the Middle Green River (Figure 3 and Figure 4), Lower Green River (Figure 5 and Figure 6), Newaukum (Figure **7**), Soos (Figure 8), and Duwamish (Figure 9) areas. The 10-year targets are approximately half of the total buffer area that is currently not forested. As shown in Table 2, the target for 2025 is to plant trees on over 2,300 acres, along approximately 327,000 feet of channel (over 62 miles), and over 800 parcels.

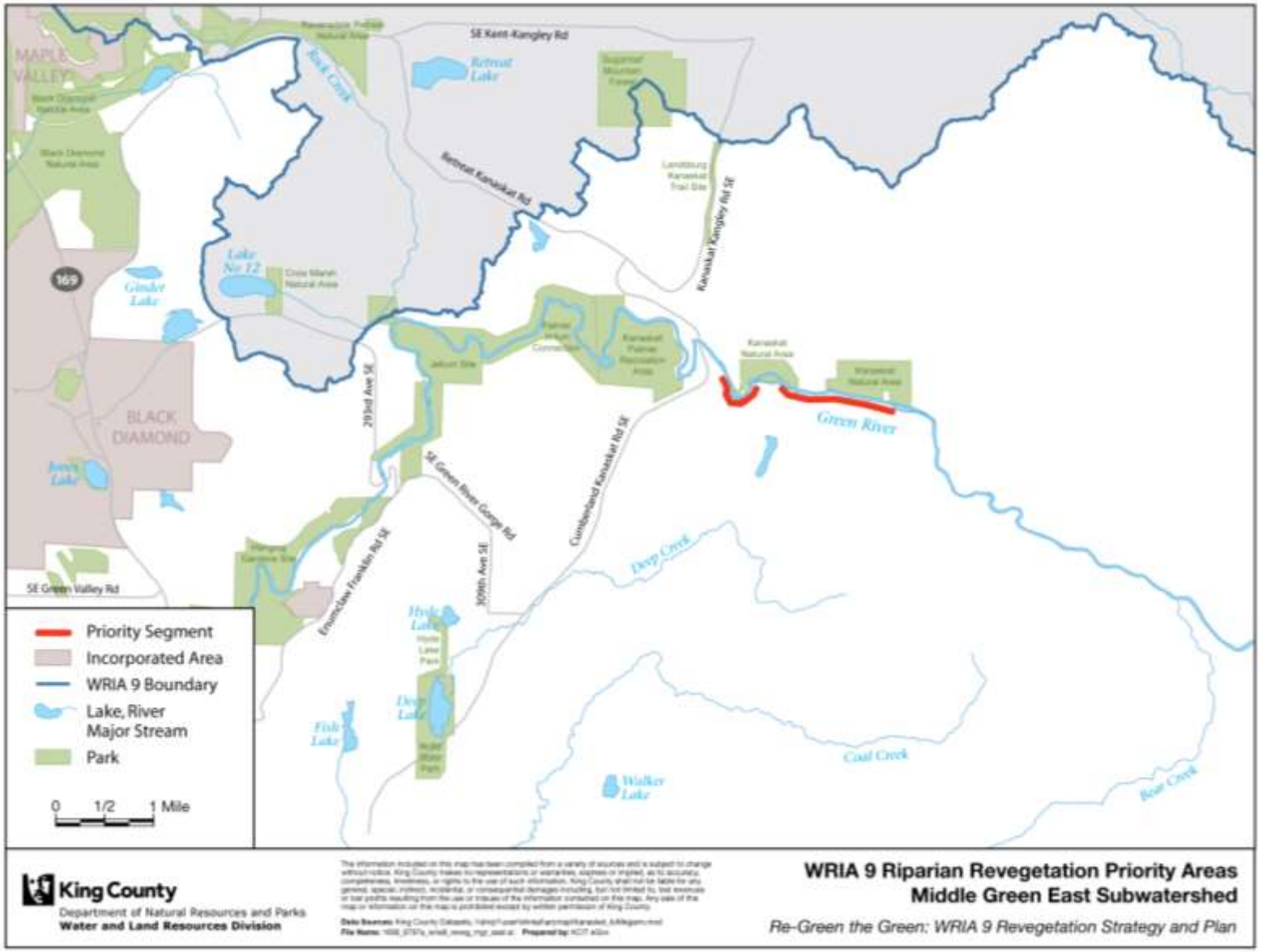

Figure 3. Priority areas for planting native trees along the Middle Green River near the Tacoma Headworks.

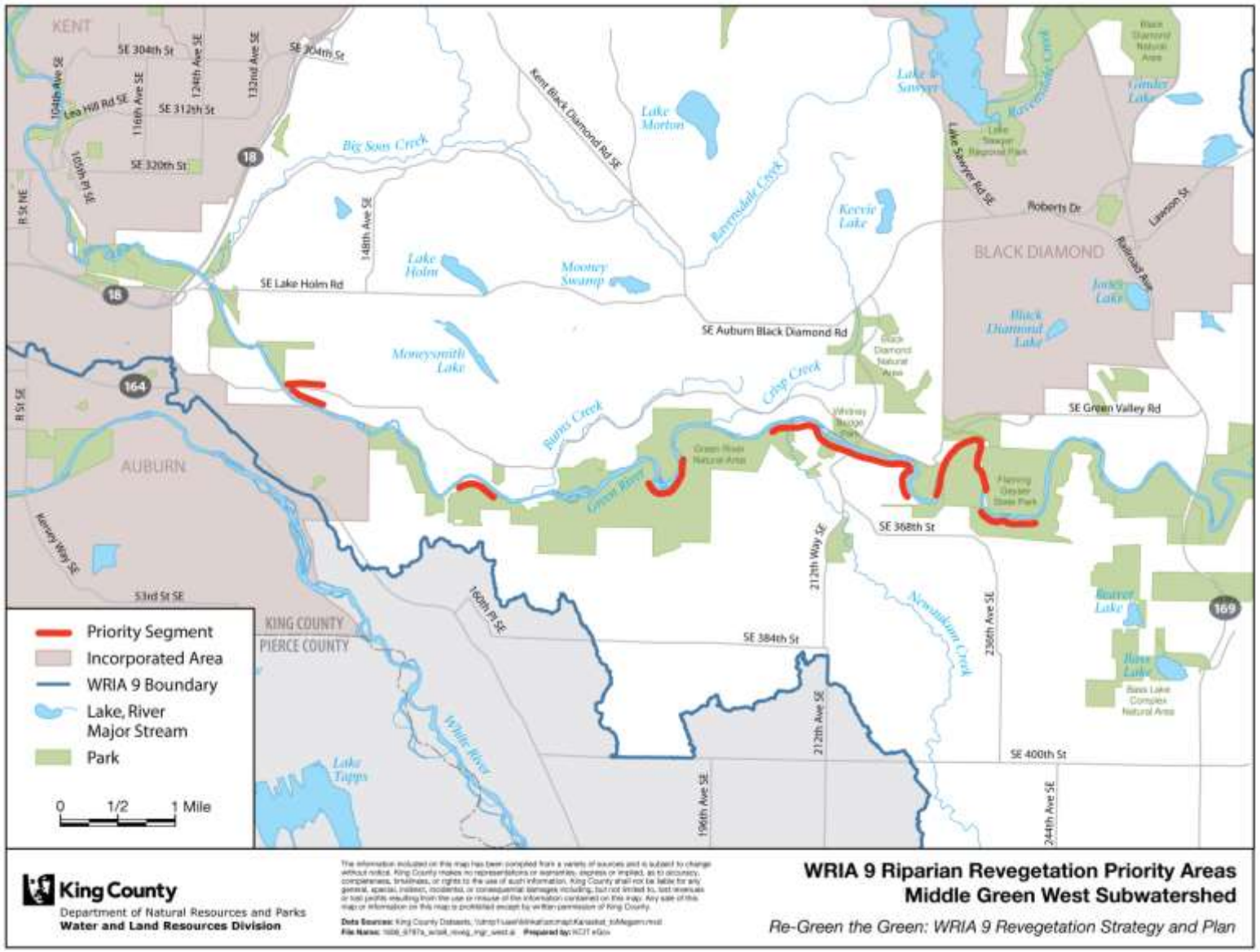

Figure 4. Priority areas for planting trees along the Middle Green River between SR 18 and SR 169.

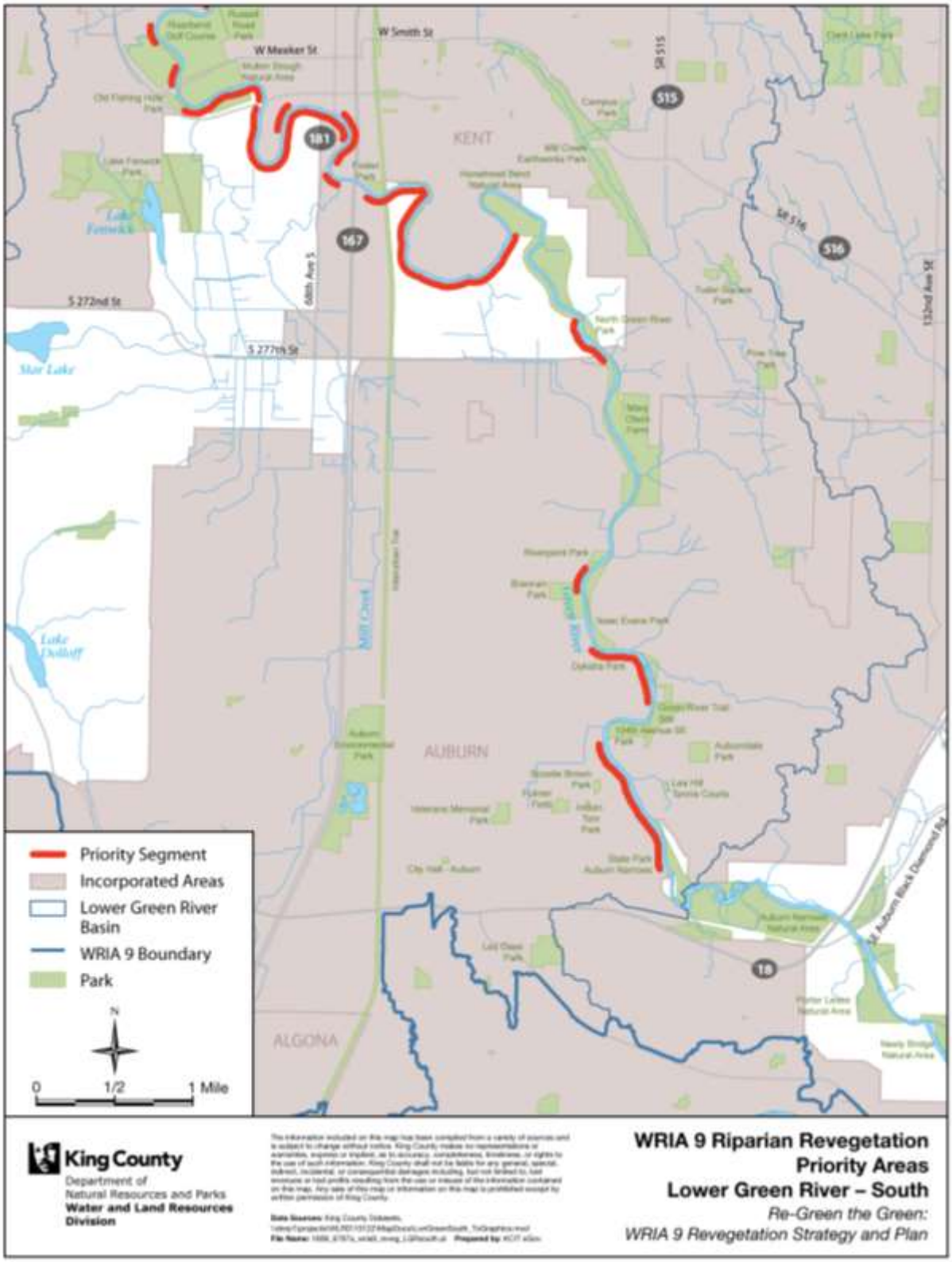

Figure 5. Priority areas for planting trees along the upstream areas of the Lower Green subwatershed.

Figure 6. Priority areas for planting trees along the downstream areas of the Lower Green River.

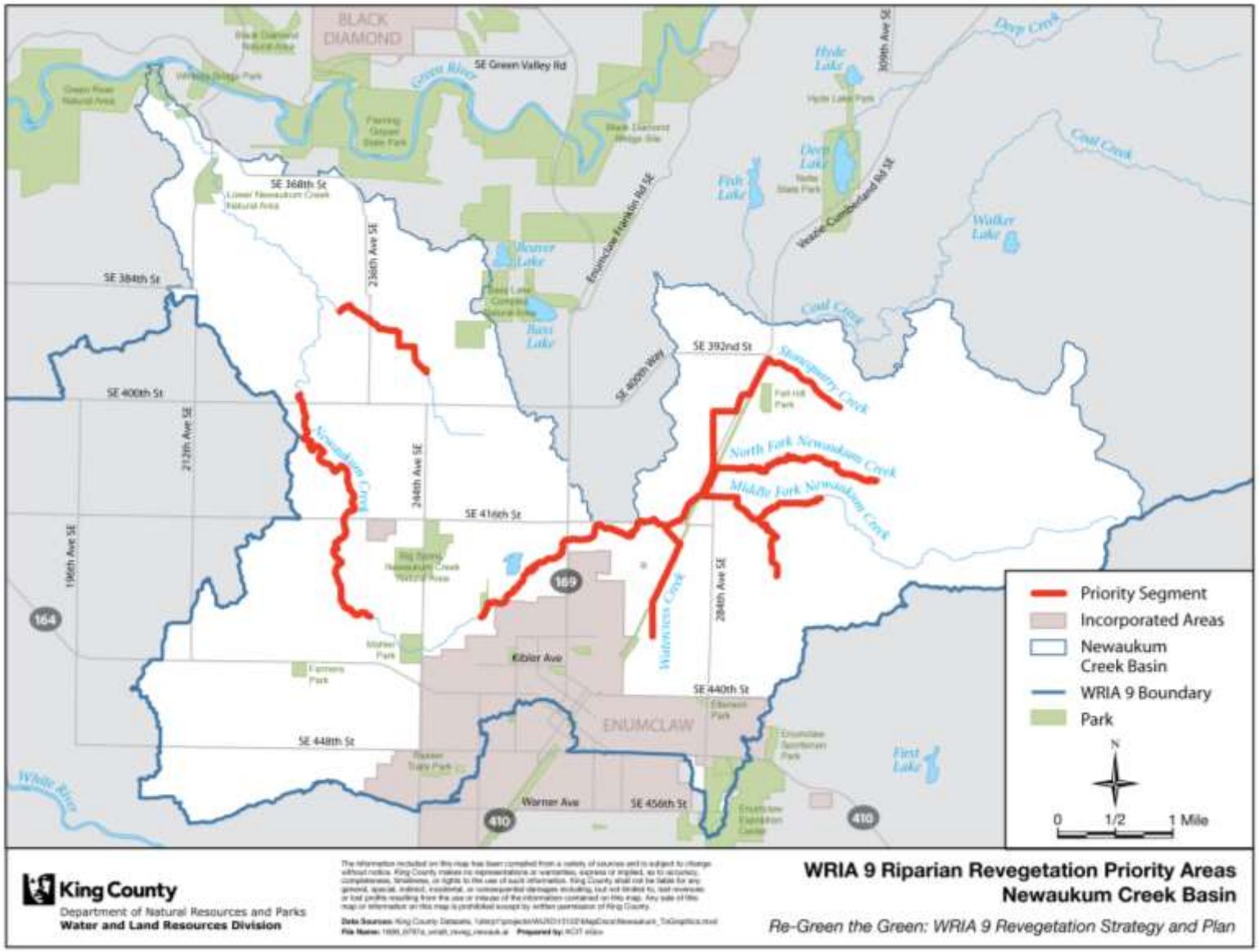

Figure 7. Newaukum Creek basin priority areas for planting trees.

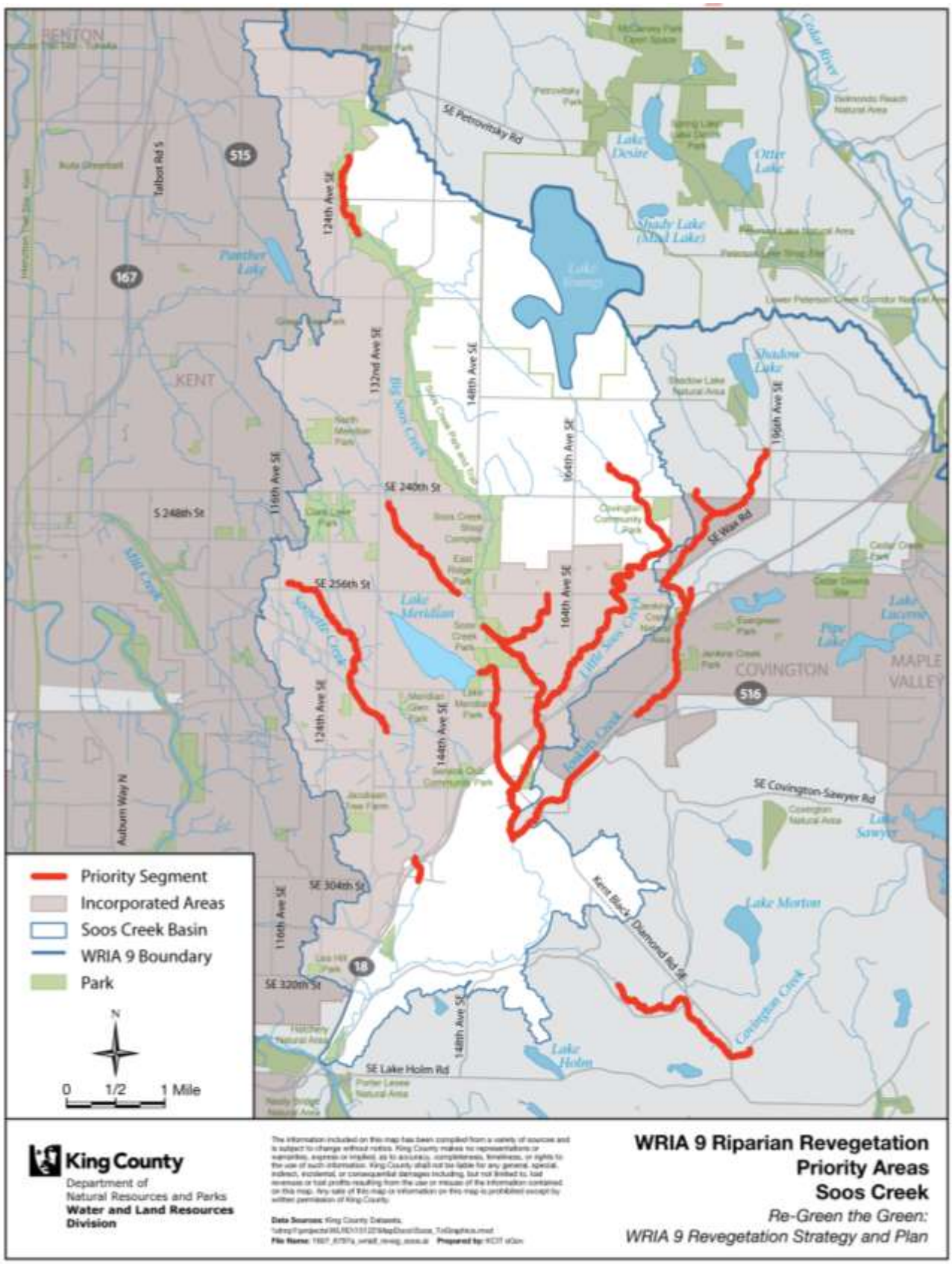

Figure 8. Soos Creek basin priority areas for planting streamside trees.

Figure 9. Duwamish River and subwatershed priority areas for planting trees.

Table 2. Targets for area of revegetation in WRIA 9 subwatersheds and other areas by the year 2025. These targets represent approximately half of the unforested buffer area, based on a buffer width of 150 feet on either side of the mainstem Green/Duwamish River and 100 feet on either side of all other channels.

Priority	Location	Target: Area of Revegetation (acres) by 2025	Target: Length of Bank (feet)	Estimated Number of Properties	Priority Area Description
1	Middle Green Mainstem	175	23,000	38	Flaming Geyser State Park, downstream to Newaukum Creek confluence
1	Lower Green Mainstem	250	45,000	80	Non-levee areas with shade priority of critical, high or medium and unforested
2	Soos & tributaries	700	62,000	263	Upstream of Soos Creek river mile 3 and major tributaries
2	Newaukum & tributaries	900	64,000	159	From Newaukum Creek river mile 4 to the lower 1 mile of the 5 tributaries
3	Duwamish mainstem	170	52,000	136	Transition zone, river miles 1-10, large parcels first
3	Duwamish tributaries	20	9,000	41	Hamm, Riverton, Gilliam creeks and Black River
4	Small tributaries to Middle Green	10	4,300	15	Protect forested areas, e.g., Covington Creek
4	Tributaries to Lower Green	8	9,400	12	Mill Creek Auburn (west side of valley) most urgent for riparian
4	Upper Green	40	21,000	10	Restore processes by restoring old logging roads and clearcuts
5	Nearshore - mainland shoreline	25	7,200	70	Mouth of creeks and areas without bluffs or shade
5	Nearshore - Vashon-Maury shoreline	37	10,000	10	Maury Island Natural Area, Lost Lake Natural Area, Judd Creek estuary, Cross Landing, Tahlequah, and other

Priority	Location	Target: Area of Revegetation (acres) by 2025	Target: Length of Bank (feet)	Estimated Number of Properties	Priority Area Description
					miscellaneous sites
6	Nearshore stream - Miller-Walker	30	12,000	20	Remove English ivy and other invasives to protect trees
6	Nearshore stream - Des Moines	10	6,000	5	Map ivy for removal
6	Nearshore stream – Judd	1.4	2,000	5	Conifer underplanting in alder-dominated forest as needed due to nitrogen inputs into Quartermaster Harbor?
6	Nearshore stream – Shinglemill	6.5	700	3	Protect forested areas; fence and revegetate 630 ft cow pasture
	Total	**2,384**	**327,600**	**864**	

Implementation

Buffer width refers to the width of forested area on each side of the channel. Buffer width is generally measured from the edge of the stream at the Ordinary High Water Mark (OHWM), or edge of vegetation, perpendicular to the direction of stream flow, in an upland direction. The targets for riparian buffers in WRIA 9 are based on what has already been approved as part of the WRIA 9 Salmon Habitat Plan, as well as regionally accepted science for buffer widths in critical areas. The targets for WRIA 9 are 200 feet on either side of Newaukum Creek for the lower 14.3 miles, per project MG-6 on page 7-38 of the Salmon Habitat Plan, and 165 feet elsewhere, where feasible.

For temperature benefits, the Green River Water Temperature TMDL study states that a continuous buffer of at least 150 feet wide with trees 105 feet tall and 90 percent canopy density (system potential shade) is necessary to prevent temperature increases and meet or closely approach state water temperature standards (Coffin et al. 2011). TMDL modeling also found that taller trees would achieve added effective shade and further decrease water temperature. The Newaukum Creek temperature TMDL allocation prescribes establishing mature riparian vegetation to a height of 32 meters (105 feet) and width greater than 148 feet (Lee et al. 2011) to achieve temperature goals. Predictive modeling of temperatures showed that planting unforested areas of Newaukum and Soos creeks was most beneficial, and that vegetation density is important for increasing shade (King County 2015). Because the TMDL guidelines are only intended to address temperatures, buffer width recommendations are smaller than those previously developed by WRIA 9 partners. Buffer widths of 100-300 feet are recommended for protecting fish communities, based on a literature review of effects of various buffer widths (Sweeney and Newbold 2014). Wider buffers help maintain macroinvertebrate ecology; increase

likelihood of LWD recruitment; reduce fine sediments; remove nitrogen from surface runoff; and provide protection from soil loss.

Objectives

1. Work with willing landowners, target private and public lands, and acquire easements or other agreements to ensure the long-term establishment and maintenance of native riparian plantings.
2. Recruit partners to contribute to an annual grant program to support non-profits and government agencies to coordinate and carry out these projects; track and report on annual progress.
3. Begin with targeted knotweed removal along the entire river and tributaries, because knotweed takes years to control, and small fragments will float downstream and recolonize treated areas if not controlled comprehensively.
4. Use local native plant lists (see Washington Native Plant Society or King County Native Plant Guide online) along with their preferred conditions to guide replanting efforts on different sections of river and tributaries, and strive for at least 165 feet of native riparian forest on each side of channels in WRIA 9, and 200 feet along the lower 14.5 miles of Newaukum Creek, where possible. Start with areas that are denuded or dominated by invasive weeds, rather than creating higher diversity in areas that already have riparian trees established.
5. By 2025, have 2,384 acres of riparian bank in active revegetation (planning/outreach, weeding, planting, 2-5 years of monitoring & maintenance, and/or long-term maintenance) in WRIA 9.
6. Work with WRIA 9 partners to further develop revegetation priorities, and share monitoring information with partners to continually adapt and improve techniques and reduce costs.
7. For temperature reduction, recommendations (Davies et al. 2004) include:
    - Plant reaches at least 1,200 meters (approximately 3.600 feet) long along tributary streams to enable temperatures to cool to pre-clearing temperatures.
    - Trees planted on south banks of the Green River will provide more benefit than those on the north banks. Refer to the riparian aspect maps for priorities for shade based on stream direction and the bank aspect (http://gismaps.kingcounty.gov/**TreePlantingViewer/**).
    - Plant areas that have no trees first, then plant within areas that are partially forested.
        - Underplanting forested riparian areas is beneficial in order to increase species diversity, add conifers to areas dominated by deciduous trees (because conifers live longer and decay more slowly after they fall), and/or increase the density of forested areas. Underplanting may become a priority in the future.

Determining techniques for the site

Sites should be assessed carefully, and techniques that are used should be proven and the lowest cost given the site conditions. The ownership of the site is an important determinant of what techniques will be used, as are the size of the site, level of weed infestation, and soil type and water table depth. The following are typical phases of a revegetation project:

Site Selection: consider factors that can affect the potential to successfully implement a revegetation project (landowner permission, contamination, levees, access, soil conditions, utilities, etc.)

Planning/Outreach: outreach to landowners/organizations, prepare plant lists or planting plans, obtain permits

Plant Selection: choose plants appropriate for the site; consider ecological succession. Use live stakes (cottonwood, willow, dogwood, etc.) where appropriate – they are easy to carry in bundles, and can be planted quickly. As a general rule, plant 80% shrubs, 20% trees. Select plants appropriate to the site conditions, considering exposure, soil moisture, etc. Select fast-growing plants adapted to river conditions, such as alders, cottonwoods, willow, and Douglas fir, and include a high proportion of shrubs, such as Pacific ninebark and red-osier dogwood. Refer to native plant web sites to select plants, e.g., Washington Native Plant Society and King County Native Plant Guide.

Site Preparation: remove invasive vegetation mechanically and/or chemically, drilling planting holes, etc.

Planting: install plants during the planting season (generally October through March). The soil around the plant stem should be the same height before and after planting to prevent insect damage and disease. If using bare root stock, make sure roots stay moist and that they are planted so that the roots are spread out evenly and not bent into a J shape.

Intensive Maintenance: aggressively maintain recently-planted sites, including watering, removing/spraying weeds, and re-planting, often for 2-5 years. Some suggest inter-planting with 25% of the plants the second year to final densities. Weeding around new plants can prevent herbivore damage by voles. For beaver or nutria, consult with experts at King Conservation District, King County, or other agencies for current best practices.

Monitoring: usually done during intensive maintenance in the first 2-5 years after planting. Assess planting project success, challenges, and adaptive management needs regularly for at least 10 years.

Long-term Maintenance: Visit the site every 6-18 months after plants have become established, usually after the initial monitoring and maintenance that may have been required is complete. Control weeds and replace plants as needed.

The phases of riparian revegetation, listed above, may take a different level of effort for public and private lands. Local Critical Areas Ordinances, enforced by the local jurisdiction, dictate maintaining natural streamside vegetation, with buffer widths based on whether the stream is fish-bearing and perennially flowing. Riparian revegetation on private property can only be done where there are willing landowners. Outreach to some landowners may take education and relationship-building before they will be willing to allow revegetation on their property. Planting plans must be developed with property owner input, and plant stock may be larger and more specialized. Smaller sites may involve more planning effort per acre, which can add to costs.

Equity and Social Justice

The development of outreach tools that consider a diversity of interests and concerns in streamside communities along the Green/Duwamish River should be prioritized and seen as an opportunity to engage one of the most ethnically and economically diverse populations in the Puget Sound. For example, grant programs could offer more points to proposals in typically underserved or immigrant communities, especially if riparian restoration design and implementation are introduced in ways that are culturally significant to each group, or specifically tied to the needs or wants of a community in terms of public health.

Research shows that the presence of trees and green spaces provides an antidote to stress and supports general wellness, as well as encouraging outdoor activities. Trees filter many types of air pollutants and contribute air cleaning services. The surfaces of leaves trap airborne dust and soot, removing millions of pounds of air pollutants annually from the air. Health impacts resulting from air pollution are found in the communities surrounding the Duwamish and are primarily the result of fuel emissions (diesel, gas, and wood burning). Documented health issues in these communities include asthma, cardiac illness, and others. Not coincidentally, these industrialized neighborhoods also have lower household incomes and limited English proficiency, making the health impacts that much more difficult to overcome (Puget Sound Clean Air Agency 2016). Opportunities to collaborate on revegetation projects with established groups with ties to local communities such as Green River Coalition and DIRT (Duwamish Infrastructure Restoration Training) Corps should also be pursued as part of the riparian revegetation strategy.

Climate Change and Resiliency

Impending projections regarding climate change (Mauger et al. 2015) indicate a need to take actions to both prevent and slow climate change and to adapt to new precipitation and temperature regimes. Salmon are vulnerable to climate change impacts including warmer air and water temperatures, low summer stream flows, and more intense winter flows. Mature streamside forests and their shade help reduce temperature changes in streams, and can even mitigate winter stream flows in some cases, which will make salmon populations more resilient in the face of climate change. Trees sequester carbon, absorb water, and prevent the air and water from warming, so planting and maintaining large trees is a great way to slow and minimize the effects of climate change.

Riparian tree planting recommendations for climate change adaptation and resiliency include:

- Plant native trees to provide shade to offset warmer water and air temperatures.
- Because local native plants may not be able to sustain themselves under new climate conditions (Kim et al. 2012), sourcing a portion of seeds for Washington native plants from areas further south, such as western Oregon, could hasten adaptation of local plants. More research is needed to determine potential benefits and risks of this approach.

Tracking

With many different groups working to revegetate streamside areas in WRIA 9, there is a need to coordinate efforts. It will be important to be able to easily find out who is doing work and where, in order to reduce duplication of efforts, avoid contacting the same property owners multiple times with similar requests, and ultimately, to save money and be successful.

To facilitate tracking of revegetation sites, WRIA 9 has created an online interactive map called the Tree Planting Viewer. The map will be used across King County for tracking planting projects. Anyone active on a site will be able to request the username and password specific to their WRIA to enter project information onto the map using an app called Collector (ESRI) on their mobile device (smartphone or tablet). The map will be updated immediately. Users will have the choice of creating a polygon or a line to represent a project area, and will enter their contact information, the type of work completed, and the number of trees and shrubs planted, the date, and the dimensions of their area. The online interactive map is available at http://gismaps.kingcounty.gov/**TreePlantingViewer**/. The map includes

base layers intended to help practitioners identify high priority areas that are suitable for planting. Project sites will be categorized by phase of work, as follows:

- **Inactive** – areas in need of riparian work – invasive weeds are present, and/or the area has less than 50% trees within 150 feet of the channel, and there is no activity towards revegetation
- **Planning/Outreach** - outreach to landowners, planting plans, permitting
- **Site Preparation/Weeding**– removing vegetation, grading, erosion control, etc. in preparation for initial planting
- **Planting** – first time plant installation after removing invasive weeds or other non-native plant cover, or to get trees established
- **Intensive maintenance and monitoring** – maintenance of recently planted site, including watering, weeding, planting, installing plant protection, etc. Often 2-3 years.
- **Long-term maintenance** – bank canopy cover is 100%, natives are established, minimal invasives are present, active weeding occurs every 6-18 months to maintain the condition.

WRIA 9 staff will work with project sponsors to assist with getting projects entered onto the map. A web page will allow users to view project summaries to track the progress of riparian revegetation.

Monitoring and Long-term Maintenance

A small proportion of funding for each project will be allocated to monitoring plant survival and/or canopy cover. Grants may be awarded for monitoring and research needs on a large scale for consistency of methods to enhance comparability across sites.

Funding for long-term maintenance of replanted sites is extremely important for their long-term viability. In this highly disturbed watershed, weed invasions are imminent, and knowledgeable crews (whether professional or volunteer) need to go through sites every six to eighteen months to pick up trash, clear invasive weeds, replace dead plants, and report vandalism or homeless encampments.

Mitigation

Planting sites will be needed for offsetting impacts to other sites where appropriate. While removing vegetation from regulatory buffers is undesirable due to the negative effects on water temperature and fish habitat, there remain instances, hopefully rare, where such actions are permitted. Along the Green River except in areas with low riparian aspect priority, removing vegetation for any purpose is especially undesirable. When such impacts occur, and sites are needed, mitigation sites should prioritize areas of high and critical shade need that are located on private property, and conservation easements should be purchased to ensure that these sites remain vegetated. Groups that oversee mitigation programs, such as the Mitigation Reserve Program's Implementation Review Team, should be made aware of the comprehensive revegetation efforts in WRIA 9 and the interactive map, and those doing mitigation projects are encouraged to enter their sites and planting dates.

Education

If we are to be successful in revegetating and protecting riparian areas in WRIA 9, the people who live, work, and recreate along the river and its tributaries need to understand and appreciate the role of trees to benefit human health and well-being as well as the natural environment. Recent analysis found that trees continue to be removed in riparian areas, especially on private property in the Middle Green,

and near existing development on the nearshore (WRIA 9 ITC 2012). As it stands, many people see trees more for the problems they cause than the solutions they create. Education programs or campaigns should aim to change the culture around trees in WRIA 9 by focusing on:

- the value of trees for human health and well-being;
- the role of trees in providing shade to reduce temperatures and meet CWA standards;
- the essential need for trees along rivers for many elements of salmonid habitat to meet ESA goals;
- understanding the need for what may seem like untidy and dense vegetation along streams to provide habitat and shade;
- working with parks departments and managers to refine ways to incorporate view corridors that do not greatly diminish the benefits of riparian plantings;
- acknowledging that there are trade-offs regarding things like views of the river or homeless encampments and meeting tribal treaty fishing obligations, retaining sport fishing, federal ESA and CWA, etc.;
- carbon sequestration benefits of trees to assist us with meeting our GHG emissions reduction goals as part of the Strategic Climate Action Plan;
- planting trees will assist with meeting the King County Million Trees Campaign project; and
- potentially convening a workshop and/or tour for grant applicants and recipients to share lessons learned, such as:
    - research being done by King County (ERES) on revegetation techniques;
    - successes, lessons learned;
    - cost-benefit of different weeding, planting, and maintenance strategies, and dealing with herbivores; and
    - successful outreach techniques for diverse audiences.

Challenges

Planting trees in wide swaths along the Green/Duwamish River and its tributaries will have many benefits to the environment, the people who live in the watershed, and ultimately improve the quality of life for the many people who live and work here. Despite this, and the many regulations protecting streamside habitat, trees continue to be removed and many barriers to planting trees remain (WRIA 9 Implementation Technical Committee 2012). The most challenging barriers are lack of funding, lack of space due to development, including levees and revetments, planting restrictions on levees and revetments, balancing recreational and environmental priorities, and policies and practices on agricultural lands. These challenges are addressed in detail here.

Levees and Revetments

Levees are mounds of dirt and rock built up to protect areas from flooding; revetments are banks which have been fortified by placing large rock, wood, or other materials to prevent erosion. A recent analysis found that ***over 36 miles of levees and revetments are in place along the Green/Duwamish River; of these, 70% do not have large trees*** (King County, unpublished data)***.*** Physical characteristics of levees and revetments, as well as regulatory issues, present extra challenges to establishing trees; some of

these constraints are described here. Because planting on or near levees is problematic, WRIA 9 encourages setting back levees and creating planting benches on the riverward side in areas of high priority for revegetation.

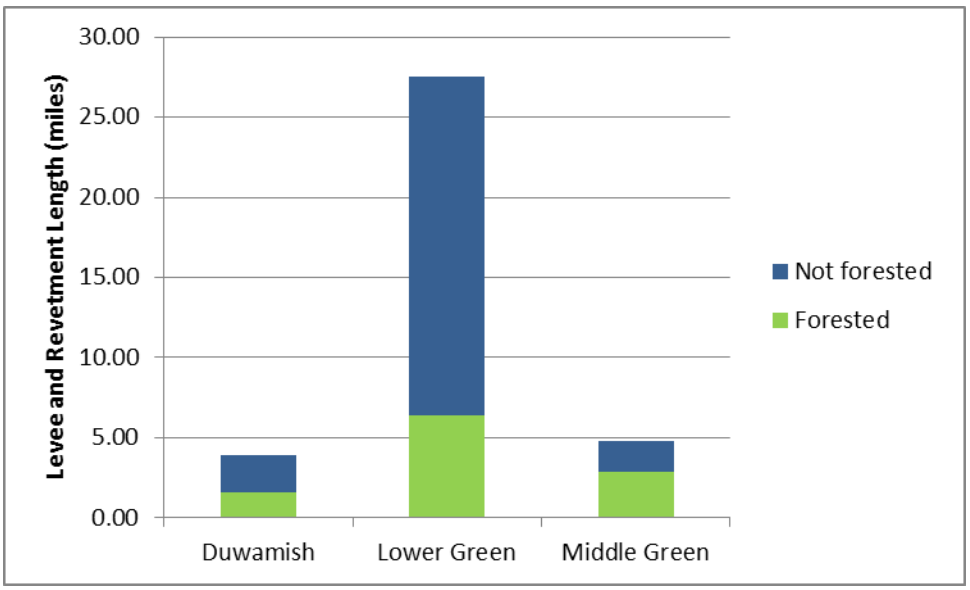

Figure 10. Length of banks with levees and revetments in each subwatershed area along the main stem Green and Duwamish Rivers, and the amount forested and unforested.

Levee Vegetation Standards and Limitations

Levee vegetation standards are determined by whether a jurisdiction has chosen to enroll in the United States Army Corps of Engineers levee Rehabilitation and Inspection program (a.k.a. PL 84-99), and are still being debated in the region. They dictate which parts of a levee may be revegetated and the nature and long-term density of this vegetation. The primary issues these standards are intended to address are structural integrity and inspection. Large trees may be a concern if they fall and uproot a critical section of the levee. Dense vegetation can prevent adequate inspection. However, restricting vegetation on levees that are near the river causes water temperatures to warm and limits habitat, and is in conflict with other federal laws including the Clean Water Act and Endangered Species Act, as well as tribal treaty rights (Figure 11). Federal agencies (Army Corps of Engineers, National Oceanic and Atmospheric Administration, and the Environmental Protection Agency) are

Figure 11. Typical levee on the Lower Green River, with non-native shrubs offering very little shade.

encouraged to find creative solutions for WRIA 9 that balance the need for flood protection with ensuring wide riparian areas with tall, densely planted native trees and shrubs, for example, reducing the risk of trees to levees and nonstandard levee inspection approaches (i.e., from the water).

Recent plans to accommodate levee inspection and repair will likely include limiting planting on PL 84-99 levees to widely spaced shrubs on the landward levee slopes and inspection areas, and trees and moderately dense shrubs on the lower one half to two thirds of the riverward slope of the levees. The top of the levee and a 15-foot corridor on the landward side will not be planted, as they serve as a levee maintenance road and recreation trail. In order to remain in compliance with current levee standards, particularly with respect to inspection, vegetation on levees needs to be more intensively managed than at other, less constrained restoration sites. Depending on the levee configuration, it may be possible to conduct inspections from the water. Inspection from a trail at the toe of the levee is discouraged because trails disturb the riparian corridor, are costly to maintain, and may provide egress for homeless encampments. Restoration projects on levees should be reviewed by County river and floodplain management staff to ensure there are no conflicts between the planting plan and levee vegetation standards, and to be sure revegetation projects are included in long-term maintenance plans. Generally speaking, planting on revetments will be less constrained than on levees since there are no formal vegetation management standards for these facilities.

Adjacent Land Uses

Levees and revetments are constructed to prevent flooding and erosion of adjacent lands. In most cases, the protected land uses begin near the landward edge of the levee. If trees are not compatible with these land uses, then problems may arise, especially as trees mature and become more susceptible to strong winds which can fell trees or break large branches. In some cases, the mere perception that trees are a problem can be a barrier to long-term tree establishment. On the Green River, a regional recreational trail has been built on the levee crest, and in some areas there is a reluctance to allow the establishment of continuous vegetation that will eventually block views.

Adjacent land uses must be considered and planned for when designing revegetation projects on levees and revetments. Planting trees in high shade value areas and lower shrubs in low shade value areas to allow intermittent views along the river is one potential approach. Adjusting values to better recognize the need to protect and restore valuable fish runs should make the added cost of maintaining vegetation on levees and revetments more acceptable to levee managers and public and private landowners. The close proximity of adjacent, typically developed, land uses associated with levees means that outreach needs may be as intense on these typically publically-owned lands as at other restoration sites.

Inundation

Regular or even one-time inundation of levee planting sites and the associated high velocity flows, heavy debris loading and sedimentation can dramatically impact the success of planting projects on levees and revetments. High velocity flows can dislodge newly planted vegetation, flood-borne debris can cause plants to become deformed or killed, and sediment can smother plants.

Appropriate species selection and enhanced maintenance can help improve the success of levee and revetment planting projects. In general, only species tolerant of being buried in sediment, such as black cottonwood (*Populus balsamifera*), Western redcedar (*Thuja plicata*) and willow (*Salix* spp.) should be planted on lower and middle slopes of levees and revetments. Species less tolerant to sediment, such as Sitka spruce (*Picea sitchensis*) and Douglas fir (*Pseudotsuga menzeseii*) are appropriate for constructed benches on the upper slopes of levees. Enhanced maintenance may include manually resetting partially uprooted plants during the first year of plant establishment and removing debris from impacted plants. These additional maintenance needs should be included in long term site management planning.

Recreation

Balancing recreational needs with environmental needs in this populated watershed can sometimes be challenging. Trails along the river provide needed access to the water for fishing, boating and swimming, as well as pathways through open spaces and parks for walking, jogging and biking. Trails that provide public access can help prevent vandalism and safety issues because of the presence of people, but in some cases provide pathways in for vandals, homeless encampments, and dumping trash. Dense vegetation in large blocks is necessary for wildlife habitat; studies show that birds nesting in areas with trails have a more difficult time raising young because they get disturbed too frequently, and dense riparian vegetation provides better shade and temperature regulation than sparse. On the other hand, dense streamside vegetation is disliked by some because it can block views or provide hiding places for criminals.

As long as vegetation in riparian areas is managed in ways that do not violate regulations, including local critical areas ordinances and shoreline master program rules, management decisions are up to individual landowners. Trends showing that riparian vegetation cover has declined over time (WRIA 9 Implementation Technical Committee 2012), primarily in developed areas and on private property, indicate that those rules are either not being followed, or that they are not effectively protecting river and stream banks. Recent investigations along the WRIA 9 nearshore found that shoreline regulations were not being consistently followed or enforced in WRIA 9 (Higgins 2014). The 2015 program implementation survey found that lack of capacity was commonly cited as a reason for not enforcing land use regulations (WRIA 9 Implementation Technical Committee, in review).

As recommended in the WRIA 9 Status and Trends report (WRIA 9 ITC 2012), further investigation into the reasons landowners remove native riparian vegetation is needed so that education, outreach incentive and other programs can be more effective. In addition, creative solutions that balance recreation, safety, and the environment need to be developed and shared.

Agricultural Lands

King County designated certain agricultural lands as Agricultural Production Districts (APDs) in 1979 to protect them from urban development. There are three APDs in WRIA 9: Lower Green (Figure 12), Upper Green, and Enumclaw (Figure 13). All of the APD lands in WRIA 9 drain to water bodies that exceed water temperature standards (Green River, Soos Creek, or Newaukum Creek). The APD area in WRIA 9 is over 25,500 acres, and there are approximately 237 miles of streams or other drainages inside the areas; roughly 86% of riparian areas in the APDs are not forested, when measured to a width of 150 feet on each side of the channel (Table 3).

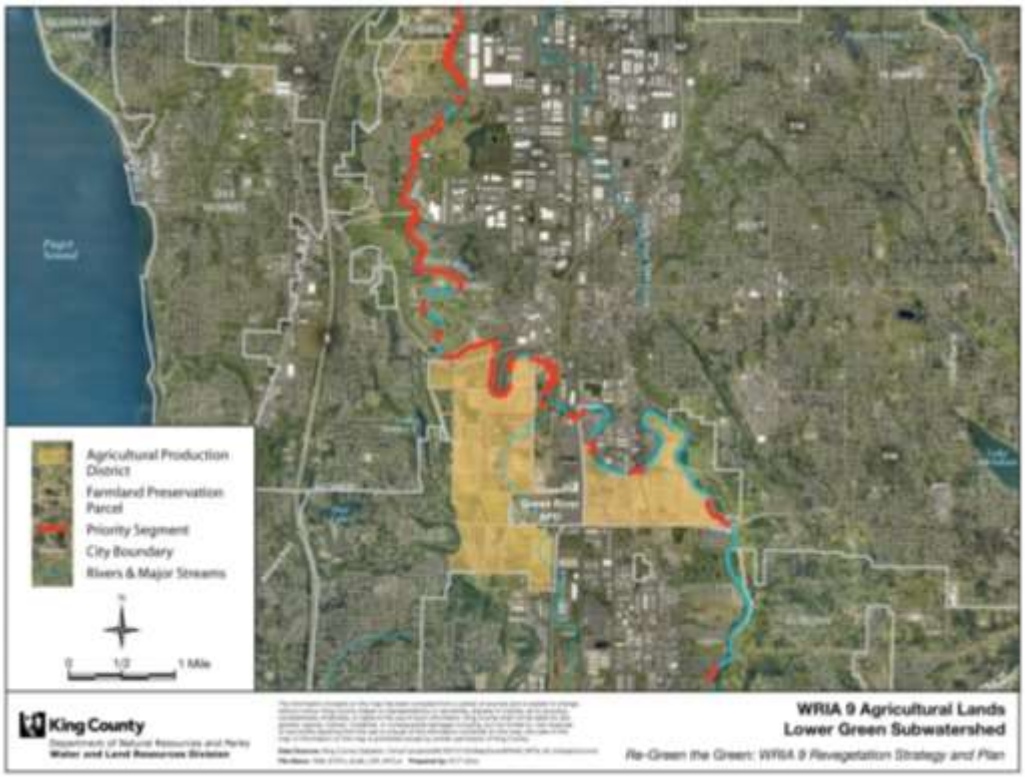

Figure 12. Protected agricultural lands in the Lower Green subwatershed.

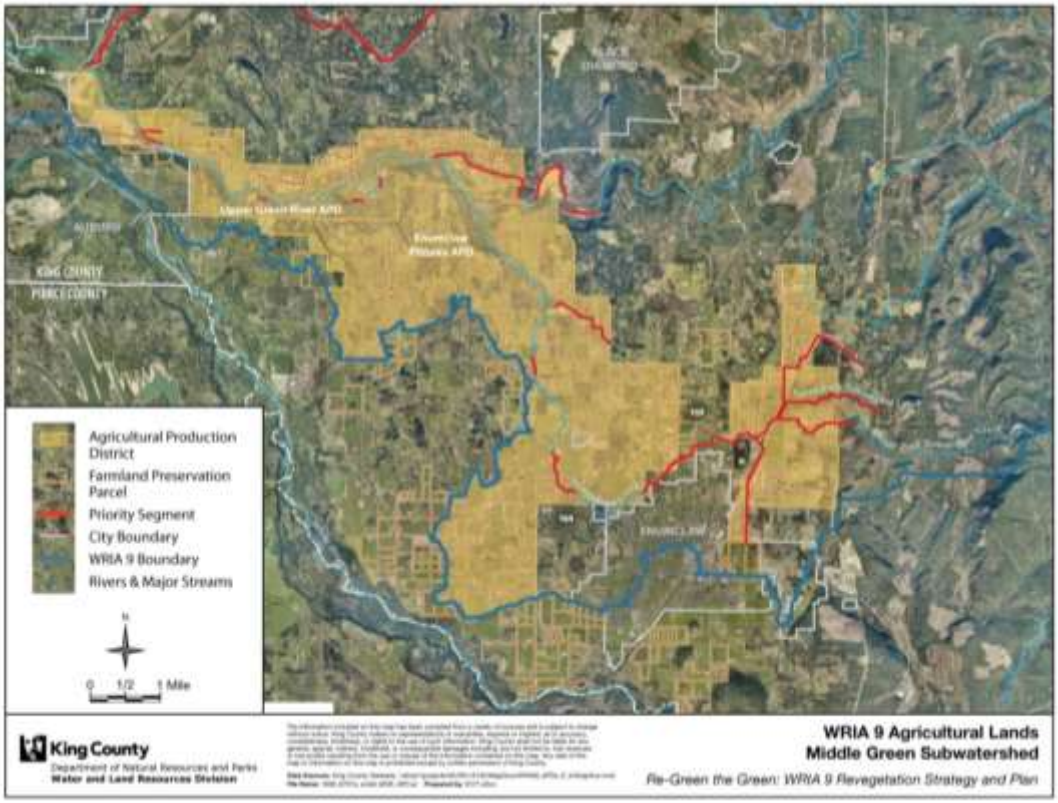

Figure 13. Middle Green River Agriculture Production District and Farmland Preservation Program lands.

Table 3. Agricultural Production Districts (APDs) in WRIA 9, total area, and potential area of forested buffer.

Agricultural Production District Name	Size (acres)	Stream length (miles)	Potential buffer area at 50' ? (acres)	Potential buffer area 150' (acres)	Unforested APD buffer area – 150' (acres)*	% Unforested stream length in APD*
Lower Green River APD	1,459.7	13.7	157	415.9	408.5	98%
Upper Green River APD	3,417.8	30.2	354.6	989.5	677.5	68%
Enumclaw Plateau APD	20,684	193.1	2199	5,921.9	5,250.9	89%
Total	**25,561.5**	**237**	**2,710.6**	**7,327.3**	**6,336.9**	**86%**

* Amount of unforested land in this area could only be calculated for 150 foot buffers because the land cover map has 90' square pixels. These are very rough estimates of amount of forested cover, and do not include recently planted areas.

Some farms, both inside and outside the APDs, have covenant restrictions on the percentage of the parcel that can be converted to "non-tillable" under the Farmland Preservation Program (FPP). Forested buffers have been interpreted as part of the non-tillable surface in recent years. FPP properties are primarily located within APD areas in the Green River watershed. The total area of FPP in WRIA 9 is approximately 5,030 acres. The distribution of FPP lands across the different APDs in the Green River watershed are shown in Table 4. There are approximately 36 miles of streams, river, and/or ditches that cross FPP lands in WRIA 9.

Table 4. Farmland Preservation Program areas for each APD, stream length, and percent riparian buffer without forest.

Name of Agricultural Production District	Length of Stream (miles)	FPP Area (acres)	% of APD in FPP	FPP Streams length within APD (miles)	Percent of APD Stream Length in FPP	Unforested FPP Buffers (150')* (acres)	% unforested FPP buffers (150')*
Lower Green River	13.7	979	67%	8.38	61%	302.2	100%
Upper Green River	30.2	804	24%	5.45	18%	156.3	85%
Enumclaw Plateau	193.1	2693	13%	18.55	10%	572.3	91%
Non-APD	n/a	823	n/a	3.67	n/a	87.9	68%
Total	237	5299	**21%**	36.05	15%	1030.8	92%

* Amount of unforested land in this area could only be calculated for 150 foot buffers because the land cover map has 90' square pixels. These are very rough estimates of amount of forested cover, and do not include recently planted areas.

WRIA 9 Agricultural Lands Policy

The WRIA 9 Salmon Habitat Plan was written in 2005 and was intended to be a 10-year plan to prioritize actions for salmon recovery. Restoration on agricultural lands was addressed in Implementation Chapter 8 (page 8-27), but the policies addressed large salmon habitat restoration projects on agricultural lands rather than riparian buffer planting, and advised completely avoiding certain farmlands. Since 2005, warm water temperatures and the need for riparian shade have become more urgent priorities. It is recommended that new policies for riparian buffer planting on agricultural lands be implemented based on these new priorities. and with strong input from King County's agricultural program, as follows (recommended deletions are shown with strikethrough, additions are shown in red):

~~For the first 10 years of the Habitat Plan, the~~ The construction of the priority habitat rehabilitation projects identified ~~by the Middle Green "Blueprint" (Chapter 7)~~ for the mainstem Green River shall be sequenced as follows:

1) Projects located on existing public land or where the channel is devoid of riparian vegetation shall be implemented first;

2) Projects located within the Rural and Urban Growth Areas shall be implemented second; and

3) Projects that are within the Agricultural Production District, ~~but not on farmland that is within the Farmland Preservation Program,~~ shall be implemented third and shall follow the principles of Habitat Plan Policy I18.

***Policy I18**: Jurisdictions shall protect, enhance, and restore high quality salmon habitat in the Agricultural Production Districts while retaining the agricultural lands zoned for protecting and maintaining the viability of agriculture. Jurisdictions and agencies shall work with agricultural landowners in the Agricultural Production Districts to:*

- *Correct water quality problems resulting from agricultural practices, including:*
  - *Implementing best management practices for livestock and horticulture.*
  - *Planting riparian corridors as needed where temperature is a water quality issue for salmonids.*
- *Prevent any further removal of forested riparian buffers through adherence to critical areas ordinance and shoreline master program implementation and enforcement.*
- *Continue riparian plantings, levee and revetment setbacks, relocation of channels and construction of off-channel refugia, limiting the scope of projects such that future farming on non-forested acreage is not precluded through acquisition unless:*
  - *Projects are on lands that are not farmed or deemed as farmable; or*
  - *Projects also present benefits for farmland such as reducing bank erosion.*
- *Encourage landowners to pursue voluntary sustainable actions for fish, farms, and soils.*

Since the original agricultural policy for WRIA 9 was written, three temperature TMDL areas have been designated in WRIA 9 due to high water temperatures that are causing stressful and lethal conditions for salmonids. APD and FPP lands overlap these TMDL drainage areas, and planting riparian buffers to increase shade is the most effective strategy for reducing water temperatures. Most of the Newaukum Creek TMDL and Middle Green River priority areas are within the Enumclaw Plateau APD, and only small areas overlap with FPP (see King County's Tree Planting Viewer map). Potential for riparian buffer plantings exist on FPP properties, but the existing covenants on each property need to be carefully understood before planting plans are created. Each FPP Deed and Agreement Relating to Development Rights (Deed) limits the proportion of non-tillable surface allowed on the property. Current FPP policy says that a replanted 25 foot buffer along a waterway would not count against the non-tillable surface limit if the planting would improve or protect the agricultural use on a part of the property. If the landowner chooses to plant a buffer larger than 25 feet or plant a buffer that would have no agricultural benefit, any area beyond the initial 25 foot buffer or that adds no agricultural value will count towards the non-tillable surface limit associated with the Deed that protects the property.

Figure 14. Mill Creek in the Lower Green River basin on a farm showing the riparian area had been recently sprayed with herbicide. This photo was taken on an APD, and the spraying continued onto the FPP property downstream. Photo courtesy of City of Kent.

The FPP program was changed in 2009 to allow riparian restoration to the extent the landowner wants at the time of the FPP purchase, but most FPP Deeds were created prior to 2009. There are currently 5,030 acres in FPP in the Green River watershed, and a 25' buffer on all of the streams on FPP lands would equal 210 acres, or four percent. It should be noted that a buffer width of only 25 feet will not be as effective in shading the Green River compared a buffer width of 100-200 feet. Further work is needed to find a way to facilitate a wider tree buffer on FPP lands with willing landowners given the serious Clean Water Act and ESA concerns now at stake, within the context of our shared desire for habitat restoration and fish recovery within a landscape where agriculture is both culturally sustainable and economically viable.

King County agricultural program staff recommended working closely with FPP landowners and the King County FPP program manager to complete restoration compatible with FPP rules on a site-by-site basis. Predicting and tracking the amount of productive farmland that needs to be converted to riparian buffers is important for the King County agricultural program. The King County Executive declared that one of his top 20 priorities from the Local Food Initiative developed in 2015 is to increase the net amount of farmland in food production by 400 acres each year, for a total of 4,000 acres by 2024. In some cases, restored riparian buffers may offset this goal, meaning additional area above the 400 acres

per year will need to be found to meet that goal. In the meantime, this should not discourage groups and landowners from initial narrow-buffer plantings in FPP areas and wider buffers in other agricultural areas, with a future goal to plant wider buffers on FPP lands.

Farm lands in the APDs do not have as many restrictions on riparian buffers as FPP. Some farmers in the APDs may be interested in reforestation of their buffers, and they can also be identified on a case-by-case basis. Some landowners may be interested in selling a conservation easement for part of their land for the purpose of reforestation. Where possible, it would be preferable to offer farmers cost or technical assistance to make other areas more productive in exchange for planting and/or fencing riparian buffers. Farms that have had success in establishing riparian buffers and also improving drainage, or other aspect of productivity could be used as demonstration sites for other farmers who have not decided about buffers. For example, deforested agricultural floodplains are 80-150% more erodible than floodplains with a streamside forest (Sweeney and Newbold 2014).

Two King County Current Use Taxation (CUT) programs for reducing landowner taxes can be applied on farms: active farmland can be enrolled in the Farm and Agricultural Land program; and non-productive farmland and other open space can be enrolled in the Public Benefit Rating System (PBRS). When buffers are planted on PBRS lands, it requires only a modification of the management plan. On lands enrolled as Farm and Agricultural CUT, there is a 20% allowance for "incidental uses:" as long as the combined total of roads, buildings, wetlands, buffers, etc. does not exceed 20%, there is no change. If the total of incidental uses exceeds 20%, the parcel can be considered for a modified CUT (lesser number of acres) or rolled into PBRS. Neither of these options are major obstacles to buffer establishment.

Funding

The cost of planting and maintaining riparian forests is much higher than the funding available. The total estimated cost for the first ten years of riparian revegetation is approximately $28,310,783 or an average of $2.8 million per year, not including purchasing lands or easements for permanent protection. Costs in the first few years will be close to $1 million per year, because with each passing year, more lands will require maintenance and monitoring. Cost estimates were generated by soliciting cost estimates from various groups that use a wide range of techniques. The total cost estimate is based on the projected cost to the target of 2,384 new acres planted by the year 2025, and for continuing at the same level of effort beyond 2025. Foresters, community groups, and professional project managers from government provided descriptions of techniques used and cost estimates. Because the cost basis techniques varied widely, an average was used, assuming a wide range of techniques will be used to meet revegetation goals. The cost estimates used to generate the average cost per acre of $16,239 are shown in Appendix 1. Costs include landowner outreach and planning, site preparation including weed removal, planting, maintenance, and monitoring. Cost estimates do not include land purchase, conservation easements or real estate fees/costs, or research.

The goal of this strategy is to take all high priority areas in the watershed to the planting phase by 2025, and establish an annual grant program to fund governments and non-profits to carry out the work. The WRIA 9 staff team is tasked with assisting potential project sponsors obtain funds to improve habitat for Chinook salmon in the watershed. WRIA 9 applied for two Cooperative Watershed Management Grants

of $250,000 each to fund a small grants program in 2015 and 2016 to award a minimum of $50,000 per applicant for on-the-ground projects and education efforts starting in spring 2016. WRIA 9 expects to continue this program annually through 2025, which would contribute a total of $2.5 million towards the estimated cost of approximately $28 million.

To fill the estimated funding gap of $25.5 million, WRIA 9 is actively seeking additional funding partners, and it is hoped that federal and state agencies, local jurisdictions, businesses, environmental non-profits, and granting programs will see the value of contributing to this effort to working across jurisdictional boundaries to revegetate in the areas of highest need according to this comprehensive strategy. One potential funding partner is the U.S. Army Corps of Engineers, which administers the Green/Duwamish Ecosystem Restoration Program (ERP). The ERP is a set of over 40 projects on the Green/Duwamish River that were authorized by the U.S. Congress in year 2000. One of the projects, the Volunteer Revegetation Program, involves providing a cost share to jurisdictions, agencies, districts, and volunteer groups for streamside planting projects. Logistical barriers prevented this project from moving forward in past years, but it is hoped that a simple and cost-effective way to implement this project can be found soon.

In addition to more funding, WRIA 9 also seeks an experienced organization to participate in reviewing and managing grant proposals and contracts. WRIA 9 will continue to direct project sponsors to grant programs at the WRIA 9 grant funding web page at www.govlink.org/watersheds/9/funding/ - this list will be updated regularly by the WRIA 9 staff team.

Costs for restoration, generally measured in costs per acre, will vary widely depending on the existing site conditions, the types and density of invasive weeds present, steepness of slopes and site access, soil types, aspect, soil types (well-drained or moist), and depth to groundwater. These characteristics will determine the amount of effort needed for weed control, both before and after planting, the types and sizes of plants needed for greatest chances of survival, site access, and the need for watering or mulch. In addition, the choice of crews may impact costs. As of 2016, we know of one professional crew that can plant over 1000 plants per day; other professional crews may do between 300 and 800, depending on the site. Service learning crews, such as WCC and EarthCorps may cost more per plant in the ground, but these programs provide young people with meaningful work and a way to get valuable experience to start their careers. Volunteers are usually the least cost effective, but again, there are benefits aside from cost to consider, such as education, building support for salmon recovery efforts, having local eyes and ears on restoration sites to prevent vandalism or neglect, giving people opportunities to do meaningful work outside, and building a sense of community.

For purposes of fundraising and determining costs for implementation each year, it is useful to break up the steps of revegetation into phases, and estimate costs for each phase. We developed annual cost estimates (Figure 15) by estimating costs for five phases of revegetation: landowner outreach (sometimes not as necessary on public lands), site preparation, planting, intensive maintenance and monitoring, and long-term maintenance. We estimated at least 200 acres of new lands entering into the program each year (Figure 16), and that each acre would take a total of 2-3 years to get to the planting phase, require three years of intensive maintenance and monitoring, and then receive annual maintenance for the long-term to maintain healthy riparian conditions.

Annual costs were estimated by determining average costs for each of the five phases listed above, and annualizing those costs to the number of acres enrolled in each phase. Cost estimates for specific phases were provided by King County and Forterra, and were estimated for other groups based on relative level of effort indicated by the descriptions of the techniques used. The annual cost estimate assumes availability of willing landowners, funding, and groups to implement projects.

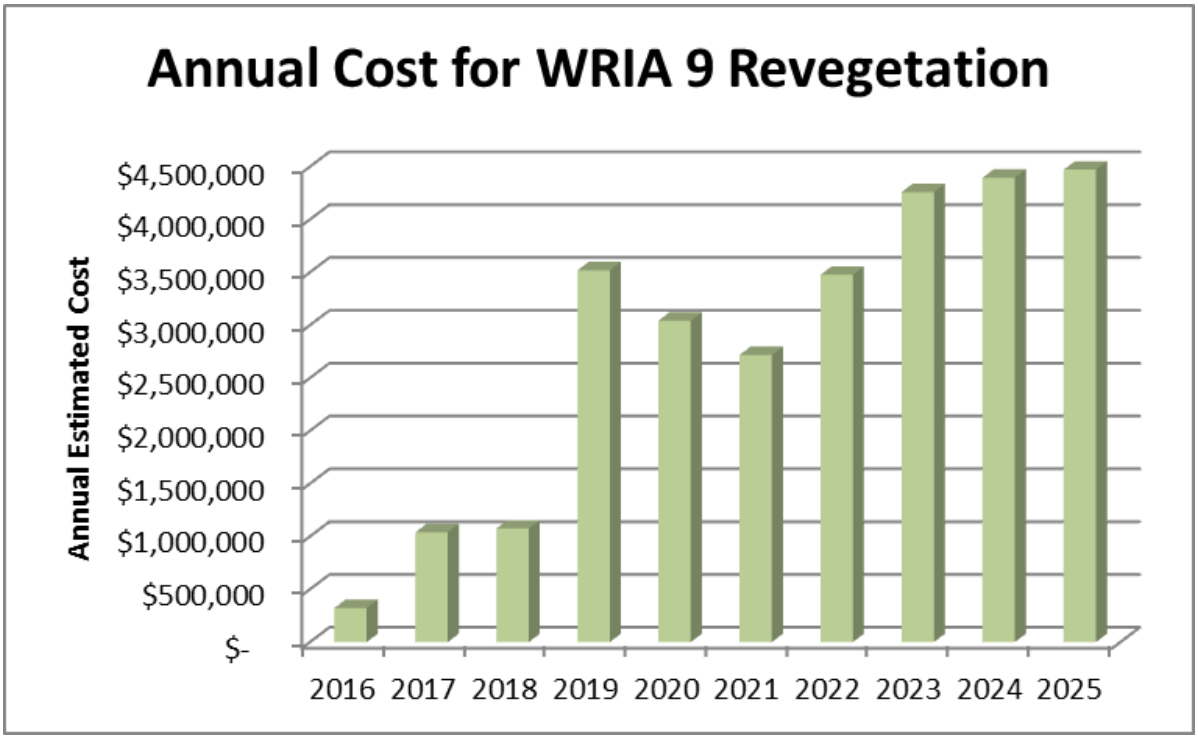

Figure 15. Estimated annual costs for the first ten years of riparian revegetation in WRIA 9. Annual costs are based on estimates of costs for five phases, including planning/landowner outreach, site preparation, planting, intensive maintenance and monitoring, and long-term maintenance. This scenario assumes that approximately 2,400 acres will be planted by 2025, and that efforts will continue at the same pace beyond 2025.

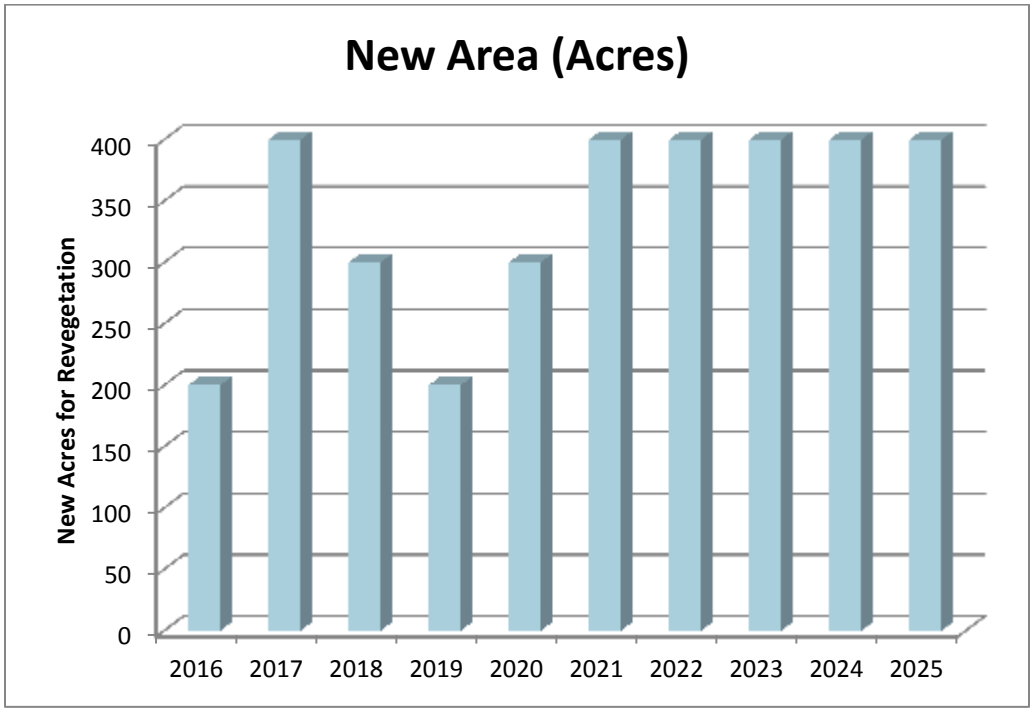

Figure 16. Annual cost estimates are based on enrolling hundreds of new acres into revegetation each year. This scenario assumes that approximately 2,400 acres will be planted by 2025, and that efforts will continue at the same pace beyond 2025.

Property Ownership

Revegetation efforts will focus on private lands where there are willing landowners as a priority. While costs may be higher because of the need to purchase lands or easements in some cases, it is important to reach out to landowners early, because it can take 2-3 years to reach agreements about replanting and future maintenance. This approach has the added benefits of educating the public about the importance of trees along waterways, and neighbors being inspired by each other. Public lands should also be aggressively replanted; this can be done at reduced costs because lands do not need to be purchased. There, landowner outreach generally takes less time, and future condition can be more easily maintained and monitored without obtaining property access permission. It has the added benefit that it will result in more shaded areas sooner.

Costs to revegetate private lands may be higher for the reasons described above. In addition, to maximize buffer widths and/or ensure future protection, it may be desirable or necessary to purchase the land or a conservation easement. Conservation easements (CE) are voluntary legal agreements between a landowner and a government agency, land trust, or other qualified organization in which restrictions on the use of a specified land area are granted by the landowner in exchange for payment to protect and/or conserve its natural resource values. CEs can be flexible and tailored to meet the individual landowner's needs and vision for the land. A CE typically protects land permanently while keeping it in private ownership. The landowner retains ownership of the property and all rights and privileges for its use, except for those uses restricted under the easement. A CE is an interest in real property established by agreement, and is perpetual and applicable to present and all future owners of the land. The grant of conservation easement is recorded and becomes a part of the chain of title for the property. Terms can be difficult to change if environmental conditions or priorities change.

Land costs are expected to vary widely by location and site condition. Acquisition fees, including a title search, soil and cultural resources testing, and appraisal are generally about $25,000 per parcel, plus an additional $10,000 where a boundary adjustment is needed, for example, to carve off part of a parcel as a separate lot for fee simple purchase. This would require approval of the jurisdiction to ensure compliance with zoning regulations (for example, minimum lot size requirements) are met. Land costs will vary widely depending on size, condition, location and zoning, as well as the economy.

In some cases, private landowners will protect or restore their own lands, or are willing to provide riparian zones for revegetation purposes without payment. The landowner is usually required to sign a temporary access easement or temporary construction easement. After buffer areas are planted, they are protected by critical area ordinances and/or fencing. Twenty-one landowners have voluntarily restored their property to date along Newaukum Creek as of November 2015.

Next Steps

To advance the goals laid out in this riparian revegetation strategy in order to improve riverine habitat and decrease water temperatures, the following actions are suggested:

- With an overall need of over $28 million over the next ten years (not including land acquisition), identify potential funding sources that WRIA 9 could use to increase funds available for an annual grant round to fund riparian revegetation projects in the watershed.
- Identify grant sources for practitioners so that WRIA 9 funds can be leveraged to attract additional funds towards this watershed-wide effort.
- Seek a partner with similar goals and expertise to run the annual grant program.
- Education of public and private streamside landowners and enforcement of existing regulations that protect riparian areas are needed to retain trees in areas that are already forested.

Research needs

- Costs for riparian revegetation are variable, much depending on site conditions. However, there are huge variations in site preparation, planting, and maintenance techniques; more research is needed to determine the best, most cost-efficient techniques for growing healthy trees on riparian banks. Encourage partners to purposefully treat planting projects as experiments to learn from them. This can be inexpensive, but requires thoughtful design during the early phases of planning
- Temperatures in the Duwamish River sub-watershed – University of Washington collected temperature data as part of a study of the salt wedge in the Duwamish. Temperature profiles should be obtained, and then it should be determined if additional data are needed. Existing data includes depth profiles around the salt wedge, but does not include temperatures across the horizontal width of the river. Timing of data collection is also unknown; temperatures during February-June and August-October during juvenile outmigration and summer/fall adult migration would be most useful. These findings may indicate the relative importance of trees along the Duwamish River for shade.

- Small tributaries, e.g., Mill, Mullen Slough are warm, but how much do they contribute to warm temperatures in the Lower Green, and what is their relative importance for shade and as fish habitat? A loading estimate for the various tributaries would be useful for prioritizing efforts.
- Upper Green subwatershed – what are temperature conditions above the reservoir? Are riparian trees needed for shade? A cursory review of the last 10 years of ACOE temperature data from the tail race indicates warm water does frequently come out of the reservoir in late summer, while according to temperature modeling, cool water is coming out of the reservoir, but it heats up quickly due to lack of riparian trees immediately downstream of the dam. An analysis of where water currently exits the dam, and whether it could be released in a way that provides cooler water is needed. The ACOE will be releasing a report analyzing their temperature data from 2002-2015 by the end of year. That report should be reviewed and any follow up research should be pursued.
- Climate change adaptation – some researchers predict that native trees will be unable to naturally reproduce after the year 2080 in the Puget Sound lowlands. Research is needed to determine which species are likely to thrive, and which species should be planted, and in what quantities, to continue to have healthy riparian trees in mountainous and lowland areas. Research on the risks and opportunities of using seeds of native plants from other regions with warmer climates and using non-native species is also needed.

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Appendix 1 – Cost estimates for revegetation

Table 5. Estimated cost per year to reach a target of 2,384 new acres planted by 2025, assuming that revegetation will continue into the future at the same level of effort.

Year	New Acres Enrolled	New Acres Planted	Annual Estimated Cost
2016	200	0	$ 322,000
2017	400	0	$ 1,038,500
2018	300	0	$ 1,074,750
2019	200	400	$ 3,517,984
2020	300	300	$ 3,041,963
2021	400	200	$ 2,716,533
2022	400	300	$ 3,475,670
2023	400	400	$ 4,258,298
2024	400	400	$ 4,394,813
2025	400	400	$ 4,470,271
Total	**3400**	**2400**	**$ 28,310,783**

Table 6. Riparian revegetation techniques used by those who provided cost estimates.

Source	Site Preparation Techniques	Plant type (bareroot or pots)	Water Plants? (y/n)	Planting Density	Maintenance Description
Robert Deal, USFS, 2014	Herbicides	bare root 1-0	no	2200-2600 stems/acre	Weed for 2 years and replace plants as necessary
Green Seattle Partnership - Oliver Bazinet	Volunteers organize volunteer work parties on flat ground, hand pull; natural area crews do woody spp and steep slopes	Pots	yes	various	3-5 years intensive, then annually
Rapid Riparian Revegetation - Oregon	mowing, brush clearing, and application of herbicides for 1-2 years	bare root 1-0 or 1-1 & stakes & seed with short, native grass	no	2,200-2,600 stems/acre	mow/spot-spray around new plants; plant 25% 2nd year at 500-800 stems/acre
Cedar River Private Property Riparian Restoration - Forterra - Judy Blanco	Crews combine manual, chemical control of noxious weeds: applications of herbicide for 3-4 years for knotweed; manual control for blackberry and ivy	Combination of bareroot, pots, and live cuttings	limited to no	Dense: 430 trees/acre, 2200 shrubs/acre, 10000 stakes/acre	3-5 years intensive, then annually
King County - Josh Kahan	Depends on site. Upland sites (Whitney for example) are generally very challenging due to dry soils, extensive sun, a lot of weeds, and dense pasture. Aggressive site prep. need. Wetland sites are mostly stake requiring minimal site prep.	Would use all container plants ($2.75 - $13 per container depending on size), at upland sites; mostly stakes at wetland sites	Upland sites would need watering, so so for wetland sites	300 trees per acre and 600 shrubs per acre on upland sites. Staking wetlands would occur at 2 - 4' centers	Extensive maintenance required for upland site. Restoration would be professionally maintained (watering, weeding). For wetland sites, very minimal maintenance generally required.
King County Rivers - John Koon	Assumes site ready to plant - post-construction. Reddington used as case study - see worksheet.	Mostly potted plants, some stakes	Yes	960 plants per acre - 3 plantings	Mulch, water, and hand weed

Table 7. Cost estimates for the different phases of riparian revegetation, including low and high estimates, which may vary based on site conditions and other factors.

	Cost Estimates – Cost per Acre											
Source	**Outreach - low**	**Outreach - high**	**Site Prep - low**	**Site prep - high**	**Planting - low**	**Planting - high**	**Short-term Maintenance & Monitoring- low**	**Short-term Maintenance & Monitoring - high**	**Long-term maint - low**	**Long-term Maint - high**	**Total Cost/acre - low**	**Total Cost/acre - high**
Robert Deal, USFS, 2014	0	0	500	2000	3000	4000	1300	4700	200	300	5000	10000
Green Seattle Partnership - Oliver Bazinet	2000	4000	8000	12000	5000	10000	9500	10000	500	2000	25,000	40000
Rapid Riparian Revegetation - Oregon	500	1000	500	2500	2500	2500	900	2000	100	100	4500	8100
Cedar River Private Property Riparian Restoration - Forterra - Judy Blanco	3000	3800	3000	3450	3000	3450	2000	2000	1000	1300	12000	14000
King County - Josh Kahan	500	1300	0	7500	4600	15000	200	7500	200	1500	5,000	35,000
King County Rivers - John Koon						$12,899.36		$7,510.30				$20,410
Average Cost	$1,200.00	$2,020.00	$2,400.00	$5,490.00	$3,620.00	$7,974.89	$2,780.00	$5,618.38	$400.00	$1,040.00	$ 10,300.00	$ 21,251.67
Average Costs - Overall		$1,610.00		$3,945.00		$5,797.45		$4,199.19		$720.00	$ 16,271.64	$ 16,273.64