Appendix B

ADAP Materials

AGRICULTURAL DRAINAGE ASSISTANCE IN KING COUNTY

The challenge

Can we drain land for agricultural productivity and protect endangered salmon species and water quality? Salmon and trout inhabit most of the streams or waterways that flow through or adjacent to farms. On the one hand, there will be no farming unless these streams and waterways – "agricultural ditches" – can be maintained as drainage-ways for adjacent farm fields. On the other hand, if this maintenance is not done with care, fish runs and water quality will not be adequately protected.

This, in a nutshell, is the challenge to keep farming and fish thriving simultaneously in western Washington. Many acres of agricultural land have not been drained for years, which greatly compromises farm productivity. At the same time, salmon and trout runs have declined to the point where some species have been listed under the federal Endangered Species Act as "threatened," and some waterways have been identified as not meeting federal Clean Water Act standards. In addition, concerns about costs to solve these problems have increased while resources available to address them have decreased.

A response

After working for years to tackle this challenge waterway by waterway, farm by farm, King County is partnering with farmers, regulators, tribes, fish interests, the conservation district, and other parties to come up with a more comprehensive and effective solution. The goal is to streamline regulatory requirements, reduce costs, and adequately drain fields for farming while protecting water quality and fish habitat.

King County has developed a system to classify waterways according to channel structure and existence of fish and then link best management practices (BMPs) to those waterway classes. The goal for the BMPs is to improve water flow and drainage from fields, minimize negative impacts on fish during and after dredging, and help improve or maintain water quality. In addition to providing the BMPs in a manual and training for farmers and contractors, King County will be working with regulatory agencies, farmers, tribes, and local salmon recovery forums to improve how onsite waterway maintenance can be better linked to priority improvements for fish habitat and water quality at the larger landscape scale. The county also expects to show how successful use of the manual, along with voluntary efforts by farmers, can enhance fish habitat and water quality, in turn allowing for streamlining of permit and regulatory requirements for maintenance projects.

Background

Western Washington has a rich history of both farming and fishing. The area is criss-crossed by large river systems and receives from 20 to 180 inches of precipitation a year that commonly falls from October through March. About 25 to 80 inches fall in the major agricultural areas.

In 2007, King County had 49,285 acres in agricultural production. This land produced goods valued at more than $127 million dollars, making it one of the top 15 agriculture-producing counties in Washington State. King County's agriculture is a mix of fresh fruit and vegetables, ornamental and horticultural plants, pasture land, and a wide diversity of livestock. This production has historically taken place in river floodplains because of the rich soils and access to water sources. Upon initial settlement by farmers, much of the floodplain was drained, mostly by modifying and straightening existing waterways and constructing drainage ditches to draw water away from highly productive wetlands to create highly productive agricultural fields. Periodic dredging of the waterways is often necessary to continue to use the fields for agricultural production and for livestock.

The county's floodplains service several major river systems through which run various populations of salmon and trout. These include Chinook, kokanee, sockeye, coho, chum, and pink salmon as well as bull trout, steelhead trout, rainbow trout, and coastal cutthroat trout. Three of these species – Chinook, bull trout and steelhead – have been listed as "threatened" with extinction, and several more are candidates for listing under the federal Endangered Species Act. In addition, the Washington Department of Ecology has identified many of King County's agricultural waterways as at risk for violating water quality standards under Section 303(d) of the federal Clean Water Act.

Human activity has impacted water quality and fish habitat throughout King County, as elsewhere in western Washington. As the most heavily urbanized county in Washington State, degradation of water quality and fish habitat in the urbanized parts of the county has been caused in large part by commercial and industrial activities along with dense residential development. Each sector is working to modify its practices in order to help recover the health of Puget Sound, its tributaries, and its fish stocks.

The challenge to the agricultural sector is how to help restore fish habitat and bring back the local fishing industry while encouraging and enhancing local farm production. When farmers dredge waterways to keep their fields drained to be productive, one option is to use best management practices to reduce the impacts to fish and other aquatic life. In fact, many of the BMPs are now required by laws and regulations.

In the earliest years of King County's agriculture, the natural hydrology was greatly modified to drain the floodplain in order to create farmable land. The modified drainage system included the digging of new artificial channels (ditches) and placement of subsurface drain tiles as well as the channelization of existing streams and wetlands. In addition, over the past several decades, invasive and noxious vegetation, most notably reed canary grass, filled many channels. Regular excavation or dredging became necessary to remove sediment and noxious vegetation that reduced drainage. Unknowingly, the customary means of draining agricultural lands, practiced for many decades, was counterproductive to salmon habitat and water quality. Portions of fish habitat were either drained or degraded to improve field drainage.

Waterway maintenance activities can harm fish in both the short and long term. In the short term, fish can be killed during removal of sediment and vegetation. Siltation can clog fish gills and alter sensory abilities. Reduced water quality and quantity and alteration of the waterway channel will degrade fish habitat quantity and quality. On a longer term scale, waterway flow likely increases in the winter and decreases in the summer, opposite to fish needs. As drainage is improved, waterways can also become disconnected from the floodplain and meander zone to strand fish. Activities necessary to maintain field drainage also severely impact water quality. To counteract these effects, layers of local, state, and federal regulations have been established that require specified permits and procedures to conduct drainage maintenance.

The Agricultural Drainage Assistance Program

To address concerns about adequate drainage of farm lands, King County established the Agricultural Drainage Assistance Program (ADAP) to help farmers navigate the permitting process and to provide assistance in the implementation of best management practices required by federal, state, and local regulations.

Upon its inception in 1998, ADAP identified about 300 miles of agricultural waterways located in the county's agricultural protection districts. For more than 10 years, the program has provided both technical and financial assistance to landowners whose agricultural waterways need maintenance. At the same time, ADAP has worked with farmers to preserve water quality and protect fish. However, concern about costs and regulatory requirements has increased as available funding has decreased. Thus King County has embarked on a collaborative process to develop a more cost-effective and efficient solution for both farmers and fish.

Requirements for a Farm Landowner to Conduct
A King County Streamlined Agricultural Drainage Maintenance Project

To conduct a drainage maintenance project under King County's streamlined agricultural drainage assistance program (ADAP) that can include receiving an expedited Hydraulic Project Approval from the Washington Department of Fish and Wildlife (WDFW), the farm landowner is required to do the following:

1. Develop a farm plan with the King Conservation District.

   A clearing and grading permit is not required from King County Department of Development and Environmental Services if 1) the maintenance work is done in accordance with an approved farm plan, 2) best management practices are employed, and 3) the work is inspected by either King County Department of Natural Resources and Parks, King Conservation District, or WDFW.

2. Contact the King County drainage maintenance program to discuss the drainage problem.
3. Allow a King County engineer to conduct an engineering survey to evaluate the drainage problem.
4. Discuss survey results and recommended plan of action with the King County engineer.
5. Fill out and submit a Joint Aquatic Resource Permit Application (JARPA) form to the WDFW (Olympia) for a Hydraulic Project Approval (HPA) permit. Include plan of action, planting plan, and coverage under ADAP programmatic State Environmental Policy Act (SEPA) review. [Examples of these will be made available.]
6. Participate in a preconstruction meeting with King County to understand timing, equipment needed, and required best management practices. If a contractor is hired, he/she must attend the preconstruction meeting.
7. Submit and sign agreement to cost-share revegetation plantings with King County.
8. Allow King County Roads Division to conduct defishing in the waterway/ditch.
9. Conduct drainage maintenance using best management practices per ADAP manual and preconstruction meeting with King County engineer.
10. Revegetate according to HPA, streamlined ADAP requirements, and cost-share agreement.
11. Maintain plants for at least three years.

NOTE:

The streamlined ADAP can be applied on artificial and modified waterways in King County Agricultural Production Districts. Application may be made on a case-by-case basis for projects on land zoned for agriculture outside the APDs.

Which Waterways Are Omitted from the Streamlined Agricultural Drainage Assistance Program

King County has developed a waterway classification system that uses the state's hydraulic code channel designations (natural, modified, and artificial) as well as known or expected level of use by salmonids (high, moderate, low). These classifications are used to determine appropriate best management practices to maintain agricultural drainage.

However, some waterways may not be appropriate for the proposed streamlined Agricultural Drainage Assistance Program (ADAP). This does not necessarily prohibit farmers from applying to conduct drainage maintenance. Rather, such projects would need to be performed on an individual basis and might require additional or different best management practices (BMPs) as well as possibly additional mitigation.

Below are criteria and rationale for determining which waterways are not eligible for King County's streamlined agricultural drainage assistance program. These were developed by King County and agreed to by Washington Department of Fish and Wildlife as guidelines to determine whether projects are eligible for an expedited Hydraulic Project Approval (HPA).

- **20 cfs or higher mean annual flow –** this is the cut-off under the Shoreline Management Act; such waterways likely have too high flow in summer to follow the streamlined ADAP bypass BMPs. These are also the waterways most likely to have more than rare or infrequent use by Endangered Species Act-listed Chinook. Examples: Harris Creek, Cherry Creek, Griffin Creek, Patterson Creek, Newaukum Creek, Coal Creek, and Boise Creek.

- **Classified as natural in King County's waterway classification system –** such waterways have high ecological value and may require BMPs other than dredging as well as additional mitigation. Examples: Harris Creek, East Fork Patterson Creek, and Patterson Creek.

- **Waterways having fish-construction-window flows higher than can be handled by readily available pumps (approximately 2 cfs)** will need more pumping capacity and may fall outside streamlined ADAP and require individual permits. Example: Lower reaches of Tuck Creek.

Note about waterways that have different classifications for different segments: Where a single waterway has different classifications for different segments, the streamlined ADAP may be used in the modified segments, while the natural segments may require individual attention and possibly additional BMPs. Examples: Ames Creek, Cherry Creek, Sikes Lake Creek, Mill Creek, Mullen Slough, and North Fork Newaukum Creek.

Pre-Construction Vegetation Removal Best Management Practices

SURVEYING
In order to perform a survey of a proposed project, vegetation may have to be removed or trimmed. This can generally be done using hand tools to have little impact to the system. Surveying requires access to the channel at least every 500 feet to survey cross sections, every 100 feet for centerline profile shots, and access to any points of interest that should be documented (culverts, beaver dams, obstructions, etc.).

For reed canary grass-choked channels, no vegetation removal is generally necessary. The survey equipment can shoot over the top of the vegetation.

For channels that have blackberries covering the banks, access points need to be cut into the vegetation. Access for cross sections must allow access from one side of the channel and extend at least to the high water mark on the opposite bank. Access for centerline points must allow access from one side of the channel and extend to the center of the channel.

For channels that have a mixture of vegetation, the access requirements are the same as for a blackberry-lined channel.

Best Management Practices (BMPs) for Vegetation Removal to Be Able to Survey
For all means of vegetation removal, minimize removal of and damage to native vegetation. Native vegetation should be retained. Native vegetation larger than 3 inches diameter at breast height (dbh) shall not be removed.

For hand removal of vegetation (e.g., machete), no additional BMPs are required.

For removal by hand-held mechanical means (e.g., weedeater), do not operate the equipment below the water surface.

For mechanical removal (e.g., by heavy equipment), vegetation removal shall not disturb dirt on the bank or the slope or in the water, and shall avoid and minimize removal of native vegetation to the maximum extent possible.

The survey corridor for each cross section shall not exceed 5 feet in width. Access points for centerline shots shall not exceed 5 feet in width and shall extend only to the toe of the opposite bank.

DEFISHING
In order to properly remove fish from a construction area, de-fishers must have access to the water column. Different types of defishing require different types of vegetation removal. For example, trapping needs "holes" of open water to place the traps but electrofishing needs room for at least two people to be in the channel with no vegetation on the banks that will hinder movement of the electrofishing unit. Vegetation removal BMPs will be tailored to channel characteristics.

BMPs for Vegetation Removal to Conduct Defishing

The following practices are the minimum requirements for site preparation for defishing. However, if more cost effective or time efficient, all vegetation that needs to be removed for construction and planting, excepting native vegetation, can be removed at one time. In all cases, vegetation removal shall not disturb dirt on the bank or the slope or in the water, and shall avoid and minimize removal of native vegetation to the maximum extent possible. Conditions that may favor removal of all non-native vegetation include avoiding duplication of effort for the contractor and avoiding excessive costs of having to rent equipment twice to remove vegetation for defishing and again for construction.

Reed Canary Grass

If reed canary grass has not filled the entire channel and there is room for de-fishers to walk up the middle of the channel (2.5 feet wide), access points into the channel will be cleared every 100 feet, no more than 5 feet in width.

If reed canary grass has filled the entire channel, the grass shall need to be removed from the channel to minimize harm to fish during defishing. To remove the reed canary grass, mowing equipment shall not be operated below the water surface, shall not disturb dirt on the bank or the slope, and shall avoid and minimize removal of native vegetation to the maximum extent possible. If the waterway is dry during mowing, the mowing equipment shall also not disturb the bed of the waterway.

For hand removal of reed canary grass, the grass will be removed from the channel and placed above the ordinary high water mark for later disposal.

For mechanical removal by heavy machinery, a thumbed bucket or rock picker shall be used. Vegetation shall be grabbed above the sediment level and lifted straight up and placed above the ordinary high water mark for later removal. After removal from the bottom of the channel, vegetation shall be removed from the waterway as quickly as possible and shall not be shaken above flowing water. Work from upstream to downstream.

Blackberries

For channels where the waterway is fairly clear of vegetation but access is restricted by blackberries, the blackberries shall be removed from one side of the channel and cleared from the other side of the channel to the point that they will not hang into or over the water. The blackberries shall be removed without entering the water or disturbing the dirt.

For hand removal, cleared vegetation shall be placed above the ordinary high water mark for later disposal.

For both hand-held and heavy-equipment mechanical removal, the machine shall not be operated below the water surface. A net or other collection system shall be placed downstream to collect material that falls in the channel. All collected material shall be placed above the ordinary high water mark for later disposal.

Knotweed
Reed canary grass is considerably more common in King County Agricultural Production Districts than knotweed. However, in case there may be knotweed present, the following steps will be taken. During the initial survey, county staff will try to note whether knotweed is present and notify the farmer accordingly. If knotweed is present, special precautions must be taken. The farmer will need to contact King County Noxious Weeds Program for removal BMPs: http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/BMPs/Knotweed-Control.pdf. These will likely include following WDFW requirements in a pamphlet HPA and meeting King County requirements of hand or light mechanical removal according to BMPs approved by the Noxious Weed Board.

Native Vegetation
For channels where reed canary grass or blackberries is not the predominant plant species, reasonable efforts shall be made to preserve as much native vegetation as possible. Desirable and native trees and shrubs shall be identified and marked prior to vegetation removal.* Where possible, access points shall be cut into the channel, then hand removal and hand-held mechanical removal shall take place from the channel. If hand removal or hand-held mechanical removal is not feasible, heavy-equipment mechanical removal should utilize the longest reach boom available to reduce disturbance of the bank vegetation. Mechanical removal shall not take place below the water surface. A net or other collection system shall be placed downstream to collect material that falls in the channel. All collected material shall be placed above the ordinary high water mark for later disposal.

Herbicides
Where property owners wish to use herbicides for vegetation removal, regardless of the type of vegetation to be removed, a licensed herbicide applicator shall apply the herbicides in accordance with current herbicide application requirements. Dead vegetation shall be removed from the channel and placed above the ordinary high water mark for disposal. Herbicides must be applied far enough in advance for them to work and for the vegetation to be removed prior to defishing. As required in state statute, the Aquatic Plant and Algae Management General Permit must be applied for at least 60 days in advance of use to remove vegetation plants from the water or where chemicals could enter the water. In addition, if the herbicides could enter the water, a National Pollution Discharge Elimination System (NPDES) project permit will be required from the WA Department of Ecology. Check the WA Department of Ecology website http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/aquatic_plants/permitdocs/permit021611.pdf for latest information on permit requirements, deadlines, and herbicide application timing. A licensed applicator should know this information or how to find it to be sure to allow sufficient time to obtain permits, apply herbicides, and remove vegetation prior to defishing.

* Note: King County has asked and will discuss with the King Conservation District whether they could help identify and mark native vegetation as part of helping the farmer design a planting plan.

King County Proposal for Defishing ADAP Waterways

In order to maximize resources and apply them where most needed to ensure survivability of fish, King County is proposing a tiered approach to defishing waterways where ADAP projects will occur. The tiering will be tied to the waterway classification system. Note: To participate in the King County program, HPA permits will be requested in artificial waterways where fish are found.

1. At this time, natural waterways (i.e., those not straightened or modified) will not be included in the streamlined ADAP. If this changes in the future, here is how defishing on natural waterway projects would be conducted. Where the waterway classification system expects HIGH numbers of salmonids in natural, modified, and artificial waterways during construction:
   King County Roads Division staff who are qualified according to NOAA guidelines will conduct defishing according to training and protocols they follow under the ESA 4(d) exemption for road maintenance.

2. Where the waterway classification system expects MODERATE numbers of salmonids in natural, modified, and artificial waterways or LOW numbers of salmonids in natural and modified waterways during construction:
   ESA-qualified King County Roads Division staff will lead the defishing efforts and may use other county staff or non-county technicians who are trained in defishing to assist.

3. Where the waterway classification system expects no or LOW numbers of salmonids in artificial waterways during construction:
   If the farmer opts to participate in the program, qualified King County Roads Division staff will set overnight traps to determine whether fish are in the waterway and possible abundance.
   a. If no fish are trapped, ESA-qualified King County Roads Division staff will use additional information (i.e., visual detection of fish that may not have been susceptible to trap capture and assessment of water flow and quality) and their best professional judgment to determine whether to conduct defishing, particularly for the length of channel where the habitat characteristics do not change dramatically.
   b. If fish are trapped, an HPA permit will be requested and the protocol under #2 above for MODERATE shall be followed once the permit is obtained.
   c. In addition, if the farmer or contractor sees fish during construction, they shall stop the project and call qualified KC Roads Division staff to conduct defishing. There will be no penalty to the farmer for this, and doing so will allow drainage maintenance to occur with minimal harm to fish.
   d. The waterway classification will be revised if appropriate from low to moderate, based on the defishing data.

4. Qualified King County Roads Division defishers will be on-site during dewatering to relocate any fish that may not have been captured and moved earlier.

Construction Best Management Practices

FISH WINDOW FOR CONSTRUCTION ACTIVITIES

- Standard fish window is July 1 – September 30.
- If Chinook are present, then the fish window is July 1 – September 1 or 15, depending on the waterway. Chinook show up early in September in waterways lower in the systems.
- Non-fish-bearing stream work window is June 15 – September 30.

GENERAL BMPs

Construction BMPs will be dependent on whether there is enough water flowing in the waterway to reasonably support fish. If water is flowing in sufficient quantity and quality to support fish, then a bypass system will be used and the project will begin at the upstream end of the project and proceed down the channel. If water is not present in sufficient quantity and quality to support fish, then the project will start from the downstream end and proceed upstream with sediment control BMPs at the downstream end of the project. The goal of the BMPs is that there be no discharge.

The following BMPs apply to all projects:

Sediment removal shall not occur lower than the historic bottom of the channel as determined by a change in the color of the material in the bottom of the channel, a change in consistency in the material in the bottom of the channel, or other means determined by the ADAP engineer.

Side slopes of the channel shall not be changed except to preserve the ditch from future failure or decline and where the capacity of the channel is controlled by a downstream section of channel or culvert. Where side slopes are reshaped, their final slope shall not exceed 2h:1v.

Projects may proceed from downstream to upstream or upstream to downstream. For projects that move upstream, a sediment control measure shall be installed at the downstream end of the project and 100 feet upstream from the end of the project. The channel between the sediment control measures shall remain untouched until the end of the project when it will be the last section to be cleaned. For projects that move downstream, a sediment control measure shall be installed at the downstream end of that day's work and 100 feet downstream, leaving the channel between sediment control measures untouched. The sediment control measures shall be moved downstream at the beginning of the next construction segment.

Turbidity measurements[1] shall be made upstream of the project before the start of construction each day and recorded on the Water Quality Monitoring Data Sheet. The upstream turbidity measurement shall be the baseline measurement. Turbidity shall also be measured at least 15 minutes after the start of construction at a point 100 feet downstream from the most downstream sediment control measure but not more than 1000 feet downstream. If the turbidity measurement after construction starts does not exceed state water quality standards, construction can proceed and the turbidity shall be measured hourly on the first day of construction. Current state water quality standards are defined as not to exceed the baseline turbidity measurement by more than 5 Nephelemetric Turbidity Units (NTU) for baseline turbidity measurements below 50 NTU and to

[1] King County will review valid methods to measure turbidity with the landowner or contractor prior to start of construction.

not exceed the baseline turbidity measurements by more than 10 percent for baseline turbidity measurements above 50 NTU. If any turbidity measurement exceeds state water quality standards, construction shall stop and existing sediments control BMPs shall be modified or additional sediment control BMPs shall be added to the project. After alterations or additions of sediment control BMPs are completed, construction can proceed and another turbidity measurement will be taken at least 15 minutes after construction has recommenced.

On subsequent construction days, if there have been no exceedence of water quality standards, then turbidity measurements shall be taken three times during the day -- at least 15 minutes after the start of construction, midway through the day, and within an hour of the end of the day. If any turbidity measurement exceeds water quality standards, work shall stop, existing sediment control BMPs shall be modified or additional sediment control BMPs shall be added to the project, and turbidity measurements shall be taken hourly for the rest of the day. If three successive turbidity measurements exceed water quality standards, work shall stop and the contractor shall contact the ADAP Engineer for guidance.

Whenever water is pumped into the downstream channel, energy dissipation measures shall be in place to minimize erosion and and re-suspension of sediment at the outfall. Common energy dissipation measures are to pump onto a sheet of plastic extending across the entire channel or pumping into a large bucket or container placed on its side with the opening pointing upstream and allowing water to overflow the container.

Spoils may be spread in the adjoining fields in a single lift no higher than six inches. Spoils shall be placed in active production areas (crop areas or pasture areas). If no active production areas are available, spoils can be placed on site outside of wetlands. If spreading the spoils in the adjoining field is not feasible, the spoils shall be removed from the site and disposed of at an approved disposal site. If spoils are disposed of offsite, a construction entrance equivalent to that detailed in the King County Surface Water Design Manual, or equivalent measures, shall be installed to prevent material from being tracked onto the public road.

BYPASS BMPs

The bypass system generally consists of two coffer dams (steel plates are commonly used) and two pumps (the bypass pump and the dirty water pump). The installation sequence for a bypass is as follows:

1) Setup up the bypass pump and start pumping.
2) Install the first coffer dam just upstream of the discharge point for the bypass pump.
3) Install the second coffer dam just downstream of the bypass pump intake.
4) Setup the dirty water pump and start pumping the water in the channel between the coffer dams into the adjoining fields at a location where it cannot flow back into the channel prior to having the suspended sediments removed.
5) Defish the channel between the coffer dams as the water level drops.
6) Begin sediment removal.

BYPASS REMOVAL

When the sediment between the coffer dams is removed and the project is being shut down for the day, the bypass system shall be removed or the bypass pump will be operated continuously until construction starts again the next day. The sequence for bypass removal is as follows:

1) Start bypass removal by removing the upstream coffer dam.
2) Reduce the capacity of the bypass pump or cycle its operation to allow the cleaned channel to fill with water.
3) Continue to operate the bypass pump until the water upstream from the downstream coffer dam is clear. The dirty water pump can speed this process by pumping dirty water into the adjoining fields.
4) When the water at the remaining coffer dam is as clean as the water flowing into the cleaned ditch, slowly remove the remaining coffer dam and turn the pumps off.

BYPASS LEAPFROGGING

When the sediment between the coffer dams is removed, if the project will continue that day, the bypass will be moved downstream by leapfrogging one coffer dam over the other. The sequence for moving the bypass is as follows:

1) Remove the upstream coffer dam.
2) Reduce the capacity of the bypass pump or cycle its operation to allow the cleaned channel to fill with water.
3) Continue to operate the bypass pump until the water upstream from the downstream coffer dam is clear. The dirty water pump can speed this process by pumping dirty water into the adjoining fields.
4) When the water upstream of the coffer dam is clear move the discharge of the dirty water pump into the channel just downstream of the coffer dam.
5) Move the bypass pump down to the remaining coffer dam and start pumping to the end of the next construction segment.
6) When the bypass pump is setup and operating again, turn off the dirty water pump.
7) Install the downstream coffer dam.
8) Setup the dirty water pump and start pumping the water in the channel between the coffer dams into the adjoining fields at a location where it cannot flow back into the channel prior to having the suspended sediments removed.
9) De-fish the channel between the coffer dams as the water level drops.
10) Begin sediment removal.

NON-BYPASS BMPs

When there is not enough water flowing in the waterway to reasonably support fish, construction can proceed without a bypass. The sequence for construction without a bypass is as follows:

1) Install approved sediment control measures downstream of the end of the project if possible or within the last 100 feet of channel. Approved sediment control measures include silt fences, coir logs, culvert obstruction, or silt dam.

2) Leave the lowest 100 feet of channel undisturbed and begin the project working from downstream to upstream.
3) If groundwater starts to enter the cleaned channel and causes turbidity measurements to be higher than state water quality standards, add additional sediment control measures in the cleaned section of the channel. As noted in the earlier section on general BMPs, current state water quality standards are to not exceed the baseline turbidity measurement by more than 5 Nepholemetric Turbidity Units (NTU) for baseline (pre-construction) turbidity measurements below 50 NTU and to not exceed the baseline turbidity measurements by more than 10 percent for baseline turbidity measurements above 50 NTU.
4) If water starts to enter the channel from field tiles, follow the procedures for groundwater entering the channel or temporarily plug the field tiles.
5) Continue sediment removal to the upstream end of the project.
6) Move to the downstream end of the project and clean the last 100 feet of starting at the downstream end and working upstream.
7) If any water is flowing in the channel after sediment removal, allow channel to flow for at least 24 hours with sediment control measures in place.
8) Remove accumulated sediment from in front of sediment control measures.
9) If sediment is still moving in the channel, repeat steps 7 and 8.
10) Remove sediment control measures.

Beavers and Agricultural Drainage

Although not based on empirical data, anecdotal evidence suggests that beaver populations in King County have been rising since the early 2000s. Currently no public agency is responsible for removing beavers that are impacting private property.

In general, King County encourages property owners to find ways to live with beavers rather than removing them. Beaver dams create habitat for many animals and plants and provide essential habitat for juvenile salmon, particularly coho. In addition, beaver ponds collect and slowly release stormwater and are a natural means of flood control and groundwater recharge. In many situations, it may make more sense to accommodate beavers and their dams rather than attempt to remove them. Property owners can minimize beavers' impacts by using beaver deceivers or flow levelers to regulate water levels.

King County does not consider trapping to be a long-term solution to beaver problems. If beavers are removed from preferred habitat, it is usually just a matter of time before another beaver moves in. However, if property owners choose removal for their method of control, they need to hire a licensed trapper to perform the removal. Landowners can contact the local office of the Washington State Department of Fish and Wildlife to find licensed trappers in their area. If beavers are removed from an area, their dams can be notched according to BMPs below to lower water levels to prevent unacceptable flooding while maintaining beneficial fish and wildlife habitat.

In some cases when beaver dams cause unacceptable flooding to agricultural fields, dam removal may be necessary. For effective removal of beaver dams, follow the BMPs below.

General Best Management Practices (BMPs)

- These beaver dam removal BMPs apply only to beaver dams that have been in place for one year or less. An individual HPA outside the streamlined ADAP is needed for removing older beaver dams.
- These beaver dam removal BMPs apply only to hand removal of beaver dams. Hand tools such as saws may be used but no mechanized equipment.
- These beaver dam removal BMPs should only be implemented in low-flow periods of the year so gradual removal of the dam does not cause peak flow rates above the capacity of the downstream conveyance system.
- The time window when dam removal can occur is based on waterway classification. Dams needing removal outside the work window require prior contact with the WDFW Area Habitat Biologist and DDES. Dams removed outside the work window should also be performed according to these BMPs.
- Prior to lowering any part of the dam and creating turbulence or velocity in the water, remove as much dirt and sediment from the upstream face of the dam as possible.
- Begin dam removal by creating a two-foot wide by six-inch to one-foot deep notch in the dam, depending on the size of the dam. Wait for water level behind dam to fall to the bottom of the notch before continuing.
- After water level has dropped to the bottom of the notch, deepen the notch another foot.

While the water level is dropping to the new level of the notch, remove the top foot of the dam.

- Because of the way beaver dams are built with sticks intertwining with each other, removal of only one foot is difficult. The goal, however, is to only remove that portion of the dam that is above the upstream water surface.
- Repeat above sequence until the dam is removed to the original stream bed.
- The sound of running water and the velocity of water trigger a beaver's damming instincts. Remove a wide enough section of dam so water does not accelerate as it passed through the removed section.
- A good tool to remove a beaver dam is a potato fork that has three or four tines.
- Material removed from the dam should not be placed in the water. Material should be placed on the bank above the high water mark or removed from the area.
- Removal of existing riparian vegetation will be held to a minimum.
- Wait for the water to drain and the land behind the dam to dry out before removing material from the formerly submerged areas. Use sediment control BMPs as needed.
- When removing multiple beaver dams, start with the most upstream dam first to utilize the sediment control benefits of the downstream dams.
- If beavers are not removed prior to dam removal, it is typical for the beaver to rebuild the dam within a day or two. It may take several cycles of removal and rebuilding before the beaver does not rebuild the dam and then it is typical for the beaver to just move upstream or downstream to a new location to build a dam.

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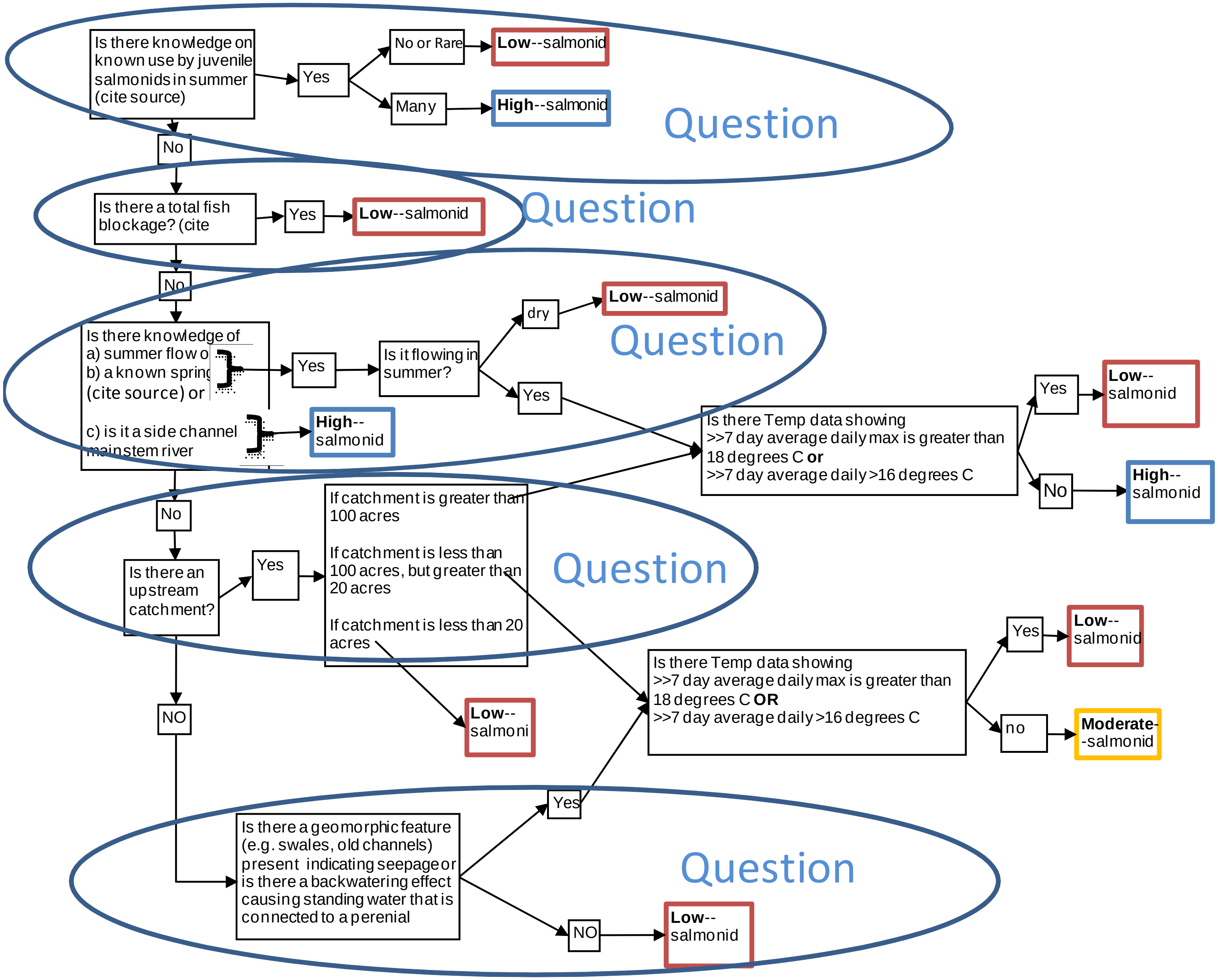
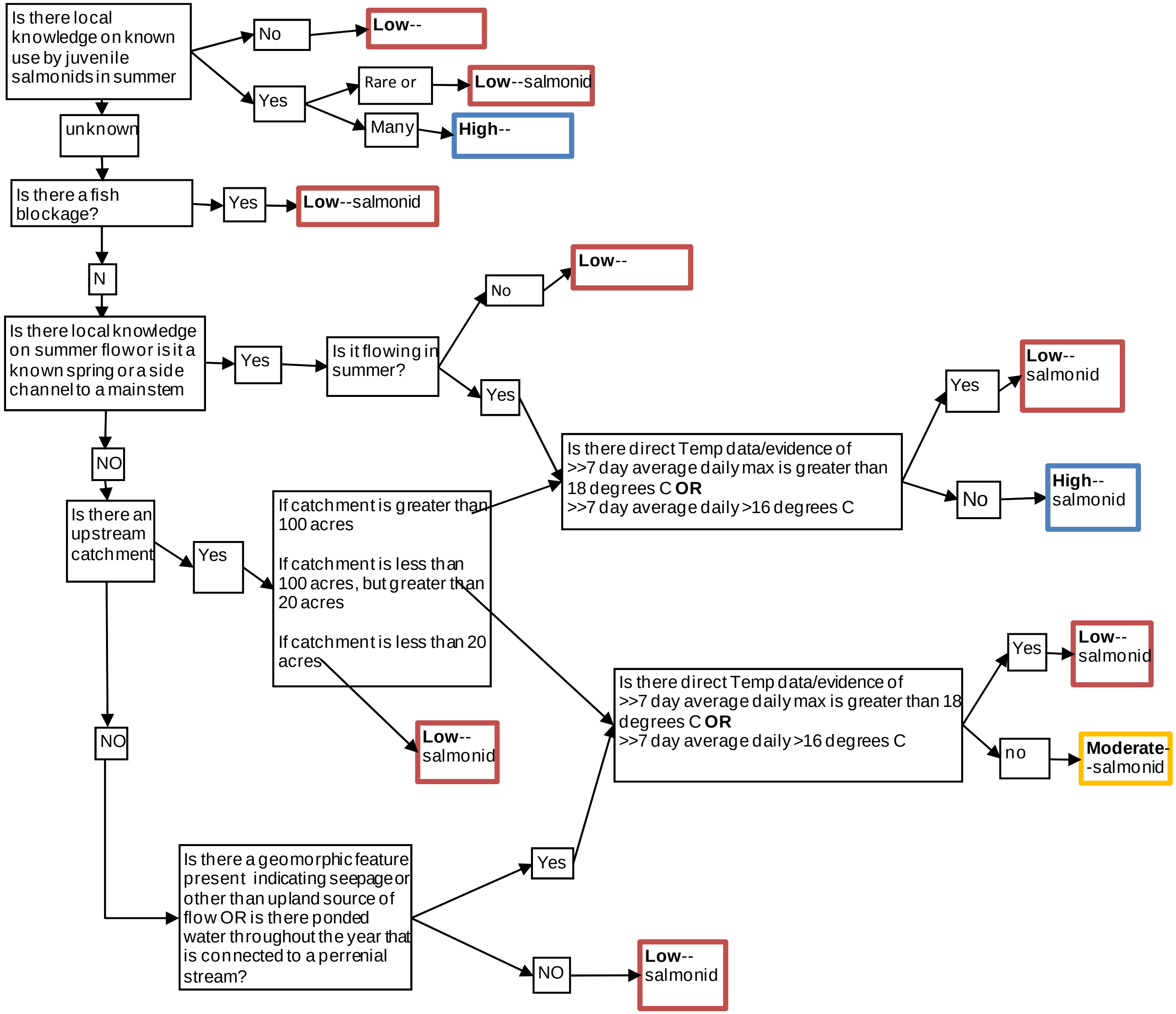
ADAP Decision Tree




Is there local knowledge on known use by juvenile salmonids in summer
No
Low--
Yes
Rare or
Low--salmonid
Many
High--
unknown
Is there a fish blockage?
Yes
Low--salmonid
N
Is there local knowledge on summer flow or is it a known spring or a side channel to a mainstem
Yes
Is it flowing in summer?
No
Low--
Yes
Is there direct Temp data/evidence of >>7 day average daily max is greater than 18 degrees C OR >>7 day average daily >16 degrees C
Yes
Low--salmonid
No
High--salmonid
NO
Is there an upstream catchment
Yes
If catchment is greater than 100 acres
If catchment is less than 100 acres, but greater than 20 acres
If catchment is less than 20 acres
Low--salmonid
Is there direct Temp data/evidence of >>7 day average daily max is greater than 18 degrees C OR >>7 day average daily >16 degrees C
Yes
Low--salmonid
no
Moderate--salmonid
NO
Is there a geomorphic feature present indicating seepage or other than upland source of flow OR is there ponded water throughout the year that is connected to a perrenial stream?
Yes
NO
Low--salmonid

A Salmon-based Classification to Guide Fish Protection Measures for Agricultural Waterways Maintenance

By

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Summary

A salmon-based classification system is presented to help guide decisions on allocation of fish protection efforts during maintenance of agricultural waterways in King County's agricultural production districts (APDs). To incorporate jurisdictional and biological concerns, this system assesses the origin and management history of the waterway as well as the potential level of salmon use. Origin and management history considers natural geomorphic features and management history to determine if a waterway was a naturally occurring feature and, if so, the degree to which it has been modified. To rate potential level of salmon use, the classification applies local, credible knowledge of salmon abundance or density, water flow, and temperature or, where such knowledge is lacking, King County Geographic Information System (GIS) data to predict the potential for high, moderate or low levels salmon use in a given APD waterway.

The classification is intended to be simple, transparent and updatable with new information. To build on and increase utility of the system, we recommend the continued collection and synthesis of relevant information to augment existing knowledge of APD waterways. As part of this, we suggest development of a comprehensive database to include, at minimum, information on fish use, water flow and temperature. Such information will help improve not only the accuracy of the classification but also, potentially, our understanding of the role APD lands play in the broader context of watershed-based salmon conservation and recovery efforts.

Introduction

King County's land management jurisdiction, which mainly covers rural areas, includes a variety of efforts to maintain the character, commerce, and natural resources of rural areas. Toward that end, King County has implemented policies, regulations, and programs and made significant capital investments that support both agriculture and salmon protection and recovery.

The county's APDs often coincide with salmon-bearing waterways, setting the stage for possible conflicts between agricultural practices and salmon protection and restoration activities. To maintain agricultural productivity, many of these waterways require periodic maintenance, including sediment removal (e.g., dredging) and beaver dam modification, which can impact salmon and other biota (amphibians, reptiles, birds, mammals) and habitat. Of particular concern are potential impacts to economically and culturally significant salmon species including federal Endangered Species Act (ESA)-listed Puget Sound Chinook salmon, steelhead trout and coastal bull trout as well as Coho salmon, an ESA species of concern, and cutthroat trout. There are also many non-salmonid fish species present that are protected by the state as game fish (e.g., bass).

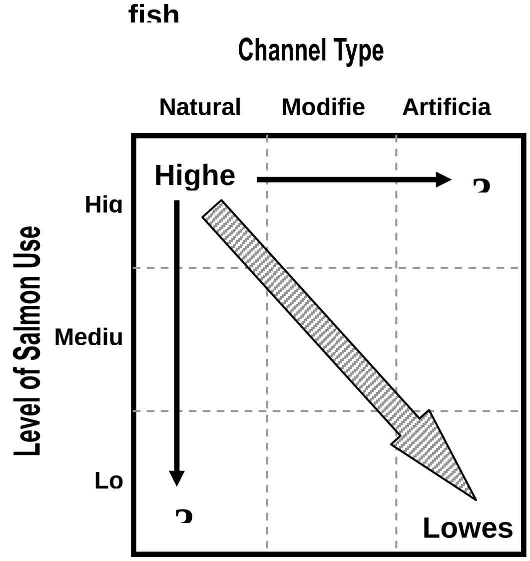
Need and purpose

By most standards, agricultural waterways would be considered relatively poor salmon habitat. Typically, they lack structural features (e.g., pools, large woody debris) that create complex instream physical habitat and have limited riparian vegetation. Many also have high temperatures and low dissolved oxygen during summer. Regardless, salmon and other fishes persist in many of them, sometimes in surprisingly high numbers, even during warm, dry periods when maintenance is usually done (see Berge et al 2000, Berge 2001, Berge 2002, WSU/UW 2008, Colvin et al 2009). As a result, there is potential for maintenance activities to affect salmonids directly through dredging, which can cause mortality, or indirectly through excessive turbidity, low dissolved oxygen, and removal or reduction of instream and riparian vegetation, any of which can cause delayed effects, such as reduced growth or increased incidence of predation.

The proposed classification was developed to guide the type and level of best management practices (BMPs) in order to allocate time and financial resources effectively and minimize costs to the farmers and the public while minimizing impacts of periodic agricultural waterways maintenance activities on salmon and their habitat. The classification system provides guidance for landowners and regulators in identifying areas under Hydraulic Project Approval (HPA) jurisdiction and potential levels of salmon use in agricultural waterways so that appropriate fish and habitat protections can be applied. It also will help guide funding allocations and determine appropriate BMPs. Figure 1 illustrates the management goal of expending more effort on waterways in the most natural condition or with the highest level of salmon use rather than on artificial waterways or waterways with low salmonid use.

Salmonids are the focus of this tool because of their ecologic, economic, cultural, and legal importance to the region. Compared to other fishes, salmonids are suited as the basis for a classification system because their habitat requirements and distribution are relatively well known (where?). Their distribution also overlaps with many other species, particularly other native cold and cool water species so actions that benefit then would benefit many other species as well. Fish species for which this classification system may be less applicable include

Figure 1. Relative effort as a function of level of fish



native three-spine sticklebacks and lampreys and non-native, warmwater species, such as bass and bluegills, all of which have distinctly different flow and temperature needs from salmonids.
This system classifies agricultural waterways in accordance with two basic waterway characteristics:

- Waterway type - artificial, natural or natural but modified, based on the origin and management history of the waterway, and
- Potential level of salmonid use - low, moderate or high, based on known level of use or, where information is lacking, connectivity to a salmon-bearing stream and flow and temperature characteristics.

Jurisdictional Waterway Type

The Washington State Hydraulic Code (RCW 77.55) provides the basis for applying measures that may be legally required. The Hydraulic Code requires that construction activity that will use, divert, obstruct, or change the natural flow or bed of state waters must be carried out under the terms of a permit called the Hydraulic Project Approval (HPA), which is issued by the Washington Department of Fish and Wildlife. The HPA authority extends to all marine and fresh waters of the state except "those waterways that are entirely artificial, such as irrigation ditches, canals and stormwater runoff devices" (Boggs and Corey 2009).

The purpose of the Hydraulic Code is to ensure that needed construction or work is done in a manner to prevent damage to the state's fish, shellfish, and their habitat. By applying for and following the provisions of the HPA, maintenance activities in agricultural waterways can be allowed with reduced impact on fish or shellfish. These permits prescribe conditions with respect to the timing of work, and require adherence to approved plans and specifications for the approved project. In general, HPAs call for minimization of disturbance of streambeds and banks and associated vegetation, to that necessary to perform the project. Other typical requirements include the use of BMPs to prevent leaks and spills of petroleum-based lubricants into the water, control of erosion and sedimentation to prevent silt-laden water from entering affected waterways and other conditions deemed necessary to mitigate project impacts.

In cooperation with local state and tribal fishery managers and conservation districts, diking and drainage districts in Skagit and Whatcom counties have established jurisdiction-based classification systems for agriculture waterways in the low-lying, deltas of the Skagit and Nooksack rivers, respectively (Boggs and Corey, 2009; Brian Williams WDFW personal communication 2010). The two classification systems vary somewhat, but both involve determination of waterway history, specifically whether the waterway was originally a naturally occurring feature or wholly artificial, in order to determine HPA jurisdiction. For naturally occurring waterways, a further distinction is made based on management history, specifically whether the waterway has been modified, e.g., ditched and/or straightened, from its natural configuration. In practice, any waterway that is not clearly natural or artificial is classified as modified or managed. The Skagit program draws further distinction based on whether a waterway has headwaters or not. An example of a non-headwater natural waterway would be a floodplain oxbow, separated from the flow that originally created it and with no contributing surface flow.

For the Skagit and Whatcom areas in question, state and tribal fishery managers consider historic naturally occurring waterways to largely coincide with known or likely salmonid use. Artificial waterways are identified as areas that are often either blocked from fish use, ephemeral or having such poor habitat that they are unlikely to contain salmon. Therefore, although no explicit salmon use criteria are used, in practice these criteria are a surrogate for salmon use. These classification systems also recognize that regardless of whether or not waterways are classified as "artificial," WDFW retains authority to reclassify them to a modified (or managed) natural waterway if fish are found in them, and will apply HPA fish protections deemed necessary to protect fish (Reinbold, WDFW, April 2010, personal communication).

A secondary distinction between the Whatcom and Skagit approach involves use of historic information. For agricultural waterways in Skagit County, historic wetlands mapped by the U.S. General Land Office (GLO, *ca* 1850) are used as an indicator of high likelihood of a waterway having been historically present. In contrast, the Whatcom County approach relies on the presence of headwaters and present-day topography (slope and aspect) and geomorphology (old stream waterways and swales) as indicators of historic waterway presence.

King County's proposed classification and criteria for waterway type adopts elements of both the Skagit and Whatcom approaches to form three basic agricultural waterway types that are combined with level of salmonid use. Those three basic types are:

- **Natural Waterways:** Natural waterways are naturally occurring water-bearing features, typically with headwaters, that have not been significantly altered from their historical flow path or floodplain in any manner.
- **Modified Waterways:** Modified waterways are historically natural waterways that have been diverted, dredged, straightened, or diked.
- **Artificial Waterways**: Artificial waterways (also known as ditches) convey water from or supply water to an individual farm property. They do not have headwaters or other natural water sources and RCW 77.55 jurisdiction does not apply to them.

Potential Level of Salmon Use

While the basic waterway type is important for determining whether an HPA is required, it does not by itself indicate number, density or even the presence of fish during maintenance. Therefore, to complement the jurisdictional component and efficiently allocate BMPs according to biological value, the proposed waterways classification also assesses the potential level of salmonid use likely to be encountered during dredging and other channel maintenance activities. It is important to note that this classification was developed for the typical agricultural maintenance time period, July through September, and does not attempt to classify winter use of these waterways.

As noted earlier, salmonid distribution is not uniform in agricultural waterways (Berge et al 2000, Berge 2001, Berge 2002, WSU/UW 2008, Colvin et al 2009). Instead, certain locations support relatively high numbers and densities while others do not, providing a basis for assessing potential levels of salmon use. This is important because greater levels of BMPs, including more pre-dredging fish removal and post-dredging enhancement, would be allocated to waterways with relatively high levels of use compared to those with lower, rare or no use.

The three basic criteria and rationale used in evaluating potential level of salmonid use are outlined in a decision-tree diagram (Figure 2) and described in detail below. Where available, the system uses credible, local data, such as population estimates, fish removal counts and temperature data from recent studies, to guide ratings. Where local data are not available, the classification is guided by mapped or mappable criteria.

Salmonid Presence - Whether salmon are known to be or *could* be present is the first consideration in assessing level of salmon use. Decision criteria use either direct evidence (population estimates, fish removal counts, reliable visual estimates) or, if absent, information on barriers.

> Decision-tree Question 1 - The first question asks whether there is credible knowledge (e.g., reach-scale population estimates, fish removal counts, or visual counts by a qualified fish biologist) of use. If yes, does that knowledge clearly indicate either high or low or no use? Based on available evidence, salmonids use in waterways can be typified as either few/low or many/high. We suggest densities of 0.2 salmonids/linear foot or more, as clearly “many” (“high” rating) and 0.1 or lower as clearly few (“low” rating).
>
> Decision-tree Question 2 – If there is no credible salmon use knowledge or such knowledge is ambiguous or unreliable, the question is then whether there is a barrier, as indicated in existing GIS databases or credible local information. If a barrier is present, then the waterway is classed as “low.”

Salmon use of agricultural waterways –

Many agricultural waterways have high potential for salmon use due to their low gradients and proximity and high connectivity to larger salmonid-bearing waterways. Actual species use, presence and abundance varies greatly among waterways due the effects of numerous factors including migration barriers, water conditions (e.g., flow, depth, velocity, temperature and dissolved oxygen), substrate, availability of food and cover, life history stage and species interactions. The influence of any one or combination of these variables is further affected by large-scale contextual factors such as season, geology, climate and human activities including land, water and fishery management. Of these many factors, barriers, geology and land use can be readily evaluated for all waterways from GIS maps. Others, such as temperature and flow, are available from project or program specific studies and only for select locations.

Seasonal use

Agricultural waterway maintenance operations, such as dredging, are typically conducted in the summer or early fall (July – September) when salmonid distribution is likely highly restricted compared to other time periods due to low flows, high water temperatures and low dissolved oxygen. This improves our ability to identify places where fish concentrate. Conversely, our understanding of salmonid use and distribution at other times of the year is less certain. Limited data indicates that areas of high summer use may be high use areas during wetter, cooler times of the year, suggesting that salmonids key in on similar flow and water quality conditions year-round.

Although a comprehensive survey of fish use in APDs has not been conducted to date, data on fish distribution, use and density are available from past King County funded research (Berge et al 2000, Berge 2001, Berge 2002,WSU/UW 2009) and from fish removals conducted for maintenance projects over the past 10 years. Salmonscape, a WDFW website, summarizes reach-scale information on salmon distribution and use (e.g., spawning, rearing) gleaned from local biologists as well as published and unpublished sources, as part of salmon recovery planning since 2001. However, salmonscape does not indicate level of use and provides little or no information for small agricultural waterways.

Table 1 summarizes counts of fish (coho, all salmonids, and non-salmonids) caught in recent ADAP projects. These data, which typify the range of use seen in APD waterways, are provided for context for the determination of values for high and low salmonid use in Question 1.

Table 1. Fish counted in recent ADAP maintenance projects.

			Coho salmon		All salmonids	All fish
	year	project length (ft)	per foot	per 100 ft	per 100 ft	per 100 ft
Boscolo-upper channel	2010	50	2.2	222	228	314
Boscolo-middle channel	2010	100	0.5	56	62	107
Boscolo-lower channel	2010	90	1.6	160	163.3	202
Stout--Ames Creek	2010	~5000	0.02	2.94	2.94	22.3
Jenson-unnamed creek	2010	~400	0.01	1	1.25	4
DD5-Enumclaw	2010	~400	0.26	26.25	26.25	111.25
Stout--FCF	2009	700	0	0	0	42
Pearce -N. Snoqualmie	2009	no fish found--had backwater	0	0	0	0
Dolder--south of Carnation	2009	was dry at time of project	0	0	0	0
Bellamy--'middle ditch'	2008	2000	1	96.5	99.7	197.9

Typically, coho salmon are the most common and abundant salmonid in agricultural waterways during the summer-fall maintenance timeframe (WSU & UW 2008, King County unpublished data). Cutthroat trout are secondary in abundance. Far less prevalent, are ESA-listed Chinook salmon and steelhead trout, which are generally absent or, when present, found in low (single digit) numbers. Chinook salmon are large-bodied fish that usually spawn and rear in larger (generally > 20 cfs mean annual flow) channels than the typical agricultural waterway. Outside of mainstem river channels, ESA-listed bull trout have not been caught or observed in King County APD waterways. Their predilection for high elevation, cold headwater streams for spawning and early rearing makes them unlikely users of small, low elevation, relatively warm APD waterways.

The relatively high coho salmon use observed in some waterways may be due to the juveniles affinity for low gradient, low velocity habitats, such as large pools and beaver ponds. When fed by water with suitable temperature and flow to support juvenile rearing, they are especially productive and valuable for coho salmon (Pollock et al 2004) .

ESA concerns -
Depending on the APD, there are up to nine native species of salmonids within or in close proximity to King County's APDs: Chinook, coho, sockeye, pink, and chum salmon, steelhead/rainbow, cutthroat and bull trout and mountain whitefish. Chinook, steelhead and bull trout were listed under the ESA between 1999 and 2007. Coho salmon were assessed for ESA listing potential in 2004. They were found to not warrant ESA listing but were classified as a Species of Concern due to specific risk factors that make them susceptible to future endangerment. Cutthroat trout were also reviewed in 2002 and determined not to be in danger of extinction at present and unlikely to become so in the foreseeable future.

Artificial Barriers
Artificial barriers have a strong influence in the classification system. Where present, they reduce the rating to "low" for upstream areas because it is presumed they effectively prevent fish from using the waterway. The resultant rating is not an assessment of a waterway's potential. Rather, it is recognition that until such time as the barrier is modified, removed or shown not to be a barrier, costly BMPs should not applied because the likelihood of encountering high levels of salmonids is low. Conversely, because the system is intended to be flexible, ratings are expected to change according to flow or temperature criteria once a barrier is made passable or removed.

Floods
Floods are a potential mechanism for transporting fish into agricultural waterway. Thus there is potential in floodplains for moderate to high levels of salmonids to be present above barriers or in waters that would otherwise rate low for salmonid use as a result of flood waters transporting fish into a waterway. Presumably, the number, type and species of fish that could be transported by floodwaters would vary by timing, size and pathway of floodwaters and the fish available to be transported. Having been transported, fish would also have to survive to the time of maintenance. While it's known that floods transport fish into agricultural waterways and some fraction of those fish may to survive to the maintenance period, we are aware of only a few such places and most likely it is a rare or at best an occasional occurrence. In any

event, there is high uncertainty about how floods affect fish distribution in agricultural waterways and therefore no role for flooding effects is described in the classification system.

Water flow -After salmonid presence, the next question is whether there is sufficient flow to support them during the maintenance time period.

> Decision-tree Question 3 This question asks whether the channel is known to be dry or mostly dry, based on the lack of perennial tributary or spring inputs or if it is known to be flowing year round. An exception is made for mainstem river side-channels which are presumed to be intercepting shallow groundwater fed by the river when not surficially connected and so are rated "high."
>
> Decision-tree Question 4 If flow is unknown or uncertain, the next question is whether there is a large enough upstream watershed to generate summer flow. Watershed areas are broken into three area-classes (> 100 acres, 20 to 100 acres, and <20 acres) representing watershed areas with high, moderate or low likelihood of having sufficient to generate perennial flow.
>
> Decision-tree Question 5 When there is no reliable knowledge of flow and no obvious contributing watershed, there remains potential for flow to be derived from low-level seepage. Therefore, the last flow questions asks a) whether the waterway is part of or situated near a particular landform, such as a swale or valley-wall, with potential to collect and hold water or b) if standing water is known to be present due to backwatering connected to a perennial stream?

Background and rationale

Observations of fish use in Skagit and Whatcom diking districts (B. Williams WDFW 2010 pers. comm.) as well as in King County APD's indicate that salmonids tend to be abundant in agricultural waterways fed by a perennial tributary or spring. Conversely, waterways with no perennial water source, many of which were presumably created explicitly for drainage and so have no historic headwater or spring source, tend to have few or no salmonids during maintenance. River side channels with no or only limited seasonal surface connection to a river are an exception. They may have little or no flow from surface sources yet have sufficient depth and temperature to support salmonids during summer-fall because they are fed by shallow groundwater from an adjacent river. Therefore, for river side channels it is presumed that the potential for significant shallow groundwater exchange is high.

The watershed area needed to generate perennial flow is highly variable in the Pacific Northwest. Table 2 summarizes relationships between watershed area and perennial flow for the Puget Sound lowlands (Konrad 2000) and Oregon Coastal Range (Clarke et al 2008) streams. Palmquist (2005) evaluated the breakpoints between perennial (Type Np) and seasonal (Type Ns) streams and found the average basin area required to produce perennial flow in westside and coastal Washington State streams was 24 and 8 acres, respectively. Jaeger et al (2007) investigated area required for perennial flow from basalt and sandstone stratigraphies in southwest Washington streams and concluded that conservative and less conservative (median) values for 2.4 and 0.5 acres and 3.8 and 0.7 acres, respectively. The relationship between perennial flow and watershed area is highly variable within and among regions depending on precipitation, topography, surficial and underlying geology and land use.

Table 2. Certainty of perennial flow by catchment area for Puget Lowland and Oregon Coastal Range streams. (Konrad 2003, Clarke et al 2008))

Certainty	**Puget Lowlands**	**OCR**
100%	9 km^2 (2,224 acres)	0.36 km^2 (88. 9 acres)
70%	2 km^2 (494 acres)	0.04 (9.9)
50%	1.2 km^2 (297 acres)	0.025 km^2 (6.1 acres)
25%	0.55 km^2 (135 acres)	0.02 (5 acres)
0%	0.05 km^2 (12.4)	0.01 km^2 (2.5 acres)

Based on our field observations, we found 100 acres to be more consistent with watershed area needed to reliably produce perennial flow. This is considerably less than Konrad's median value of roughly 300 acres and more than Palmquist's estimates. The differences are likely due to inherent differences in precipitation and geology among areas as well as uncertainty over underlying local geology and inaccuracies in mapping drainage areas. Many APD streams flow through or emanate from valley walls that are often highly productive for producing groundwater-derived flow. In these areas, surface flow may be derived from significantly larger areas than topography would indicate due to the surrounding flat, plateau topography and complex, inter-bedded nature of the subsurface geology. Observations of known salmonid use and flow by county staff highly familiar with APD waterways were used to suggest >100, 20 – 100, and <20 acres as initial criteria for selecting watershed areas with high, medium and low likelihoods to produce perennial flow, respectively.

Even without a contributing perennial stream, spring or adjacent river channel, waterways may collect seepage water emanating from surrounding landforms, such as valley walls. Waterways fed solely by seepage from such features are considered likely to have less flow than waterways fed by well-defined sources and therefore lower potential. As a result, those features are considered likely to support no more than moderate numbers of salmonids during the summer-fall maintenance period.

Water Quality - If salmonids are likely to be present and there is flow, the third factor is whether water temperatures are suitable.

Decision-tree – Where flow is known or is suspected to be present, temperatures should not exceed the 7-day average daily or average daily maximum thresholds of 16 ^{o}C or 18 ^{o}C temperatures, respectively, to be considered salmonid bearing.

The effect of the current temperature regimes on salmonids in lowland agricultural streams is for the most part unknown (Monohan 2004). Optimal summer temperatures for coho salmon growth range from 10 to 15 ^{o}C and they can potentially withstand up to 26 ^{o}C (McPherson 2006). Beschta (1987) concluded salmonids tend to avoid temperatures above 15 ^{o}C. In assessing physical habitat limits for coho salmon, Reeves at al (1989) suggested temperatures exceeding 20 ^{o}C for two weeks as being limiting for coho salmon in western Oregon and Washington. More recently, Welsh et al (2001) found that the Mattole River of northwestern California, coho salmon were not likely to occur in stream reaches where the 7-day mean daily temperature exceeded 16.3^{o}C or 7-day average maximum daily temperatures exceeded 18 ^{o}C. We suggest the Welsh criteria for use as the initial screening criteria for temperature suitability.

In King County's APDs, there are a places (e.g., lower Ames Creek, Abella et al 2010) where temperatures (and other parameters) have been reliably measured, providing a basis for assessing temperature and other critical parameters for fish. In most places, however, temperature data don't exist or are inadequate for creating reliable 7-day profiles. It is tempting to infer temperature from spot measurements, but generally fish are capable of surviving very warm water for at least a brief period of time. Therefore, while spot measurements may be informative, they are inadequate to determine multi-day temperature regimes.

A variety of reach and catchment scale factors were considered as refinement to the temperature element of the system. Monohan (2004) examined a variety of potential basin and reach scale variables affecting temperature in the Skagit River basin. She found buffer width and density to be the primary factor in determining temperatures and that discharge, basin size, and land use, were not significant determinants of temperature. One reason for lack of correlation with larger-scale variables is that during summer baseflow periods, flow in agricultural waterways is mostly from relatively cool, locally-derived groundwater seepage rather than surface runoff. Therefore, temperatures in small agricultural waterways may be more influenced by amount and quality of groundwater and local riparian vegetation, than the condition of upstream areas.

Results

Each watercourse was evaluated using the above classification. Table 2 shows a summary of the classification system throughout the 5 APDs. Several areas (especially very flat areas on Enumclaw Plataea) were not able to be classified without more field work. As part of implementing the classification, new channels were found as well as previous channels thought to exist were found to not exist. These GIS errors are being fixed and will be classified in January of 2011.

Table 3. Summary of agricultural waterway classification for the APDs within King County.

Classification type	Miles	%
Unknown (need to field check)	19.24	4.86%
GIS errors (will be classified Jan 2011)	68.64	15.35%
High Natural	59.40	15.02%
High Modified	89.98	22.75%
High Artificial	0.38	0.10%
Moderate Natural	14.90	3.77%
Moderate Modified	51.29	12.97%
Moderate Artificial	1.15	0.29%
Low Natural	5.13	1.30%
Low Modified	16.79	4.24%
Low Artificial	58.39	14.76%
Lake	10.25	2.59%
total	395.55	100.00%

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Definitions for King County ADAP Waterways Classification System relating known or potential high, moderate or low level of salmonid use to natural, modified or artificial channels. (see also Waterways Classification Decision-tree)

NATURAL CHANNELS

High–

- Known with certainty to have high summer salmonid use (~> 0.2 salmonids/linear ft), *or*
- If fish use unknown, is fed by perennial flow <u>and</u> temperatures, if known, do not exceed 7-day thresholds, *or*
- If, unsure of fish use, flow and temperature, then contributing upstream catchment is at least 100 acres <u>and</u> there is no known or mapped downstream barrier, *and*
- Channel configuration likely occurred naturally and has not been substantially modified (straightened and/or relocated) relative to its likely natural alignment, as inferred from surrounding topography and geomorphic features, or,
- If modified in the past, channel has either been naturalized or restored to a configuration similar to historic conditions.

Moderate–

- Known with certainty to have intermediate levels of summer fish use (~ 0.01 to 0.2 salmonids/linear ft), *or*
- If fish use unknown, is fed by perennial flow <u>and</u> temperatures, if known, do not exceed 7-day thresholds, *or*
- If, unsure of fish use, flow and temperature, then contributing upstream catchment is between 20 and 100 acres <u>and</u> there is no known or mapped downstream barrier, or
- If there is no upstream catchment and unsure of fish, flow and temperature, but there is a geomorphic feature present indicating likely seepage or known standing water (i.e., a backwater) and there is no known or mapped downstream barrier *and*
- Channel configuration likely occurred naturally and has not been substantially modified (straightened and/or relocated) relative to its likely natural alignment as inferred from surrounding topography and geomorphic features, *or*
- If modified in the past, channel has either been naturalized or restored to a configuration similar to historic conditions.

Low–

- Known with certainty that there is no or, at most, very low (<0.01 salmonids/linear ft) summer fish use, *or*
- If fish use unknown, it is known with certainty that the waterway is totally dry or water is contained in clearly stagnant, discontinuous pools of standing water, If water present <u>and</u> temperatures, if known, exceed 7-day thresholds, *or*
- IF, fish use, flow and temp are unknown or uncertain, then contributing upstream catchment is 20 acres or less, or
- If there is no upstream catchment and unsure of fish, flow and temperature, but there is a geomorphic feature present indicating likely seepage or known standing water (i.e., a backwater) or
- There is a downstream barrier, *and*

- Channel configuration likely occurred naturally and has not been substantially modified (straightened and/or relocated) relative to its likely natural alignment as inferred from surrounding topography and geomorphic features, *or*
- If modified in the past, channel has either been naturalized or restored to a configuration similar to historic conditions.

MODIFIED CHANNELS

High–

- Known with certainty to have high summer fish use (> 0.2 salmonids/linear ft), *or*
- If fish use unknown, is fed by perennial flow <u>and</u> temperatures, if known, do not exceed 7-day thresholds, *or*
- If, unsure of fish use, flow and temperature, then contributing upstream catchment is at least 100 acres <u>and</u> there is no known or mapped downstream barrier, *and*
- Channel likely occurred naturally and is fed by a natural water source (i.e., stream, spring wetland or toe-of-slope drainage) but has been modified (straightened and/or relocated) relative to its likely natural alignment.

Moderate–

- Known with certainty to have intermediate levels of summer fish use (~ 0.01 to 0.2 salmonids/linear ft), *or*
- If fish use unknown, is fed by perennial flow <u>and</u> temperatures, if known, do not exceed 7-day thresholds, *or*
- If, unsure of fish use, flow and temperature, then contributing upstream catchment is between 20 and 100 acres <u>and</u> there is no known or mapped downstream barrier, *and*
- Channel likely occurred naturally and is fed by a natural water source (i.e., stream, spring wetland or toe-of-slope drainage) but has been modified (straightened and/or relocated) relative to its likely natural alignment.

Low–

- Known with certainty that there is no or, at most, very low (<0.01 salmonids/linear ft) summer fish use, *or*
- If fish use unknown, it is known with certainty that the waterway is totally dry or water is contained in clearly stagnant, isolated pools of standing water, *or*
- If water present <u>and</u> temperatures, if known, exceed 7-day thresholds, *or*
- IF, fish use, flow and temp are unknown or uncertain, then contributing upstream catchment is 20 acres or less, *or*
- There is a downstream barrier, *and*

- Channel likely occurred naturally and is fed by a natural water source (i.e., stream, spring wetland or toe-of-slope drainage) but has been modified (straightened and/or relocated) relative to its likely natural alignment.

ARTIFICIAL CHANNELS

High–

- Known with certainty to have high summer fish use (> 0.2 salmonids/linear ft), *o*r
- If fish use unknown, but channel is known to have perennial flow <u>and</u> temperatures, if known, do not exceed 7-day thresholds, *or*
- There is no known or mapped downstream barrier, *and*
- Channel clearly and entirely created for drainage and likely did not occur naturally as indicated by a lack of a water source and/or a channel-bearing topographic feature, e.g., a swale.

Moderate–

- Known with certainty to have intermediate levels of summer fish use (~ 0.01 to 0.2 salmonids/linear ft), *or*
- If fish use unknown, is fed by perennial flow <u>and</u> temperatures, if known, do not exceed 7-day thresholds, <u>*and*</u>
- There is no known or mapped downstream barrier, *and*
- Channel clearly and entirely created for drainage and likely did not occur naturally as indicated by a lack of a water source and/or a channel-bearing topographic feature, e.g., a swale.

Low -

- Known with certainty that there is no or, at most, very low (~ <0.01 salmonids/linear ft) summer fish use, *or*
- If fish use unknown, it is known with certainty that the waterway is totally dry or water is contained in clearly stagnant, isolated pools of standing water, *or*
- If water present <u>and</u> temperatures, if known, exceed 7-day thresholds, *or*
- There is a downstream barrier, *and*
- Channel clearly and entirely created for drainage and likely did not occur naturally as indicated by a lack of a water source and/or a channel-bearing topographic feature, e.g., a swale.

Waterway Classification Summary as of February 2011

for maps found at ftp://green.kingcounty.gov/transfer/ADAP/new_maps

	Total all APDs	
Classification type	Miles	%
Unknown (need to field check)	23.21	5.90%
High Natural	59.92	15.24%
High Modified	97.16	24.71%
High Artificial	0.38	0.10%
Moderate Natural	19.21	4.88%
Moderate Modified	70.69	17.98%
Moderate Artificial	1.40	0.35%
Low Natural	5.35	1.36%
Low Modified	20.79	5.29%
Low Artificial	84.99	21.61%
Lake	10.15	2.58%
total	393.23	100.00%

	Total all APDs			
Classification type	**Miles**	**%**	**Miles Subtotals**	**% Subtotals**
Unknown (need to field check)	23.21	5.90%	23.21	5.90%
Natural high	59.92	15.24%		
Natural moderate	19.21	4.88%		
Natural low	5.35	1.36%		
Total naturals			84.48	21.48%
Modified high	97.16	24.71%		
Modified moderate	70.69	17.98%		
Modified low	20.79	5.29%		
Total modifieds			188.64	47.98%
Artificial high	0.38	0.10%		
Artificial moderate	1.40	0.35%		
Artificial low	84.99	21.61%		
Total artificials			86.77	22.06%
Lake	10.15	2.58%	10.15	2.85%
Total	393.23	100%	393 .25	100%

Summary of major categories as of February 2011

Green River APDs				
	High	Moderate	Low	total*
Natural	16.21%	3.26%	1.23%	20.71%
Modified	25.44%	16.94%	4.69%	47.07%
Artificial	0.00%	0.45%	26.24%	26.69%
total*	41.66%	20.65%	32.15%	

Snoqualmie APD				
	High	Moderate	Low	total*
Natural	15.03%	8.45%	1.73%	25.21%
Modified	22.77%	18.97%	5.26%	47.00%
Artificial	0.29%	0.00%	12.69%	12.98%
total*	38.09%	27.42%	19.68%	

Sammamish APD				
	High	Moderate	Low	total*
Natural	0.00%	0.06%	0.11%	0.16%
Modified	29.89%	26.94%	16.12%	72.95%
Artificial	0.00%	2.00%	23.89%	25.89%
total*	29.89%	29.00%	40.12%	

ALL APDS				
	High	Moderate	Low	total*
Natural	15.24%	4.88%	1.36%	21.48%
Modified	24.71%	17.98%	5.29%	47.97%
Artificial	0.10%	0.35%	21.61%	22.06%
total*	40.04%	23.22%	28.26%	

* The total will not add up to 100% since there are categories that are not shown in this table

ADAP CLASSFICATION TABLES FEBRUARY 17 2011

	Lower Green Apd		Middle Green APD		Enumclaw APD		Total all Green APDs	
Classification type	Miles	%	Miles	%	Miles	%	Miles	%
Unknown (need to field check)	0.27	1.56%	0.49	2.08%	12.94	6.27%	13.70	5.54%
High Natural	2.53	14.62%	14.48	61.02%	23.11	11.20%	40.11	16.21%
High Modified	5.25	30.39%	1.92	8.10%	55.77	27.02%	62.95	25.44%
High Artificial	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Moderate Natural	0.74	4.30%	5.15	21.70%	2.18	1.06%	8.07	3.26%
Moderate Modified	3.67	21.24%	0.57	2.41%	37.66	18.25%	41.90	16.94%
Moderate Artificial	0.00	0.00%	0.00	0.00%	1.11	0.54%	1.11	0.45%
Low Natural	0.00	0.00%	0.86	3.64%	2.18	1.06%	3.05	1.23%
Low Modified	0.00	0.00%	0.00	0.00%	11.59	5.62%	11.59	4.69%
Low Artificial	4.82	27.90%	0.25	1.06%	59.84	28.99%	64.91	26.24%
Lake	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
totals	17.28	100.00%	23.72	100.00%	206.39	100.00%	247.40	100.00%

	Sammamish APD		South Snoqualmie APD		North Snoqualmie APD		Total Snoqualmie	
Classification type	Miles	%	Miles	%	Miles	%	Miles	%
Unknown (need to field check)	0.14	0.99%	3.18	7.60%	6.19	6.89%	9.37	7.11%
High Natural	0.00	0.00%	9.17	21.90%	10.63	11.83%	19.80	15.03%
High Modified	4.21	29.89%	10.34	24.70%	19.67	21.88%	30.01	22.77%
High Artificial	0.00	0.00%	0.00	0.00%	0.38	0.42%	0.38	0.29%
Moderate Natural	0.01	0.06%	3.70	8.85%	7.42	8.26%	11.13	8.45%
Moderate Modified	3.79	26.94%	4.56	10.89%	20.44	22.73%	25.00	18.97%
Moderate Artificial	0.28	2.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Low Natural	0.01	0.11%	0.74	1.77%	1.55	1.72%	2.28	1.73%
Low Modified	2.27	16.12%	1.97	4.70%	4.96	5.52%	6.93	5.26%
Low Artificial	3.36	23.89%	3.29	7.87%	13.42	14.93%	16.72	12.69%
Lake	0.00	0.00%	4.90	11.72%	5.24	5.83%	10.15	7.70%
totals	14.07	100.00%	41.85	100.00%	89.91	100.00%	131.76	100.00%