2000 Annual Monitoring Report

King County Agricultural Drainage Assistance Program

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View of Mt. Rainier from Enumclaw farmlands

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KING COUNTY

PURPOSE AND NEED

This report presents data from monitoring activities conducted by King County staff in the Agricultural Drainage Assistance Program (ADAP). It covers activities from 1998 through March of 2001 and presents pre-project monitoring data for several potential ADAP projects identified in 2000. This document fulfills the annual reporting requirements outlined in the "1999 Monitoring Plan for the King County Agricultural Stream and Ditch Maintenance Program for 1998 and 1999 Projects.

The primary goals of the ongoing ADAP monitoring activities are to evaluate the effects of agricultural watercourse maintenance on the aquatic environment and to assess the effectiveness of Best Management Practices (BMPs) and mitigation measures taken to minimize any negative impacts of these practices on aquatic resources. These measures were required as part of the landowner's Hydraulic Project Approval (HPA's 00-D6982-01, 00D6983-01, and 00-D6984-01) and the Clearing and Grading Permit (L97G0163) issued by the King County Department of Development and Environmental Services in 1998 and 1999. Further monitoring efforts specified in this document are necessary to track changes in the condition of the aquatic resource as a result of watercourse maintenance.

BACKGROUND

Biological monitoring is a critical element in understanding changes in an aquatic system. Monitoring activities can be used to evaluate the adequacy of BMPs, and can guide scientists in the recommendation of appropriate mitigation measures (Kershner 1997). The primary goals of this monitoring program are to detect changes in the aquatic environment that have occurred as a result of permitted "ditch maintenance," and to assess the value of BMPs and mitigation measures taken to minimize any impact of these practices on aquatic biota.

Three general types of biological monitoring are often used to determine if the initial goals and objectives of a project have been successfully met, and it is important to apply the appropriate monitoring type to a specific question (MacDonald et al. 1991). These types include implementation, effectiveness, and validation monitoring (Solomon 1989). Implementation monitoring is the first step in determining whether or not BMPs and mitigation measures were followed as outlined in the landowner's HPA, and Clearing and Grading permits. Once this determination has been made effectiveness monitoring is applied to determine if the BMPs and mitigation measures actually created the predicted outcome.

The third step, validation monitoring, is applied to assess if the desired outcomes are actually a result of BMPs or if they are a result of other factors (Kershner 1997). Adaptive management, which King County has embraced as an essential approach to resource management, uses the results of validation monitoring to provide a mechanism for change in the application of BMPs and mitigation measures in future ADAP projects. Early detection of changes in the aquatic environment through monitoring activities can provide an opportunity to reduce any damage occurring as a result of the permitted maintenance activities. Future monitoring reports will address both validation monitoring and adaptive management.

INTRODUCTION

In 1998 and 1999, as pilot projects of King County's newly conceived agricultural watercourse maintenance program (the predecessor of ADAP), several watercourses were maintained with the technical assistance of King County staff in the Snoqualmie Agricultural Production District (APD; see map in Appendix A). The citizens who farm this land contended that excess water was not draining from the fields, and because of evolving regulations at several levels of government, they were unable to maintain (dredge) the drainage channels as they had historically. Resolving the effects of excess water in their fields was necessary to prepare the soil and commence the planting of crops early in the spring.

In common with many other agricultural areas, these agricultural fields often have a permanent system of drain tiles that facilitate the drainage of surface and subsurface water from adjacent agricultural lands into channelized streams or, more rarely, artificial ditches. The farmers have found that over the course of several years an accumulation of sediment in these receiving watercourses will eventually block the apertures of these drain tiles, thereby preventing drainage from the adjacent fields. Both surface and subsurface moisture greatly reduces the capacity for these lands to produce crops or to support livestock operations. Without proper drainage, farm equipment cannot operate in these fields and plant growth is retarded. Maintenance of drainage systems has been routinely conducted in all King County agricultural areas for over a century to maximize the farmer's use of the land during the growing season.

In addition to agricultural interests, these floodplain watercourses provide high-quality rearing habitat for several species of salmonids, particularly during the winter months (Sommer et al. 2001; Berge et al. 2000). Young-of-the-year fishes seek refuge in many of these tributaries to avoid predators and the high flows that often occur in main channel habitats (Reeves et al. 1991). Age 1 coho and Dolly Varden are particularly affected by losses in over-winter habitat (Dolloff 1986), and Peterson (1982) found that increasing the amount of lowland pond habitat adjacent to salmonid streams greatly increases the abundance of coho salmon. Juvenile coho and cutthroat use agricultural watercourses in the Snoqualmie River Basin (Berge et al. 2000). Recent studies in the Sacramento Basin have found that agricultural ditches can actually provide better habitat for juvenile chinook than the mainstem of a large river, given historical practices such as dike and levee installation (Sommer et al. 2000).

Tuck Creek and Cherry Creek are examples of two tributaries that provide high flow refuge for juvenile salmonids within the Snoqualmie River Basin, but are also important for drainage of nearby agricultural lands (Berge et al. 2000). Historically Tuck Creek and Cherry Creek were important waterways for salmonids in the Snoqualmie River watershed. Species of salmonids known to be present or historically occurring in some association with these streams include: cutthroat trout (*Oncorhynchus clarki*); steelhead (*O. mykiss*); coho (*O. kisutch*); chinook (*O. tshawytscha*); chum (*O. keta*); pink (*O. gorbuscha*); and speculatively Dolly Varden (*Salvelinus malma*) and bull trout (*S. confluentus*). The extent of use varies with each species, but spawning and rearing are the most prevalent life stages to be expected to occur in such a watercourse. The potential for these species to utilize such streams still exists to some extent, but changes in the aquatic habitat within these watercourses have directly influenced current usage by all species (Dolloff 1986).

USGS data from 1897 shows several small streams south of Tuck Creek as directly joining the Snoqualmie River via a southward draining channel. Today these streams are "ditched" toward the east into what are known as the Middle and South Ditches in the Tuck Creek project area, and reach the Snoqualmie River via Tuck Creek. These channelized ditches do not contain the same quality habitat as their free-flowing precursors (Vannote et al. 1980). However, when compared with nearby urban systems (which may no longer even exist in some cases) these offer a reasonable chance for increasing the abundance and quality of rearing habitat for sensitive fish species (Sommer et al. 2001).

Water quality in the King County APDs has been degraded from the historical condition by several means. Increased sediment loads from land that is logged and developed is an obvious non-historical condition that is compounded by increased channelization and other changes in hydrological conditions. Road run-off can introduce pollutants into watercourses by providing a conduit from the polluting source to streams, via culverts and ditches (May 1997). Fecal microbes from livestock, along with fertilization of fields with manure, contribute to the reduction of water quality should this material enter the agricultural ditches and streams. Increases in nutrient levels may lead to anaerobic conditions unfavorable to salmonids, as well as fueling increased growth of invasive in-stream vegetation slowing water passage resulting in increased sediment and thermal loading. Reduced riparian vegetation also results in greater stream temperatures, which decreases salmonid habitation in these watercourses.

Hydrological modifications have altered both the quantity and quality of fish habitat throughout King County, often to alleviate problems of soil saturation in the agricultural areas. These modifications include such practices as the deforestation in upland headwater areas, the draining of wetlands, the channelization of naturally occurring streams, the creation of drain tile systems, and the construction of entirely artificial drainage ditches where no watercourses existed previously (Armco 1938). Residents of King County watershed who “maintained” many of these watercourses prior to the 1950s were primarily concerned with issues directly related to drainage and personal economics, and viewed rivers as “unruly adversaries” (Armco 1938). In the early 1900s fisheries resources were not considered to be in a state of decline as a result of such practices, but flooding issues were a major priority for residents. Local residents were always searching for ways to “tame” the Snoqualmie River (Carnation Research Farm 1983). The residents of the time were successful in 'taming' much of the Snoqualmie River through the construction of culverts, bridges, and levees. As a result of installing these structures, large woody debris and channel meanders have become almost nonexistent in the mainstem and lowland tributaries (Bayley 1995). This change in hydrology and natural processes has contributed to the decline of endemic salmonid species in the Snoqualmie River.

As different as these habitats are from the original conditions in the floodplain 150 years ago, these watercourses are in much better condition than their urban counterparts (Sommer et al. 2001). Agricultural lands provide off-channel habitat that is critical for overwinter survival of several species of salmonids, in addition to providing migration corridors for adult anadromous fishes to complete their life cycle in the streams where they began. Although anthropogenic influences have changed these systems dramatically, resident fishes do continue to use these watercourses for rearing, foraging, and migration purposes. Because of these ecological associations, it is important for biologists to assist landowners in developing alternatives and BMPs to reduce impacts of agriculture on the natural resources of King County.

DESCRIPTION OF THE PROJECTS

The following is a description of Fish and Ditch projects carried out in 1998, 1999, and 2000. The 2000 description also includes pre-project monitoring data in the case that these sites are included in the program during 2001 and subsequent years.

ADAP Projects conducted in 1998 in the Snoqualmie APD

In October 1998, two tributaries of Tuck Creek (a tributary of the Snoqualmie River) were altered to improve the effectiveness of established drain tiles within agricultural lands. These two project sites (the "North Ditch" and "Middle Ditch") were monitored after maintenance to determine the effect of ditch maintenance on the aquatic community. A map of these watercourses is included as Appendix B.

The North Ditch is an overflow for Tuck Creek (stream catalog number 070267) that drains in an easterly direction. The water in this ditch flows parallel to the Woodinville-Duvall Road. Then total length of the North Ditch is approximately 1800 feet (550 m). Although much of this watercourse is dry throughout the summer, it drains a significant amount of water from the adjacent fields during the spring and winter and is often inundated by backwater from Tuck Creek (Appendix B). Seventy-five pieces of large woody debris were added to the North Ditch following excavation as mitigation for habitat loss by the removal of depositional soils and aquatic plants. These LWD pieces (rootwads and treetops) were spaced every 20 feet to compensate for these losses.

The Middle Ditch flow originates on a hillside west of the West Snoqualmie Valley Road (paralleling Tuck Creek) and flows through several agricultural fields until it merges with Tuck Creek. The portion of the Middle Ditch affected by the 1998 project activities is approximately 3400 feet (1036 m) long. The project began at a culvert under a farm access road immediately east (downstream) of the West Snoqualmie Valley Road and extended to the confluence with Tuck Creek (Appendix B). One hundred and seventy pieces of woody debris spaced at varying frequency (1 per twenty feet or 1 per 50 feet) were placed in this watercourse following maintenance activities.

In 1998 both the North and Middle ditches were dredged; a list of the BMPs for these projects is included in Appendix C. Prior to maintenance activities salmonids were removed from the watercourse, and the water was re-routed to another watercourse in the same subsystem with the use of an electric pump. A licensed contractor performed the maintenance of the watercourses using a diesel-powered track hoe with a bucket to remove the fine sediment within the channel. The dredge spoils were removed from the bottom of the stream and leveled in the soil of the surrounding agricultural fields as stipulated by King County's BMPs.

Mitigation measures applied immediately after the watercourse maintenance included the addition of anchored large woody debris and bank revegetation with native species. Woody debris was placed in the channel to increase the complexity of available fish habitat and to reintroduce some degree of natural channel meandering to the system. Native vegetation was planted along the upper portion of the Middle Ditch to shade the stream and to stabilize the bank from erosion. Native vegetation in 1998 included: a hydroseeding of Oregon bentgrass, red fescue, white dutch clover; and a planted mix of serviceberry, red-osier dogwood *(Cornus sericea)*, beaked hazelnut *(Corylus cornuta)*, oceanspray *(Holodiscus discolor)*, pacific ninebark *(Physocarpus capitatus*), wood rose *(Rosa gymnocarpa*), thimbleberry (*Rubus parviflorus*), scouler willow *(Salix scouleriana)*, red elderberry (*Sambucus racemosa*), and snowberry *(Symphoricarpus albus*). Watering of these plants during the summer months was necessary to increase survivorship. In 2000 the remaining areas that were not planted in 1998 were planted with the same mix of native vegetation as prescribed in the HPA.

Monitoring activities carried out at 1998 project sites include fisheries sampling, macroinvertebrate survey, and temperature and dissolved oxygen profiles.

ADAP Projects conducted in 1999 in the Snoqualmie APD

In August 1999 two projects similar to the 1998 projects were completed in the Snoqualmie APD. These projects were again associated with relieving the problems associated with obstructed drain tiles. These two project sites (the "South Ditch" and the "Cherry Valley Tributary") were monitored after maintenance to determine the effect of maintenance on the aquatic community. A map of these watercourses is included as Appendix B.

Protocols applied in the 1999 projects were updated from those applied in 1998. The problems associated with the first project were avoided in the 1999 projects. These improvements included a more efficient means of erosion control, a better dewatering strategy, more complete fish removal prior to maintenance (trapping for five consecutive nights), and project completion in August during low-flow conditions.

The same BMPs were used to minimize fish disturbance and mortality in the1999 projects that were used for the 1998 projects. In general, the mitigation measures were also the same as those used in the1998 project, with the exception that woody debris was anchored in the channel at low flows rather than into the streambank at higher flows. Native vegetation was planted along all watercourses maintained in 1999 and included willow and dogwood instead of the mix chosen in 1998. These species were selected based upon their ability to colonize quickly and provide shade to the stream in a shorter period of time than those used in 1998.

The South Ditch is parallel to, and approximately 100 meters south of, the Middle Ditch, which was dredged in 1998. The South Ditch is formed by a combination of backwater from Tuck Creek, and drainage tiles within the adjacent agricultural fields. This waterway is approximately 1900 feet (580 m) long and drains easterly to its confluence with Tuck Creek (Appendix B).

The Cherry Creek Tributary (also known as Rasmussen Creek) flows out of Rasmussen Lake, underneath the NE Cherry Valley Road, then in a northerly direction between two agricultural fields to its confluence with Lateral A (at the end of the project area), which then flows into Cherry Creek. The project area begins at the upstream end of these agricultural lands, and ends at the confluence with Lateral A. The length of the segment of this watercourse, which was maintained in 1999, is approximately 1500 feet (460 m) (Appendix B).

Monitoring activities carried out at 1999 project sites include fisheries sampling, macroinvertebrate survey, temperature and dissolved oxygen profiles, and surveys to evaluate survivorship of vegetation planted as mitigation.

ADAP Project conducted in 2000 in the Enumclaw APD

In September of 2000, a watercourse maintenance project was completed at the Ritter Property on the Enumclaw Plateau, in the Green River Watershed (Water Resource Inventory Area [WRIA] 9). This watercourse has not been inventoried although it drains to the White River (stream inventory number 100050). This project was completed in an area that is dry during much of the summer and devoid of salmonids, making many of the mitigation measures carried out in previous projects inappropriate, although all the appropriate BMPs for erosion control were in place. A map of this project area is attached as Appendix D

Vegetation survivorship is the only monitoring activity required at the Ritter Site.

2000 Pre-project Monitoring

Snoqualmie APD

In February of 2000, Mr. Scott Turner, a blueberry farmer in the Snoqualmie River floodplain due west of the city of Carnation, requested technical assistance from King County ADAP staff. Shortly after, ADAP staff began data collection activities at this project site (stream inventory number 070280) and nearby watercourses. A map of this project area is included as Appendix E. The Turner's project would affect nearby Ames Lake Creek (070278) and Sikes Lake Creek (070279), two tributaries of the Snoqualmie River. The baseline information collected at this site is necessary in part for appropriate BMP and mitigation prescriptions in the Washington HPA (Hydraulic Project Approval) and necessary King County Clearing and Grading Permits.

In August 2000, this project had moved toward implementation, up to the point of extensive fish trapping within the project area, when it was halted due to an appeal by the Tulalip Tribe of the SEPA determination made by King County's Department of Development and Environmental Services. This appeal was rescinded in April of 2001, and this maintenance activity is projected to commence in August of 2001.

Pre-project data for the Turner Site includes fisheries sampling, macroinvertebrate survey, and temperature and dissolved oxygen profiles. Post-project monitoring activities will include all of the pre-project activities as well as surveys to evaluate survivorship of vegetation planted as mitigation, and longitudinal profiles to evaluate the changes in channel geomorphology.

Green River APD

Pre-project monitoring was conducted in the Lower Green APD at possible sites in Mullen Slough (stream inventory number 090045) and Mill Creek (stream inventory number 090051). A map of these project sites is included in this document as Appendix F. These data will be used as baseline information in the chance that a maintenance project occurs in the Mullen Slough or Mill Creek.

Pre-project monitoring data for the Mullen/Mill site includes fisheries, macroinvertebrate, dissolved oxygen, temperature, water quality (nutrients, fecal coliform, phosphorous, etc.), flow data, and longitudinal profiles.

METHODS AND SAMPLING DESIGN

For any monitoring program it is imperative to ask the right questions and select the right parameters and approaches to answer these questions. We have focused upon both the direct effects of watercourse maintenance activities on salmonid species and on the effectiveness of mitigation measures in reducing these impacts on salmonids. To evaluate the stream condition for salmonids in these watercourses both before and after each maintenance activity, we first examine the correct application of BMPs and mitigation prescriptions (implementation monitoring). Effectiveness monitoring commences following the complete implementation of BMPs and mitigation measures.

The main objective of the monitoring data is to examine the effects of ditch maintenance along with mitigation prescriptions on salmonids that utilize these watercourses. For this purpose physical, chemical, and biological conditions prior and following maintenance activities are used to evaluate the effectiveness of mitigation prescriptions recommended at project sites. Physical parameters include longitudinal profiles (geomorphology), discharge measurement (gauges), piezometers, and water temperature measurements. Chemical constituents include ammonia, nitrates, phosphorous, turbidity, dissolved oxygen, pH, and conductivity. Biological criteria include macroinvertebrates, vegetation survival, and fisheries data.

Project Implementation of BMPs

BMPs were established to reduce the effects of dredging on the aquatic and terrestrial communities near the project sites prior to maintenance activities. These BMPs are included as Appendix C. Several personnel from King County were on site to make certain BMPs were followed throughout the dredging process at all project sites. Evaluation of BMPs is addressed through implementation monitoring.

Longitudinal and Cross Sectional Profiles

Longitudinal and cross sectional profiles were established for sites in the Mullen Slough, the Ames Lake Creek tributary, and the drainage ditch on the Ritter Property. Surveys were conducted with a laser level and stadia rod to provide an idea of gradient, habitat complexity, and channel cross-section configuration at these sites.

Gauging Stations

Gauging stations were constructed in Mullen Slough to monitor the relative depth of the water column during seasonal sampling events. Although not immediately useful at this time, these data will be valuable if ditch maintenance activities occur in the Mullen Slough.

Piezometers

Since chronic soil saturation is a major concern to the King County ADAP, the saturation levels in these soils need to be studied to determine how to solve this issue. Piezometers are instruments that measure the depth of the water table and were placed at the Ames Lake Creek site and the Mullen Slough. These devices can determine the extent of saturation in the soils of agricultural lands adjacent to watercourses, and provide information on the hydraulic gradient present in many of these areas. Most importantly, these data can evaluate future projects to determine whether or not ditch maintenance actually has the desired outcome. These data will be useful if the Turner Site or Mullen Slough area is altered to facilitate drainage.

Temperature

Water temperature influences metabolism, behavior, and survival of fish and other aquatic organisms (Mihursky and Kennedy 1967). Most salmonid species present in the Puget Sound Lowlands and all salmonids captured at agricultural monitoring sites (coho, chinook, cutthroat, and steelhead) prefer temperatures between 10 and 14 °C for stream residence (Bjornn and Reiser 1991). At less than optimal temperatures, salmonid metabolism and growth are greatly reduced. Above the optimal temperatures, salmonid metabolism is used for maintenance instead of growth. In either extreme, salmonid fitness is limited (Bjornn and Reiser 1991). NOAA (1996) determined that "properly functioning conditions" include maximum water temperature thresholds of 15.7 °C for spawning and 17.9 °C for rearing and migration of anadromous salmonids.

In addition to instantaneous temperature measurements, we installed thermistors to obtain a continuous measurement of temperature over a longer time period. Onset Stowaway™ and Tidbit™ dataloggers were placed in all watercourses in 2000 to evaluate the effects of ditch maintenance and mitigation on the thermal regime of these watercourses. Unfortunately, several incidences of vandalism occurred at different project sites and some valuable data were lost due to these violations. Efforts are being undertaken in 2001 to avoid these problems.

YSI Probes

Dissolved oxygen (DO) is a function of atmospheric exchange, photosynthesis, and respiration. The concentration of dissolved oxygen also depends upon temperature, pressure, and the concentrations of various ions (Wetzel 1983). Dissolved oxygen represents the concentration of useable oxygen in the water for aquatic organisms. Aquatic macrophytes produce oxygen during the day and consume (through respiration) oxygen at night. Most natural salmonid streams have adequate DO concentrations, although concentrations in small watercourses may be reduced by organic loading, especially in areas with warm temperatures and little flow, such agricultural watercourses in King County (Hall and Lantz 1969). Ideally, DO concentrations should remain within 76-93% saturation (approximately 8.0 mg/L). Oxygen concentrations below 8.0 mg/L severely limit the suitability of a stream for salmonids. DO levels below 5.0 mg/L severely limit growth, metabolism, and swimming performance (including migration) of stream dwelling salmonids (Alabaster et al. 1979; Bjornn and Reiser 1991). Table 1 depicts the relationship between salmonid response and percent saturation at particular DO concentrations and water temperatures.

Table 1: Response of freshwater salmonids to different concentrations of dissolved oxygen (taken from Bjornn and Reiser 1991).

Dissolved Oxygen *(mg/L)*	**Salmonid Response**	**Temperature (Celsius) and Percent Saturation**					
		0	**5**	**10**	**15**	**20**	**25**
7.75	Normal Function	76	76	76	76	85	93
6	Initial Distress Symptoms	57	57	57	59	65	72
4.25	Fish Negatively Affected	38	38	38	42	46	51

We measured instantaneous temperature and DO concentrations using a YSI Model 55™ multimeter. We calibrated our instruments at each sample site visit, and recorded temperature data to the nearest tenth of a degree Centigrade (C), and DO concentrations to the nearest tenth of a milligram per liter (mg/L). Calibration methods followed were those described in the operator's manual for the instrument.

In addition to instantaneous measurement, several YSI Model 6000™ probes were deployed at strategic locations throughout Mullen Slough to look at diurnal changes in conductivity, DO concentrations, pH, and temperature. These instruments were calibrated to the manufacturer's specifications in the laboratory as specified in the operator's manual. These data were immediately downloaded following the 24-hour sampling interval.

Water Quality Sampling

Water quality parameters in agricultural areas are of great concern. After finding very low concentrations of dissolved oxygen in portions of Mullen Slough, nine water quality samples were taken on February 27, 2001. These parameters include DO, BOD, fecal coliform, ammonia, nitrates, phosphorous, turbidity, and pH. Sample bottles were obtained through the King County Environmental Lab, and protocols were followed as instructed by their personnel. Samples were immediately stored on ice, and brought to the lab for appropriate care prior to analysis.

Macroinvertebrate Sampling

Benthic macroinvertebrates are an important component of aquatic systems (Rader 1997; Vannote et al. 1980). In lotic systems, invertebrates consume the biomass of primary consumers, process allocthonous energy sources, serve as detritivores, and filter organic matter carried in the water column (Vannote 1980; Hynes 1970). Invertebrates are strongly influenced by physical factors; different organisms prefer different microhabitats (Minshall 1984). Elements of essential habitats include substrate type and water velocity as well as water quality characteristics such as temperature, dissolved oxygen, chemical constituents, and nutrients. Invertebrates have been shown to be effective indicators of water quality, and are particularly sensitive to activities such as logging, agricultural runoff, urban runoff, road crossings, herbicide application, and mining (Rosenberg and Resh 1993).

The only post-project macroinvertebrate site which ADAP staff is monitoring is the Cherry Valley Tributary. This stream was sampled in 1999 prior to dredging, and was revisited in 2000.

In 2000, macroinvertebrate sampling occurred at the Ames Lake Creek Tributary, Mullen Slough, and Mill Creek pre-project sites. Post project sampling was carried out at the Cherry Valley Tributary and the Middle Ditch sites, although no pre-project macroinvertebrate data exists for the Middle Ditch site. Macroinvertebrates were collected using a Surber sampler with a 500-micron mesh. Samples were stored in a 95% ethanol solution and subsequently sent to a professional taxonomist for identification and subsequent analysis. For this analysis, macroinvertebrate data is reported as a B-IBI multi-metric index score as described by Karr and Chu (1997).

Fisheries Sampling

Salmonid pre-project data were collected with an electrofisher for the 1998 project sites. Multi-pass electrofishing was used as a method for fish removal prior to excavation in 1998. For all 1999 and 2000 fisheries data (including fish removal), baited minnow traps were placed in the watercourses overnight as described by Hurbert (1996). The bait consisted of canned pink salmon as recommended by Doug Hennick, Area Habitat Biologist for the Washington Department of Fish and Wildlife (Doug Hennick, personal communication). We also sampled outside of the project areas to assess the function of the project area as a migration corridor for resident and anadromous salmonids. We sampled seasonally for salmonid use of the project areas.

We detected the following fish and amphibian species in our sampling efforts.

- Coho Salmon (*Oncorhynchus kisutch*)
- Chinook Salmon (*Oncorhynchus tshawytscha*)
- Cutthroat Trout (*Oncorhynchus clarki*)
- Rainbow Trout/Steelhead (*Oncorhynchus mykiss*)
- Three Spine Stickleback (*Gasterosteus aculeatus*)
- Pumpkinseed (*Lepomis gibbosus*)
- Black Crappie (*Pomoxis nigromaculatus*)
- Sculpin (*Cottus spp*)
- Western Brook Lamprey (*Lampetra richardsoni*)
- Northwestern Salamander (*Ambystoma gracile*)
- Peamouth (*Mylocheilus caurinus*)
- Largemouth Bass (*Micropterus salmoides)*
- Smallmouth Bass (*Micropterus dolomieu*)
- Bullfrog (*Rana catesbeiana*)
- Long-toed Salamander (*Ambystoma macrodactylum*)
- Pacific Treefrog (*Hyla regilla*)

RESULTS BY APD

Snoqualmie APD

In the Snoqualmie APD, both pre and post-project monitoring activities were carried out in 2000. Pre-project data represents the condition of the agricultural waterway prior to maintenance activity, and can serve as a benchmark for recovery of a watercourse following dredging. Post-project monitoring is examining the condition of the resource following maintenance, and is used to establish whether or not the desired outcome was met.

Post-Project Monitoring at 1998 and 1999 Project Sites

We first evaluated the correct application of the BMPs in the project areas. The mitigation and prescribed BMPs were adhered to with one exception in the 1998 project: the necessary plantings were not carried out until 2000.

Temperature and Dissolved Oxygen Concentrations

For the 1998 sites, temperatures were recorded following the project prescription, and dissolved oxygen concentrations were recorded seasonally in 1999. Instantaneous temperature and dissolved oxygen measurements were made before and after construction in all of the 1999 project sites. Unfortunately, temperature loggers were not installed at any of the sites prior to excavation. In 2000 all monitoring sites had thermistor arrays deployed in June. These recording thermistors collected data continuously on two-hour intervals through the remainder of the year. Data anomalies occurred when the thermistor was removed from the water column, either due to falling water levels stranding the unit, vandalism, or, in at least two instances, due to the ratcheting action of plant growth at the attachment point.

The North Ditch has little flow, and warms up during the day from solar radiation as a result of little shading. As a consequence of the direct solar radiation, the North Ditch also has relatively high DO concentrations produced by photosynthetic algae. Temperature data sets indicate that this ditch is much warmer than Tuck Creek or any of the other watercourses nearby. In the summer months, high temperatures in the North Ditch are likely a limiting factor for salmonids. Data collected in the North Ditch are included in Table 2.

Table 2: Dissolved Oxygen Concentrations in the North Ditch

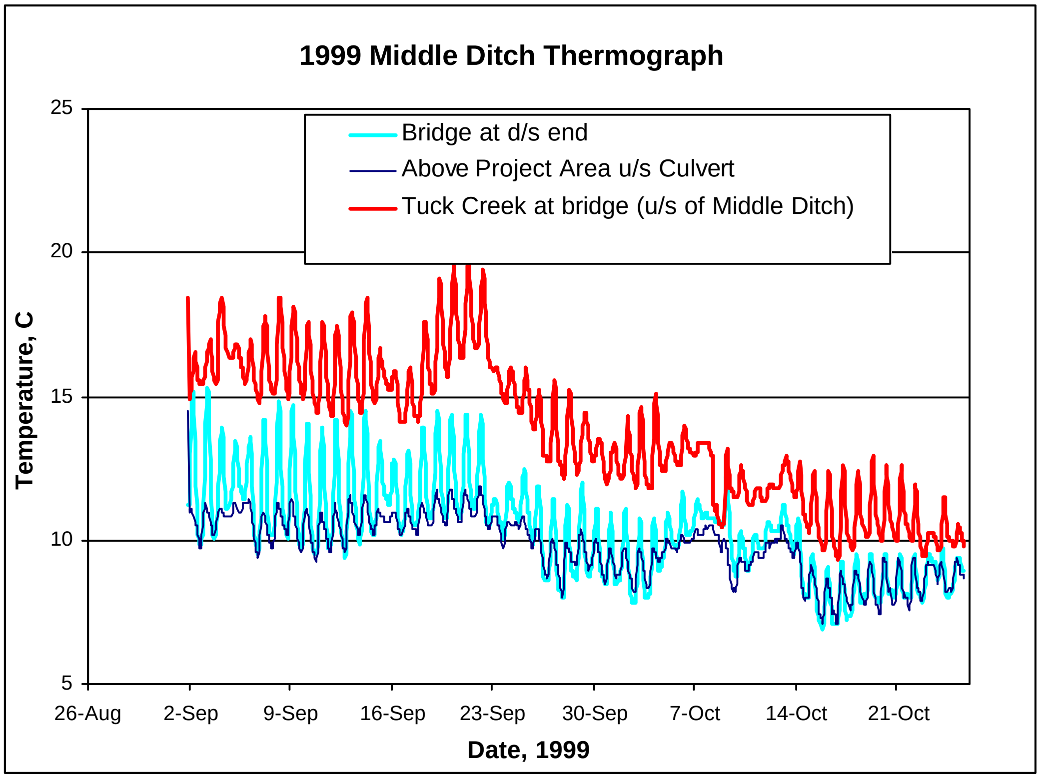
North Ditch Dissolved Oxygen and Instantaneous Temperature Data					
Date	**Station**	**Dissolved Oxygen** *(mg/L)*	**Temperature** *(deg C)*	**Time** *(24 hr)*	**Notes:**
26-May-99	2		16.5		
26-May-99	4		18.5		
16-Jul-99	1	9.8	14.6	16:56	*Ambient air: 21.5 deg C*
	2	6.3	18.5	15:03	*Abundant algae*
	3	3.6	17.8	17:10	*Leaf litter in channel*
	4	2.2	18	17:15	*Leaf litter in channel*
	5	9.2	15.8	15:22	
7-Jun-00	2	9	14.4	14:10	*Ambient air: 19.1 deg C*
	3	4.8	15.9	14:20	
9-Nov-00	4	10.37	7.4	10:30	*Ambient air: 10.1 deg C*

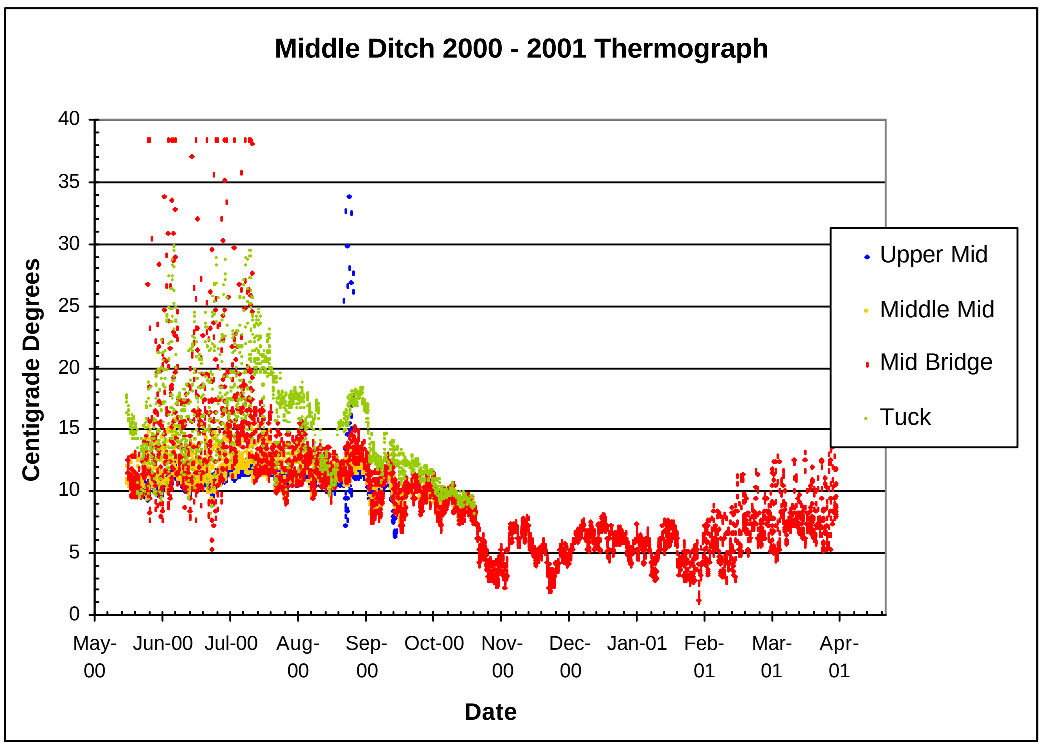
Stations:

1	Just downstream of West Snoqualmie Valley Road
2	At Tuck Creek overflow under the Woodinville-Duvall Road
3	Upstream of large cottonwood; just downstream of property boundary
4	Just upstream of station 5 (30 m)
5	Under the bridge at the confluence with Tuck Creek

Instantaneous temperature recordings in the Middle Ditch indicate a slight increase in temperature through the upstream portion (above the property boundary) and then a gradual decline toward the confluence with Tuck Creek. The thermographs of the Middle Ditch (Figure 1) support this downstream warming trend in the project area. Just upstream of the confluence with the Middle Ditch, the water in Tuck Creek is much warmer than the water originating from the Middle Ditch. Unfortunately, without pre-project temperature data, it is difficult to determine if the temperature of the Middle Ditch has been affected by the maintenance project, although the Middle Ditch appears to be much cooler than the nearby portion of Tuck Creek. After studying the temperatures in the Middle Ditch for two summers, we conclude that temperatures in the Middle Ditch are not limiting salmonid success in this watercourse. Unfortunately data was compromised at two sampling sites on the Middle Ditch, but after seeing a similar trend in 2000 data as observed in 1999 data, it seems apparent that temperatures in the Middle Ditch are near optimum for the salmonid species observed in this waterway.

Figure 1: Thermographs of Middle Ditch following dredging in 1999.





Dissolved oxygen concentrations in the Middle Ditch (Table 3) are not limiting for salmonids. Photosynthetic macrophytes along with cool water temperatures appear to enhance the capacity of the water in the Middle Ditch to hold oxygen in the project portion of this watercourse. In the portion of the Middle Ditch that mixes with Tuck Creek, a very different situation exists. At the confluence with Tuck Creek, the water in the Middle Ditch carries little oxygen due to a combination of warmer water, groundwater influences, and high biochemical oxygen demand (BOD). Oxygen levels in this portion of the Middle Ditch are not conducive for salmonid habitation, although the portion of the Middle Ditch where dredging occurred appears to have adequate oxygen for salmonids.

Table 3: Dissolved oxygen concentrations in the Middle Ditch.

Middle Ditch Dissolved Oxygen and Instantaneous Temperature Data					
Date	**Station**	**Dissolved Oxygen** *(mg/L)*	**Temperature** *(deg C)*	**Time** *(24 hr)*	**Notes:**
26-May-99	1		10.5		
26-May-99	5		21.5		
16-Jul-99	1	9.7	12.3	16:51	Ambient air: 21.5 deg C
16-Jul-99	2	11.7	11.7	16:45	
16-Jul-99	2a	8	13.8	16:48	
16-Jul-99	3	10.2	12.4	16:40	
16-Jul-99	4	9.6	13.9	16:30	
16-Jul-99	5	9.3	15.1	16:12	
16-Jul-99	6	6.8	18.2	16:10	
9-Aug-99	1	10.5	12.5	9:40	
	2	9.9	14	9:12	
	3	10.1	13.8	9:22	
	4	7.9	13.6	9:30	
20-Jan-00	4	8	4.7		
7-Jun-00	1	11.7	10.5	11:45	Ambient air: 18.9 deg C
	2	8.97	11.5		
	3	10.3	11.9		
	4	12.3	12.1		
17-Aug-00	4	10.75	10.3	11:10	Ambient air: 21.5 deg C
	5	10.7	10.3	11:25	
	6	2.3	16.3	11:35	
18-Oct-00	Between 1 & 2	10.94	10.3	11:10	Ambient air: 17 deg C
9-Nov-00	4	11.3	8.5	12:15	*Ambient air: 11.5 deg C*
	Between 4&5	11.1	8.5	12:00	
	5	11.18	8.3	11:15	
	6	3.19	8.6	11:20	

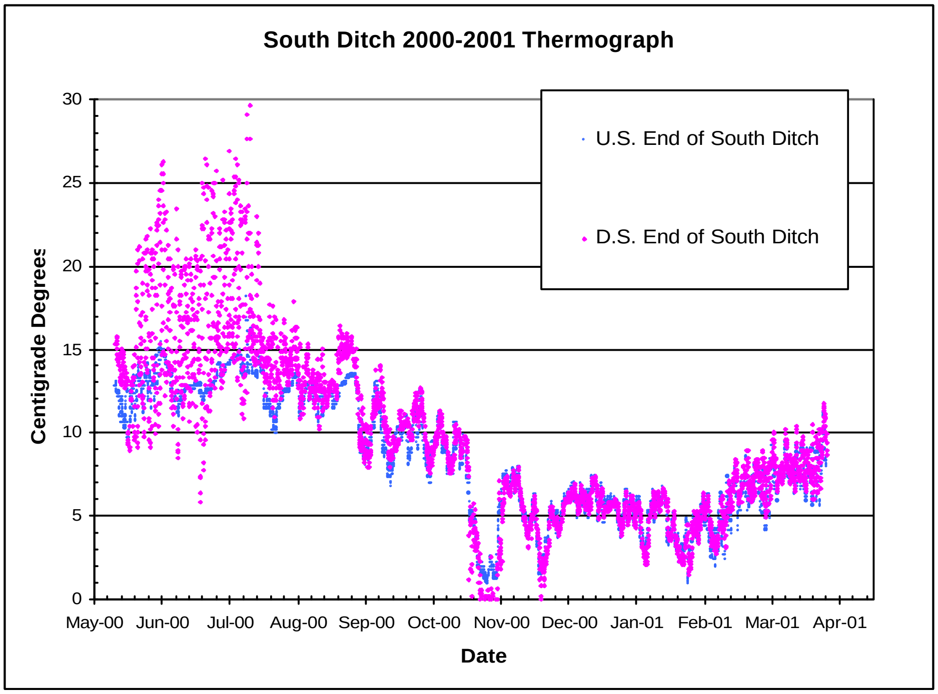
Stations:

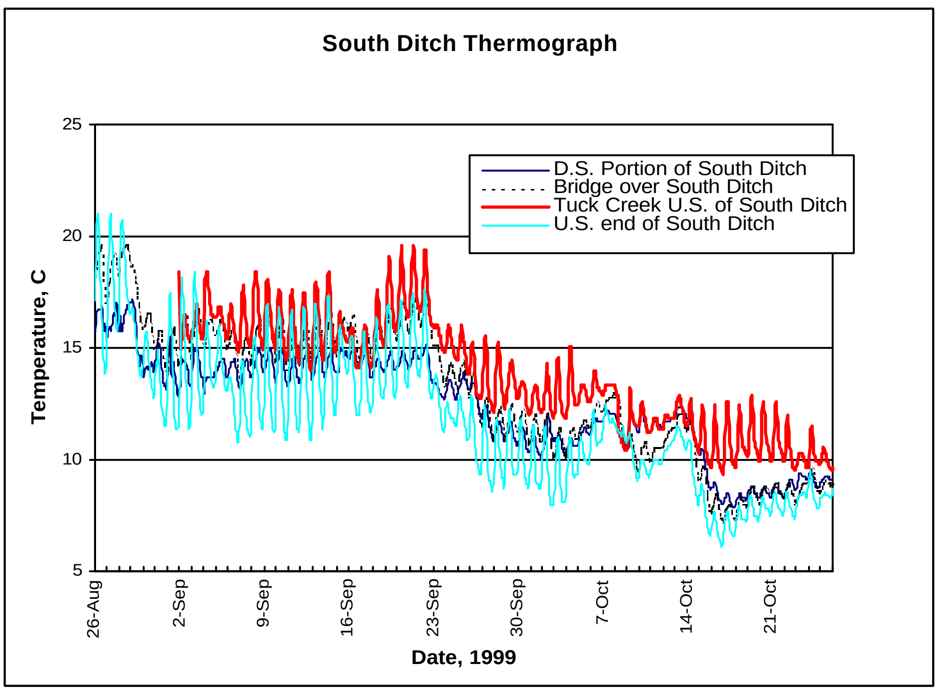
1	*Immediately below West Snoqualmie Valley Road*
2	*At confluence below perched culvert, and above tributary*
2a	*Tributary flowing into the Middle Ditch (5 meters u.s. of confluence)*
3	*Immediately upstream of the large salmonberry plant*
4	*at Property boundary*
5	*At bridge near confluence with Tuck Creek*
6	*Tuck Creek at bridge just upstream of the Middle Ditch*

The South Ditch is cooler than Tuck Creek at the location upstream of its confluence with the Middle Ditch. Because the Middle Ditch apparently cools Tuck Creek above its confluence with the South Ditch, the temperature of the South Ditch is also cooler than Tuck Creek above the

Middle Ditch confluence (Figure 2). In the pre-monitoring stage of this project we did not found salmonid activity in the South Ditch, possibly because of the low DO and dense in-channel vegetation. However, since that time we have found salmonids in this watercourse, likely a result of this project. However, there is an issue with a culvert located in the middle of this watercourse that has become perched as a result of maintenance activities carried out in 1999. This barrier prevents fish passage to the upstream extent of the South Ditch. Water temperatures in the South Ditch have been decreased since the 1999 maintenance activities, and should continue to do so as the mitigation vegetation matures.

Figure 2: Thermographs of South Ditch following dredging in 1999.





DO concentrations in the South Ditch are interesting. Prior to excavation the DO levels in the South Ditch were consistently below 8 mg/l, except at the mouth where water from the Middle Ditch increased the DO in the Tuck Creek water to near optimum levels. Immediately following excavation, the DO levels in the South Ditch increased to near optimum levels, presumably due to increased atmospheric exchange caused by the additional wetted surface area. Since 1999, they have continued to fluctuate although the temperatures in the South Ditch remain cool. Presumably this fluctuation is a result of groundwater and BOD in this watercourse. Salmonids have been captured in the South Ditch, which implies that DO levels are improved from 1999 levels.

Table 4: Dissolved oxygen concentrations in the South Ditch.

South Ditch Dissolved Oxygen and Instantaneous Temperature Data

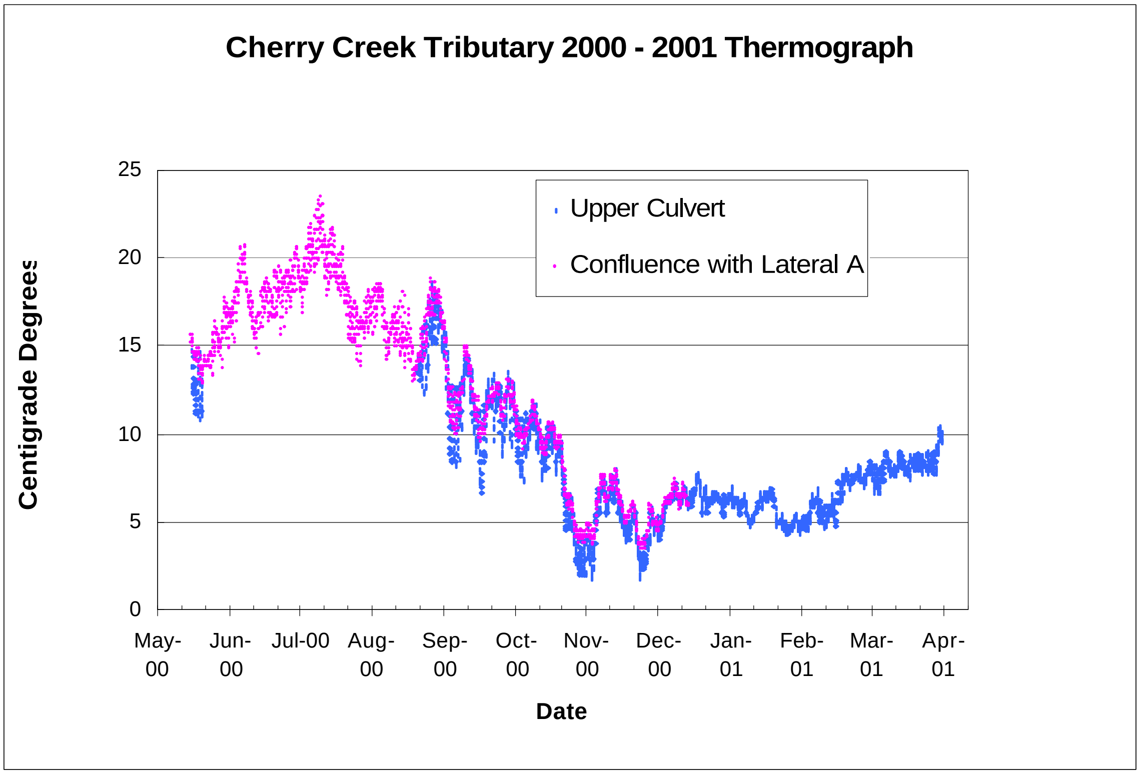
Date	**Station**	**Dissolved Oxygen** *(mg/L)*	**Temperature** *(deg C)*	**Time** *(24 hr)*	**Notes:**
16-Jul-99	1	2.4	14.8	16:23	*Ambient air: 21.5 deg C*
16-Jul-99	2	4.4	14.8	16:20	
16-Jul-99	3	4.1	15	16:18	
16-Jul-99	4	8.2	16.5	16:15	
	1	9.9		10:44	
7-Aug-99		9.6	14.9		
7-Aug-99	3	9.6	14.6	10:30	
7-Aug-99	4	7.5	13.8	10:34	
20-Jan-00	3	5	3.5		
7-Jun-00	1	11.1	13.8	13:00	*Ambient air: 19.1 deg C*
	2	8.1	14.1	13:15	
	4	10	15.2	13:25	
17-Aug-00	1	1.4	10.6	12:05	*Ambient Air: 21.5 deg C*
	3	3.55	12.4	11:50	
9-Nov-00	1	5.15	9.5	11:45	*Ambient Air: 11.5 deg C*
	2	7.06	9.4	11:30	
	5	6.29	8.7	11:20	

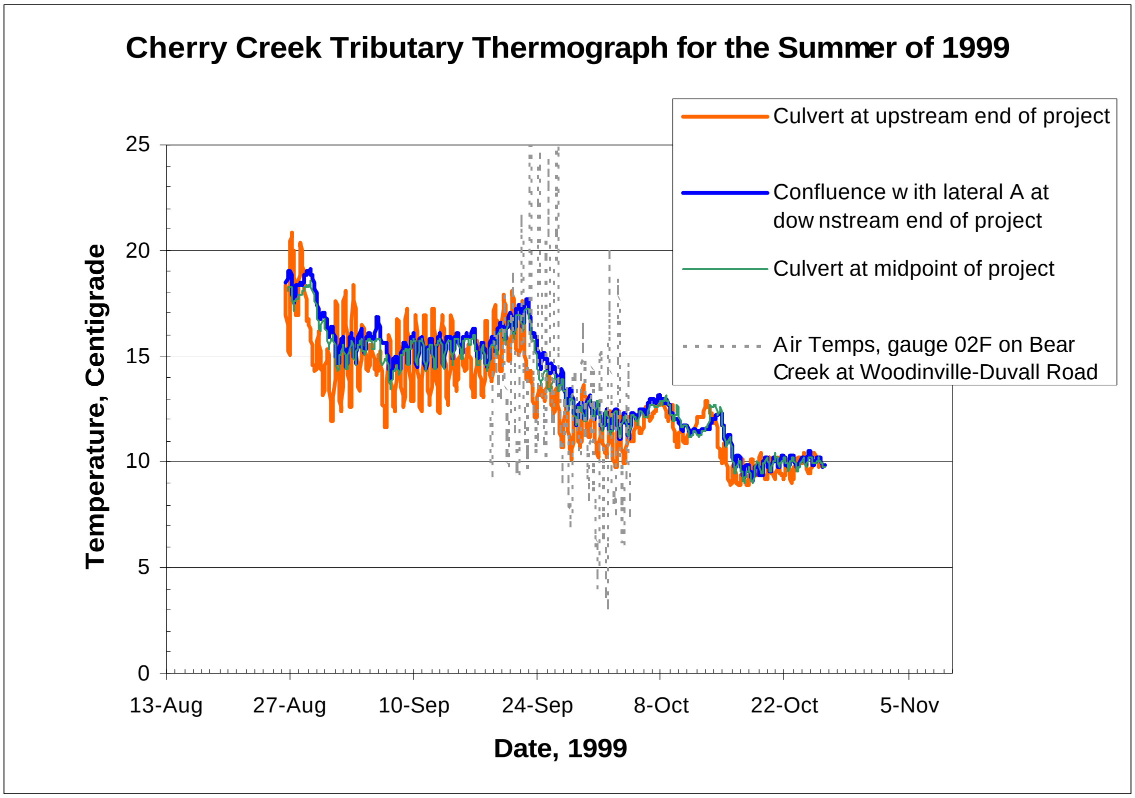
Stations:

1	Just D.S of property boundary
2	Immediately u.s. of Bentham's bridge
3	Immediately d.s. of Bentham's bridge
4	Upstream of confluence with Tuck Creek
5	Tuck Creek below mouth of South Ditch

Water temperatures appear to remain stable in the Cherry Valley Tributary throughout the project area (Table 7). Neither temperature or DO concentrations in this watercourse appear to be limiting salmonid success, as temperatures above 20°C are rare and DO concentrations are near 8.0 mg/L during most of the summer months (Figure 3).

Figure 3: Thermographs of Cherry Valley Tributary following dredging in 1999





The dissolved oxygen levels observed in the Cherry Valley Tributary are not a major hindrance

and photosynthetic algae is decadent, the DO levels decline below optimum concentrations. The lower portion of this watercourse has even lower DO levels, presumably due to the influence of

Table 5: Dissolved Oxygen and Instantaneous Temperature Data in the Cherry Valley Tributary

Cherry Valley Tributary Dissolved Oxygen and Instantaneous Temperature Data					
Date	**Station**	**Dissolved Oxygen** *(mg/L)*	**Temperature** *(deg C)*	**Time** *(24 hr)*	**Notes:**
16-Jul-99	1	8.9	16	15:00	*Ambient air: 19.0 deg C*
	2	8.7	16.5	15:56	
	3	8.4	17.2	15:52	
	4	7.4	17.9	15:48	
27-Jul-99	1	6.5	20.8	16:31	
	2	6.3	20.8	16:33	
	3	7.2	24.7	16:18	
	4	7.2	24.9	16:16	
4-Aug-99	5	5.2	23.5	15:30	*Ambient air: 23 deg C*
20-Jan-00	3	6	4		
	1	8	4		
7-Jun-00	1	11	13.5	10:30	*Ambient air: 18.9 deg C*
	2	8.7	14.2	10:35	
	4	10	15.4	10:40	
	5	10.7	15.7	10:50	
17-Aug-00	Between 2 & 3	9.1	13.9	10:45	*Ambient air: 20*
	Between 3 & 4	7.1	14.7	10:30	
	5	3.15	14.3	10:15	
18-Oct-00	2	10.11	12.7	11:50	*Ambient air: 17.5*
	3	5.87	13.1	11:40	
	5	4.88	13	11:25	

Stations:

1	Upstream of culvert on Bellamy's road (area not dredged)
2	Immediately d.s. of culvert
3	Upstream of bridge crossing (in the middle of the project area)
4	Half-way between bridge and Lateral A
5	At confluence with Lateral A

Macroinvertebrate data from the project watercourses provide insight to the diversity and aquatic health of these systems. Karr and Chu (1997) developed a Benthic Index of Biological Integrity

benthic macroinvertebrate community. This work is a follow up of the river continuum concept (Vannote et al. 1980), with specific analysis metrics used to evaluate stream health and

The ratings for B-IBI are on a scale of 10 to 50, with 50 being a very healthy reference system, and 10 being a very poor response reach. As one may expect because of the highly altered ecosystem, agricultural waterways have a B-IBI score nearer to 10 than 50. The Cherry Valley Tributary scored 17 prior to the excavation, and scored a reduced 14 after the first year of recovery. The subtle differences between these two scores may be attributed to sample bias and taxonomic discrepancies, although in this instance it seems neither of these alternatives is likely. It appears that benthic macroinvertebrates have been negatively affected by dredging activities at the Cherry Valley Tributary, and we will continue to monitor the health of these streams with respect to aquatic insect diversity. Once mitigation vegetation matures, it is possible that the B-IBI values in these watercourses will increase (Rader 1997).

Fish Use

Fisheries data at the 1998 project sites were collected immediately prior to excavation, with the exception of the North Ditch. Both pre- and post-project fisheries data were collected at all 1999 sites. These data were collected through the use of both electrofishers and minnow traps at all sites prior to the 1999 projects.

1998 Projects

No fisheries data were collected for the North Ditch prior to the project. Post-project, in May 1999, 2 juvenile coho and 252 sticklebacks were captured in the North Ditch. A trapping in June 1999 yielded no salmonids, but over 100 sticklebacks. Subsequent sampling in the North Ditch in 2000 resulted in the detection of salmonids. It appears that these fish are beginning to use the North Ditch once again. As vegetation matures along the North Ditch, it is likely that salmonids will continue to utilize this habitat.

Table 6: Fisheries sampling in the North Ditch

Date	Number	Species	Length
12 October 1998	25	Coho	Juveniles
	7	Lamprey	
	2	Sculpin	
16 June 1999	~100	Stickleback	
20 January 2000	~100	Stickleback	
14 June 2000	~175	Stickleback	
9 November 2000	11	Stickleback	25-50 mm
	1	Sculpin	90 mm
31 January 2001	7	Coho	60-90 mm
	10	Stickleback	25-50 mm

Limited fisheries data for the Middle Ditch were collected prior to dredging activities. The only data collected was that of fish removal immediately prior to dredging. Following the project, 29 sticklebacks, 10 pumpkinseed, 4 juvenile coho, and 6 sculpin were trapped in May 1999. An additional trapping in June 1999 yielded 4 juvenile coho. A trapping event in January 2000 captured 2 coho juveniles in the upstream portion of the Middle Ditch, and another trapping event in June 2000 yielded 4 coho in the Middle Ditch. In every trapping event since June 2000, salmonids have been detected in the Middle Ditch. It appears that the habitat in the most upstream portion of the Middle Ditch includes both pools and riffles, which will probably increase the use of this reach by salmonids.

Table 7:

Date	Number		Length
12 October 1998	141		Juveniles
	122	Coho	Juveniles
	2	Sculpin	~90 mm
	23	Lamprey	~120 mm
28 May 1999	4	Coho	Juveniles
	10	Pumpkinseed	~60 mm
	29	Sticklebacks	~40 mm
	6	Sculpin	~100 mm
20 January 2000	2	Coho	~70 mm
14 June 2000	4	Coho	35-60 mm
	7	Stickleback	30 mm
	1	Sculpin	90 mm
17 August 2000	4	Stickleback	40 mm
	4	Coho	40-55 mm
	1	Crayfish	80 mm
	6	NW Salamander	55-150 mm
18 October 2000	3	Cutthroat	70-140 mm
	3	Lamprey	90-130 mm
	1	Sculpin	45 mm
	1	Coho	60 mm
9 November 2000	5	Coho	60-95 mm
	1	Sculpin	85 mm
	9	Stickleback	25-45 mm
31 January 2001	1	Cutthroat	70 mm
	13	Coho	70-90 mm
	1	Sculpin	120 mm
	15	Stickleback	25-45 mm

1999 Projects

In 7 sampling events, no salmonids were detected in the South Ditch. However, in August 2000 salmonids were detected for the first time in the South Ditch. Monitoring activities in January 2001 yielded 16 salmonids in the South Ditch, rendering this project a success. Increased channel volume and increased woody debris seem to have improved this habitat for salmonids. This sampling was conducted prior to the project and following the dredging activities. Northwestern salamanders and stickleback have been detected in small numbers in this watercourse. Table 8 depicts fisheries data from 11 sampling events.

Fisheries sampling in the South Ditch

Date		Species	Length
12 October 1998		NW Salamander	(Larvae)
	1	Stickleback	
5 August 1999	4	Stickleback	
	8	NW Salamander	(Larvae)
6 August 1999	2	Stickleback	
	4	NW Salamander	(Tadpoles)
7 August 1999	1	Long Toad Salamander	(Tadpoles)
	1	Pacific Treefrog	(Adult)
8 August 1999	1	Stickleback	
	2	Bullfrog	(Tadpoles)
	3	NW Salamander	(Larvae)
9 August 1999	3	Stickleback	
	2	NW Salamander	(Larvae)
20 January 2000	0		
14 June 2000	6	Bullfrog	(Tadpoles)
	4	NW Salamander	(Larvae)
	38	Sticklebacks	35 mm
17 August 2000	1	Long-toed Salamander	
	4	Coho	50-85 mm
	9	Cutthroat	30 mm
	11	Stickleback	35-45
	1	NW Salamander	
9 November 2000	5	Stickleback	45 mm
31 January 2001	22	Stickleback	30-40 mm
	15	Coho	60-90 mm
	1	Cutthroat	100 mm
	8	NW Salamander	160-250 mm

The Cherry Valley Tributary has yielded varying numbers of salmonids (coho, cutthroat, and chinook) in 8 trapping events. In August of 1999 (immediately prior to dredging), we set traps for 5 successive nights to remove fish in the project area. No salmonids were captured (or recaptured) in the project area prior to excavation, but in each sampling event, coho were captured upstream of the project area and then marked and released out of the project area. It is clear that salmonids use this portion of the Cherry Valley Tributary for rearing and migration, especially during the winter months. In fact, one adult coho carcass was observed upstream of the project area during the winter sampling event in January 2000, indicating that coho attempt to spawn upstream of the project area where there is a very limited supply of suitable spawning habitat. In June 2000, we trapped one juvenile chinook salmon in the Cherry Valley Tributary, indicating that agricultural ditches can provide off-channel habitat for chinook as well as coho and cutthroat.

Table 9: Fisheries sampling in the Cherry Valley Tributary

Date	Number	Species	Length
26 April 1999	48	Sticklebacks	
	29	Pumpkinseed	(Juveniles)
	6	Cutthroat Trout	(Juveniles)
	5	Coho	(Juveniles)
	2	Lamprey	
	2	Bullfrog	(Tadpoles)
20 May 1999	4	Coho	62 mm
	16	Pumpkinseed	60 mm
20 May 1999	28	Stickleback	40 mm
	6	Bullfrog	85 mm
	2	Peamouth	60 mm
	1	Lamprey	
	1	Crayfish	25 mm (carapace)
5 August 1999	5	Coho	68 mm
	379	Stickleback	~25-45 mm
	1	Bullfrog	(Tadpoles)
	1	Black Crappie	65 mm
	1	Pumpkinseed	50 mm
	1	Lamprey	80 mm
6 August 1999	4	Coho	65 mm
	1	Bullfrog	(Tadpole)
	80	Stickleback	
7 August 1999	12	Coho	75 mm
	1	Pumpkinseed	45 mm
	60	Stickleback	
8 August 1999	6	Coho	68 mm
	89	Stickleback	
9 August 1999	3	Coho	72 mm
	37	Stickleback	
	5	Lamprey	130 mm
	6	Bullfrog	(Tadpoles)
20 January 2000	3	Coho	90 mm
	1	Coho (Adult)	675 mm
14 June 2000	17	Coho	40-60 mm
	1	**Chinook**	70 mm
	163	Stickleback	30-50 mm
	16	Pumpkinseed	50 mm
17 August 2000	63	Stickleback	30-45 mm
	1	Pumpkinseed	40 mm
18 October 2000	3	Coho	50-55 mm
	3	Bullhead	50-70 mm
	4	Peamouth	60-75 mm
	13	Stickleback	30-45 mm
	4	Pumpkinseed	40-50 mm
31 January 2001	30	Coho	60-150 mm
	111	Stickleback	30-50 mm
	2	Cutthroat	70 mm

2000 Pre-Project Monitoring

Ames Lake Creek Site

Pre-project monitoring data was collected at the Ames Lake Creek (Turner) project site. These data represent pre-project baseline conditions. Mitigation prescriptions, if ditch maintenance were to occur at this site, are based upon these data reported below.

Temperature and Dissolved Oxygen Concentrations

Ames Lake Creek tributary sites include both what we have termed for convenience the "East Ditch", and the "Turner Ditch", although much of that ditch does not lie on Mr. Turner's land (Appendix E). The East Ditch originates from the hillsides to the southeast, and supports salmonids throughout its length. The Turner Ditch is entirely artificial and originates in an agricultural field; it does not support salmonids until its confluence with the East Ditch. After this confluence, salmonids are present in this watercourse. For the 2001 proposed project, the Turner Ditch, and that portion of the watercourse downstream and along NE 80th will be dredged until the confluence with Sikes Lake Creek. This portion of the watercourse is immediately adjacent to agricultural lands and NE 80th. As a consequence, the water quality parameters in this watercourse are not conducive for salmonid success, although temperatures remain cool. Dissolved oxygen levels upstream of the confluence with the East Ditch are too low for salmonids. These values are a result of decomposing reed canary grass and little atmospheric exchange due to the vegetation density in the channel itself. In addition, the gradient of this ditch is less than ½ of 1%, eliminating the opportunity for turbulent flow, which would introduce oxygen into this waterway. Below this confluence, however, the water in the channel has a much greater volume surface area which allows photosynthesis and atmospheric exchange to occur, greatly enhancing the DO of this watercourse. Interestingly enough, it is at this confluence where salmonids begin to use this watercourse. Table 10 represents the DO and instantaneous temperature data collected at this site.

Table 10: Dissolved Oxygen and Temperature Measurements at the Ames Lake Tributary

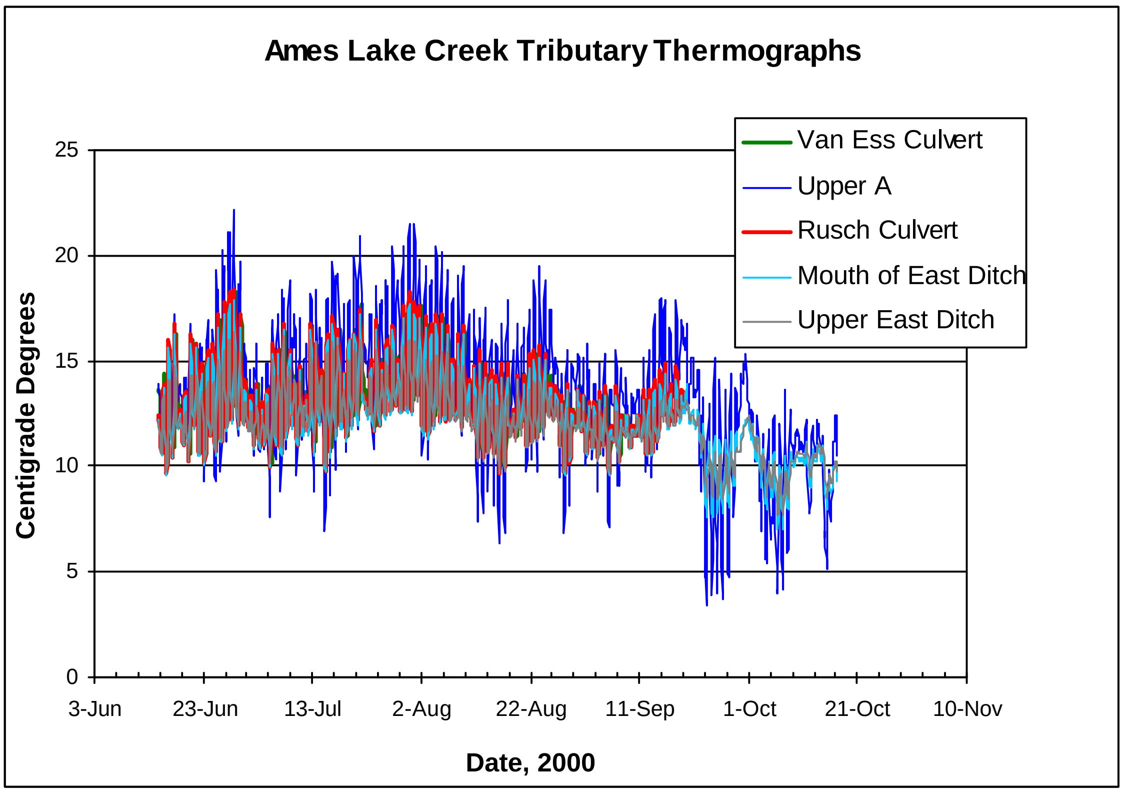
Dissolved Oxygen and Instantaneous Temperature data for the Ames Lake Creek Tributaries				
Date	**Station**	**Dissolved Oxygen** *(mg/L)*	**Temperature** *(deg C)*	**Time** *(24 hr)*
29-Feb-00	1	2.73*	7.5	
29-Feb-00	2	2.9*	7.6	
29-Feb-00	9	9.7	8.5	
29-Feb-00	10	10.3	8.4	
29-Feb-00	3	6	7	
29-Feb-00	4	9.8	8.3	
29-Feb-00	11	10.2	8.1	
29-Feb-00	12	9.9	8.2	
29-Feb-00	5	9.1	8.3	
29-Feb-00	6	8.7	8.3	
29-Feb-00	7	9.3	8.7	
14-Jun-00	1	Dry		
14-Jun-00	2	2.6	13.8	
14-Jun-00	9	N.S.		
14-Jun-00	10	10.6	14.1	
14-Jun-00	3	N.S.		
14-Jun-00	4	11.2	12.1	
14-Jun-00	11	N.S.		
14-Jun-00	12	8.7	11.9	
14-Jun-00	5	7.5	12.2	
14-Jun-00	6	7.2	12.2	
14-Jun-00	8	5.8	13.9	
17-Aug-00	4	9.6	11.9	12:50
17-Aug-00	12	10.7	12.6	12:40
17-Aug-00	8	9.45	11.3	13:05
6-Sep-00		10.34	12.1	11:40
6-Sep-00		10.39	11.7	11:55
18-Oct-00	2	2.88	12.8	10:15
18-Oct-00	10	9.44	10.6	9:50
18-Oct-00	12	9.54	10.7	11:00
18-Oct-00	7	8.59	10.7	10:50
18-Oct-00	8	8.53	10.7	10:40
29-Nov-00	5	9.35	6	10:30

Stations:	
1	Top of Turner's blind ditch
2	Turner Prop Boundary
3	Rusch Fence
4	Corner of blind ditch at 80th
5	Culvert under 80th
6	1/2 way between 80th and smashed culvert
7	Smashed culvert
8	Confluence with Sykes Lk Ck
9	East Ditch bridge
10	East Ditch directly west of Site 1
11	Property boundary and beaver dam on ED
12	ED corner with 80th

Temperature

Temperature loggers installed in the Ames Lake Creek tributaries provide insight to the thermal regime of potential projects prior to maintenance. The upper reach ("Reach A" which starts on the Turner Property) has little flow and fluctuates with changes in solar radiation and ambient air temperature. In contrast, the other tributaries do not appear to be limiting for salmonids based upon temperature. If a project takes place at these sites, future thermographs will provide insight to the actual change of the thermal regime as a result of watercourse maintenance. This pre-project data will be critical in this analysis.

Figure 4: Thermograph of potential ADAP Project at Ames Lake Tributaries (Turner's Project)



Macroinvertebrates

Benthic macroinvertebrates were sampled at this site in 2000. Pre-project data indicates a B-IBI score of 16 near the culvert under NE 80^{th}, and 14 at the end of the project site (the confluence with Sikes Lake Creek). Again, these low scores are not particularly surprising, although with the revegetation and habitat complexity required as a result of mitigation measures by an ADAP project, there is a potential for these values to increase with appropriate mitigation requirements (Rader 1997).

Fish Use

Surveys began in February of 2000 to determine the use by salmonid species of potential project watercourses. Minnow traps were used to collect these data. We found salmonids in "Reach B and C", but not in "Reach A", which is an observation expected, given DO and temperature data in that reach. Fisheries removal efforts for a culvert replacement along NE 80th by King County Roads found a considerable number of salmonids in the lower reaches of this project site. Both cutthroat and coho are found throughout most of these watercourses. Table 11 is a synopsis of fish that have been captured at the Ames Lake Creek Tributary sites.

Table 11: Fisheries data collected at the Ames Lake Creek Project area

Date	Number	Species	Length
29 February 2000	6	Coho	45-100 mm
	6	Crayfish	100 mm
14 June 2000	1	Sculpin	75 mm
	11	Stickleback	45 mm
	10	Coho	45-60 mm
	3	Crayfish	60-90 mm
17 August 2000	12	Coho	40-75 mm
	1	Cutthroat	150 mm
	5	Stickleback	35-50 mm
6 September 2000	25	Stickleback	40 mm
18 October 2000	3	Cutthroat	70-100 mm
	5	Coho	40-70 mm
	2	Sculpin	50-80 mm
	1	Crayfish	60 mm
	1	Stickleback	35 mm
29 November 2000	0		
31 January 2001	11	Stickleback	35-50 mm
	9	Coho	60-70 mm
	1	Cutthroat	90 mm
	1	Crayfish	150 mm

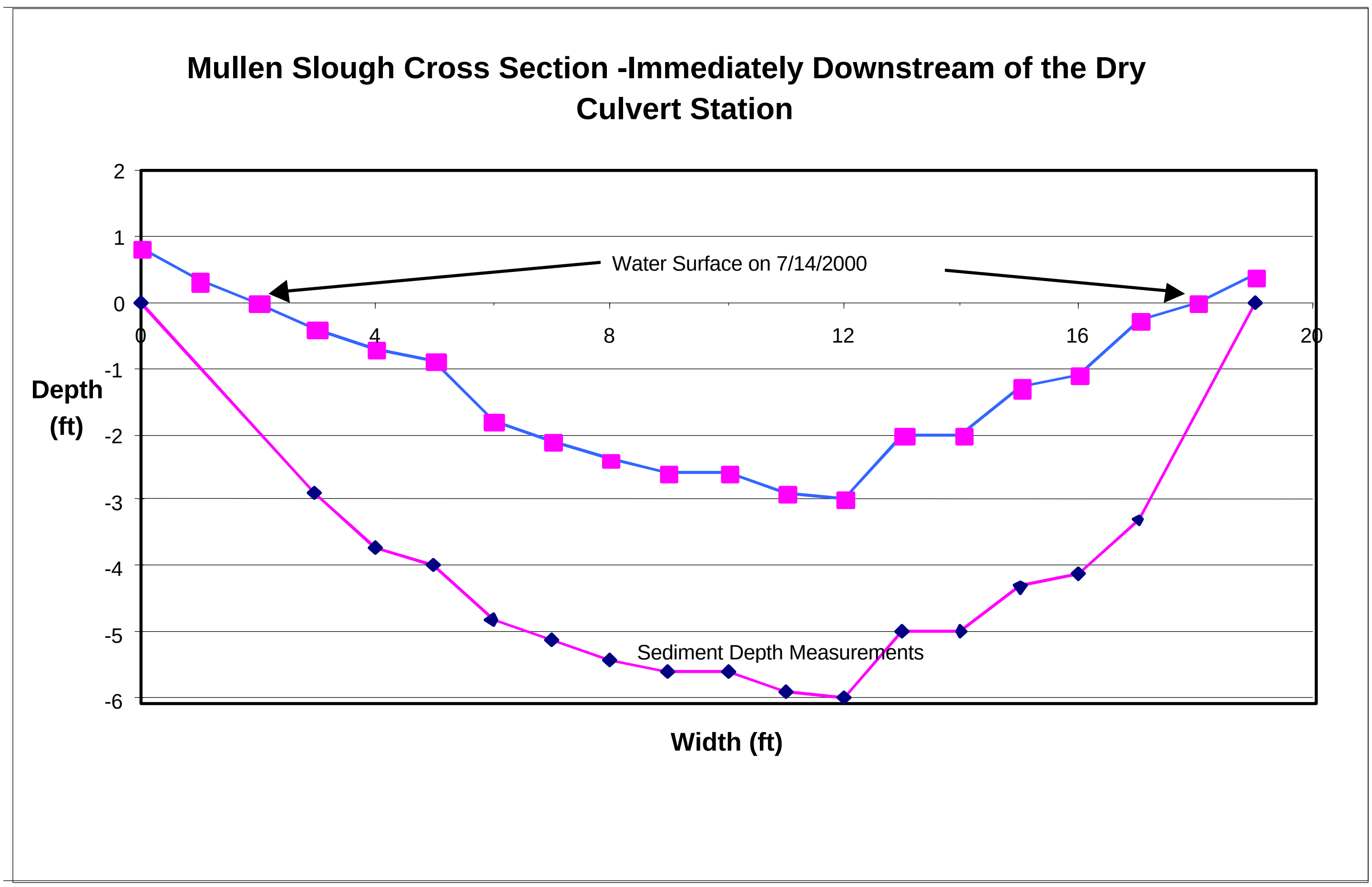
2000 Pre-Project Monitoring

Mullen Slough

Mullen slough is a tributary of the Green River that originates on hillsides to the east and south, and flows for several miles through agricultural fields. Drainage problems have occurred in this watercourse for many years, although they have become exacerbated by recent development on the adjacent upland. Data collection activities for Mullen Slough began in October of 1999, with the idea that some sort of a watercourse maintenance project could occur in 2000 or 2001.

Similar to other agricultural waterways, the rate of sedimentation in Mullen Slough has skyrocketed with recent development on the hillside. In many instances, fine sediments account for a greater percentage of the channel volume than does water. Figure 5 represents a typical channel configuration found in Mullen Slough. Such an accumulation of in-channel sediment may lead to an increased frequency and severity of saturated agricultural soils.

Figure 5: Typical channel configuration of Mullen Slough



Longitudinal

Longitudinal profiles were surveyed throughout Mullen Slough. These profiles provide data for channel gradient, as well as changes that may occur if dredging does occur. While not particularly useful for monitoring data, these baseline data will be critical in monitoring the rate at which Mullen Slough re-fills with fine sediment if a maintenance activity should occur in subsequent years.

Gauges and Piezometers

Relative stage gauges and piezometers were installed in Mullen Slough during the fall of 2000. These devices will help establish if channel drainage does improve as a result of ditch maintenance by measuring the hydraulic gradient in both the soils and the water level of the channel.

Temperature and Dissolved Oxygen Concentrations

Mullen Slough appears to remain cool for most of the year, although DO concentrations fluctuate widely between sampling sites. The uppermost portion of Mullen Slough is generally forested (the "Upper Middle" and "West Trib" sampling sites) and contains cool water with high concentrations of dissolved oxygen. However, once this water reaches the floodplain it begins to lose oxygen at a rapid rate ("Upper Boscolo" to "277th Bridge"). Dissolved oxygen levels decline through Mullen Slough until the West Tributary contributes cool, well oxygenated waters from the hillside ("Smith Bros. Bridge"), and then decline rapidly once again ("Tree Zone" and "Dry Culvert"). The "2 Log Bridge" site rebounds a little after turbulent flows occur as a result of a beaver dam in the lower portion of Mullen Slough. Figure 6 shows these trends along a typical 24-hour cycle. "Mill Test1" and "Mill Test2" are replicate sites to verify the proper operation of the instrumentation.

This trend is likely a result of agricultural land use practices and groundwater upwelling. Agricultural waste and clearing practices generally decrease the DO concentrations in watercourses adjacent to these lands (Wetzel 1983; Alabaster et al. 1979). Seasonal values are represented in Table 12.

Figure 6: Dissolved Oxygen Concentrations along Mullen Slough (November 2000)

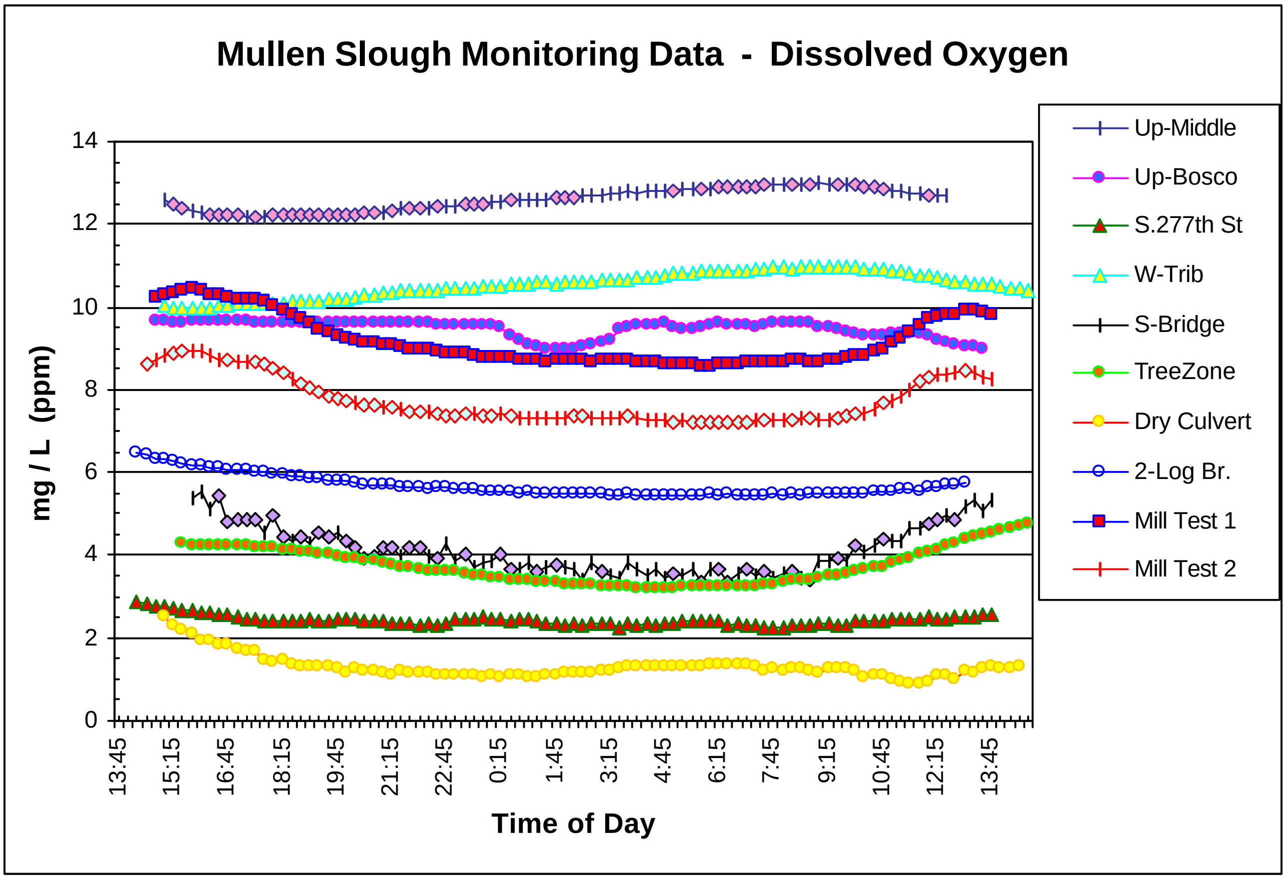
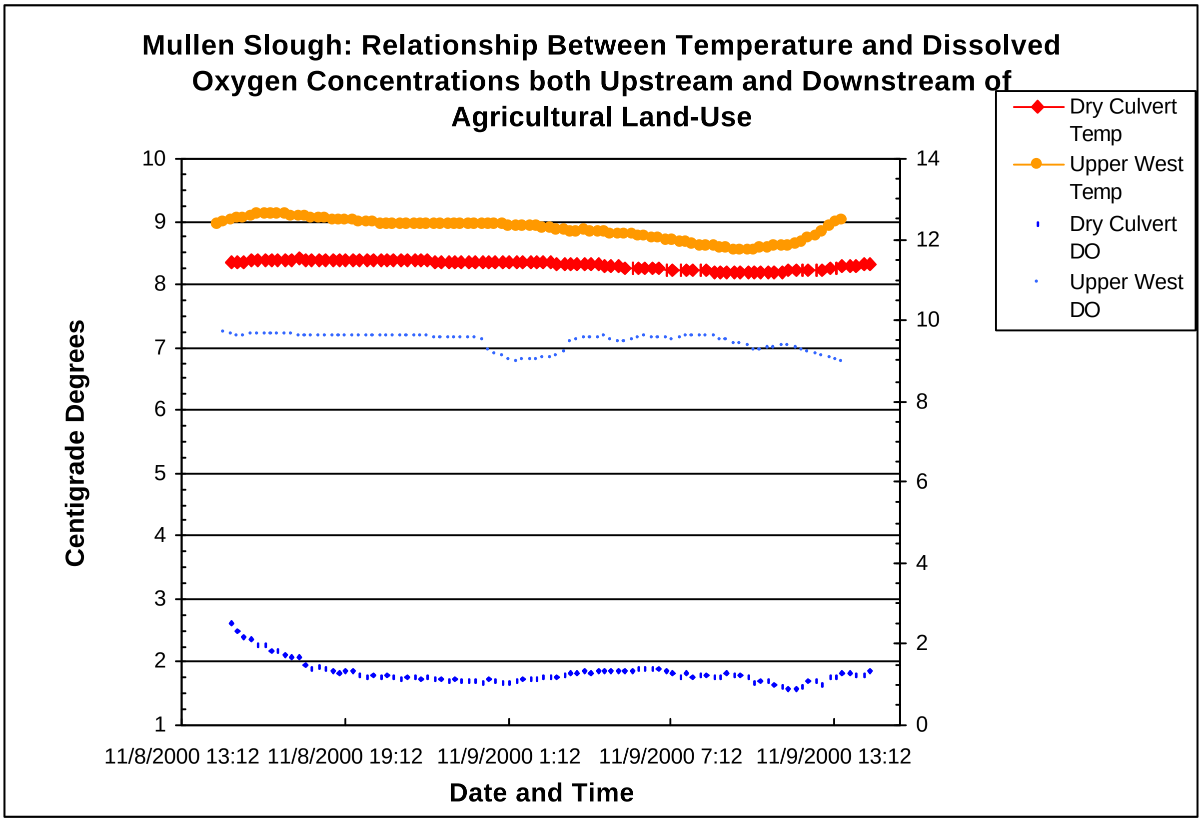


Table 12: Dissolved Oxygen and Temperature Measurements in Mullen Slough

Dissolved Oxygen and Instantaneous Temperature in Mullen Slough						
Date	**Site**	**Time** *(hrs:min)*	**D.O.** *(mg/l)*	**D.O.** *(%)*	**Temp.** *(deg C)*	**Notes:**
9/20/99	8	14:40	3.60	~35%	13.2	Ambient Air 18.7 deg C
	8A	13:50	1.98	~29%	12.9	
	12	12:45	8.00	~67	9.6	Ambient Air 24.5 deg C
	11	11:30	5.00	~62	9.1	
	9	noon	4.40	~43	9.0	
21-Jul-00	7	10:22	0.25		15.3	
	8	10:30	2.3		15.8	
	9	11:17	0.69		17.5	
	10	11:24	0.18		17.8	
	11	11:35	2.1		16.8	
	12	11:45	4.42		16.7	Amidst the garbage and squalor
4-Oct-00	7	10:55	1.29		9.3	Flow visible
	8	11:45	6.41		9.3	
	9	12:45	0.95		10.2	
	11	13:00	4.61		10.4	
1-Dec-00	7	14:30	2.89	22.9	5.6	
	8	13:45	5.78	46.1	5.8	
27-Feb-01	11	12:05	5.07	39	4.4	
	9	11:50	5.65	45	5	
	8	13:08	9.2	72	5.7	
	7a	12:50	9.83	86	9.5	
	7	14:10	2.19	17	5.1	
	3	13:53	11.32	94	7.3	
Stations:						
1	West Ditch 287th Street				8	Smith Bros. Bridge - Staff Gage # 1
2	Middle Ditch 287th Street				8A	South (u/s) end of treed wetland reach
3	East Ditch 287th Street				9	Dry Culvert - Staff Gage # 2
7	277th St. Bridge - Box Culvert				11	Two Log Bridge - Staff Gage # 3
7A	West Trib - between 277th and Smith Bridge				12	Under HWY 516 Bridge

Further investigation into DO levels in agricultural areas of Mullen Slough show the dramatic effect of how agricultural land use can have a substantial change on the DO levels of nearby watercourses. Figure 7 shows the relationship of temperature and DO levels at “Dry Culvert”, a site downstream of agricultural land-use, and the “Upper West Trib” a site immediately upstream of agricultural lands. The low DO values of the agricultural areas of Mullen Slough act as a barrier for fish, much like a perched culvert or a dam. Both of these areas offer cool waters, but the DO levels at the Dry Culvert site (as a result of agriculture) will prevent salmonids from accessing the high quality habitat upstream (Bjornn and Reiser 1991; Wetzel 1983). These findings suggest that consideration needs to be given to factors other than temperature when mitigating for ditch maintenance and developing BMPs in agricultural areas.

Figure 7: Relationship between Temperature and Dissolved Oxygen in Mullen Slough (November 2000)



Temperature

Temperatures in the Mullen Slough do not seem to be limiting for salmonid use. Other factors, in particular dissolved oxygen, seem to be more important at defining critical salmonid habitat in the Mullen Slough (and tributaries). Water temperatures both upstream and downstream of agriculture remain stable at the Mullen Slough sampling sites (Figure 8). In small headwater areas of Mullen Slough, the temperature extremes logged over a 24-hour period are more pronounced than at downstream sites where larger channel volumes reduce thermal variability (due to physical properties of water). Figure 9 details the daily variation in temperature at upstream and downstream sampling sites in Mullen Slough.

Figure 8: Thermograph of Mullen Slough

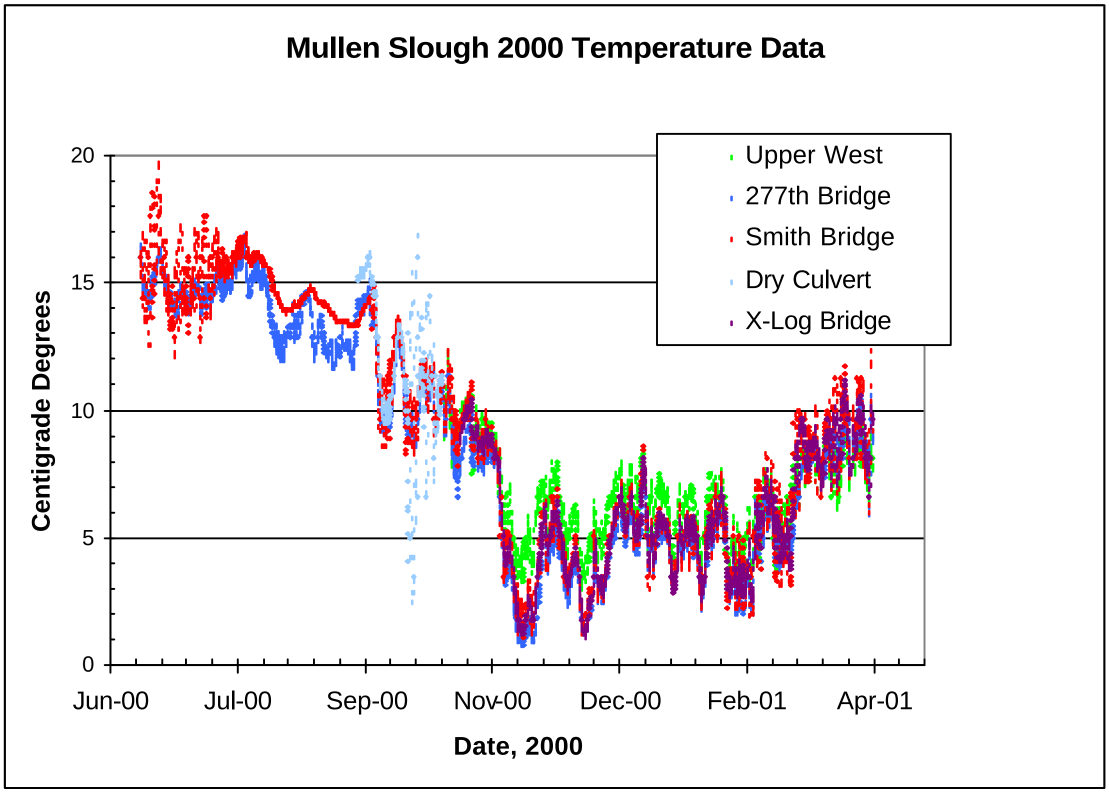
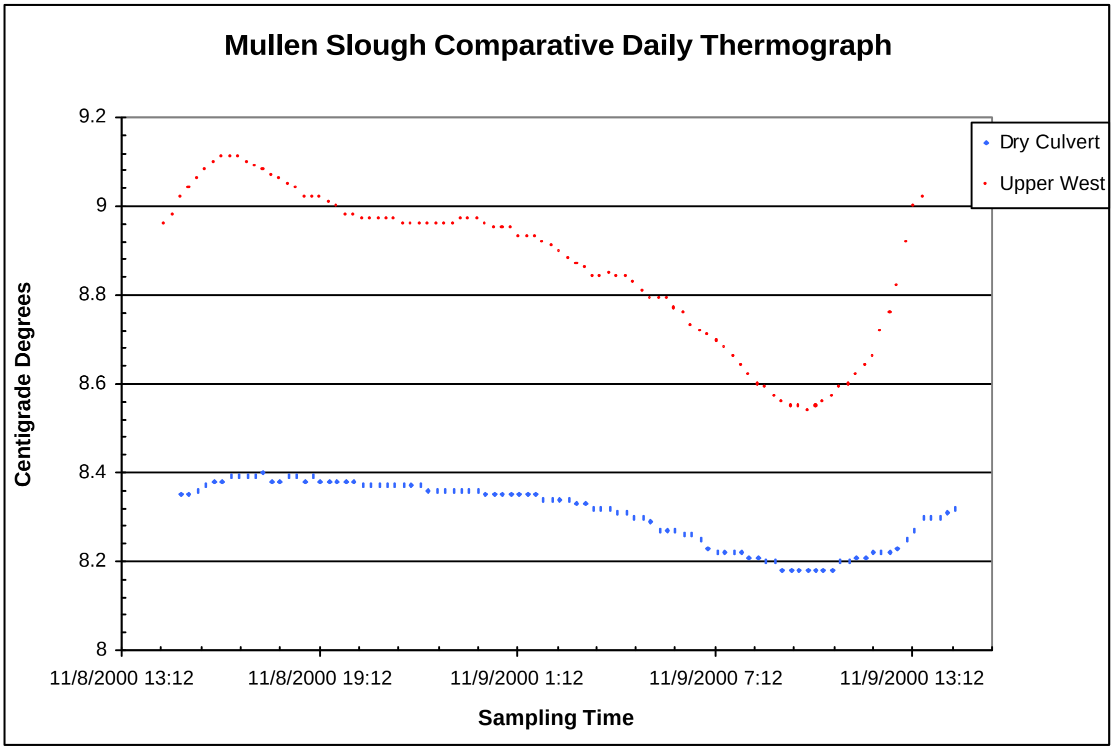


Figure 9: Daily variation in Water Temperature at two sites in Mullen Slough (November 2000)



Water Quality

Water quality sampling took place on 27 February 2001 at the Mullen Slough. This data reiterates the DO data, indicating that water quality is reduced in areas heavily influenced by agriculture. These data also reaffirmed the accuracy of our multi-meters in assessing DO and temperature, as evident in the comparison of “on site probe” vs. lab analysis methods (Winkler method). Low levels of phosphorous, nitrates, and ammonia are surprising, given the extensive agricultural use in this area. Watercourses adjacent to agricultural lands generally have high levels of fecal coliforms, as a result of manure application in agricultural fields. In the Mullen Slough, fecal coliform levels are low, indicating that the farmers in this area are conscientious about applying manure in a manner that reduces organic loading in nearby watercourses. The one spike of fecal coliform levels is at a site (“West Prong”) where human farm workers were observed to contribute sources of fecal coliform directly to the stream environment, although not as a direct result of agricultural practices. Appendix G is a synopsis of the water quality data collected at this sampling event.

Macroinvertebrate Data

Benthic macroinvertebrates were sampled at this site in 2000. Pre-project data indicates a B-IBI score of 14 near the mouth of Mullen Slough. Sampling in 2001 will include areas upstream and downstream of agricultural land use. Again, these low scores are not particularly surprising, given the channel gradient and substrate (fine sediment instead of cobble/gravel).

Fish Use

Like many other agricultural waterways, a variety of fish use the Mullen Slough. Coho and cutthroat trout have been observed in the lower reaches (“2 Log Bridge” site), but apparent low concentrations of dissolved oxygen act as a barrier to these sensitive fish, and limit their range to this area.

Table 14: Fisheries Data collected at the Mullen Slough

Date	Number	Species	Length
30 September 1999	51	Crayfish	
	16	Coho	60 mm
	7	Stickleback	25-50 mm
15 December 1999	2	Cutthroat	45 mm
	10	Coho	60 mm
22 June 2000	14	Stickleback	40 mm
	1	Crayfish	
	5	Coho	40-70 mm
	1	Sculpin	
	1	Smallmouth Bass	60 mm
31 August 2000	1	Brook Lamprey	150 mm
	2	Sculpin	70 mm
	44	Stickleback	35-50 mm
	2	Pumpkinseed	45-70 mm
4 October 2000	108	Stickleback	25-50 mm
	1	Sculpin	35 mm
	15	Pumpkinseed	50 mm
7 March 2001	2	Sculpin	60 mm
	49	Stickleback	30-50 mm

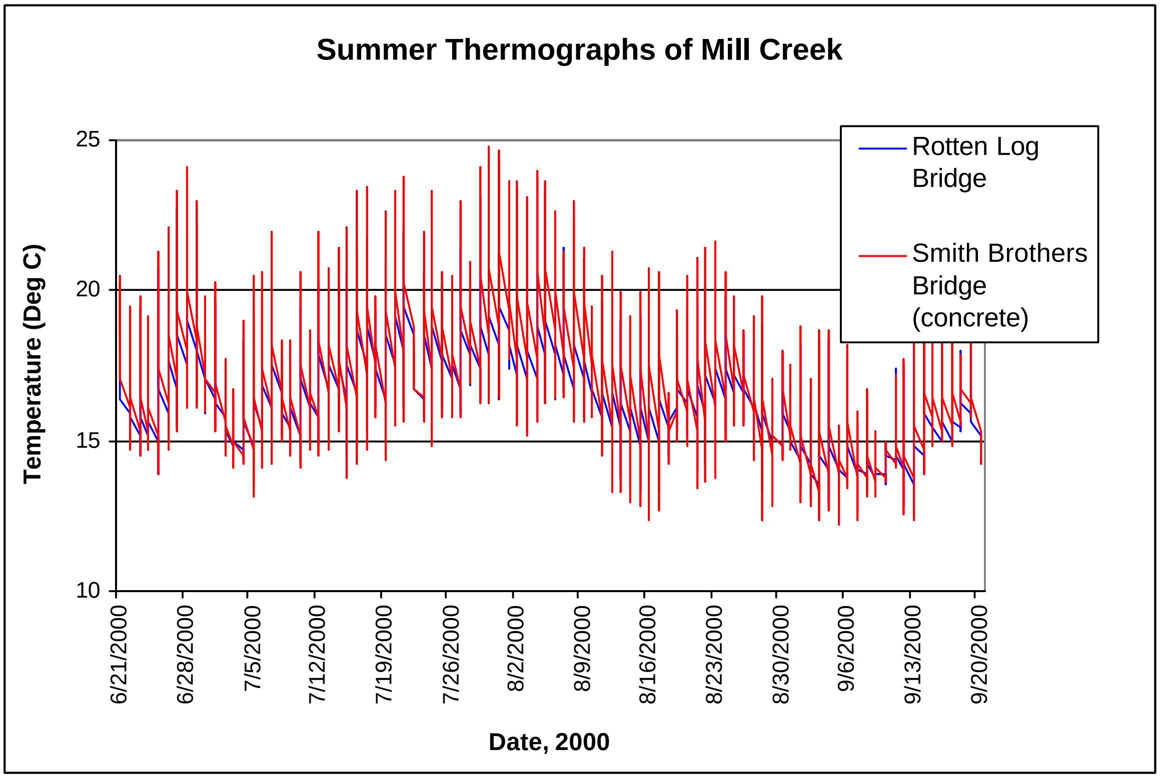
Mill Creek

Mill Creek is a tributary of the Green River that contains salmonids. Data collection activities began at the lower portion of Mill Creek in September 1999. On the first site visit, a female chinook (adult) was observed in Mill Creek migrating over a beaver dam. Portions of this watercourse are choked with reed canary grass, making drainage difficult. Similar to Mullen Slough, drainage problems in this watercourse have become exacerbated by recent development on the adjacent upland. Data collection activities for Mill Creek began in September of 1999, with the idea that a ditch maintenance project could occur in 2000 or 2001.

Temperature

In June 2000, several thermographs were placed in Mill Creek. Unfortunately, due to vandalism and tampering, some of these data have been compromised. However, summer temperatures in this watercourse would not limit salmonids use. Although winter data is not included below, it can be inferred that temperatures during the winter months would be more conducive to salmonids using this portion of Mill Creek. Figure 10 is a thermograph for the portion of Mill Creek that maintenance has been proposed.

Figure 10: Summer Thermograph of Mill Creek



Fish Use

A series of fisheries sampling events have been conducted in Mill Creek since September 1999. One adult chinook female was observed jumping over a beaver dam by ADAP staff (Site 3, see Table 15). This isolated observation suggests that chinook spawning may occur in portions of Mill Creek, although no other adults have been observed in recent years. Only one other salmonid (a juvenile coho) has been trapped in Mill Creek as part of this program. Table 15 is a synopsis of fisheries data collected at three sites in Mill Creek.

Table 15: Fisheries data collected in Mill Creek

Fisheries Sampling in Mill Creek					
Date	**Station**	**Number**	**Species**	**Length** *(mm)*	**Notes**
29-Sep-99	3	1	Chinook	750 mm	Adult female chinook observed jumping over Beaver Dam
15-Dec-99	All	0			
22-Jun-00	1	0			
22-Jun-00	2	1	Crayfish	60 mm	
22-Jun-00	3	1	Stickleback	35 mm	
31-Aug-00	1	3	Crayfish	40-50 mm	
	1	15	Stickleback	25-50 mm	
31-Aug-00	2	5	Crayfish	50 mm	
	2	2	Stickleback	25 mm	
31-Aug-00	3	3	Crayfish	40-60 mm	
4-Oct-00	1	1	Coho	110 mm	
	1	1	Stickleback	35 mm	
	2	9	Stickleback	35-45 mm	
	3	1	Crayfish	45 mm	
7-Mar-01	1	1	Crayfish	40 mm	
	2	2	Stickleback	45 mm	
	3	0			

Stations:

1 Rotten Log Bridge near Smith Bro's Pump house

2 Bridge at Smith Bro's

3 Shig's Bridge

Enumclaw APD

One project site on the Enumclaw Plateau was permitted for maintenance through the ADAP. This is the only permitted

2000 Project Site

Ritter Property

The Ritter Property was surveyed for fish use prior to excavation. No fish were captured at the site by ADAP staff and the state fish habitat biologist for this area felt that no fish would be present at the site. This finding made an HPA unnecessary and greatly minimized the mitigation prescription and need for a monitoring plan. A pre-project longitudinal survey was completed at this project site, and will be repeated in 2001 to monitor change in geomorphology following ditch excavation. Vegetation survival will also be monitored at this site in 2001.

2000 Pre-Project Sites

The Henderson Property near the intersection of SE 388th Street and 188th Ave SE on the Enumclaw Plateau was visited to establish whether or not it was a candidate project for the ADAP (stream inventory number 090101). After identifying a natural anadromous fish barrier, and after electrofishing and trapping the small stream above the barrier, it was clear that this stream did not contain salmonids. However, for other reasons, this site was determined to not be a potential project for the ADAP program.

Sammamish APD

No sites were identified in this APD in the year 2000 for eventual ADAP projects. The 2001 Annual Monitoring Report will describe any projects identified this year.

Discussion

Many large rivers in the Pacific Northwest have been levied to reduce flooding and channel migration, and many of their tributaries, whether they are natural streams or artificial ditches, have also been channelized. These practices have resulted in the significant loss of many vital off-channel habitats for resident fishes and amphibians, of which salmonids in this region depend. Although they look very different than their predecessors, and in most cases are a poor substitute, agricultural drainage ditches can still provide adequate over-winter and off-channel rearing habitat for young-of-the-year salmonids (Sommer et al. 2001; Rosenfeld et al. 2000; Bradford and Higgins 2001). In the King County APDs, it appears that salmonids, particularly coho, use these tributaries for a variety of purposes at different times of the year. It is important that these critical over-winter habitats are protected from further degradation.

Watercourse maintenance appears to have affected salmonid use of these habitats. In each project site, with the exception of the South Ditch and the North and Middle Ditches of Tuck Creek for which we do not have pre-project data, we have seen a decrease of salmonid use following excavation. If the extent of loss is only reflective in the first two year’s following maintenance, further monitoring efforts will verify this. Monitoring efforts in the year 2001 will examine this observation more thoroughly, and we will provide further recommendations in the 2001 annual report about the effectiveness of mitigation for fisheries recovery in these waterways. We expect salmonid use and macroinvertebrate diversity to increase in these ditches as the vegetation required for mitigation matures and provides a source of allochthonous material for these aquatic environments (Rader 1997; Dolloff 1986).

Salmonids can tolerate temperature extremes, but often they will migrate out of an area if temperature fluctuations are too dramatic (Bjornn 1978). In all cases we found the maximum temperature in project watercourses to be below the lethal level for salmonids, and in many cases we found the maximum temperature was near the optimum (Bjornn and Reiser 1991; Brett 1952; Bell 1986) for the species encountered in the project watercourses.

The relationship between temperature and dissolved oxygen is important for salmonids. Colder water has a higher capacity to hold oxygen than warm water. This relationship is shown in Table 1, along with the response of salmonids to various DO levels. Dissolved oxygen concentrations directly influence salmonid behavior and survivorship. In the Mullen Slough, this apparent DO barrier severely limits salmonid fitness, and needs to be addressed.

In some instances, ditch maintenance may actually benefit salmonids using these watercourses. For example, the South Ditch contains habitat better suited to salmonids than prior to dredging in 1999. Continued sampling of this watercourse will help us to understand salmonid use of these tributaries, and similar agricultural waterways. The 2001 monitoring year will be critical in assessing the success of mitigation measures.

Future Monitoring Efforts

ADAP monitoring efforts in 2001 and 2002 will be more extensive than those activities carried out in 2000. After looking at additional parameters in Mullen Slough, we will evaluate our fisheries sampling methodologies, macroinvertebrate survey techniques, water quality sampling techniques and application, and improve upon our temperature monitoring. Additional study will focus on salmonid growth during the summer months in agricultural waterways. In addition, vegetation survival at all sites will be monitored and additional plantings may occur where survivorship falls below 80%.

Because monitoring efforts are “a work still in progress” and rely heavily upon adaptive management, we will continually modify our program to increase the effectiveness and quality of the monitoring data we collect. We have found a lack of data describing the use of agricultural areas by salmonids in comparison with forested and urban settings that have been studied extensively. This is particularly the case in very low-gradient floodplains, which flow through the rural parts of Western Washington. We feel that our monitoring activities will not only provide us the tools to eventually maintain the existing watercourses with minimal damage to fish populations, but may actually provide the data to help us improve the existing salmonid habitat available in these watercourses.

ACKNOWLEDGEMENTS

A number of individuals were instrumental in monitoring efforts for these projects, including Kate O’Laughlin, Bob Swartz, Eric K. Nelson, Claire Dyckman, Aaron Bert, Jim Mattila, Karin Osterhaug, Jennifer Vanderhoof, Karen Fevold, and Bill Priest of the King County Department of Natural Resources. The authors would like to particularly thank the landowners for their assistance and flexibility in allowing access to their property.

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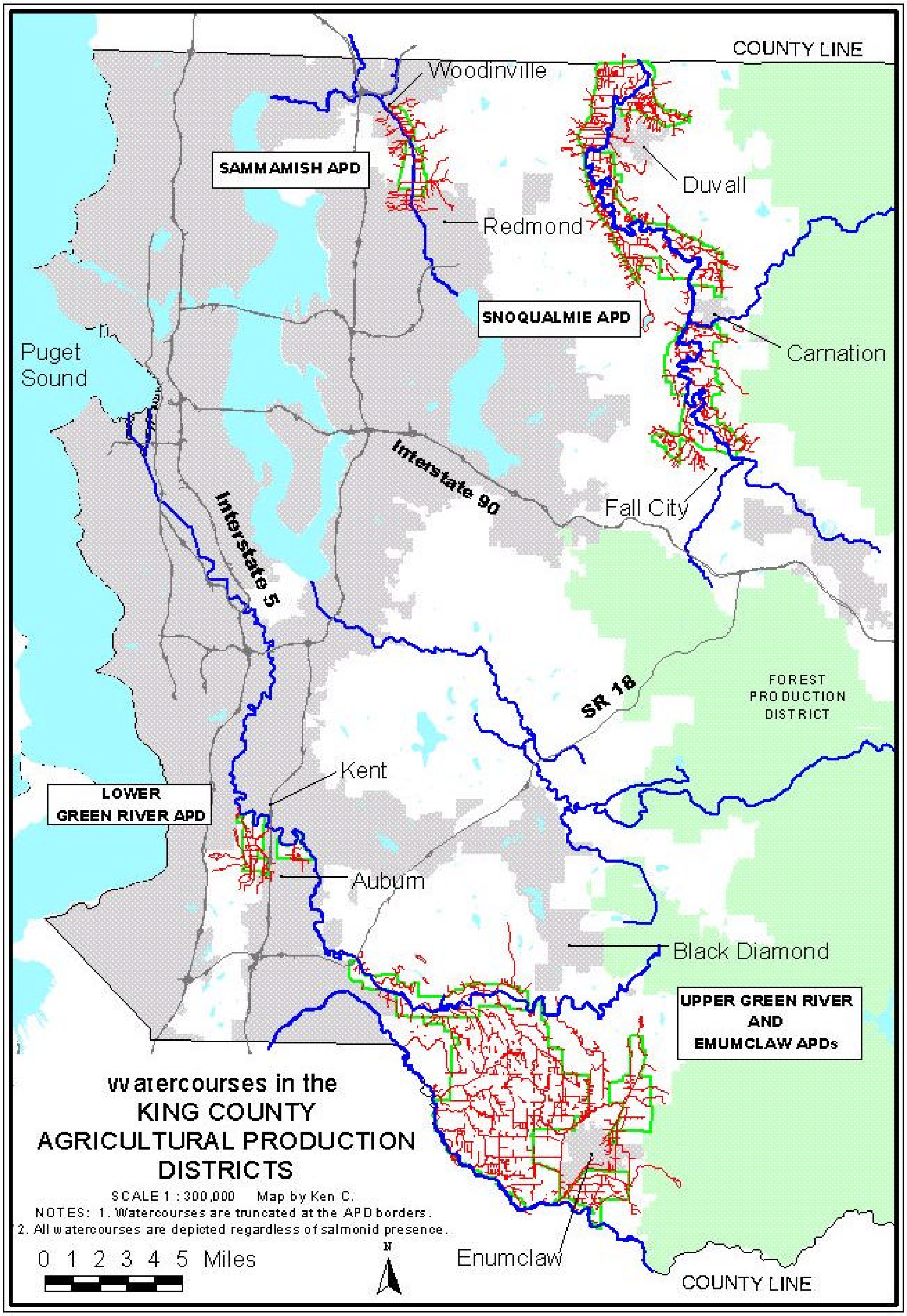
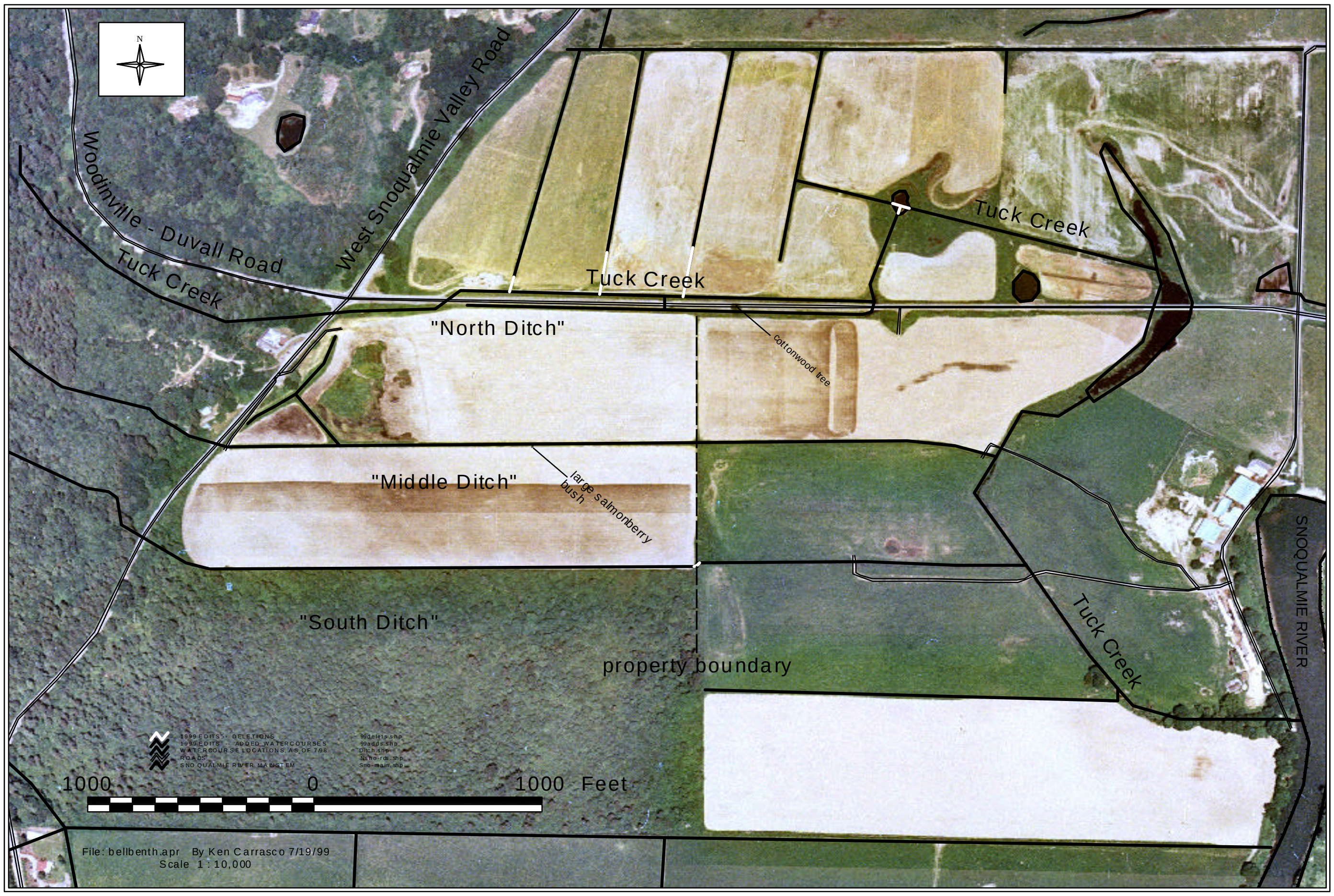
APPENDIX A: MAP OF KING COUNTY AGRICULTURAL PRODUCTION DISTRICTS

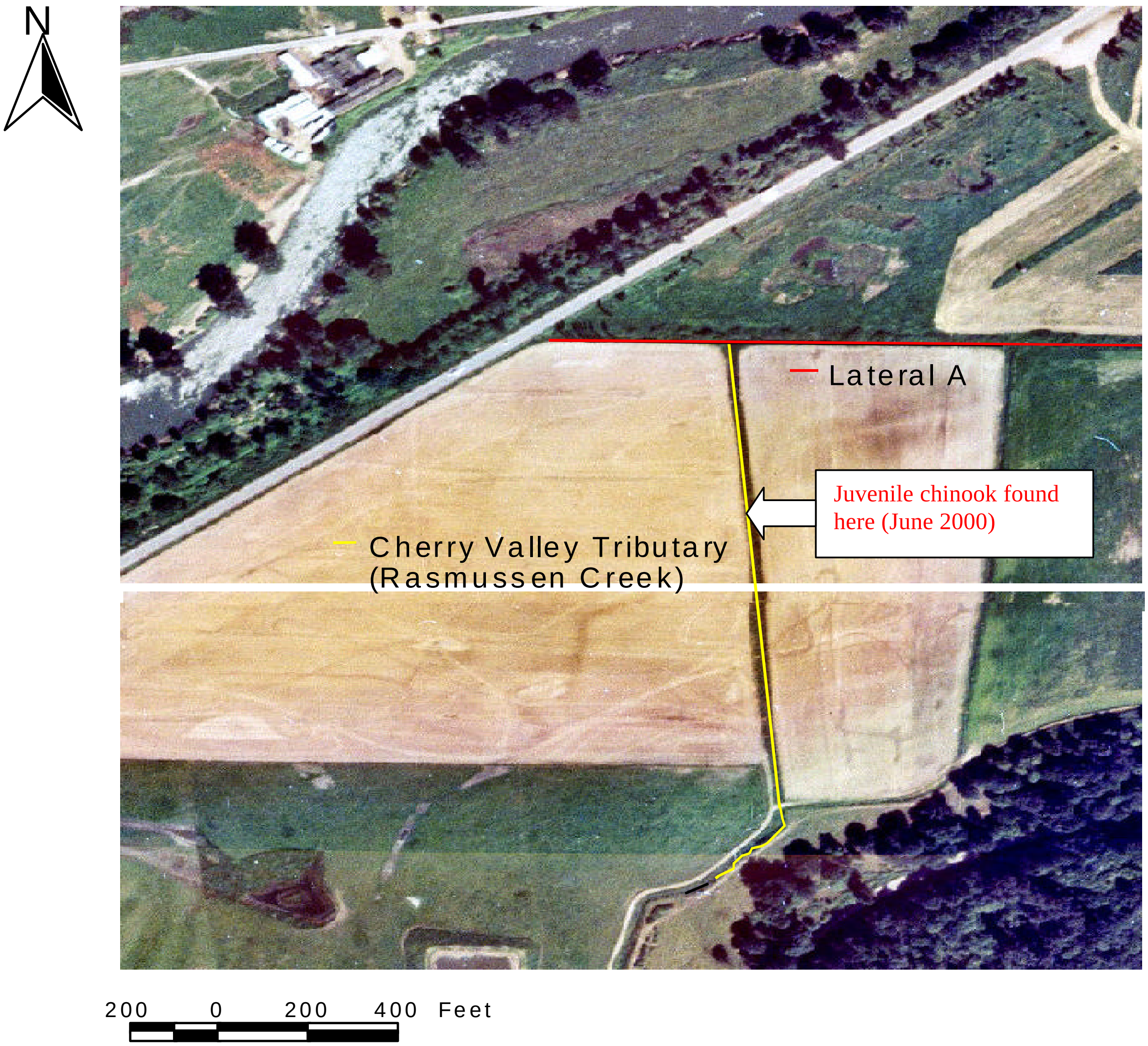


APPENDIX B: MAPS OF 1998 AND 1999 PROJECT SITES IN THE SNOQUALMIE APD

TUCK CREEK TRIBUTARIES



CHERRY CREEK TRIBUTARY



APPENDIX C: KING COUNTY BEST MANAGEMENT PRACTICES FOR DITCH MAINTENANCE

Best Management Practices for Agricultural Waterways

Project Timing:

BMP 1 Timing: The maintenance shall occur between July 15 - September 15

Detailed condition:

Any maintenance activities in or adjacent to the waterways shall occur between July 15 - September 15, when flow is lowest. The department, in concurrence with Washington Department of Fish and Wildlife (WDFW), may extend the period up to 30 days on a case by case basis if the department determinations, in writing, that:

a. the flow remaining at low levels;

b. the presence of salmon remaining at or below the numbers present during the originally prescribed maintenance window; and

c. no increased risk to salmonids or salmonid habitat.

The department may authorize maintenance activities at another time period determined to be more appropriate for that water system, based on and supported by written studies conducted by WDFW, federally recognized tribes or county agency which has natural resource management as its primary function, if there is no increased risk to salmonids and salmonid habitat.

Fish Protection Measures

BMP 2 Downstream Protection: Install temporary silt fences downstream of the project to protect against erosion or failures during the project.

Detailed condition:

Whether the waterway is wet or dry, temporary silt fences shall be installed just down-ditch or down-stream of the project area to protect downstream fish against erosion and sediment suspended during the maintenance activities or from storms or a system failure during the project. Installation shall be consistent with the King County Erosion and Sediment Control Standards. The temporary silt fences shall be removed within two days of maintenance completion in those waterways where salmonid use is known or suspected unless BMP 16 applies. If the department determines that salmonids will not be present during the maintenance window, the department may specify a period of time that the silt fences shall remain in place to improve erosion and sediment control.

BMP 3 Diversion Dams: If there is water flow in the waterway, diversion dams shall be constructed at both ends of project area.

Detailed condition:

If there is any water flowing in the waterway, diversion dams shall be constructed at both ends of project area in order to isolate the entire maintenance area. To determine if there is flow, a silt fence or straw bale covered with impermeable fabric shall be installed to test whether water backs up behind and eventually over-tops the structure. If the water measurably rises above a mark placed at the original water level within two hours, diversion dams shall be required to stop any flow through the project area during maintenance. Dams shall be adequate to restrain the flow and keep water from entering the project area. Sand bags are needed for higher velocities; straw bales or fences covered with impermeable fabric or other similar materials may be adequate for minimum low flows. Impermeable fences shall be installed with enough subsurface footing to seal the ditch.

BMP 3 Fish Capture: Fish shall be removed prior to any work by an authorized person using an electroshocker, and placed upstream of the blocked off work area.
Detailed condition:
Immediately prior to in-waterway activity, salmonids shall be removed subject to the conditions of a Washington Department of Fish and Wildlife scientific sampling permit. The portion of the waterway between diversion dams from which salmonids are to be removed shall be electrofished for several passes with an electroshocker. The passes should preferably be done prior to dewatering and again as the section is being de-watered and the water level is dropping. If diversion dams are not required, the portion of the waterway from which salmonids are to be removed shall be block netted off at each end prior to electroshocking. Where channels are choked with vegetation, a ten square foot area will need to be cleared and a low voltage pass to drive fish to the clearing shall precede any electroshocking. The removed salmonids shall be placed upstream of the screened off section. The department may allow the removed salmonids to be placed downstream or in a tank when the alternative is approved by the Washington Department of Fish and Wildlife, the County, or a tribe. The department may prescribe modifications to this method or approve an alternative method of salmonid removal such as netting to achieve a higher level of salmonid protection.

BMP 4 Flow Bypass: Flow in the waterway shall be bypassed around the project area .
Detailed condition:
If there is any water flowing in the waterway, a pipe shall be installed above the upstream diversion dam to collect and divert water around the project area. The pipe shall be adequate to carry the existing flow (6” - 8”(6”” - 8”” often adequate during low flow). If there is not adequate slope on the site to keep water from backing up behind the upstream diversion dam, a pump may be necessary. The pump intake shall be screened adequately to keep salmonids from being drawn into the pump. Where there is no salmonid use, flow may be discharged into fields instead of back into channel downstream of the lower diversion dam.

Excavation of waterway.

BMP 5 Excavation direction: Excavate from beginning or upstream portion of the waterway and work down
Detailed condition:
Excavation shall start at the highest elevation of the portion of the waterway in the project area and proceed downstream. The upstream end of the excavation shall not exceed a final grade of six inches drop for every ten feet to avoid headcutting the channel further upstream. The upstream grade requirement may be dropped by the department for low gradient, low velocity waterways. Where waterway gradient exceeds three percent and there is nine inches or greater of sorted gravel on the bottom, the department shall determine if and how excavation can be done in a manner protective of any existing spawning habitat.

BMP 6 Placement of Dredge Spoils: Dredge spoils from a waterway flowing through a agricultural field shall not be placed in a sensitive area or its buffer.
Detailed condition:

Dredge spoils from a waterway originating upstream of and flowing through the agricultural field shall not be placed within a sensitive area (stream, wetland, floodplain) or its buffer unless the dredge spoils are:

a. spread evenly in a thin layer across agricultural fields in current use; and
b. greater than 25 feet away from any waterway.

The dredge spoils shall be immediately removed off-site to a legal disposal area or spread on agricultural fields. If crops in the field prevent immediate spreading, spoils may be temporarily stockpiled on areas in current agricultural use as far as practical as the operating machinery will allow but in no case closer than the edge of the existing vegetated strip immediately adjacent to the fields in use. All temporary stockpiles shall be covered, seeded, or silt fenced to control erosion. Temporarily stockpiled dredge spoils may be left on a field up to nine months if the fields are too wet following crop harvest for machinery to spread if placed in a manner to not divert or impede flood flows within a flood hazard area.

BMP 7 Placement of Dredge Spoils: Dredge spoils from a waterway originating in the field shall not be placed immediately adjacent to the waterway

Detailed condition:

Dredge spoils from a waterway originating in the field shall not be placed immediately adjacent to the waterway, but as far away as the operating machinery allows. In no case shall the spoils be placed within the area adjacent to the waterway that is not in current agricultural use. If dredge spoils are not to be spread in a thin layer and leveled on the field within one week, they must be covered, seeded or silt fenced and placed in a manner to not divert or impede flood flows within a flood hazard area.

BMP 8 Waterway cross-section: Configure waterway to optimal width/depth/slope

Detailed condition:

The width, depth and side slopes of the waterway shall be excavated to the requirements determined for the site specific conditions by the U. S. Natural Resources Conservation Service and the King Conservation District. Side slopes shall not be steep enough to allow any sluffing of soil from sides into the waterway. The bottom width shall be that necessary to convey the estimated sediment load through the waterway with minimum deposition to eliminate or reduce as much as possible the need for future excavation. The depth shall not exceed the original grade of the waterway prior to filling with sediment except where necessary to obtain the width to depth configuration needed to adequately convey sediment through the waterway or to comply with BMPs 11 or 12 as appropriate.

BMP 9 Waterway meanders: Configure waterway to allow meander within allowed excavation cross-section

Detailed condition:

Where the existing channel width of the waterway exceeds the optimal width needed for conveying sediment, a channel that meanders back and forth between the existing side walls of the waterway shall be excavated. The U. S. Natural Resources Conservation Service and the King Conservation District shall determine the sediment conveyance capacity of the existing configuration and the needed channel width and meander amplitude to convey the predicted sediment load. The meanders shall remain within the existing waterway side walls.

BMP 10 Waterway meanderbelt: Restore meanders to waterway, within existing area not in current agricultural use

Detailed condition:

Where the existing channel width of the waterway is not wide enough to contain the appropriate channel configuration for conveying sediment, a channel that meanders back and forth across a width that exceeds the width of the existing channel side wall shall be excavated. The U. S. Natural Resources Conservation Service and the King Conservation District shall determine the sediment conveyance capacity of the existing configuration and the needed channel width and meander amplitude to convey the predicted sediment load. The meanders shall only extend past the existing waterway sidewalls where the area adjacent to the waterway is not in existing agricultural use.

BMP 11 Within-channel pools: Configure waterway to contain pools

Detailed condition:

Pools shall be excavated within the waterway as determined for the site specific conditions by the U. S. Natural Resources Conservation Service and the King Conservation District. Pools may be excavated below the historic grade of the waterway for adding channel complexity where salmonids use occurs or for additional sediment capacity in waterways with sediment loadings higher than can be conveyed by the flow. The upstream end of the excavation shall not exceed a final grade of six inches drop for every ten feet to avoid headcutting the channel further upstream and shall be resistant to erosion through the placement of large woody debris or other hard materials acceptable to the department. The upstream grade and erosion resistance requirements may be dropped by the department for low gradient, low velocity waterways.

BMP 12 Off-channel alcoves: Configure waterway to contain alcoves

Detailed condition:

Alcoves shall be excavated adjacent to the waterway as determined for the site specific conditions by the U. S. Natural Resources Conservation Service and the King Conservation District. Alcoves may be excavated below the historic grade of the waterway for adding channel complexity where salmonids use occurs, for additional sediment capacity in waterways with sediment loadings higher than can be conveyed by the flow or at the outlets of existing drain tiles for adjacent fields.

Erosion Control

BMP 13 Vegetated sideslopes: Leave vegetation on sides of waterway

Detailed condition:

Where possible, the sides of the waterway shall not be excavated and the existing vegetation shall be left rooted in the side slopes to reduce erosion into the waterway.

BMP 14 Vegetated strip: Leave existing vegetative strip alongside the waterway

Detailed condition:

The existing vegetation within the area adjacent to the waterway not in existing agricultural use shall be left in place to reduce erosion into the waterway and provide filtration of field runoff. The minimum amount possible of the vegetated areas alongside the waterway shall be disturbed during work within the waterway.

BMP 15 Site stabilization: Reseed exposed soils alongside waterway

Detailed condition:

All disturbed areas and bare soil on the side slopes and within the area adjacent to the waterway not in existing agricultural use shall be stabilized by reseeding. Hydroseeding is preferred but hand seeding and mulching is allowed. Seed mixes shall be consistent with the Surface Water Design Manual or those approved by the U. S. Natural Resources Conservation Service and the King Conservation District that do not include invasive species.

BMP 16 Permanent filter: Place a permanent filter adjacent to any fish bearing waterways

Detailed condition:

If the waterway does not have salmonid use, the silt fences installed just down-ditch or down-stream of the project (BMP 2) shall be left in place and maintained to provide a permanent filter. An alternative silt fence (or vegetative strip if the waterway is dry most of the year) between the waterway and the next adjacent waterway may be permitted. Installation shall be consistent with the King County Erosion and Sedimentation Control Standards. Permanent filters shall be checked regularly and replaced as needed but at least every two years.

BMP 17 Seasonal filter: Place a seasonal filter adjacent to any fish bearing waterways

Detailed condition:

If annual contour ditches for runoff from row crops are used in the field, silt fences shall be installed between the seasonal ditches and the next adjacent waterway project to protect downstream fish against erosion from high runoff. In those areas where field rows drain directly to a waterway without passing through a vegetated buffer adjacent to the waterway, a silt fence shall be installed along the edge of the waterway. Installation shall be consistent with the King County Erosion and Sedimentation Control Standards.

BMP 18 Temporary Sedimentation Trap: Place a temporary sediment trap within the waterway

Detailed condition:

In extremely limited cases, instream sediment traps may be allowed as a temporary erosion and sediment control where the sediment load is determined by the U. S. Natural Resources Conservation Service and the King Conservation District to exceed the carrying capacity of the waterway in its most efficient configuration. The upstream end of the excavation shall not exceed a final grade of six inches drop for every ten feet to avoid headcutting the channel further upstream. The downstream end shall be configured to ensure a low flow channel that insures passage of fish. These sediment traps may be maintained as needed during the seasonal timing identified for that waterway (BMP1). The sediment trap shall only be permitted until the upstream sediment source can be adequately addressed.

<u>Habitat</u>

BMP 19 Stream restoration: Restore a natural channel shape with meanders and buffer

Detailed condition:

Restore meanders to stream with a corresponding easement or compensation.

BMP 20 Small woody debris: Anchor small woody debris in the waterway

Detailed condition:

Small woody debris shall be anchored to the banks of the waterway and placed in the channel to provide cover for seasonal salmonid use as determined for the site-specific conditions. Small woody debris is used in seasonal and smaller waterways that originate in the agricultural field and can be anchored to be removable from the waterway for future maintenance and conveyance of high storm flows.

BMP 21 Large woody debris: Anchor large woody debris in the waterway

Detailed condition:

Large woody debris shall be anchored to the banks of the waterway and placed in the channel to provide cover and channel complexity for seasonal or continuous salmonid use as determined for the site-specific conditions. Large woody debris is used in year-round or larger waterways that originate upstream of the agricultural field and can be anchored to be removable from the waterway for future maintenance and conveyance of high storm flows. The large woody debris shall be large enough to stay in the system where it is placed but in no case shall be smaller than six inches in diameter and ten feet long.

BMP 22 Vegetative strip of plants: Plant a strip of native plants along waterway

Detailed condition:

Vegetation shall be planted to provide shading of the water during the first appropriate planting season but in no case more than one year after project completion. The plantings within the existing vegetative strip shall be of native plants of the type and spacing to provide shade and cover appropriate for the site-specific conditions. Planting will vary dependent on the width, side wall slope, depth from field level to water level and orientation of the waterway and the predicted maintenance frequency. Some non-native species may be allowed in County-approved pilot projects that will be monitored for research purposes provided no pesticides or herbicides are allowed.

Note: the County is developing the planting guidelines for width/depth/orientation/ soil conditions present at a site.

BMP 23 Planting maintenance: Maintain vegetated strip plantings until established

Detailed condition:

The planted vegetation shall be maintained for three years or for the period needed to permanently establish the vegetation. Maintenance shall include watering, weeding, removal of invasive species and pest controls such as tubes and covers.

BMP 24 Noxious weed eradication: Permanently remove noxious weed from banks

Detailed condition:

If clearing noxious weeds such as reed canary grass from banks of the waterway is proposed as part of the project, install filter fabric perpendicular to the waterway, clear the noxious weed, and reseed or replant consistent with BMPs 15 and 22 as appropriate. Any bare dirt shall be covered with weed barriers, three inches of soil and reseeded where plantings are not required.

Water Quality

BMP 25 Spill prevention/control: Have adequate spill control materials at the site

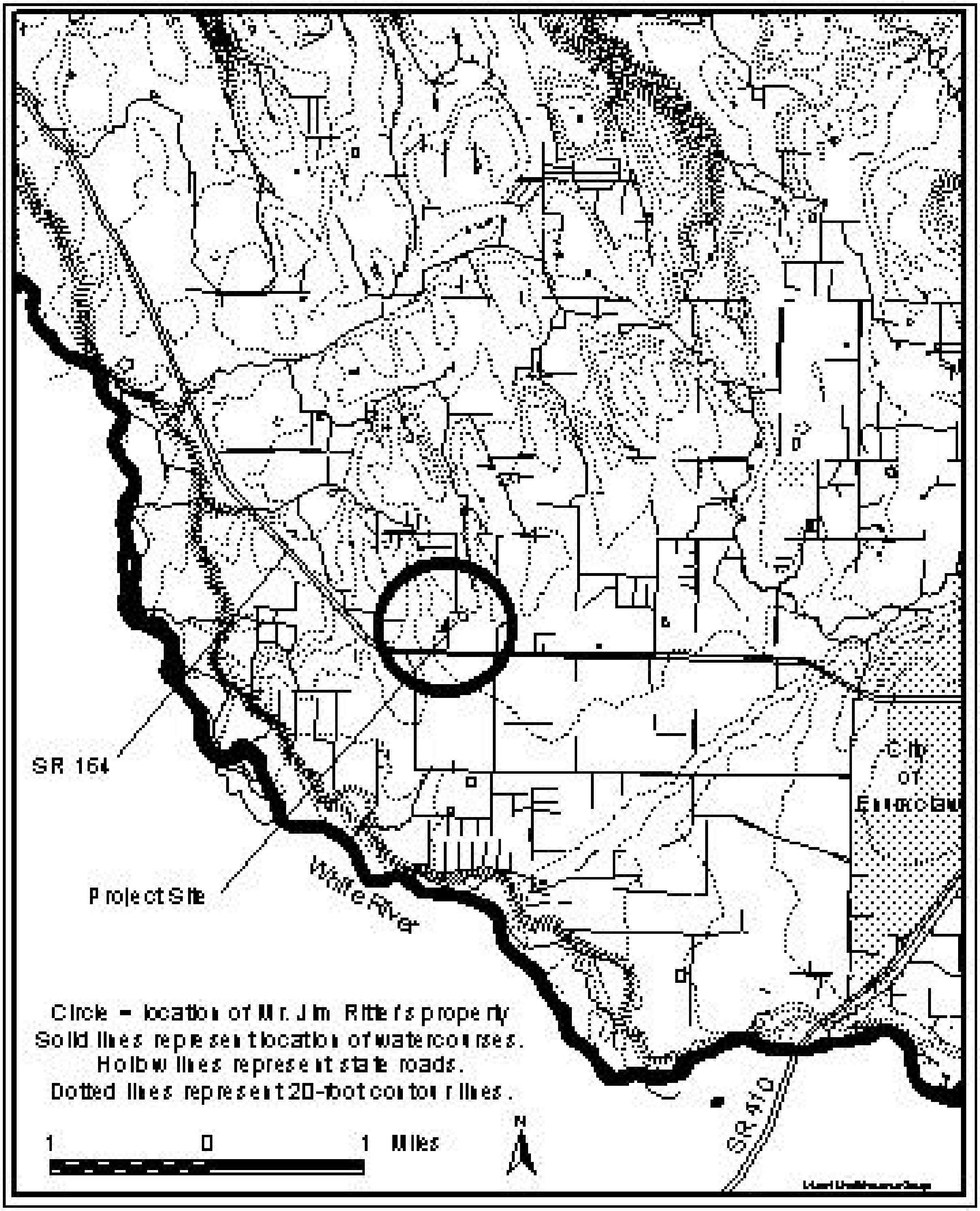
Detailed condition:

If heavy equipment or engines are used, there shall be appropriate spill cleanup materials at the site and all operators shall be familiar with proper spill cleanup procedures. If any equipment is actively leaking petroleum or hydraulic products, the leaked material shall be cleaned up and the equipment shall be moved away from the waterway until the leak is repaired.

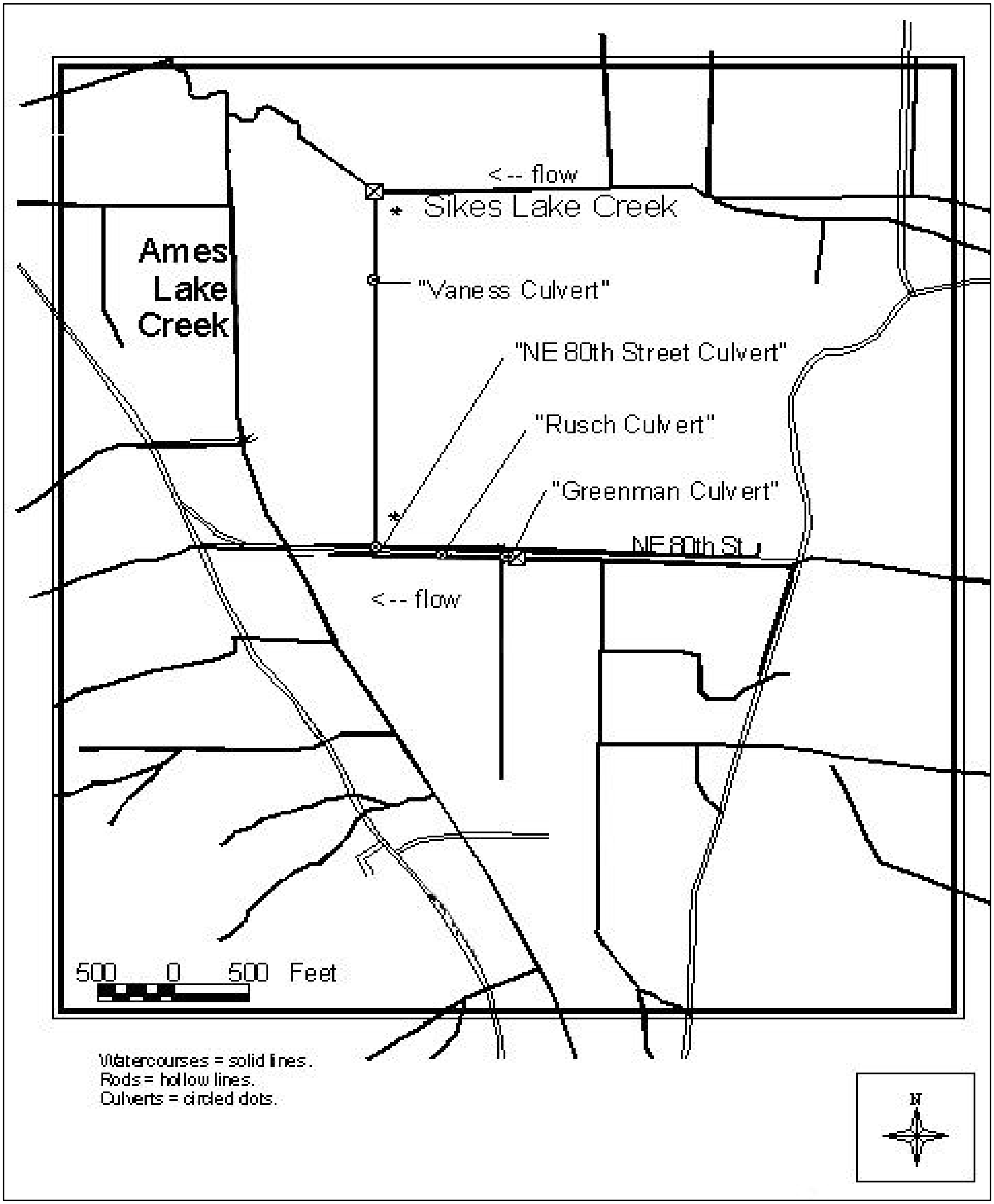
APPENDIX D: PHOTOS AND MAP OF RITTER PROJECT AREA PRIOR TO DREDGING

RITTER DITCH PRIOR TO DREDGING, SUMMER 2000

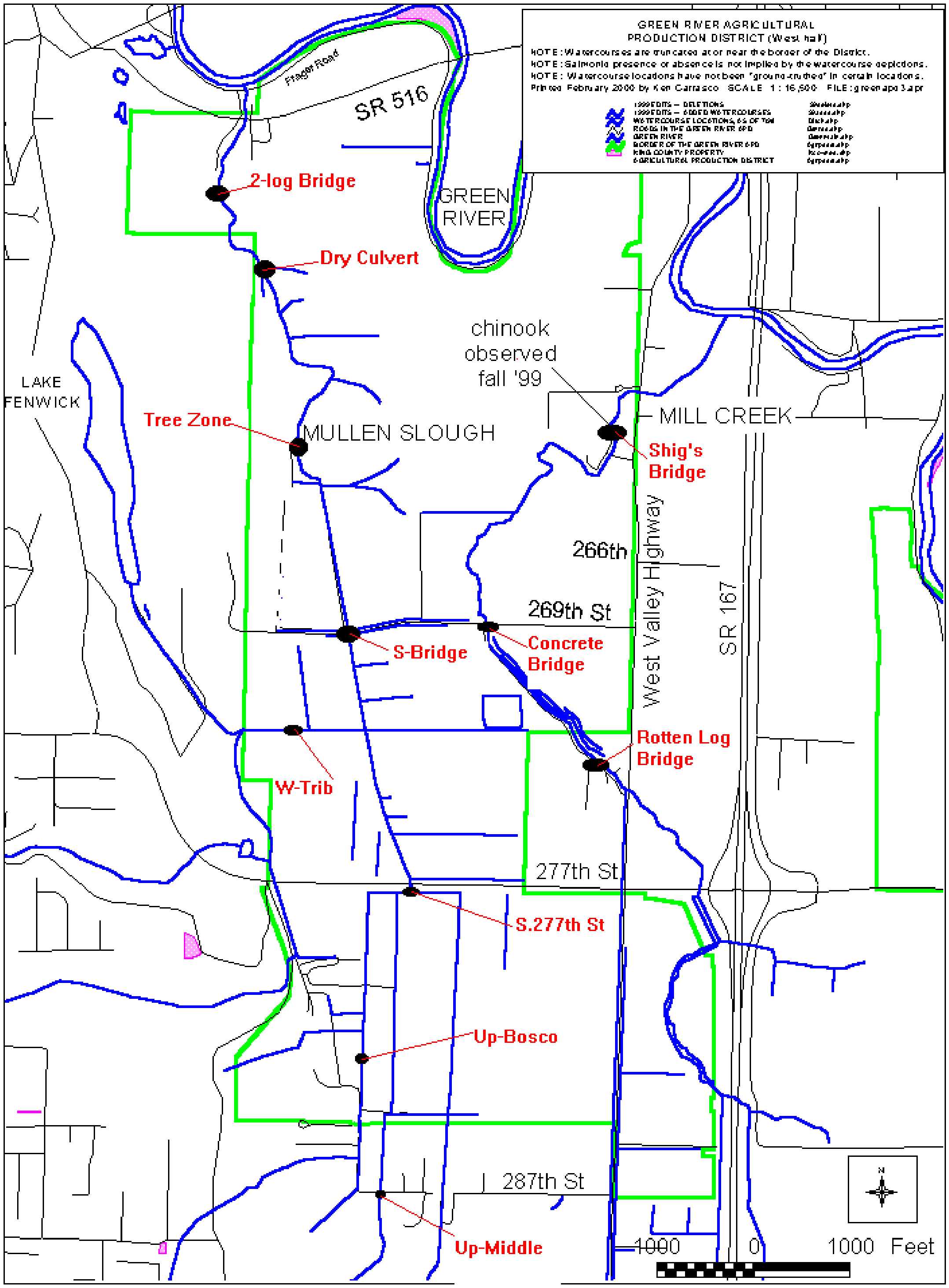
MAP OF RITTER PROJECT



APPENDIX E: MAP OF TURNER PROJECT AREA



APPENDIX F: MAP OF MULLEN SLOUGH AND MILL CREEK PROJECT AREAS



APPENDIX G: WATER QUALITY DATA FOR MULLEN SLOUGH, 27 FEBRUARY 2001

Water Quality Sampling for Mullen Slough 27 February 2001		Mullen 1		Mullen 2		Mullen 3		Mullen 4		Mullen 5		Mullen 6		Mullen 7		Mullen 8		
		2-log bridge		**dry culvert**		**Smith Bros. Bridge**		**Trib draining lakes Fenwick, Star, Bingamon Pond**		**277th Bridge**		**West prong along 59th**		**Trib to west prong**		**East prong, upstream**		
	Reference Levels	**On-site probe**	**lab results**	**On-site probe**	**lab results**	**On-site probe**	**lab results**	**On-site probe**	**lab results**	**On-site probe**	**lab results**	**On-site probe**	**lab results**	**On-site probe**	**lab results**	**On-site probe**	**lab results**	**lab replic- ate, "8a"**
Total Phosphorus, mg/l	<0.1 mg/l		0.74		0.88		0.33		0.05		0.10		0.11		0.05		0.04	0.04
Total Nitrogen, mg/l			1.73		1.74		1.47		2.43		1.48		0.64		0.81		1.84	1.93
NO2 + NO3 - N, mg/l	<10 mg/l		0.56		0.50		0.60		2.16		<		0.37		0.24		1.57	1.63
Ammonia - N, mg/l	0.020 mg/l (at pH of 6.5, T=7.0)		<		<		0.03		<		0.12		0.06		<		<	<
DO (Winkler), mg/l	>5.0; optimum >8.0										1.80							
Temp, ^{o}C	<18.0	4.4		5		5.7		9.5		5.1		6.7		4.6		7.3		
DO (probe), mg/l	>5.0; optimum >8.0	5.07		5.65		9.20		9.83		2.19		10.30		7.25		11.32		
DO (probe), % sat		39		45		72		86		17		84		67		94		
Conductivity, umhos/cm	10 - 1,000 typical for freshwaters	139 - 229		141 - 228		120 - 192		0.3 - 0.4		107 - 181	178	100 - 153		0.5 - 0.8		114 - 172		
BOD, mg/l	2 mg/l or less is typical for unpolluted waters								<		<		<		<		<	<
Turbidity, NTU	<5 below background										7.2							
Fecal Coliform, CFU/100ml	For Class A waters: GM <100CFU/ml. For B: <200		6		5		5		0		1		210		6		2	4
pH	6.5 to 8.5										6.9							

Notes: < signifies is below either minimum or reportable detection limits.

APPENDIX H: PHOTOGRAPHS OF FROM THE 2000 MONITORING SEASON

COHO PARR FOUND IN THE SOUTH DITCH, JANUARY 2001

NW SALAMANDERS CAPTURED IN THE SOUTH DITCH, SUMMER 2000

CHERRY VALLEY TRIBUTARY, WINTER 2001