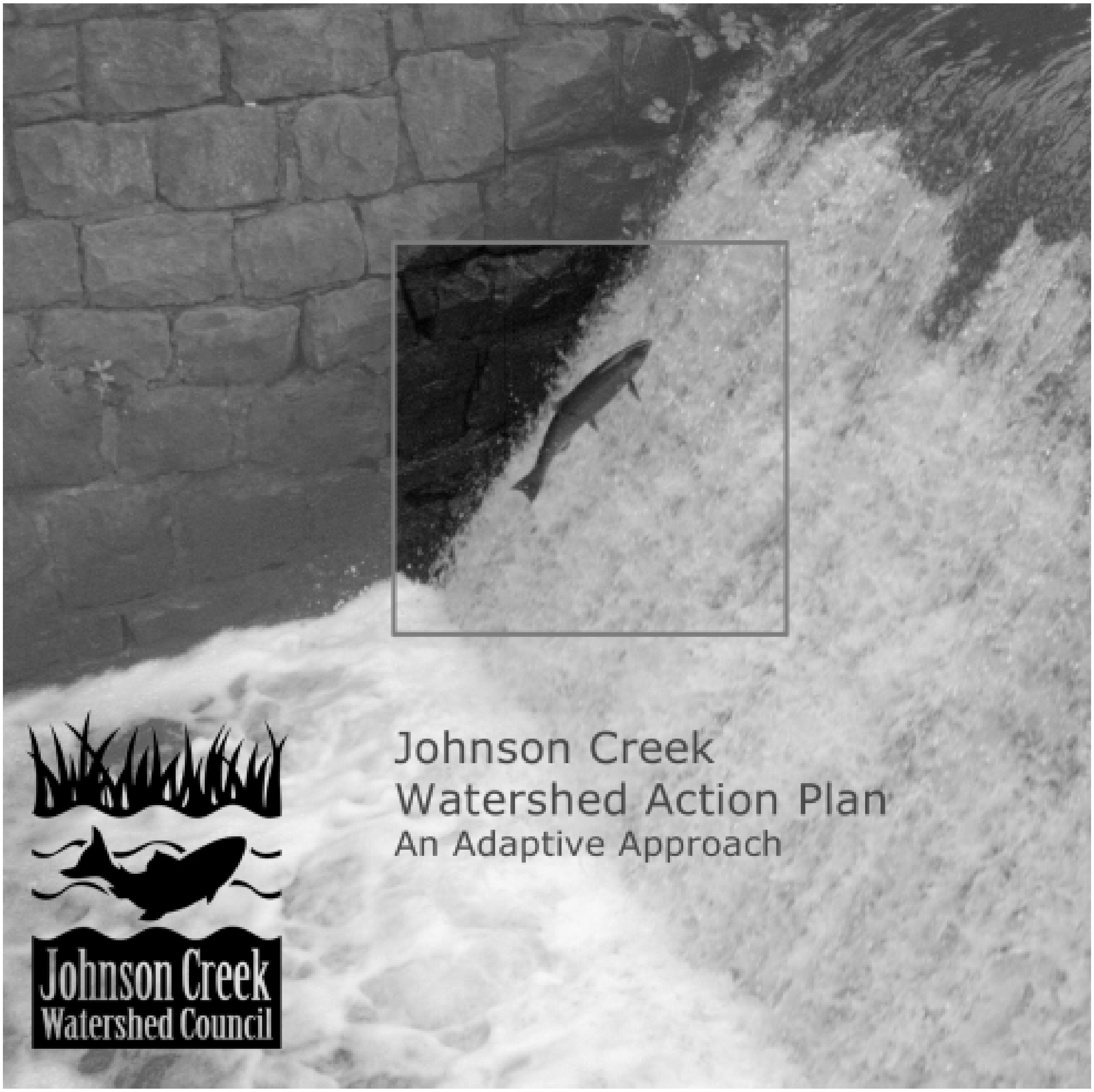

Johnson Creek Watershed Council
P.O. Box 82584
Portland, Oregon 97282

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ACRONYMS AND ABBREVIATIONS

AC-FT	Acre-feet
ASA	American Sportfishing Association
BES	Bureau of Environmental Services
B-IBI	Benthic – Index of Biotic Integrity
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operations
CCSWCD	Clackamas County Soil & Water Conservation District
Cfs	Cubic Feet per Second
CIP	Capital Improvement Project
CSO	Combined Sewer Overflow
CWA	Clean Water Act
Dbh	Diameter at breast height
DEQ	Department of Environmental Quality
DO	Dissolved Oxygen
DDE	Breakdown component of pesticide DDT
DDD	Breakdown component of pesticide DDT
DDT	Pesticide (1,1,1-trichloro-2, 2-bis (*p*-chlorophenyl) ethane)
EDT	Ecosystem Diagnostic & Treatment
EMSWCD	East Multnomah Soil & Water Conservation District
EPA	Environmental Protection Agency
EPSC	Erosion Prevention and Sediment Control
EPT	Ephemeroptera, Plecoptera, and Tricotera
ESA	Endangered Species Act
ESRA	Environmentally Sensitive Restoration Area
ESU	Evolutionarily Significant Unit

FEMA	Federal Emergency Management Agency
FLIR	Forward Looking Infrared Radar
FWS	Fall, Winter, and Spring
GIS	Geographic Information System
IBI	Index of Biotic Integrity
JCCC	Johnson Creek Corridor Committee
JCJCCC	Johnson Creek Joint Culvert Crossing Committee
JCWC	Johnson Creek Watershed Council
JLA	Jeanne Lawson Associates, Inc.
LWD	Large Woody Debris
MS4	Municipal Separate Storm Sewer System
Msl	Mean Sea Level
NMFS	National Marine Fisheries Service (now NOAA Fisheries)
NOAA	National Oceanic and Atmospheric Agency
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODFW	Oregon Department of Fish & Wildlife
ODOT	Oregon Department of Transportation
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
OWQI	Oregon Water Quality Index
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated biphenyls
PFC	Properly Functioning Condition
PoWER	Partnership for Willamette Ecosystem Restoration

RLIS	Regional Land Information System
RM	River Mile
4SOS	For the Sake Of the Salmon
SOWS	Save Our Wild Salmon
STEP	Salmon and Trout Enhancement Program
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TP	Total Phosphorus
TSS	Total Suspended Solids
UGB	Urban Growth Boundary
UIC	Underground Injection Control
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
VGI	Vigil-Agrimis, Inc.
WES	Water Environment Services
WPA	Works Progress Administration
WPCF	Water Pollution Control Facility
WWTP	Wastewater Treatment Plant
WY	Water Year

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EXECUTIVE SUMMARY

Introduction

This plan identifies and prioritizes projects and actions for the Johnson Creek Watershed Council (JCWC) and its watershed stakeholders to take in addressing watershed health problems and opportunities. The planning effort focuses on achieving the vision of a healthy, functional Johnson Creek watershed through development of a comprehensive Watershed Action Plan.

One of the main goals of the Watershed Action Plan is to identify, prioritize, and sequence specific projects and actions necessary to address factors limiting watershed health. The overall goal of the Action Plan is to protect, restore, and enhance the health and function of the Johnson Creek watershed.

The scope of the project included the following four tasks: 1) Information collection and analysis; 2) Public participation and landowner strategy development; 3) Criteria development and project/action prioritization; and 4) Compilation of action plan documents. A Technical Advisory Committee (TAC) assisted with the development of the Watershed Action Plan.

There are a number of planning efforts focused on the Johnson Creek watershed and related to this Action Plan. These planning efforts were conducted to satisfy local, state, or federal requirements or were completed as part of other watershed planning and management activities by local agencies, regional governments, or cooperating organizations. This Watershed Action Plan incorporates information from these plans and summarizes the problems and opportunities found throughout the entire Johnson Creek watershed.

Watershed Assessment

The Johnson Creek watershed assessment highlights and summarizes the most important and up-to-date information available for the basin. Many studies have previously been completed on various watershed functions and elements within the Johnson Creek watershed. The watershed assessment summarizes the results of these studies. The assessment also identifies key problems or factors limiting watershed health and aims to initiate discussion about the sources and conditions of these problems. The assessment also suggests opportunities for protecting, restoring, and enhancing watershed functions.

The watershed assessment provides a general description of the watershed, highlights the human and built environmental conditions, and summarizes the current conditions and four main attributes for watershed and river health. These attributes are: 1) stream flow and hydrology; 2) physical habitats; 3) water quality; and 4) biological communities.

Description

Located on the east side of the greater Portland Metropolitan region, Johnson Creek originates in Clackamas County, east of Boring, Oregon, and flows westward approximately 25 miles to its confluence with the Willamette River. The Johnson Creek drainage basin encompasses approximately 34,000 acres or about 54 square miles. The mostly urban watershed is contained within six local jurisdictional entities including Clackamas and Multnomah Counties, and the cities of Gresham, Happy Valley, Milwaukie, and Portland. A recent City of Portland assessment of the watershed divided the basin into reaches defined as the main stem Johnson Creek (lower, middle, and upper); and the following major tributaries: Crystal Springs Creek; Kelley Creek; Butler Creek; Hogan Creek; Sunshine Creek; and Badger Creek. In addition, Minthorn or Spring Creek discharges into Johnson Creek within the city of Milwaukie (see Figure 1 in Chapter 2 - Watershed Assessment).

Elevations in the watershed generally range between 0 to 1,100 feet above mean sea level. Slopes are highly variable and range generally between 1 to 25 percent. Soils in the watershed are primarily Multnomah and Latourell-Urban Land Complex (Type B hydrologic group) or Cascade Silt Loam (Type C hydrologic group).

The Johnson Creek watershed is highly developed. A mix of land use is present varying from heavily developed urban areas in the lower and middle reaches of the watershed to rural residential and agricultural in the upper watershed. Current land use (2003) in the basin reveals single family residential makes up the largest acreage and percentage at approximately 13,400 acres or 39%. In the agricultural areas of the upper watershed, 50% of the land base is currently used for cultivated crops or pastures, and another 29% is used for tree and ornamental plant nurseries, greenhouses, or Christmas tree plantations (Reininga and Davis, 1994). The Springwater Corridor Trail is a key recreational facility in the watershed, extending more than 16 miles and occupying a former railroad right-of-way paralleling Johnson Creek for much of its length.

The urban growth boundary (UGB) for the Portland metropolitan region passes through the Johnson Creek watershed. About 72% of its 34,000 acres or approximately 24,000 acres of the watershed lies within the UGB (Meross, 2000). Approximately 170,000 residents currently reside within the watershed. In 1997, Metro approved the 2040 Regional Growth Plan that will accommodate a population increase of 1.1 million new residents in the region by 2040. Comprehensive planning is currently underway in Pleasant Valley, the Springwater area east of Gresham, and the Damascus area to the south.

Much of the two lower sections of Johnson Creek (15 miles) are deeply channelized and confined. Most of the channelization, designed to control flooding, is the product of depression-era public works agencies, primarily the Civil Works Administration and the Works Projects Administration (WPA). At several locations along the stream, a new course was created and the stream channel was straightened, deepened, and simplified. Dikes were constructed to contain and control the stream at high flow. Beginning in 1933, streamside vegetation was removed, and the dikes and streambed were armored with basalt rocks.

Watershed Conditions

Flow and Hydrology

Johnson Creek is a low gradient stream that drops approximately 700 feet over its course. The average gradient along the mainstem is 0.5 percent. Land uses, piping of flow, and the addition of impervious surfaces highly impact flow patterns in the watershed. General hydrologic patterns in Johnson Creek are driven by patterns of rainfall and groundwater inflow. High flows normally occur in December, January, and February in response to abundant precipitation and high amounts of runoff as soils become saturated through the rainy season. Summer low flows in July, August, and September reflect minimal groundwater contributions to streamflow throughout the watershed. A 1984 study of the effects of development and resultant impervious surfaces on peak flows in Johnson Creek (Clement, 1984) concluded that for a storm of a given size the peak flow under 1980 conditions was 30 percent greater than under 1940 conditions. However, peak flow frequency at the Sycamore streamflow gauge (River Mile 10.2) shows no discernable upward trend over the last 60 years (See Figure 5 in Chapter 2 – Watershed Assessment).

Bankfull discharges at the Sycamore gauge are around 867 cubic feet-per-second (cfs) and occur about 3 times per year. Flood stage is reached at a flow of around 1,080-cfs, which occurs on average about 1.8 times per year. Major floods correspond to flows of 1,650 cfs, which has occurred about once every 3-4 years. Flooding events primarily affect four areas within Portland: 1) Tideman-Johnson Park at SE 45th; 2) the area west of SE 82nd; 3) the Lents area; and 4) lower Powell Butte.

Johnson Creek suffers from a low baseflow during the late spring/early summer through early fall season. Some of the tributaries dry up during the summer periods and the velocity and volume of baseflows in the main stem Johnson Creek become minimal. The Oregon Department of Fish and Wildlife (ODFW) has set minimum flow targets to protect salmonids in Johnson Creek (Meross, 2000). Flows in the middle and upper watershed frequently do not meet those minimum flows, particularly in spring and summer months. Below spring-fed Crystal Springs, which provides consistent and abundant year-round flow, minimum instream flows are typically met.

The Portland ESA Program assessed baseline conditions for flow and hydrology indicators in Johnson Creek. The following indictors were rated as not properly functioning: hydrograph, hydrologic sources, and floodplain presence and connectivity. The impervious surfaces indicator was rated as at-risk. These indicators and their assessed baseline condition compared to properly functioning conditions were incorporated into an Ecosystem Diagnosis & Treatment (EDT) model.

Physical Habitats

The Johnson Creek watershed contains a mosaic of vegetation types, including agricultural lands, urban and suburban landscapes, upland forests, riparian woodlands, and wetlands. Remnants of predevelopment vegetation are rare, as a result of extensive logging and clearing (Portland Bureau of Planning, 2001).

Upland Habitat

The forest that historically covered the Johnson Creek watershed ridges and lowlands was mostly cleared in the early 1900s for agriculture, timber production, and urban uses. Forest clearing of second growth has increased dramatically in recent years as housing development expanded from the lowlands onto the ridges and hillside slopes. Presently, about 57% of the watershed is vegetated (City of Portland, 2001). The Johnson Creek watershed straddles the border between the Willamette Valley vegetation zone and the Western Hemlock zone. The upland forest community exhibits characteristics common to both zones. The Boring Lava Domes area is more heavily forested than most of the watershed.

The Lava Domes forest generally ranges from 40 to 100-year old second growth stands in a mid-successional stage referred to as *conifer topping hardwood*. Certain areas in the watershed, however, contain much older forest stands with tree diameters reaching five feet or more (Portland Bureau of Planning, 1998). Upland forests in the watershed are typically comprised of a mixed conifer/deciduous forest with western red cedar (*Thuja plicata),* bigleaf maple (*Acer macrophyllum*), and Douglas fir (*Pseudotsuga menziesii)*, frequently occurring as dominant tree species. Dominant shrubs in the forest community include vine maple (*Acer circinatum*), western hazel (*Corylus cornuta),* Indian plum (*Oemleria cerasiformis*), and snowberry (*Symphoricarpos albus*). Common herbaceous plants include western sword fern (*Polystichum munitum*), Oregon grape (*Mahonia sp*.), and fringecup (*Tellima grandiflora)*.

Wetlands

No accurate estimate of the total acreage of wetlands in the watershed prior to European settlement exists but anecdotal sources indicate that there has been a substantial reduction. The remaining wetlands are extremely diverse in nature, and include forested, scrub-shrub, emergent, wet meadows, and open water (aquatic) vegetation types. Wetlands within the watershed range in size from the 19-acre Beggars Tick marsh in the Lents area, to numerous diminutive emergent wetlands in the basin of less than a tenth of an acre (Adolfson, 2000). Several of the larger wetlands within the watershed contain intact native vegetation and have moderately mature, mid - to late successional vegetative communities. However, many of the wetlands in the watershed have non-native and invasive plant species that dominate most or all of the wetlands.

Two major groups of wetlands exist within the watershed: The first group of wetlands are those associated directly with the hydrology of Johnson Creek and its tributaries. The second major group of wetlands are small hydrologic systems in and of themselves that either drain into Johnson Creek directly or contribute to the creek's annual flow through groundwater recharge. Many wetlands in the basin have good connectivity with undeveloped open space, upland habitats, and the Johnson Creek riparian corridor. Several; significant areas of wildlife breeding and nesting are found in wetlands within the basin with dense breeding populations of amphibians, including red-legged frogs (Adolfson, 2000).

Riparian Areas

The riparian corridor along Johnson Creek and its tributaries varies in width, from extensive vegetated areas over 600 feet in width to reaches with little or no vegetation along the bank. The most extensive vegetated riparian areas in the drainage basin are in smaller headwater creeks in the Boring Hills south of Powell Butte on either side of the Gresham/Portland urban services boundary (Portland Bureau of Planning, 2001). On the mainstem, reaches 12 and 16 and parts of 13 and 14 have the largest forested riparian areas. The tributaries with the most heavily forested riparian areas are Mitchell, Badger, Sunshine, and Deardorf/Wahoo Creeks. Crystal Springs and the lower reaches of Johnson Creek (near the Milwaukie/Portland boundary) have the least extensive riparian vegetation. The headwater streams flowing through rural and agricultural lands in the upper watershed have very little riparian vegetation. Riparian areas within the Johnson Creek watershed consist primarily of mixed forest with some coniferous forest and shrub areas. Riparian vegetation is either narrow, minimal or lacking throughout much of the watershed. Generally, existing riparian vegetation consists of areas dominated by blackberry or young native plants and lack large mature trees.

Instream Habitat

The channelization of Johnson Creek has had a significant impact on the quality of instream physical habitat. Because the historic floodplain of Johnson Creek is disconnected or minimally connected through much of its length flood flows cannot spread out and attenuate on the floodplain. The Oregon Department of Fish and Wildlife (ODFW) conducted aquatic habitat inventories throughout Johnson Creek during 1999-2000. The ODFW findings generally indicate that Johnson Creek has extremely low wood volumes instream, particularly large wood necessary for pool formation. This is due to a lack of large, mature riparian trees and active removal of wood debris from the creek by citizens and staff from city agencies trying to prevent obstruction of flows downstream (McConnaha, 2002). ODFW also found a high percentage of hardened banks, lack of refugia through many reaches, channel incision, and high levels of fine sediment. ODFW found that glides, which are generally uncommon in natural, healthy creeks, are widespread throughout the creek. This is an indication of the quality of instream habitat and is likely due to the deficiency of instream wood, a key element in breaking glides into pools and riffles.

The habitat assessment of Kelley Creek reveals that there are a few small sections of higher quality habitat, while much of the creek is impacted or degraded. Most impacts are due to the lack of high quality riparian habitat and large quantity of stormwater draining the creek as a result of tiling and other agricultural practices (ODFW 2000, BES 2001). Crystal Springs Creek habitat is degraded as well. Much of the creek has been channelized and lacks healthy riparian buffers.

The Portland ESA Program assessed baseline conditions for habitat indicators in Johnson Creek. These indicators and their associated baseline conditions were then compared to properly functioning conditions. The following habitat indicators were rated as not properly functioning: floodplain quality, riparian integrity, channel substrate, off-channel habitat, large wood, shoreline complexity, and fish passage/access. Habitat attributes that were rated at risk included depth refugia, and harassment. These habitat attributes were incorporated into an EDT model.

Water Quality

Numerous water quality studies have been conducted throughout the Johnson Creek watershed. The Oregon Department of Environmental Quality (DEQ) has been monitoring Johnson Creek at SE 17^{th} Avenue since 1990, and the agency rates Johnson Creek water quality as poor. At this location, Johnson Creek is impacted by very high concentrations of nitrate-nitrogen, and high concentrations of total phosphates, fecal coliform bacteria, total solids, and biochemical oxygen demand. The Cities of Portland and Gresham, the United States Geological Survey, and Clackamas Water Environment Services (WES) have collected data on water quality in Johnson Creek. The key water quality problems are as follows:

Temperature

From an analysis of one year of data it appears that the number of total days with maximum temperatures above 20 degrees C increases when moving downstream. Kelley Creek had the fewest days above 20 degrees C (McConnaha, 2002). Maximum temperatures collected by the City of Portland ranged from 15.8 to 24.3 degrees C with a mean maximum of 18.2 degrees C. Although it is fed by cool groundwater springs, Crystal Springs Creek has warmer summer and wintertime temperatures than Johnson Creek. DEQ has developed a draft Total Maximum Daily Load for Johnson Creek's temperature.

Dissolved Oxygen

While some studies reveal that oxygen levels in Johnson Creek do not generally fall below water quality standards, levels do decrease in the middle, flat section of the creek, possibly a result of the addition of oxygen depleted groundwater in the area. Minimum dissolved oxygen (DO) values, collected by the City of Portland, ranged from 5.5 to 9.8 mg/L with a mean value of 7.84 mg/L. A number of these concentrations do not meet the state water quality standard for Johnson Creek. The standard varies according to season and location, but generally requires DO levels between 8 and 11 mg/L.

Bacteria

Routine monitoring by both Portland and Gresham have revealed high bacteria levels throughout the Johnson Creek watershed. Data suggest that the bacteria levels exceed water quality standards for *E. coli* bacteria. *E.coli* water quality standards are as follows: A 30-day log mean of 126 *E. coli* organisms per 100mL, based on a minimum of five samples, and no single sample shall exceed 406 *E. coli* organisms per 100mL.

Nutrients

A number of studies of nutrient levels in Johnson Creek show high levels of phosphorus (P) and nitrogen (N) at various locations. Nitrate levels were found to increase downstream and particularly where there is low flow. Nitrate levels are also high in Crystal Springs, likely a result of leaching from septic tanks and input from the duck pond in Westmoreland Park (McConnaha, 2002). Johnson Creek is not currently listed by DEQ as polluted with nutrients.

Sediment and Turbidity

Turbidity has been monitored during both high and low flow conditions in Johnson Creek. Relatively high turbidity levels were measured during both high and low flow conditions most likely as a result of bank erosion, erosion from roadside ditches, runoff from construction activities, and agricultural and nursery operations. Turbidity levels appear to be higher in upper portions of the watershed indicating that sedimentation begins and sources are most likely originating in the upper watershed (Gresham, 2001).

Metals

Johnson Creek has elevated levels of many metals and is classified as a “waterbody of concern” by the DEQ due to elevated levels of copper, chromium, and nickel in water and sediments. Higher levels of copper and zinc are found when flows are high, most likely a result of runoff into the creek. Generally, metals concentrations increase downstream. When flows are high Johnson Creek may also be a source for chromium, copper, mercury, and zinc in the Willamette River (McConnaha, 2002).

Stormwater

The City of Gresham conducted storm event water quality sampling at four locations within Johnson Creek during 2000-2001. Results reveal extremely poor water quality conditions at Palmblad Road (upstream jurisdictional boundary).

303(d) Listing

In general, water quality in Johnson Creek is considered poor. In 1998, Johnson Creek was placed on the 303(d) list by DEQ for bacteria, summer temperature, and toxics (DDT and Dieldrin). In addition, DEQ proposed adding PCB’s and PAH’s to the 2002 303(d) list. The 303(d) list of impaired waterbodies includes Johnson Creek from the mouth to its headwaters. DEQ is currently developing a Total Maximum Daily Load (TMDL) for the Johnson Creek watershed. The TMDL is expected to be completed in December 2003.

The Portland ESA Program assessed baseline conditions for water quality indicators in Johnson Creek. These indicators and their assessed baseline condition compared to properly functioning conditions were incorporated into an EDT model. Both temperature and thermal refugia indicators were rated as not properly functioning. The following three water quality indicators were rated at risk: eutrophication, toxic materials, and sediment.

Biological Communities

Fish

As part of the Lower Columbia River Evolutionary Significant Unit, steelhead trout and Chinook salmon are listed as threatened in Johnson Creek under the ESA. The City of Portland in 1992, and ODFW in 1993, conducted surveys of the fish community in Johnson Creek. The fish community is dominated by species tolerant of warm water and disturbed conditions, particularly redside shiners, reticulate sculpin, and speckled dace (McConnaha 2002, JCCC 1995). Large-scale suckers are abundant in the lower reaches.

Johnson Creek historically had large salmon populations. Numbers declined dramatically once urbanization began and particularly after the channelization work was completed (McConnaha, 2002). However, adult salmonids have been observed in recent years, including: coho salmon, Chinook salmon, cutthroat trout, and steelhead (ODFW unpublished data, as cited in Portland BES, 1999). Coastal subspecies of cutthroat trout are also present in Johnson Creek. This coastal subspecies has both sea-run and resident forms.

In 2001, ODFW and the City of Portland's ESA program began a project to inventory fish communities within Johnson Creek to determine salmonid presence, life history, and habitat usage throughout the watershed (Graham and Ward, 2002). Fish surveys were conducted in eight Portland streams including Crystal Springs, Johnson, and Kelley Creeks. Johnson Creek had the highest number of families including salmonids, lamprey, cottids, cyprinids, and centrarchids. Johnson Creek had both cutthroat trout and rainbow/steelhead. Coho salmon were only found in Johnson Creek. Lampreys were limited to reaches 8, 14, and 16 within Johnson Creek. Lampreys were most abundant in Kelley Creek. A total of 131 non-native fish were collected and identified, all from the lowest reach of each stream (Graham and Ward, 2002).

Culverts and Barriers

In 2000-2001, a multijurisdictional effort identified and assessed a total of 226 structures which could pose fish passage barriers in the Johnson Creek watershed, including culverts, dams, and bridges. Nineteen culverts were inventoried within Portland and a total of 39 structures (16 of which were culverts) within Gresham. Although there are no culverts on the mainstem until the upper reaches of the watershed, they are present on nearly all the tributaries to Johnson Creek. Due to timing restrictions on federal grant fund programs and other constraints, the jurisdictions completed only the first phase of the inventory. Additional assessment will be required to finalize the culvert prioritization process.

Refugia

Refuge areas for fish consist of both chemical and thermal refugia as well as structural and biotic. Currently, fish usage within the Johnson Creek watershed is not fully documented. The following areas currently contain salmonids and lamprey:

• Lower Kelley and Hogan Creeks	Steelhead
• Crystal Springs Creek	Rainbow/Steelhead
• Lower and Upper Kelley, Johnson Creek Reach 16	Cutthroat trout*
• Lower Crystal Springs Creek, Johnson Creek Reaches 1 and 2	Coho spawners
• Johnson Creek Reach 1 and 2	Chinook

- Kelley Creek, Crystal Springs Creek, and Johnson Creek Reaches 4, 6, 8, 12, and 16 — Lamprey

* Cutthroat trout are likely in other areas of Johnson Creek and its tributaries.

Benthic Macroinvertebrates

More information is needed on Benthic Macroinvertebrates to accurately characterize the existing populations. During 1999, PSU conducted the only known study on macroinvertebrates in Johnson Creek. The results of the study found that benthic communities are degraded in comparison to regional reference creeks within the same ecoregion (Hoy 2001; Pan et al., 2001; Walker 2001). As expected, macroinvertebrate assemblages were significantly different between the urban and rural streams. Mean richness of total number of taxa, and number of Ephemeroptera, Plecopetera, and Tricoptera (EPT) in the two urban streams were significantly lower than those in the rural streams.

Wildlife

While no exhaustive database of information exists on wildlife resources and their habitats throughout the watershed, studies in other watersheds of similar composition suggest that the diversity of wildlife species in the watershed has been significantly reduced. Anecdotal information indicates that the large mammal population includes black-tailed deer, limited cougars, and coyotes. Birds are the most abundant wildlife forms living in urban and rural areas within the watershed. Sensitive species known to occur in the riparian areas of Johnson Creek include three salamander species (long-toed, northwestern, and Columbia), two frog species, and one toad species. Painted turtles have been identified in the upper watershed. Other species known to exist include great horned owls, red-legged frogs, and hawks.

Watershed Problems and Opportunities

Overview

The strategy for protecting and restoring the Johnson Creek watershed is to protect the remaining high quality habitats first, and then restore remaining areas using a prioritized approach. Opportunities are watershed conditions or features that are currently in a healthy, properly functioning condition and that are considered key to sustaining important watershed functions. Problems or challenges are watershed conditions or features that are not properly functioning or that contribute to impairment of watershed health. Fixing problems and restoring functioning conditions within the watershed requires an assessment of limiting factors including data needs.

Limiting Factors

Baseline conditions from historical and recent studies were utilized in conjunction with an Ecosystem Diagnosis and Treatment (EDT) model to assess current and future conditions within the Johnson Creek watershed. The EDT model method was designed to provide a practical, science-based approach to develop and implement watershed management plans. Salmonid biological performance is utilized and defined by three elements—life history diversity, productivity, and capacity. These elements of performance are characteristics of the ecosystem that describe persistence, abundance, and distribution potential of a population (Mobrand Biometrics, 2002). Much of the EDT modeling performed by Mobrand Biometrics and the City of Portland’s ESA Program to date has focused on coho salmon.

Preliminary results for steelhead have also recently been completed, though not in time to provide significant data for this assessment.

The EDT Modeling project identified the following eight key limiting factors that are most critical for coho salmon in the Johnson Creek watershed:

1) Low habitat diversity due in part to a lack of wood;
2) Simplified channel structure;
3) Degraded banks including WPA rock work, bank grading, and channel lining;
4) Degraded riparian areas;
5) High summer water temperatures;
6) Excessive sedimentation;
7) Lack of food (aquatic benthic macroinvertebrates); and
8) Toxic pollutants.

In addition, high bacteria levels throughout the watershed are considered problematic and should also be considered a high priority.

Identification of High Priority Areas

To begin focusing the restoration efforts of the Johnson Creek Watershed Council, high priority areas were defined and include:

1) Areas of existing high quality core habitats and refuge areas. These areas will be the focus of protection efforts to minimize further degradation.
    a. Upper and Lower Kelley Creek
    b. Upper Mitchell Creek
    c. Johnson Creek Reach 16
    d. Lower Hogan Creek
2) Areas that contribute to or affect watershed processes and functions and provide the highest restoration benefit.
    a. Upper Crystal Springs Creek
    b. Tideman Johnson/Errol Heights
    c. Middle Kelley and Lower Mitchell Creeks
    d. Johnson Creek Reach 15

    e. Lower Sunshine and Badger Creeks

3) Opportunity areas where implementation funds exist or significant planning efforts are already underway or where restoration work can open other doors, or provide additional opportunities.

    a. Middle Johnson Creek

4) Areas that are known contributors of water quality problems or degradation to downstream core habitats or refuge areas.

    a. All the area that drains to Reach 16

Targets and Objectives

For each of the four functional goals of hydrology and flow, physical habitat, water quality, and biological communities, objectives were developed specific to the area. Each objective has one or more indicators that can be used to measure existing function. Targets were set for the indicators based on the desired level of function and the constraints of the priority reach.

Criteria Development

The types of projects to be considered and ranked were divided into four distinct categories based on the nature of the project. The four project categories are:

- Monitoring, information collection, and data management
- Protection (policies and programs);
- Public outreach and education; and
- Restoration projects.

Several holistic or big-picture concepts were utilized up front to drive the process of criteria development. These involved: 1) prioritize protection over restoration; 2) rely on the Ecosystem Diagnostic and Treatment (EDT) modeling results for identifying or characterizing limiting factors, properly functioning conditions, and core habitat areas; and 3) rank restoration projects on watershed health scores and rank other project types by the sum of watershed health scores and the socio/economic scores.

The criteria are divided into two general categories: one for watershed health, and the second for social and economic considerations. Criteria points are assigned (0, 1, 3, or 5) depending on how effectively the project addresses the criteria. The total points for both watershed health criteria and social and economic criteria were totaled together and than averaged to determine the overall ranking for monitoring and data management, protection (policies and programs), and public outreach and education projects. Restoration projects were ranked based only on the total watershed health score but the social and economic criteria scores are provided in Appendix I to allow for additional evaluation. Please see Chapter 4 in the Action Plan for more details on the criteria.

Proposed Projects and Actions

Protection Projects

Twenty-five projects related to the protection of functions from further degradation including land use, advocacy, policy, transportation, and planning projects were identified by TAC members, stakeholders, and the public. The following protection projects were evaluated against the criteria and ranked as the top tier projects (Table ES-1). See Appendix I for a complete listing of protection projects and individual ranking scores.

Table ES-1 Top Tier Protection (Policies and Programs) Projects

Project Title	Location	Project Description
Implementation Code for the Springwater Concept Plan	Upper Johnson Creek	Creation of concept and implementation plans for land use code, street network, public facilities plan, annexation plan, and natural resources protection, restoration and enhancement plan. Ensure that code is adopted and implemented.
Clackamas County Water Environment Services (WES) New Development Standards	Clackamas County Service District (CCSD) #1	Implement CCSD #1 R&R: Erosion control which provides for a comprehensive, district wide erosion and construction site pollutant control program; provide training and other support as needed.
New Development Standards – actions under Portland's MS4 permit	Lower and Middle Johnson Cr	Implement City Code Title 10: Erosion Control, which provides a comprehensive, citywide erosion and construction site pollutant control program; provide training and other support as needed.
Implementation Code for the Damascus Concept Plan	Johnson Creek tributaries	Creation of concept and implementation plans for land use code, street network, public facilities plan, annexation plan, and natural resources protection, restoration and enhancement plan. Ensure that code is adopted and implemented.
Implementation Code for the Pleasant Valley Concept Plan	Kelley Cr.	Creation of concept and implementation plans for land use code, street network, public facilities plan, annexation plan, and natural resources protection, restoration and enhancement plan. Ensure that code is adopted and implemented.
Illicit Discharges Controls – actions under MS4 permit	Watershed Wide	Implement all elements of the Illicit Discharge Elimination Program to prevent, search for, detect, and control illicit discharges to the MS4; continue to evaluate existing properties and non-stormwater discharges.
Healthy Portland Streams	Lower and Middle Johnson Creek	Environmental Zone remapping and code revision to ensure that environmental zoning adequately protects streams, wetlands, riparian areas and uplands and that restoration efforts are promoted.
Metro Goal 5	Watershed Wide	Fish and wildlife protection regulation including uplands and restoration opportunities.

Project Title	Location	Project Description
Stormwater Master Plan	Kelley Cr.	Create Master Plan to accompany the Public Facilities Plan for stormwater. Determine appropriate size and design for conveyance swales and regional stormwater management facilities. Determine appropriate location and release rates for stormwater management.
Implementation and restoration of ESRA's	Kelley Cr.	Develop plans and/or programs to protect those areas of the Environmentally Sensitive Resource Areas (ESRA) that are not protected by environmental zoning and to address potential takings involved where properties have lost all development potential. Also, develop plans and or programs to revegetate.
Other Activities – actions under MS4	Lower and Middle JC	Continue implementation of the Stormwater Monitoring Plan. Continue program management evaluation and reporting activities.
Three Bridges Project	Lower Johnson Cr.	Extend the Springwater Corridor by building three bridges, one over Johnson Cr., one over McLoughlin Blvd., and one over Union Pacific RR.
Fallen Tree Policy	Lower and Middle JC	Develop City policy for dealing with fallen trees in creeks. When to remove, where to place, and how to protect.

Monitoring Projects

Thirteen projects intended to improve understanding of watershed functions including monitoring, modeling, and database management were identified by TAC members, stakeholders, and the public. The following monitoring, modeling, and data management projects were evaluated against the criteria and ranked as the top tier projects (Table ES-2). See Appendix I for a complete listing of monitoring and database management projects and individual ranking scores.

Table ES-2 Top Tier Monitoring Projects

Project Title	Location	Project Description
Sediment Monitoring	Upper Johnson Cr	Conduct Total Suspended Solids (TSS) and Turbidity monitoring to identify point and nonpoint pollution sources.
TMDL Bacteria	Watershed Wide	Baseline monitoring of E.coli bacteria levels at eight locations along Johnson Cr. to support establishment and implementation of TMDLs.
Toxics Source ID	Watershed Wide	Identification of sources of toxics.
Cutthroat Trout EDT Modeling	Watershed Wide	Cutthroat Trout EDT Model Results
Fishery Survey	Tributaries	Additional fish surveys to determine presence and extent of use of all tributary streams.
Fish Passage Barriers Inventory	Watershed Wide	Complete inventory of passage barriers to include private lands; characterize severity and rank.
Upland habitat and wildlife resources	Watershed Wide	Characterize upland habitat problems and opportunities.
Upland watershed tributary habitat and water quality	Upper JC	Characterize habitat and water quality conditions in upper watershed tributaries; focus on tributaries suspect to provide refuge; collect similar level of data available for Kelley and Crystal Springs Cr.
Vegetative Monitoring	Watershed Wide	Create volunteer structure to monitor revegetation sites for water quality, habitat, and other objectives.
Water Rights Information	Watershed Wide	Locate legal and illegal water rights information including diversions and quantify the extent of water withdrawals.
Outfall discharge characterization	Watershed Wide	GPS specific outfall locations and collect and characterize pollutant loading information.
Fish Passage	Watershed Wide	Prioritization of fish passage barrier removal/replacement within the entire watershed (may supercede other proposed fish passage projects).
ID specific WPA locations and conditions	Lower and Middle JC	GPS specific locations of bank and channel lining and condition.
Operations and Maintenance	Lower and Middle Johnson Cr.	Review and enhance the implementation of a Stormwater Maintenance Program that includes elements needed to successfully maintain and enhance performance of MS4 conveyance and treatment facilities within the City's urban services boundary
Johnson Cr. Ambient Monitoring	Watershed Wide	Baseline monitoring of Johnson Cr. to support TMDL process. Include chemical, physical, and biological parameters.
Identification of Fish Refugia Areas	Watershed Wide	Identify fish refugia areas that provide cool waters or conditions that support areas for avoiding hot spots, or chemicals.

Public Outreach and Education Projects

Nine projects intended to inspire stewardship behavior including public outreach and education were identified by TAC members, stakeholders, and the public. Ranking of Public Outreach and Education Projects are included in Table ES-3: See Appendix I for a complete listing of monitoring and database management projects and individual ranking scores.

Table ES-3 Top Tier Public Outreach and Education Projects

Project Title	Location	Project Description
Lower Willamette Enhanced Agricultural Water Quality Rule Implementation	Upper Johnson Cr	Coordinate with East Multnomah Soil & Water Conservation District (EMSWCD), Clackamas County Soil & Water Conservation District (CCSWCD), and the Oregon Department of Agriculture (ODA) to enhance education and technical assistance programs towards meeting WQ Management Area rules and minimize need for enforcement and fines.
Landowner Outreach	Upper Johnson Cr Reaches 17-18	Contact all landowners in these reaches, especially in the confluence area of N.F. Johnson Cr., Badger Cr., and Sunshine Cr. ID and prioritize all project opportunities in this high priority area. Apparent large-scale project opportunities for channel reconstruction, floodplain, wetland reclamation, addition of large wood structure, revegetation, etc. Plan and implement pilot project to initiate interest.
Community Restoration Project	Middle Johnson Cr	Work with private property owners to restore creek and riparian area to provide flood storage and improve habitat and water quality.
Construction BMPs	Watershed Wide	Offer assistance to regulatory agencies, builders and developers, to ensure adequate erosion prevention and sediment control and other construction site BMPs.
Public Involvement and Participation Program	Watershed Wide	Implement a comprehensive stormwater/watershed Public Participation Program that includes information, education, involvement, and stewardship.
Car trip reduction	Watershed Wide	Reduce car trips in watershed through education program in order to reduce petroleum aromatic hydrocarbons and other pollutant levels.
Signage Program	Watershed Wide	Develop an educational signage program for stormwater treatment facilities, creek crossings, and other sensitive areas, and along Springwater Corridor.
Annual Watershed Report	Watershed Wide	Annually monitor, report, and publicize stream health and status report by subwatershed.
Exotic Fish Education	Watershed Wide	Develop and disseminate educational program on exotic fishes and ID potential areas for removal.

Restoration Projects

Fifty-three projects focused on restoration and enhancement of watershed functions including revegetation, habitat improvement or recovery, floodplain connectivity and flow management, etc. were identified by TAC members, stakeholders, and the public. Restoration projects were ranked by Total Watershed Health Scores. Total Social/Economic Scores were ranked and summarized only for informational purposes. Ranking of the top tier Restoration Projects are included in Table ES-4. See Figure 15 for the location of the highly ranked restoration projects. See Appendix I for a complete listing of monitoring and database management projects, their limiting factors that are addressed, targeted areas that the project benefits, and their individual ranked scores.

Table ES-4 Top Tier Restoration Projects

Project Title	Location	Project Description
Reed Branch Habitat Restoration/Fish Passage	Crystal Springs	Replacement of culvert at 28th Avenue; Large wood placement upstream in Reed Canyon. Revegetation in Reed Canyon for temperature reduction; this is a possible subsurface channel.
Alsop/Brownwood Flood Mitigation and Habitat Restoration	Middle Johnson Cr	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmonids and water quality improvements.
Kelley Cr. Confluence flood mitigation/ habitat improvements	Middle Johnson Cr/Kelley Creek	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmonids and water quality improvements.
Tideman Johnson/Errol Heights Flood Mitigation	Lower Johnson Cr Reach 4-5	Purchase frequent flooded properties and create flood storage to mitigate nuisance flooding. Rehabilitate over 50-acres of wetlands. Create off-channel habitat for salmonids and water quality improvement.
SE 7th Street Br.	Middle Johnson Cr Reach 15	Develop two wetlands, reconnect floodplain, remove invasives, and stabilize bank and toe.
Main City Park Improvements (B)	Upper Johnson Cr at Main City Park Reach 15-16	Implement Master Plan. Large project with channel reconstruction, daylighting a tributary, wetland and floodplain creation.
West Lents Flood Mitigation	Middle Johnson Creek	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmon and water quality improvement. Purchase frequently flooded properties to move people out of the floodplain.
Freeway Land Company Flood Mitigation	Middle Johnson Creek	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmon and water quality improvement.
Springwater Wetlands Complex	Middle Johnson Creek	Create and restore wetlands habitat for flood storage, aquatic and wildlife habitat, and water quality improvement.
East Lents South of Foster Flood Mitigation	Middle Johnson Creek	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmon and water quality improvement. Purchase homes to move residents out of floodplain.

Project Title	Location	Project Description
Habitat Restoration	Kelley Creek (Mitchell to mouth); Richey through Bliss property	Large wood placement/enhancement of instream habitat complexity and floodplain connectivity/revegetation.
SW 14th Street Riparian Corridor	Butler Creek and Upper JC Reach 15	Control erosion by re-grading banks of JC and install soil bioengineering. Remove invasive and install natives. Add large wood. Address streambank instability and erosion.
Main City Park Improvements (A)	Middle Johnson Cr Reach 15	Remove island and dig out a pond and create wetland for flood storage, remove invasives and plant natives.
Westmoreland Park Improvements	Crystal Springs	Master planning effort to create a variety of habitat enhancements, including establishing Crystal Spring's channel and revegetation the banks to create a more naturalistic riparian edge. Other improvements may include adding boardwalks and viewpoints.
Habitat Restoration	Reach 17	Restore channel with large wood. Enhance instream habitat complexity and floodplain connectivity and revegetate.

Public Outreach

Community investment is a cornerstone of the Johnson Creek Watershed Council's effort to protect and enhance the Johnson Creek Watershed. The Council will be requesting investment of time and resources from community agencies and organizations as well as individuals to implement the actions identified in this plan. JCWC staff, committees and board worked with Adolfson Associates, Inc. and subcontractor Jeanne Lawson Associates, Inc. to develop a public outreach plan (see Appendix G) to provide opportunities for public involvement in the development of this Action Plan.

This involvement was accomplished through four major avenues:

1) Participation of community members on the Technical Advisory Committee;

2) Stakeholder interviews;

3) Stakeholder survey;

4) Public review of action plan documents; and

5) Development of a Landowner Participation Strategy.

Action Plan Implementation

Roles and Responsibilities

As a community based organization, the Johnson Creek Watershed Council recognizes the value of working in partnerships with other public and private organizations. Many organizations are actively working on Johnson Creek projects, including monitoring, restoration and enhancement, education, and land use planning. Each of these partners will take on different roles as funding, resources, and planning indicate. The JCWC is undertaking a Strategic Planning process for the purpose of assessing needs and organizational development as well as assessing the overall capacity of the organization.

Prioritization and Sequencing

For watershed action implementation to accomplish its goals, restoration and protection projects and actions need to be prioritized in terms of need, effectiveness, and the effect on future actions and programs. Actions also need to be sequenced so that implementing one doesn't impact the effectiveness of another. As suggested in the City of Portland's Framework for Integrated Management of Watershed and River Health, the following elements and their order is a matter of importance:

1) **Protect existing populations and their habitats**. Protecting and rebuilding an existing population is more feasible and efficient than reintroducing a population that has been lost.

2) **Reconnect favorable habitats.** This allows existing populations to provide 'colonists' that can re-establish satellite populations in nearby habitat where populations have been extirpated.

3) **Identify and control sources of degradation**. Causes of degradation should be identified and quantified before their impacts within the watershed are addressed.

4) **Restore the processes that maintain watershed health**:

    a. Normalize flow and hydrology;

    b. Restore physical habitat;

    c. Improve water quality; and

    d. Reestablish biological communities.

Sequencing of projects and actions is critical for the success of the Council's Action Plan. Sequencing projects and actions should be based on several key components including but not limited to: 1) severity of the problem; 2) goals and objectives of the project and the assumed or known effectiveness of the project or action; 3) technical feasibility; 4) timing; 5) funding; and 6) other local and regional planning efforts and implementation projects.

Monitoring and Adaptive Management

Monitoring

A monitoring plan developed around a prioritized list of data gaps will be required to further our understanding of the problems and opportunities facing the Johnson Creek watershed. Monitoring must also be incorporated into the design of each project that is implemented. A long-term monitoring program is recommended to assess trends and track progress and effectives of the Action Plan.

In addition to the prioritized data gaps that will form the basis of the monitoring plan, the following three additional elements are recommended for monitoring: 1) EDT modeling follow-up; 2) TMDL Water quality; and 3) Biological (fish and benthic macroinvertebrates).

For the purpose of tracking progress with Action Plan implementation, an annual report should be produced to document implemented projects and monitoring conducted annually. These annual reports should be published on the JCWC's web site and summarized at the annual Springwater Festival.

Adaptive Management

Adaptive management techniques will assess progress and make changes to the Action Plan. Tracking project effectiveness and subsequent changes to the limiting factors throughout the watershed will be key to determining improvement and whether health indicators are achieving properly functioning conditions in the future.

The Adaptive Management Plan consists of the following sequential elements:

1) Assess the resources and/or the problem.

2) Decide on the goals, policies and actions, and develop hypotheses that need testing.

3) Implement actions and develop/conduct monitoring programs.

4) Evaluate results, and

5) Decide on adaptations and adjustments.

The Action Plan's Adaptive management adheres to the guidelines detailed in the City of Portland Framework, 2002. These guidelines recommend the following elements in an adaptive watershed management plan:

- Clear, measurable objectives against which to measure success in achieving watershed and river health goals.

- Interim or benchmark values pegged to timelines, to map out the expected rate of progress in achieving the objectives.

- A monitoring program for use in checking progress in achieving the objectives, and

- Regular review of the monitoring data, comparison of the data with the benchmark or optimal values, and a method of adjusting actions in response to this comparison.

Funding Opportunities

The JCWC has been successful in the recent past in obtaining funds and grants to hire staff, purchase equipment and office supplies, facilitate forums, conduct public and organizational meetings, develop educational programs and materials, and implement restoration and volunteer projects. JCWC must continue with a cooperative approach with a number of partners to continue this success.

CHAPTER 1.0 INTRODUCTION

1.1 Purpose

This planning effort focused on identifying and prioritizing activities and projects for the Council and watershed stakeholders to conduct in addressing watershed health problems and opportunities. The purpose of the project was to develop a Comprehensive Watershed Action Plan accessible and useful to the Council, its partners, local jurisdictions and watershed stakeholders.

1.2 Scope of Project

The Watershed Action Planning process included four primary tasks: 1) Collect and analyze information to develop a watershed assessment; 2) Involve the public in developing the plan, and create a strategy for encouraging landowner participation; 3) Develop criteria to prioritize projects and actions; and 4) Document the planning process and results.

1.3 Project Goals

One of the main goals of the Watershed Assessment is to identify, prioritize, and sequence specific projects and actions necessary to address factors limiting watershed health. The overall goal of the Action Plan is to protect, restore, and enhance the health and function of the Johnson Creek watershed. To accomplish this goal, the action plan must also:

- ✓ Raise awareness of the issues and constraints facing the watershed and the JCWC.
- ✓ Identify key problems that are most detrimental to watershed health.
- ✓ Identify key opportunities that are most important to protecting watershed health.
- ✓ Build support for its implementation through public input, ensuring the plan is accessible and useful to the multiple local jurisdictions and stakeholders who will be involved in its implementation.
- ✓ Provide the JCWC with priorities to focus efforts and provide direction for partnering and plan implementation.
- ✓ Serve as a tool to obtain future grants and implementation funding.

1.4 Role of JCWC and TAC

The Johnson Creek Watershed Council (JCWC) formed in 1994 to meet the need for a Watershed Management organization identified by the Johnson Creek Resource Management Plan. The organization is dedicated to inspiring and facilitating community investment in the Johnson Creek Watershed for protection and enhancement of its natural resources. The Council provides 24 positions representing the broad array of stakeholders within the watershed. Council members are elected by the Council to serve renewable two-year terms. Ten reach representatives speak for neighborhoods throughout the watershed, eight jurisdictional representatives maintain contact with local jurisdictions, and six representatives keep the council in touch with the following groups: agriculture/nursery, environmental, education, small woodlots/forestry, business and industry, and homebuilders and developers.

The Council provides a forum for discussion of complex watershed management issues. It collaborates with governments, neighbors, environmentalists, recreational users and businesses to provide stewardship, educational, and outreach activities. It sponsors tours, hikes, bike trips, workshops, and classes that educate the public about this natural resource and its neighborhoods. The Council participates in land use decisions and planning through membership on advisory committees and formal feedback to councils and commissions. The Council facilitates, implements, and advises on restoration projects to improve watershed function and health.

The JCWC assembled a Technical Advisory Committee to assist with the development of the Watershed Action Plan. TAC members and their affiliations include:

- Jeff Uebel — USDA Forest Service, JCWC Chair, and watershed resident
- Jon Bowers — Oregon Department of Fish & Wildlife, JCWC Council member, and watershed resident
- Karl Lee — U.S. Geological Survey and watershed resident
- Kim Peoples, Chuck Beasley — Multnomah County
- John Nagy — Clackamas County
- Ruthanne Bennett — City of Milwaukie
- Kathy Majidi, Lynn Kennedy — City of Gresham
- Ali Young, Daniela Brod — City of Portland
- Ted Gresh — Planning Consultant and Restoration Committee member

TAC members' role included 1) review of deliverables including public outreach plan and materials, watershed assessment, and criteria development; 2) submittal of recommended projects and analysis of prioritization process; 3) review of draft and final reports; and 4) coordinating with and informing local constituency groups of project progress. Monthly meetings were held beginning in January 2003.

See Chapter 7 – Action Plan Implementation for a preliminary list of project sponsors and potential partners and their associated roles and responsibilities.

1.5 Relationship to other Planning Efforts

There are a number of planning efforts focused on the Johnson Creek watershed and related to this Action Plan. These planning efforts were conducted to satisfy local, state, or federal requirements or were completed as part of other watershed planning and management activities by local agencies, regional governments, or cooperating organizations. Please see Appendix H –Annotated Bibliography for summaries on these and other Johnson Creek related documents.

The Watershed Action Plan differs from other plans because it summarizes problems and opportunities throughout the entire watershed taking a holistic approach and focusing on watershed functions. Nevertheless, the Watershed Action Plan builds upon results of and is consistent with recommendations included in many of these other plans.

- Johnson Creek Basin Protection Plan (Portland Planning Bureau, 1991);
- Johnson Creek Resources Management Plan (Johnson Creek Corridor Committee, 1995);
- Flood Management Amendments to the Johnson Creek Basin Plan District (Portland Planning Bureau, 1998);
- Johnson Creek Aquatic Inventories Project Physical Habitat Surveys (City of Portland BES, Gresham, and ODFW, 1999 and 2000);
- Pleasant Valley Concept Plan (2000) and Implementation Plan (in progress);
- Johnson Creek Restoration Plan (City of Portland BES, 2001);
- Healthy Portland Streams – Inventory of Significant Riparian and Wetland Resources for Johnson Creek Basin Resource Sites – Discussion Draft (Portland Bureau of Planning, 2001);
- Crystal Springs Creek Fish and Wildlife Habitat Assessment (Portland, and Adolfson Associates, 2001);
- Johnson Creek Land Acquisition Partnership and Implementation Strategy (JCWC and Portland BES, 2001);
- Multnomah County West of Sandy River Transportation and Land Use Plan (Multnomah County, 2002);
- Ecosystem Diagnostic and Treatment (EDT) model including baseline environmental conditions in Johnson Creek (Portland and Mobrand Biometrics, 2002 and in progress);
- Johnson Creek TMDL Development (DEQ in progress);
- Johnson Creek Master Plan update (Gresham in progress); and
- Johnson Creek Watershed Plan (Portland in progress).

1.6 Completed and Ongoing Projects

There are numerous projects that are in progress or have been completed by a host of watershed stakeholders. A list of projects and a map of the project locations is provided in Appendix F. The list provides only a few examples and is not intended to be comprehensive. The following summary highlights four completed or ongoing programs that have wide application for watershed restoration and protection efforts throughout the Johnson Creek watershed. They were chosen based on their recent and significant accomplishments.

1.6.1 Portland Watershed Revegetation Program

Since 1988, the City of Portland's Watershed Revegetation Program has partnered with local agencies, volunteers, businesses, and other stakeholders in the watershed. From 1998 through 2002, a total of 31 revegetation projects throughout the Johnson Creek watershed have been conducted totaling more than 106 acres and more than 38,800 ft of stream bank. During 2003, a total of 13 additional projects are expected to be completed. Typical projects have five years of maintenance, twice per year, and have about 1,500 trees and shrubs planted per acre. The goal is to have 50% of the plantings to be thriving at year 5.

1.6.2 Johnson Creek Restoration Plan

The Johnson Creek Restoration Plan completed in 2001 by Portland BES was a call to action for watershed partners to cooperate in identifying solutions and implementing projects that achieve multiple watershed restoration objectives. Restoration actions included reducing nuisance flooding, improving water quality, and restoring or enhancing fish and wildlife habitat. The 2001 Restoration Plan updated the concepts in the 1995 Johnson Creek Resources Management Plan while adding design objectives, project ideas, and management strategies (Portland BES, 2001). The 2001 Restoration Plan goal was to rehabilitate the watershed's natural functions to resolve flooding problems, rather than relying on flood control structures to alleviate the problem. To achieve this goal, the plan recommends restoration components that are compatible with natural watershed functions, such as the restoration of floodplains, riparian buffers, wetlands, and in-stream habitat complexity.
Eight early action projects were identified including: 1) Lower Johnson Creek Restoration (Milwaukie); 2) Tideman Johnson Nature Park (Portland); 3) Bell Station Flood Mitigation (Clackamas County); 4) West Lents Flood Mitigation (Portland); 5) Lents Alternatives (Portland); 6) Alsop Floodplain Restoration (Portland); 7) Gresham Stream Corridors (Gresham); and 8) Upper Reaches Riparian Improvements (Clackamas and Multnomah Counties).

Opportunities identified by reach include the following: 1) reconnection and restoration of the floodplain; 2) stabilize stream banks; 3) protect tributaries and their confluence's; 4) mitigate outfalls and remove barriers; 5) create or enhance wildlife corridors; 6) protect and restore riparian vegetation; 7) increase in-stream complexity; 8) reduce adverse effects of impervious surfaces; 9) improve water quality; 10) add large woody debris; and 11) provide educational opportunities and encourage stewardship.

The Johnson Creek Restoration Plan Willing Seller Program is an implementation strategy of the Restoration Plan. This program has been actively purchasing properties in the watershed since 1997. To date more than 115 acres have been acquired and over 50 households have been assisted in moving out of harm's way of flooding. The program was expanded to include all jurisdictions in the watershed and other potential partners who will make acquisition feasible given the current economic and funding situation. A total of 15 target areas have been determined and prioritized based on targets set in the Restoration Plan. Once target areas have been identified and contact is made with a potential willing seller, individual properties are evaluated and ranked based on several criteria. For more detailed information of the City of Portland's acquisition process see the Johnson Creek Land Acquisition Partnership and Implementation Strategy (Portland BES, 2001).

1.6.3 Lents Flood Management Alternatives

Portland BES has been working with the Lents community and other City bureaus since 2000 to develop flood management alternatives as part of the Portland Development Commission Lents 2040 Urban Renewal Project. The objective is to store floodwaters generated by up to 10-year flood events (or "nuisance" floods) in ways that will improve the environment while also expand options for community redevelopment. Only one of the four alternatives studied ranked as feasible when analyzed against the following seven design considerations: 1) ability to store the nuisance flood; 2) difficulty of construction; 3) long term stability of channel or floodplain modifications; 4) ease of long-term operations and maintenance; 5) use of existing public lands; 6) downstream impacts; and 7) environmental impacts and ability to obtain permits. The approach would manage nuisance floodwaters south of SE Foster Road between SE 112th and Interstate 205. Construction would include creating a wider, two-stage channel within Johnson Creek. The design would also include off-channel storage areas within the floodplain and flood relief channels to route high flows to storage locations or to create alternative downstream flowpaths (Lents Technical Memorandum, Portland BES, 2002).

1.6.4 Lower Willamette Agricultural Water Quality Management Area

A local advisory committee for the Lower Willamette Agricultural Water Quality Management Area that includes Johnson Creek is currently developing the Agricultural Water Quality Plan and Rules. The plan and rules commonly referred to as Senate Bill (SB) 1010 address a wide range of conditions such as erosion, siltation, animal waste, and riparian area management. The SB 1010 directs the Oregon Department of Agriculture to work with farmers to develop overall water quality management plans for watersheds listed on the Federal Clean Water Act section 303(d) and associated list of water quality parameters not meeting water quality standards. The Lower Willamette Agricultural Water Quality Management Area Local Advisory Committee is made up of resource agencies, nursery and farm owners, and environmental organizations.

The plan will describe the management area, water quality concerns, mission, goals, strategies to achieve the goals and objectives, and strategies for monitoring and evaluating the effectiveness of the plan. The rules will become OAR's (Oregon Administrative Rules) and will be enforced by the Oregon Department of Agriculture. The committee will be drafting four rules that will cover waste (manure, sediment, etc.), nutrients, erosion, and riparian areas. The goal is to have a draft of both the Plan and Rules sometime during the summer of 2003. The State Board of Agriculture will approve the Plan and Rules. Both the Plan and Rules will be reviewed by the committee every two years and will be updated to address any new 303(d) listings or TMDL's in the management area.

CHAPTER 2.0 WATERSHED ASSESSMENT

2.1 Introduction

Johnson Creek Watershed Council (JCWC) Watershed Assessment compiles, synthesizes, and summarizes the most relevant information on existing conditions within the Johnson Creek Watershed. Subsequently, the assessment is used to meet the main goals of the Action Plan; namely to identify, prioritize, and sequence specific projects and actions necessary to address factors limiting watershed health. The overall goal is to protect, restore, and enhance the health and function of the Johnson Creek watershed. To accomplish this goal, the action plan must also:

- Raise awareness of the issues and constraints facing the watershed and the JCWC.
- Identify key problems that are most detrimental to watershed health.
- Identify key opportunities that are most important to protecting watershed health.
- Build support for its implementation through public input, ensuring the plan is accessible and useful to the multiple local jurisdictions and stakeholders who will be involved in its implementation.
- Provide the JCWC with priorities to focus efforts and provide direction for partnering and plan implementation.
- Serve as a marketing tool to obtain future grants and implementation funding.

This watershed assessment highlights and summarizes the most important and up-to-date information available for this basin. More detailed information on various elements and functions of the Johnson Creek Watershed can be obtained in the following key studies or reports: Johnson Creek Resources Management Plan (Johnson Creek Corridor Committee, 1995); Salmon Restoration in an Urban Watershed: Johnson Creek, Oregon (Meross, 2000); Aquatic Inventory Project Physical Habitat Surveys (ODFW, 2000); the Johnson Creek Master Plan (City of Gresham, 2003); and the Johnson Creek Restoration Plan (Portland Bureau of Environmental Services (BES), 2001).

The JCWC Watershed Assessment summary is an introductory chapter in the Action Plan and identifies the key problems or factors limiting watershed health. The watershed assessment also initiates discussion about sources of these problems and conditions and suggest opportunities that could lead to actions for protecting, restoring, and enhancing watershed functions.

It is important to note that while there is a focus and attention placed on fish and restoring conditions for their recovery and sustainability, they were selected as an indicator species for this watershed assessment. Improving conditions for both resident and anadromous fish species will improve overall watershed health, including water quality for human contact and conditions for other fish and wildlife species. In addition, flooding and factors that are contributing to flood conditions in the watershed are extremely important. Flooding elements are being addressed in the Action Plan and through recommended projects that pertain to watershed functions. Restoring watershed functions will aid in reducing the frequency and magnitude of floods.

As an introduction to the Watershed Action Plan, this assessment provides a general description of the watershed, highlights the human and built environmental conditions, and summarizes the current conditions and four main attributes for watershed and river health. These attributes are: 1) stream flow and hydrology; 2) physical habitats; 3) water quality; and 4) biological communities. The watershed assessment concludes with a summary of the problems and opportunities, highlights the key functions and processes, outlines the major limiting factors, and focuses on specific reaches and sections of Johnson Creek which would most benefit from protection and restoration actions.

2.2 Watershed Description

2.2.1 General Location and Size

Located on the east side of the greater Portland Metropolitan region, Johnson Creek originates in Clackamas County, east of Boring, Oregon, and flows westerly approximately 25 miles to its confluence with the Willamette River. The Johnson Creek drainage basin encompasses approximately 34,000 acres or about 54 square miles.

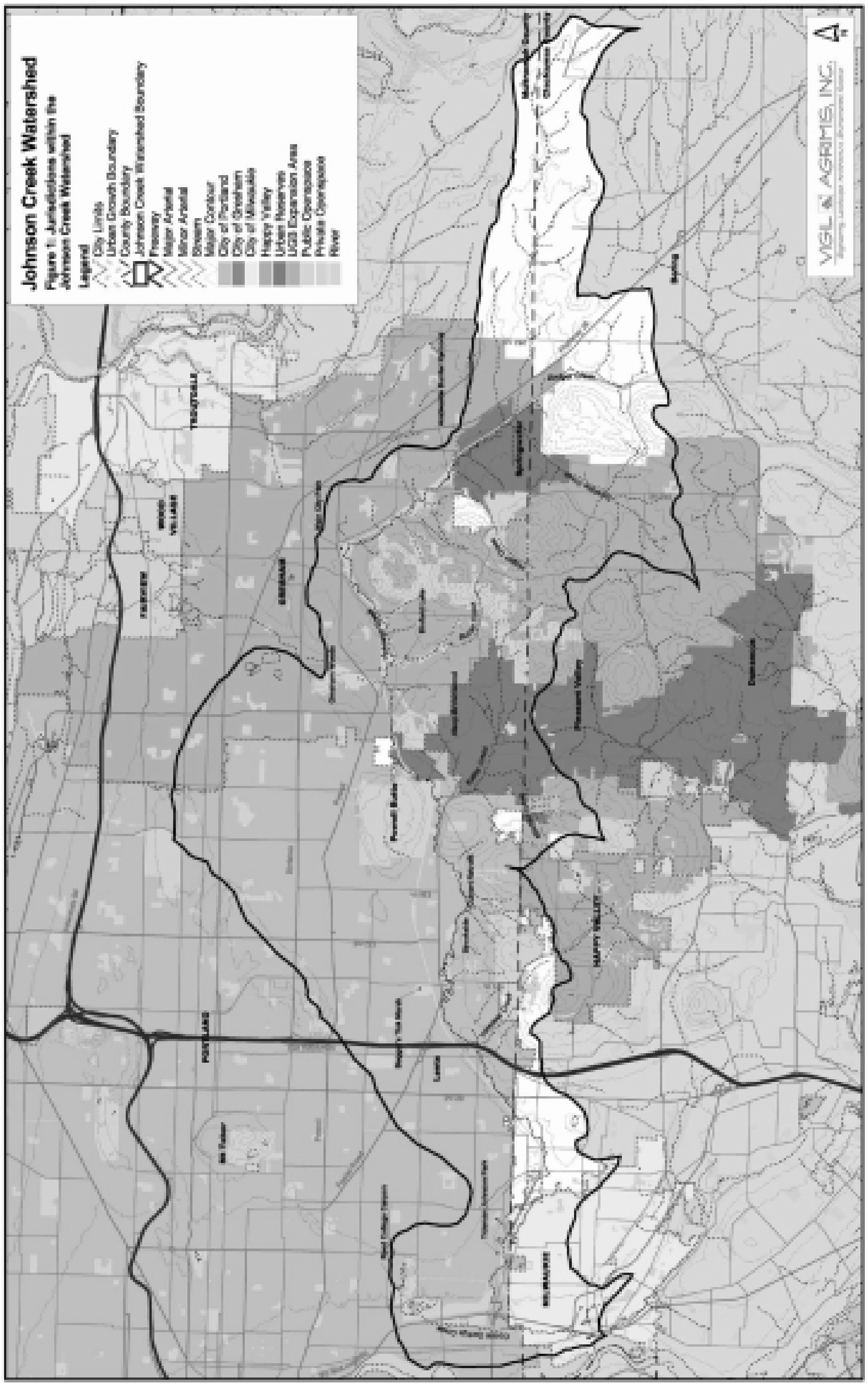
2.3 Jurisdictions and Sub-watersheds

The mostly urban watershed is contained within six local jurisdictional entities including Clackamas and Multnomah Counties, and the cities of Gresham, Happy Valley, Milwaukie, and Portland. Portland, Clackamas County (outside of Milwaukie and Happy Valley), and Gresham have the greatest portion of the watershed at 38 percent, 24 percent, and 23 percent respectively. The remainder of Multnomah County (outside of Portland and Gresham), Milwaukie, and Happy Valley has the least land acreage as a percentage respectively and are highlighted below (City of Portland BES, 2000). The general watershed location and jurisdictional boundaries are included in Figure 1.

Jurisdiction	Jurisdiction as percent of Watershed	Watershed as percent of Jurisdiction
Portland	38 %	14 %
Unincorporated Clackamas County	24 %	<1 %
Gresham	23 %	53 %
Unincorporated Multnomah County	11 %	1.2 %
Milwaukie	4 %	42 %
Happy Valley	0.1 %	19 %

The characterization of the Johnson Creek watershed is based on sub-watersheds and reach areas. A recent City of Portland assessment of the watershed divided the basin into reaches defined as the main stem Johnson Creek (lower, middle, and upper); and the following major tributaries: Crystal Springs Creek; Kelley Creek; Butler Creek, Hogan Creek; Sunshine Creek, and Badger Creek (City of Portland ESA, 2002). Crystal Springs Creek and Kelley Creek are the largest tributaries in terms of flow contribution. In addition, Minthorn or Spring Creek discharges into Johnson Creek within the city of Milwaukie. Most of the tributaries are located south of Johnson Creek. Crystal Springs Creek is largely groundwater-fed and originates from springs on the north side of Johnson Creek.

Figure 1. Jurisdictions within the Johnson Creek Watershed



2.4 Landscape Factors

2.4.1 Topography

Elevations in the watershed generally range between 0 to 1,100 feet above mean sea level (msl). Slopes are highly variable and range generally between 1 to 25 percent. Mt. Scott and Powell Butte, which rise to approximately 1,000 feet, and have relatively, moderate to steep slopes ranging from 10 to 30 percent. Gresham and Hogan Buttes have the highest slopes, with a few approaching or exceeding 50 percent.

The highest point in the watershed is in the Boring Hills at approximately 1,100 feet above msl. The Boring Hills are of volcanic and erosional origin. Several of the hills reach an elevation of more than 1,080 ft. This is more than 800 feet higher than the terraces to the north and west. The Boring Hills are divided into three main sections by their characteristically broad and gently rolling hills (Laenen, 1980).

The Kelso slope is a dissected northwestward-sloping surface west of the canyon of the Sandy River. It slopes from an altitude of approximately 1,000 feet near Sandy to around 400 feet east of Gresham. The ancestral Columbia and Willamette Rivers formed the east-side terraces. The terraces do not have a well-developed stream system in all areas and are underlain mostly by permeable sand and gravel. Although the precipitation is abundant, most of it percolates down to groundwater and leaves these areas by underflow (Laenen, 1980). Three isolated hills – Rocky Butte, Mount Taber, and Kelly Butte – rise about 200 to 400 feet above the surrounding terraces (Laenen, 1980). With the exception of the Powell Butte area, the terrain on the north side of Johnson Creek is less steep than the south side of the creek, which includes both Mt. Scott and the Boring Lava Domes.

2.4.2 Soils

Soils in the watershed are primarily either Multnomah and Latourell-Urban Land Complex (Type B hydrologic group) or Cascade Silt Loam (Type C hydrologic group). Type B soils are predominant (71 percent), followed by type C soils (21 percent). The Urban Land Complex classification refers to areas largely covered by impervious surfaces; these soils have been graded, cut and filled, or otherwise disturbed to the extent that their soil identification is not feasible. Soil erodibility varies throughout the watershed. The northwest part of the watershed mainly within Portland is characterized by Latourell soils, which have a medium-high risk of erosion. Maximum erosion for this type of soil is approximately 5 tons per year per acre. The potential for erosion is not a large threat however, due to the area being relatively flat and developed. Multnomah soils, which have a low-medium erosion factor, dominate in the northeast portion of the watershed. The southeast portion of the watershed is dominated by Cascade soils, which have a medium risk of erosion. Soils surrounding the Powell Butte and the Boring Lava Domes have an extremely high erodibility factor and are sensitive to ground disturbance.

The soils within the watershed also have varying ranges of permeability and water retaining capacity. In areas where soils are relatively undisturbed, permeability is moderate, and available water capacity is 4 to 12 inches per hour. The areas south of the creek and at the eastern end of the watershed consist mostly of clay soils that tend to have a high runoff potential and are incapable or are only minimally capable of absorbing water through infiltration. Northern areas of the watershed are generally porous, with moderate to high permeability, and are suitable for infiltration type facilities.

In summary, the Johnson Creek watershed is a relatively large and diverse watershed. A mix of land use is present varying from large areas of urbanization and associated impervious surfaces to areas of undeveloped land and rural uses and activities. The mostly urban watershed is contained within six local jurisdictions. Elevations are highly variable and stream systems are either well defined or are not well developed in all areas depending in part on ancestral river formed terrace locations. Soil erodibility varies as does permeability and water retaining capacity.

2.5 Built Environment Conditions

2.5.1 Land Use

The land use varies from heavily developed urban areas in the lower and middle reaches of the Johnson Creek watershed (Cities of Portland, Milwaukie, and Gresham) to rural and agricultural in the upper watershed (Figure 2). Current land use (1999) in the basin reveals single-family residential and rural designations make up the largest acreage and percentages at approximately 15,000 acres or 45 percent and 11,000 acres or 33 percent respectively (Meross, 2000). Multi-family residential accounts for 9 percent, while industrial and commercial taken together make up 8 percent. Parks and open space account for the remaining 5 percent. In the agricultural rural areas of the upper watershed, 50 percent of the land base is currently used for cultivated crops or pastures, and another 29 percent is used for tree and ornamental nurseries, greenhouses, or Christmas tree plantations (Meross, 2000). There are currently 49 developed parks and recreational facilities within the Johnson Creek Watershed, totaling more than 1,000 acres (City of Portland BES, 2000). The Springwater Corridor Trail is a key recreational facility in the watershed. It extends more than 16 miles and occupies a former railroad right-of-way paralleling Johnson Creek for much of its length.

2.5.2 Current Development

The Johnson Creek Watershed is highly developed with over 50 percent of the watershed urbanized. Development consists primarily of buildings and structures, stormwater and sanitary systems, roadways, bridges, pipes, outfalls, and culverts. Metro estimated that approximately 38 percent of the tributaries were piped or relocated by development over the years (Meross, 2000). These drainage systems originated mainly in the northern portion of the watershed within Portland and a portion of Gresham. However, as noted earlier, the east side terraces do not have a well-developed stream in all areas and precipitation that falls on mostly permeable sand and gravel percolates to groundwater and leaves the area by underflow (Laenen, 1980).

2.5.3 Future Development

The urban growth boundary (UGB) for the Portland metropolitan region passes through the Johnson Creek watershed. In 1997, Metro approved a UGB expansion including the 1500 acre area known as Pleasant Valley, which roughly corresponds to the Kelley Creek watershed. With this expansion, about 72 percent of the watershed’s 34,000 total acres, or approximately 24,000 acres of the watershed, lie within (Meross, 2000). In 2002, as the Pleasant Valley Concept planning process drew to a close, the Metro regional government expanded the urban growth boundary again. The bulk of the 2002 expansion area consists of more than 13,000 acres south and east of Gresham, including approximately 3000 acres of the Johnson Creek Watershed. The UGB and Expansion Areas are shown on Figure 3.

Figure 2. Land Use within the Johnson Creek Watershed

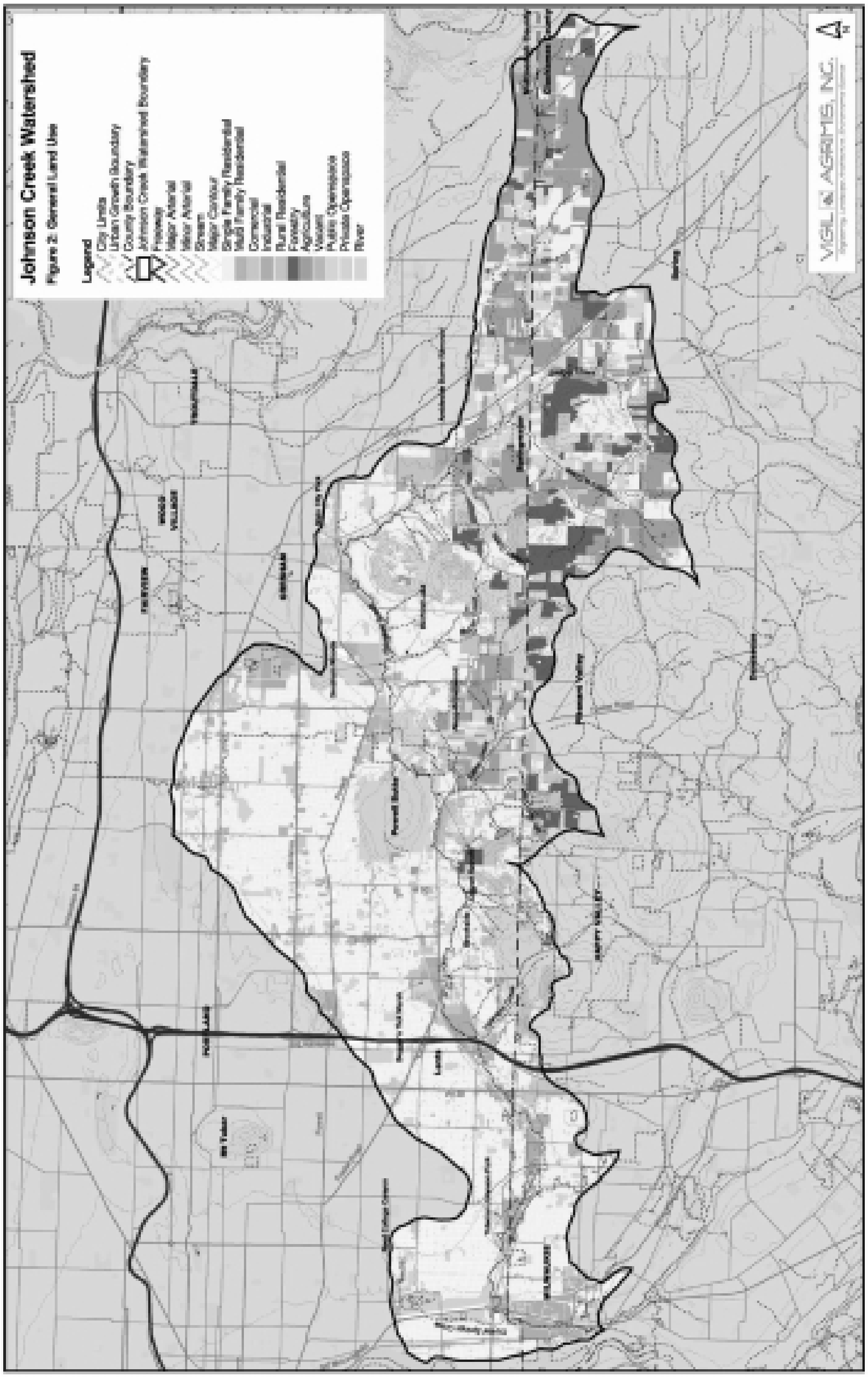
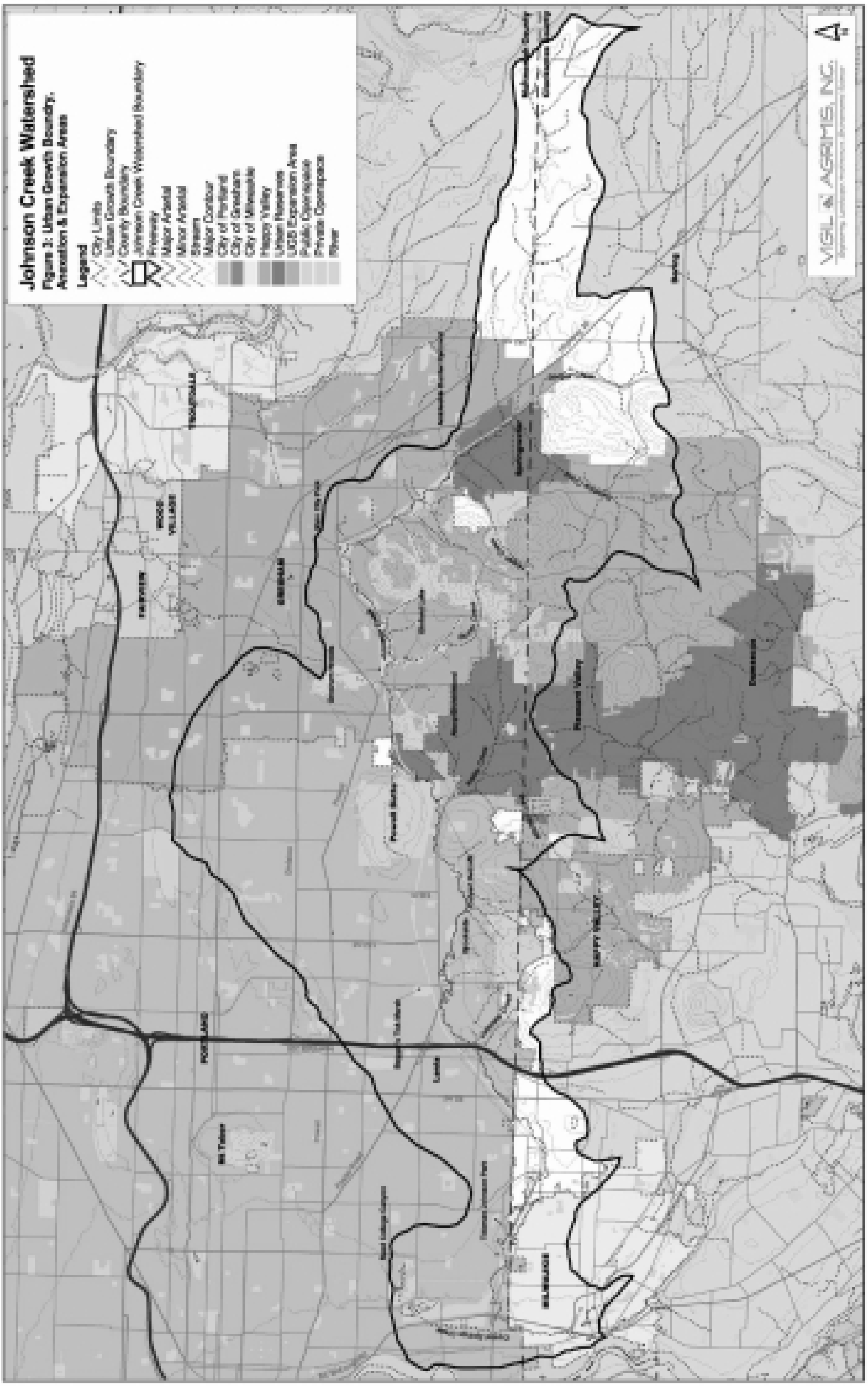


Figure 3. Urban Growth Boundary Annexation & Expansion Areas Map



2.5.4 Impervious Surfaces

Much of the existing development consists of impervious surfaces. Impervious surfaces as a percentage in the Johnson Creek watershed were estimated from aerial photographs and zoning maps. Within Portland, approximately 29 percent of the watershed is covered with impervious surfaces. Approximately 43 percent of the watershed as a whole is covered with impervious surfaces. This percentage was derived from BES's multispectral vegetation data analysis (Young, BES, 2003). The amount of impervious area increases as you go downstream in the watershed from the agricultural areas of the headwaters to the inner city at the mouth with as much as 45 percent impervious area within the Crystal Springs Creek sub-watershed. It is important to note that a large percentage (35 percent) of the lower watershed does not drain to Johnson Creek as overland flow. Approximately 23 percent of the watershed in the Portland region of the watershed drains to groundwater through stormwater sumps. Approximately 8% is directed to Portland's combined sewer system, and approximately 6% is hydrologically disconnected from the watershed (Meross, 2000). Percent effective impervious within the Johnson Creek watershed varies considerably; large areas in the middle and upper watershed areas have relatively low effective imperviousness that swamps out high percentages in the lower watershed. The net result is that overall, very little of the watershed actually exceeds the threshold of 10-15% effective impervious (ESA, 2001).

Stormwater and Sanitary Pipe Conveyance System

Drainage patterns in the lower portion or western end of the watershed were significantly altered by construction of a piped storm drainage system (Johnson Creek Corridor Committee, JCCC, 1995). Within this area the Sellwood, Eastmoreland, Westmoreland, and Woodstock neighborhoods of Portland contain 110,832 lineal feet of the city's combined sewer system within two basins- Lents 1 and Lents 2. There are no significant hydraulic problems in the Lents 1 basin; however, there are potential areas of basement flooding from saturated ground conditions and peak storm flows. Lents 2 has significant capacity problems that result in basement flooding. Problems are caused by undersized conveyances, flat slopes, and very long collection networks (Portland ESA, 2000). The Portland Public Facilities Plan (Portland BES, 1999) identifies capital improvement program (CIP) projects for both of these basins to address basement flooding and combined sewer overflow (CSO) reduction.

Stormwater within the city of Portland is conveyed through approximately 38,832 lineal feet of storm drainage pipe and is treated by 31 pollution reduction facilities within the watershed. It is then discharged into one of three main locations: the combined system, sumps, or directly into Johnson Creek. The sump or dry well area within the city limits in the portion of the watershed covers more than 8,000 acres and treats approximately 23 percent of the city's stormwater.

Within Gresham's portion of the Johnson Creek Watershed, stormwater is conveyed through 384,282 feet of stormwater pipe. As the soil north of Johnson Creek is appropriate for infiltration facilities, 47 sumps have been installed within the northern portion of the watershed, receiving runoff from a mix of commercial, residential, and transportation land uses. There are no combined sewer system pipes within Gresham's city limits.

The public stormwater system within the upper portion of the watershed that extends from the 2002 Gresham UGB east approximately four miles to the watershed boundary consists of roadside ditches and culverts that convey runoff directly to Johnson Creek and its tributaries. In addition to surface water runoff, the ditch system carries water from farm field subsurface drainage systems to area creeks. The ditch system provides no water quality treatment other than in areas where ditch vegetation is maintained.

For new developments, the rate of stormwater runoff from private property is required to be controlled to the pre-development amount under Multnomah County ordinances. Runoff from agricultural fields into the roadside ditch system is in the jurisdiction of the Oregon Department of Agriculture.

The Oregon Department of Environmental Quality (DEQ) through the federal National Pollution Discharge Elimination System (NPDES) Permit Program regulates stormwater. As of March 2003, the following stormwater permits were issued by DEQ to permitted facilities that have discharges in or near Johnson Creek: 11 construction stormwater permits, 13 industrial stormwater permits, three combined animal feeding operations or (CAFO that are administered by the Oregon Department of Agriculture including one dog, one mink, and one swine operation), two industrial hydrocarbon cleanup related permits, and one domestic sewage drainfield (DEQ 2003). This does not include permits pending or those that have expired. Construction stormwater permits are for sites greater than 5 acres, although the threshold was lowered to sites greater than 1 acre in December 2002. The industrial permits allow precipitation to contact raw industrial materials and runoff into surface waters only if best management practices and controls are in place. Two of the industrial permits are for clean up of petroleum-contaminated soils at RM 10.8 and groundwater at RM 15.3. There is also an active permit for a Water Pollution Control Facility (WPCF), in this case, a church and domestic drainfield at RM 18.2. WPCF permits authorize discharge to groundwater, but not surface water.

At the current time, there are no known estimates for the amount of stormwater that enters Johnson Creek from the direct stormwater outfalls. (See Data Needs on page 93.)

In accordance with Clean Water Act (CWA) requirements, the Oregon Department of Environmental Quality (DEQ) issued municipal National Pollutant Discharge Elimination System (NPDES) permits to both Gresham and Portland and their co-permittees in 1995. These permits cover a five-year period and require the implementation of a stormwater management plan and submittal of annual reports. As of 2003, DEQ has received permit renewal packages from these jurisdictions but have opted to allow Gresham, Portland, and their co-permittees to continue functioning through an extension of their expired permits. Permit renewal will be completed by 2004.

Both Gresham and Portland are implementing management programs for the new state and federally mandated Underground Injection Control (UIC) program. In addition, Multnomah County has implemented a UIC program within Gresham.

Sanitary sewer systems within the watershed are mainly owned, operated and maintained by the Cities of Portland, Gresham, and Milwaukie. Parts of these systems are located within the floodway of Johnson Creek and several manholes are located within the stream channel. Sanitary sewerage within Portland (along with some combined flow) is conveyed by two pump stations within the watershed to the Columbia Boulevard Wastewater Treatment Plant. Sewage is conveyed through the watershed within Portland by 153,794 lineal feet of sewer pipe (Portland ESA, 2000). In Gresham, sewage is piped through 470,721 feet of sewer pipe and pumped to the Gresham Wastewater Treatment Plant on the Columbia River. Sewage from development in the upper watershed east of the Gresham UGB is treated in onsite septic systems as there are no sewer extensions allowed outside of urban areas. There are also some onsite septic systems still being used in certain areas of Milwaukie. Siting, development, and maintenance of onsite septic systems is in the jurisdiction of the DEQ, and the program for Multnomah County is administered by the City of Portland Bureau of Development Services. A new WWTP is under construction in the Kelley Creek subwatershed to replace a failing septic field in Happy Valley.

2.5.5 Roads

The roadway network is extensive in the lower and middle sections of the Johnson Creek watershed. There are more than 50 bridges that cross the main stem of Johnson Creek.

An estimate of total impervious surfaces from roadways throughout the watershed is presently not available. For a discussion of roadway culverts and fish passage barriers see Section 2.10 Biological Communities.

2.5.6 Channelization

Much of the two lower sections of Johnson Creek (15 miles) are deeply channelized and confined. Most of the channelization, designed to control flooding, is the result of depression-era public works agencies, primarily the Civil Works Administration and the Works Projects Administration (WPA). At several locations along the stream, a new course was created and the stream channel was straightened, deepened, and simplified. Dikes were constructed to contain and control the stream at high flow. Beginning in 1933, streamside vegetation was removed, and the dikes and streambed were armored with basalt rocks. The intent was to remove wood and vegetation behind which flows ponded and to increase the flushing rate of the creek. This channelization and armoring has had important consequences for the stream.

The channelization throughout the lower 15 miles did not stop major flooding. The channelization substantially altered the creek's configuration and severely limited connectivity to its historic floodplain. These alterations have had long-lasting and marked effects on the physical habitat structure and hydrology of the watershed, constraining lateral movement of the stream almost entirely and increasing winter flushing to an extent that large wood and other structural diversity is almost non-existent. There are other reasons however, for the lack of large wood including lack of source material within the riparian areas and removal of vegetation.

The WPA crews also constructed new features such as a canal and waterfall above Tideman Johnson Park, a nearby fish ladder, an old Tacoma Street Bridge and many other rock walls, stairways and bridges. They also worked in Lower Kelley Creek and Crystal Springs Creek where they constructed ponds at Westmoreland Park and piped water from Crystal Springs Lake to create a casting pond (City of Portland ESA, 2002).

2.5.7 Water Rights

Adolfson performed a cursory water rights information query from the Oregon Water Resources Department (OWRD) web site: http://stamp.wrd.state.or.us/apps/wr/wrinfo/wrinfo.php.

Table 1 summarizes query results from the period 1900-2003 obtained for claims, permits, applications, or certificates currently listed for the Johnson Creek watershed:

Table 1. Water Rights including number of Claims, Permits, Applications, or Certificates within the Johnson Creek Drainage Basin

Number of Claims Permits, Applications, or Certificates	Characteristic	Type	Total flow (cfs) or volume (AC-FT)* for all claims, permits, applications, or certificates
32 Claims	Groundwater Registrations (GR)	Wells	15.17
65 Permits	Groundwater (G)	Wells	62.03
53 Permits	Surface water (S)	Surface Water including creeks, streams, or springs	31.51 (includes 12.0 cfs for Butler Cr. Reservoir and 6.0 cfs for Hessel Reservoir (Frank Schmidt Nursery)
3 Applications	Groundwater (G)	Wells	3.28
2 Applications	Instream Flow (IS)	Surface Water	15.0 cfs – Crystal Springs 25.0 cfs – Johnson Creek
4 Applications	Ponds (P)	Surface Water	5.60 AC-FT
23 Applications, Permits, or Certificates	Reservoirs (R)	Surface Water	110 AC-FT

* cfs = cubic feet per second; AC-FT = acre feet

Water diversions and withdrawals can have significant impacts on watershed hydrology. Increasing baseflows throughout the Johnson Creek watershed will be important for restoring hydrology to a normal hydrograph and to obtain properly functioning conditions. More research will be required to: 1) locate illegal water diversions and withdrawals, 2) identify areas for irrigation improvement; 3) assess alternatives for off-line systems; 4) contact holders to assess opportunities for instream water rights purchase; and 5) review and comment on new water rights applications.

2.6 Watershed Conditions

The following provides an overview of existing environmental conditions in Johnson Creek, and evaluates watershed health by summarizing and presenting data available on a series of key indicators. The importance and justification for the selection of the indicators is described in the Internal and IST Review Draft *Framework for Integrated Management of Watershed and River Health* (City of Portland 2002).

This baseline is not intended to be a comprehensive summary of existing information on Johnson Creek. A number of reports provide excellent overviews of the large amount of information on environmental conditions and restoration efforts within the watershed (e.g., JCCC1994; JCCC 1995; Meross 2000; BES 2001).

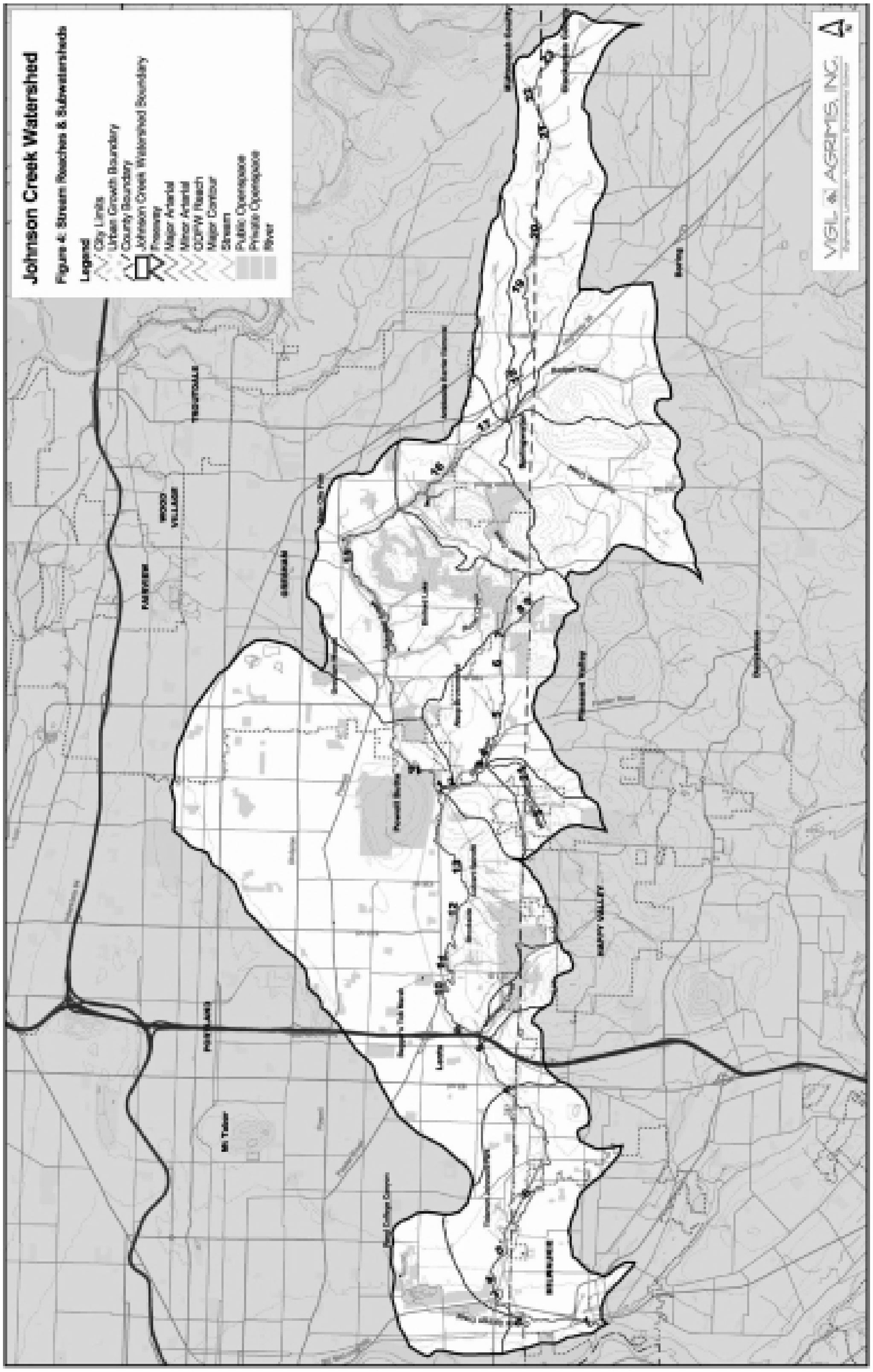
For the 2000-2001 ODFW Aquatic Habitat Inventory Project, Johnson Creek was segregated into 23 separate stream reaches. BES grouped these reaches into three main areas – lower, middle, and upper Johnson Creek in a subsequent modeling project. Lower Johnson Creek consists of reaches 1-7; Middle Johnson Creek consists of reaches 8-15; and upper Johnson Creek consists of reaches 16-23. Table 2 highlights the stream reaches and their location (see also Figure 4).

The City of Portland ESA Program recently completed a summary of baseline environmental conditions in the Johnson Creek watershed. This document provides a brief narrative overview of existing conditions, and then evaluates a series of key indicators of watershed health by summarizing and presenting data available on each of the indicators (See Appendix A). These data served as background information and were inputs into an Ecosystem Diagnosis and Treatment (EDT) model to assess protection and restoration opportunities in the Johnson Creek watershed (See Key Limiting Factors in Chapter 2.12).

Table 2. ODFW Stream Reaches

Number	Boundary Location
1	Willamette River confluence to Hwy. 224 overpass
2	Hwy. 224 to Crystal Springs tributary junction
3	Crystal Springs tributary junction to Old Tacoma bridge crossing
4	Old Tacoma bridge crossing to Tideman-Johnson rail and footbridges
5	Tideman-Johnson rail and footbridges to Johnson Cr. Blvd. bridge crossing
6	Johnson Cr. Blvd. bridge crossing to SE Linwood Ave. bridge crossing
7	SE Linwood Ave. bridge crossing to SE 82nd Ave. bridge crossing
8	SE 82nd Ave. bridge crossing to I-205 bridges
9	I-205 bridges to SE 106th bridge crossing
10	SE 106th bridge crossing to SE 110th Drive bridge crossing
11	SE 110th Drive bridge crossing to Brookside restoration site
12	Brookside Restoration site to SE 132nd bridge crossing
13	SE 132nd bridge crossing to Kelley Cr. tributary junction
14	Kelley Cr. tributary junction to SE 190th bridge crossing
15	SE 190th bridge crossing to Main City Park in Gresham
16	Main City Park in Gresham to Palmblad Road bridge crossing
17	Palmblad Road bridge crossing to Sunshine Cr. (known to locals as "McDonald Creek")
18	Sunshine Cr. or "McDonald Cr." to U.S. Hwy 26
19	US Hwy 26 to SE Stone Road crossing
20	SE Stone Road crossing to first tributary junction east of SE Orient Dr.
21	First tributary junction east of SE Orient Dr. to second tributary junction east of SE Altman Road
22	Second tributary junction east of SE Altman Road to last marked tributary junction on USGS topo map
23	Last marked tributary junction on USGS topo map to where creek disappears into a culvert draining cornfields.

Figure 4. Johnson Creek Subwatersheds and ODFW Stream Reaches



2.7 Flow and Hydrology

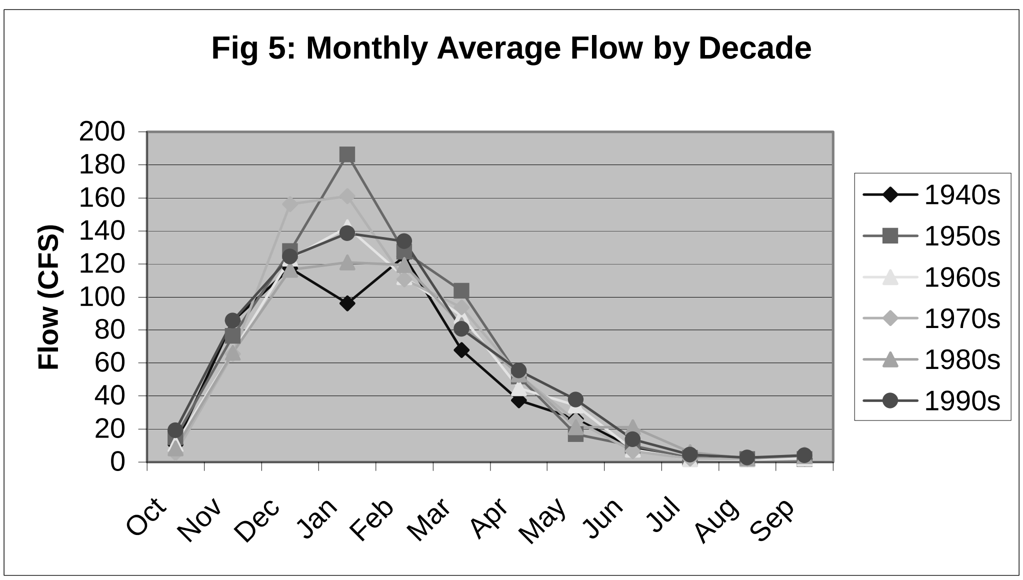
2.7.1 Gradient

Johnson Creek is a low gradient stream that drops approximately 700 feet over its course. The average gradient along the mainstem is 0.5 percent. The steeper upper section with a gradient of 0.8 percent begins in the headwaters and extends down to about 5.5 miles to Regner Road in Gresham. The middle section is extremely flat and takes on a slough-like character with an average gradient of 0.4 percent (McConnaha, 2002). Beginning about at SE 82nd Avenue, Johnson Creek begins to cut its way down to the Willamette River with a correspondingly higher gradient than the middle section.

2.7.2 Flow

Land uses, piping of flow, and the addition of impervious surfaces highly impact flow patterns in the watershed. A 1984 study of the effects of development and resultant impervious surfaces on peak flows in Johnson Creek (Clement, 1984) concluded that for a storm of a given size the peak flow under 1980's conditions was 30 percent greater than under 1940's conditions. However, peak flow frequency at the Sycamore streamflow gauge (River Mile 10.2) shows no discernable upward trend over the last 60 years (ODFW Stream Reach 13).

General hydrologic patterns in Johnson Creek are driven by patterns of rainfall and groundwater inflow. High flows normally occur in December, January, and February in response to abundant rainfall and high amounts of runoff as soils become saturated through the rainy season. Summer low flows in July, August and September reflect minimal groundwater contributions to streamflow throughout the watershed (Figure 5).



Average monthly flow for the period of record at the Sycamore flow gauge (1940-2000). There does not appear to be any obvious pattern of increasing high flows over time in the decadal averages. This is consistent with Clark (1999), who found increasing "flashiness", but no significant increase in peak flows.

During the 1995 and 1996 Water Years the USGS has reported that Johnson Creek at Sycamore (station 14211500), had one of the lowest percent-base-flow components of streamflow (47 to 52 percent) compared to more than 50 other streamflow gaging stations throughout the Willamette basin. This was thought to be attributable to rapid runoff from urban areas of the basin and lack of infiltration of precipitation into the groundwater system due to extensive impervious land cover (USGS, 2002).

There is also evidence of adverse impacts from excessive peak flows. The Sycamore gage provides the longest period of record with which to evaluate changes in flow over time due to human activities. Statistical evaluation of flow since 1940 indicates some increase in the flashiness of peak flows over the period of record (Clark 1999). Since much of the intensive rural and urban development upstream of the Sycamore gage occurred after the gage was installed, the gage data provides some indication that increased flashiness may be related to increased development. However, the range of variables (including soil type, slope, other geological factors, and watershed characteristics and conditions) makes it impossible to establish a direct cause and effect relationship. Significant impacts on peak flows in Johnson Creek also appear to be affected by alterations in the stream channel and floodplain that change the way floods flow through Johnson Creek (Portland ESA, 2002).

2.7.3 Flooding

The flow of Johnson Creek is primarily precipitation fed with peak flows typically in December through February and low flow in late summer and early fall. The U.S. Geological Survey (USGS) operates four gaging stations throughout the Johnson Creek watershed. In addition, the Oregon Department of Water Resources Department operates a gaging station in Crystal Springs Creek. A summary of these gaging stations is listed in Table 3.

Table 3. USGS Gaging Stations within the Johnson Creek Drainage Basin

USGS Gage Number/Location	River Mile	Drainage Area (mi.^{2})	Period of Record	Extremes for Period of Record *
14211400 Johnson Cr. at Regner Road (Gresham)	16.3	17.8	February 1998 to current year	Max.: 629 ft^3/s Feb. 27,28, 1999; gage=8.58 ft. Min.: 0.26 ft^3/s Sep. 27,28, 2000
14211499 Kelley Cr. at SE 159th Dr. (Portland)	At mouth	4.69	March 2000 to current year	Max.: 81 ft^3/s May 10, 2000, Mar. 27, gage=4.34 ft. Min.: 0.03 ft^3/s Sep. 27, 2000
14211500 Johnson Cr. at Sycamore, (Portland), Oregon	10.2	26.5	July 1940 to current year	Max.: 2,620 ft^3/s Dec. 22, 1964; gage=14.68 ft. and 2,350 ft^3/s Feb. 7, 1996; gage= 14.28 ft. Min.: 0.08 ft^3/s Aug. 21, 1966
14211546 Crystal Springs Creek at Clatsop St. (Portland)	At mouth	**???**	Periodic measurements during late 1980's and 1998-2000	Average flows approx. 10-14 cfs prior to 1997 and 17-20 cfs 1997-1998. Higher flows thought to be caused by higher than normal precipitation and subsequent elevated groundwater discharges (Adolfson, 2001).
14211550 Johnson Cr. at Milwaukie, Oregon	0.7	51.8	April 1989 to current year	Max.: 2,170 ft^3/s Feb. 8, 1996; gage=30.27 ft. Min.: 10 ft^3/s July 1, and 3-5, 1994

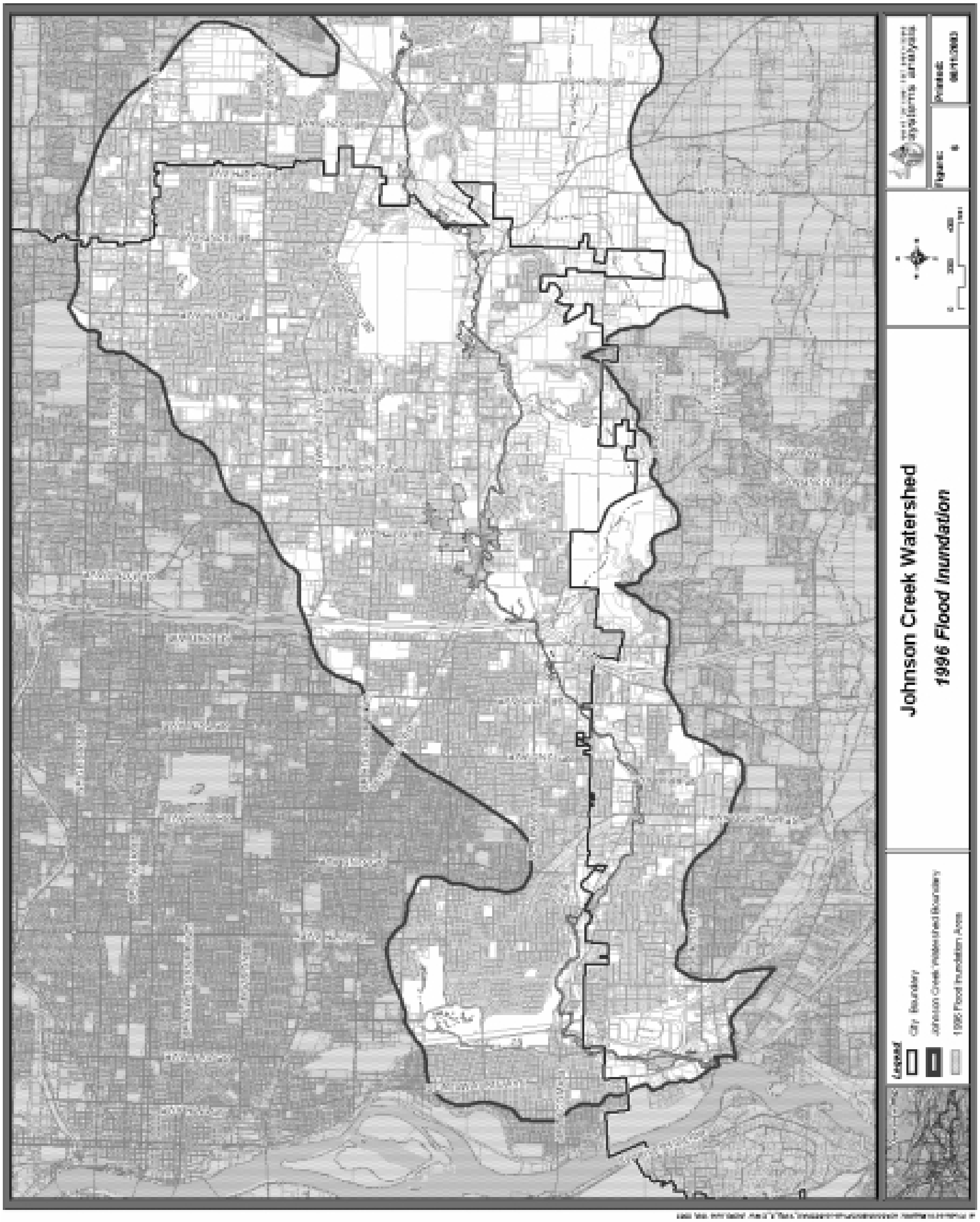
***** Does not include peak flows recorded during January 2003.

The long-term average streamflow at the Sycamore gaging station is 54 cubic feet per second (cfs) (USGS and McConnaha, 2002). Maximum flows usually are recorded in December or January. Minimum flows occur usually in August or September. Bankfull discharges at the Sycamore gage are around 867 cfs and occur about 3 times each year. Flood stage is reached at a flow of around 1,080-cfs, which occurs on average about 1.8 times each year. Major floods correspond to flows of 1,650 cfs, which has occurred about once every 3-4 years. The streamflow gage at Milport Road (Milwaukie) and its associated drainage area is almost twice as large as the drainage area of the Sycamore gage. Yet, the total annual runoff at the Milwaukie gage is only about 45 percent higher than runoff at the Sycamore gage. This supports the conclusion that the upper watershed (located upstream of the Sycamore gage) is contributing a much greater stream flow than is proportionate to its size (Portland ESA, 2000).

Flooding events primarily affect four areas within Portland: 1) Tideman-Johnson Park at SE 45th; 2) the area west of SE 82nd; 3) the Lents area, and 4) lower Powell Butte. Due to its low gradient most flooding takes place in the middle section of the creek where floodwaters tend to spread out (McConnaha 2002). Lents is by far the largest area affected, flooding approximately 10-20 acres on average once every other year. Designated as a Flood Risk area by the City of Portland, this area has stricter development codes. Based on past history, the Lents area faces a high risk each winter that Johnson Creek will overflow its banks and flood nearby community roads and properties. Since 1941, there have been 37 out-of-bank flood events, 28 of which have resulted in property damage. Twenty-one of these events were considered "nuisance events" (a 10-year flood or less) (Lents Technical Memorandum, Portland BES, 2002). Frequently flooded areas in Lents include: 1) along Johnson Creek from 117th to 101st; 2) Foster Road between 111th and 101st; 3) Springwater Trail from 111th to Foster Road; and 4) Beggar's Tick Marsh associated marshlands.

Several of the largest flooding events in gaged history for Johnson Creek occurred during the 1990s (Portland ESA, 2000). Since 1978, 156 flood insurance claims have been paid, totaling approximately $2,015,300 (FEMA estimate 1997). Areas of inundation for the February 1994 and 1996, and November 1996 flood events have been mapped and identified (Portland Bureau of Planning, 2001). It is important to note that mapped flooded areas can range in accuracy depending on the data and methodology used. See map of 1996 flood inundation areas in Figure 6.

While most of the watershed and its tributaries are fed primarily by precipitation (average annual varies from 40 inches near the mouth to over 70 inches in the upper watershed), and surface water, some areas are controlled primarily by groundwater processes. Crystal Springs is the largest springs in the Portland Basin, with a total discharge of more than 5,000 gallons per minute (McFarland and Morgan, USGS, 1996). Crystal Springs Creek flooded during the summer of 1997 due to high ground water levels. It was the first recorded flooding and was attributed to three consecutive record precipitation years (Portland ESA, 2000). Holgate Lake, formed by the local water table, is located near the intersection of Holgate Boulevard and Southeast 136th Ave. The lake is located on private property. Elevated water levels in this area have caused flooding in the surrounding area, including damage to residences south and west of the lake. The latest episode of flooding occurred in the spring of 1999.


Johnson Creek Watershed
1996 Flood Inundation
Legend
City Boundary
Johnson Creek Watershed Boundary
1996 Flood Inundation Area

2.7.4 Baseflows

Flow monitoring in Johnson Creek indicates that low flow conditions in Johnson Creek may adversely impact aquatic life. ODFW has set minimum flow targets to protect salmonids in Johnson Creek (Meross 2000). Flows in the middle and upper watershed frequently do not meet those minimum flows, particularly in spring and summer months. Below Crystal Springs, which provides consistent and abundant groundwater flows, minimum instream flows are typically met.

Johnson Creek suffers from a lack of base flows during the late spring/early summer through early fall season. Some of the tributaries dry up during the summer periods and the velocity and volume of base flows in the main stem of Johnson Creek become minimal. A lack of minimum stream flows can contribute to reduced habitat and degraded conditions in terms of properly functioning conditions for aquatic species. Springs and groundwater are significant assets to many watersheds including Johnson Creek, providing maintenance of summer time flows, cool clear water, and refuge areas for many aquatic species. Springs are major contributors to the Crystal Springs Creek and Errol Creek tributaries, and springs also contribute significantly to base flows in Johnson Creek within Reach 5 (near Tideman Johnson Park), and Minthorn Spring to Reach 1.

The Portland ESA Program assessed baseline conditions for flow and hydrology indicators in Johnson Creek (see Table 4). These indicators and their assessed base line condition compared to properly functioning conditions were incorporated into an Ecosystem Diagnosis & Treatment (EDT) Model. See Watershed Problems and Opportunities in Chapter 2 for discussion of this model and results of selected indicator attributes and their protection and restoration values. Additional baseline data graphs from the Portland ESA program are provided in Appendix E.

Table 4. Flow and Hydrology Indicators within the Johnson Creek Watershed

Indicator	Baseline Condition	Key Function	Key Process or (Source)	Effect	Notes
Hydrograph	Not Properly Functioning	A stream's hydrograph characterizes the frequency, magnitude, and duration of flow. The hydrograph plays a key role in stream formation processes and characteristics.	An altered hydrograph can result from climate change and human development activities including a loss of vegetation in a watershed and increased impervious surfaces.	Altered hydrographs can result in stream scour and bank erosion. Altered hydrographs are also characteristic of changes in the magnitude, frequency, and duration of both peak and base flows.	*Peak Flow*: Statistical evaluation of flow since 1940 indicates that Johnson Creek has become "flashier" over time. While increases in absolute peak flows are not evident, the amount of rainfall needed to produce a peak flow had decreased over time (Clark, 1999). *Base Flow*: Low flow conditions in Johnson Creek may adversely impact salmonids: Flows in the middle and upper watershed frequently do not meet minimum flows, particularly in spring and summer months.
Impervious Surfaces	At Risk	The amount of effective impervious surface within a watershed has been generally shown to be negatively correlated with overall watershed health. Impervious surface reduces opportunities for stormwater infiltration. Collects pollutants.	Impervious surfaces include roads, buildings, parking lots, and other compacted surfaces that result from urbanization.	Impervious surfaces reduce groundwater recharge resulting in low summer flows. Increased stormwater runoff erodes banks and incises channels. Polluted runoff impairs aquatic organisms and reduces species richness and diversity. Water flows through system faster.	The City of Portland is in the process of obtaining estimates of impervious surfaces in the upper watershed. In the middle and lower watershed, smaller tributaries are at or above threshold values of 10-15 percent effective impervious area. The mainstem may have relatively low values when compared to other urban streams because of low levels of imperviousness in the upper watershed and diversion (CSO) of impervious areas in the most densely urbanized sections.
Hydrologic Sources	Not Properly Functioning	Springs, seeps, wetlands, floodplains supply water to streams. Provide cold water sources. Forests and uncompacted soils hold water and maintain streamflows.	Groundwater baseflow Springs, seeps in terraces and banks Off-channel wetlands Forests, intact topsoil	Loss of hydrologic sources results in low summer flows, higher stream temperatures, and water quality problems. Fish barriers	Thirty-eight percent of the former drainage network of the watershed has been artificially routed or diverted (piped, sumped, or diverted to the CSO), although only 8 percent of this flow has been piped away. Crystal Springs provides consistent and abundant inflows of groundwater, supplementing insufficient baseflows in the lower mainstem. Changes in groundwater dynamics through the rest of the watershed are unknown.

Indicator	Baseline Condition	Key Function	Key Process or (Source)	Effect	Notes
Floodplain Presence and Connectivity	Not Properly Functioning	Floodplains allow interaction with the stream channel, lateral channel movement, storage of floodwaters providing attenuation, and reduction in downstream flooding. Provide room for dynamic channel movement and water storage areas, and off-channel wetlands. Floodplains also provide habitat connectivity, refugia, sediment transport and storage, organic inputs and nutrient cycling.	Floodplains develop from an interaction of geology, hydrology, climate, and geomorphic processes.	The lack of floodplains and connectivity concentrates water into the main channel, increasing scour and degrading instream habitat. Water flushes through system faster.	Due to channel alterations, the historical floodplain of Johnson Creek is minimally accessible or inaccessible through much of its length.

Source: Portland ESA Program and modified by Adolfson.

2.8 Physical Habitats within the Johnson Creek Watershed

The Johnson Creek watershed contains a mosaic of vegetation types, including agricultural lands, urban and suburban landscapes, upland forests, riparian woodlands, and wetlands. Remnants of predevelopment vegetation are rare, as a result of extensive logging and clearing (Portland Bureau of Planning, 2001). The following is a summary of the various habitats (upland, wetland, riparian, and instream physical) that make up the Johnson Creek watershed and their baseline conditions.

2.8.1 Upland Habitat

The forest that historically covered the Johnson Creek watershed ridges and lowlands was mostly cleared in the early 1900s for agriculture, timber production, and urban uses. In the mid and late 20th century some areas such as the buttes and ridges in the south central and eastern part of the basin were left to regenerate into a second growth forest. Forest clearing of second growth has increased dramatically in recent years as housing development expanded from the lowlands onto the ridges and hillside slopes. Presently, about 57 percent of the watershed is vegetated including all types such as, but not limited to, grass, trees, or blackberries (Portland Bureau of Development Services, 2003).

The Johnson Creek watershed straddles the border between the Willamette Valley vegetation zone and the Western Hemlock zone (Franklin and Dyrness). The upland forest community exhibits characteristics common to both of these zones. The prominent occurrence of western red cedar and the presence of hemlock suggests that the forest is best characterized by the *Thuja plicata/Acer circinatum/Polystichum munitum* (red cedar/vine maple/sword fern) community of the Western Hemlock zone. The Willamette Valley *Pseudotsuga menziesii/Acer circinatum/ Polystichum munitum* (Douglas fir/vine maple/sword fern) community is similar though cedars are less common associates. Both of these communities frequently occur on north slopes such as those that make up the Boring Lava Domes and other buttes. The Boring Lava Domes area is more heavily forested than most of the watershed. The Lava Domes forest generally ranges from 40 to 100-year old second growth stands in a mid-successional stage referred to as *conifer topping hardwood*. Certain areas in the watershed, however, contain much older forest stands with tree diameters reaching five feet or more (Portland Bureau of Planning, 1998).

Upland forests in the watershed are typically comprised of a mixed conifer/deciduous forest with western red cedar (*Thuja plicata*), bigleaf maple (*Acer macrophyllum*) and Douglas fir (*Pseudotsuga menziesii*) frequently occurring as dominant tree species. Other occasional dominant trees include red alder (*Alnus rubra*), western hemlock (*Tsuga heterophylla*) and black cottonwood (*Populus trichocarpa*). Dominant shrubs in the forest community include vine maple (*Acer circinatum*), western hazel (*Corylus cornuta*), Indian plum (*Oemleria cerasiformis*) and snowberry (*Symphoricarpos albus*). Common herbaceous plants include western sword fern (*Polystichum munitum*), Oregon grape (*Mahonia sp.*), and fringecup (*Tellima grandiflora*).

Johnson Creek acts as a wildlife corridor for the passage of species not normally observed in large cities, including deer, coyote, bear, cougar, and many woodland and meadow birds (Portland Bureau of Planning, 1998). Pileated woodpeckers have been observed in the Boring Lava Domes forests.

2.8.2 Wetlands

Over time, development and associated changes to the landscape has highly impacted wetlands within the Johnson Creek Watershed. No accurate estimate of the total acreage of wetlands prior to European settlement exists but there has been a substantial reduction. The remaining wetlands are extremely diverse in nature, and include forested, scrub-shrub, emergent, wet meadows, and open water (aquatic) vegetation types. Wetlands within the watershed range in size from the 19-acre Beggars Tick marsh in the Lents area, to numerous diminutive emergent wetlands in the basin of less than a tenth of an acre (Adolfson, 2000).

Forested wetlands within the Johnson Creek watershed are dominated by western red cedar (*Thuja plicata*), Oregon ash (*Fraxinus latifolia*), Pacific willow (*Salix lasiandra*), or red alder (*Alnus rubra*). Scrub-shrub wetlands within the watershed are dominated by Pacific willow, Piper's willow (*Salix hookeriana*), or hardhack (*Spiraea douglasii*). Emergent wetlands within the watershed are dominated by common cattail (*Typha latifolia*), colonial bentgrass (*Agrostis capillaris*), reed canarygrass (*Phalaris arundinaceae*), stinging nettle (*Urica dioica*), jewelweed (*Impatiens noli-tangere*), creeping spike-rush (*Eleocharis palustris*), common rush (*Juncus effusus*), or slough sedge (*Carex obnupta*). Wet meadows within the watershed were dominated by common rush, creeping spike-rush, dagger-leaved rush (*Juncus endifolius*), reed canarygrass, or meadow foxtail (*Alopecurus pratensis*).

Several of the larger wetlands within the watershed contain intact native vegetation and have moderately mature, mid – to late successional vegetative communities. However, many of the wetlands in the watershed have non-native and invasive plant species that dominate most or all of the wetland. Human-made wetlands include shallow drainage channels and excavated ponds of various sizes (Adolfson, 2000). Spring-fed wetlands are commonly associated with the numerous terraces found throughout the watershed but particularly along Crystal Springs Creek.

Two major groups of wetlands exist within the watershed: The first group of wetlands are those associated directly with the hydrology of Johnson Creek and its tributaries. These wetlands tend to be located within the 100-year floodplain and often in very close proximity to the creek or tributary channels. These wetlands are often cut-off meanders from the creek, terraced wetlands, or lowlands that receive overland flows from the creek and are fed by shallow sub-surface flows or groundwater. The second major group of wetlands are small hydrologic systems in and of themselves that either drain into Johnson Creek directly or contribute to the creeks' annual flow through groundwater recharge. These wetlands are found in Errol Heights, Beggars Tick marsh area in Lents, and the Saddle area in Pleasant Valley. These systems function more or less independently of Johnson Creek, and contain spring and seep-fed hydrology, which tends to create high quality aquatic ecosystem. The springs and wetland in Errol Heights, in particular, are directly connected to the hydrology of Johnson Creek, providing overland drainage directly to the creek.

Many wetlands in the basin have good connectivity with undeveloped open space, upland habitats, and the Johnson Creek riparian corridor. Several significant areas of wildlife breeding and nesting are found in wetlands within the basin with dense breeding populations of amphibians, including red-legged frogs (Adolfson, 2000).

2.8.3 Riparian Areas

The riparian corridor along Johnson Creek and its tributaries varies in width, from extensive vegetated areas over 600 feet in width to reaches with little or no vegetation along the bank. The most extensive vegetated riparian areas in the drainage basin are in smaller headwater creeks in the Boring Hills south of Powell Butte on either side of the Gresham/Portland urban services boundary (Portland Bureau of Planning, 2001). On the mainstem, reaches 12 and 16 and parts of 13 and 14 have the largest forested riparian areas. In Gresham, the most extensive and intact riparian area is located upstream of Regner Road (McMonnaha 2002). The tributaries with the most heavily forested riparian areas are Mitchell, Badger, Sunshine, and Deardorf/Wahoo Creeks. Crystal Springs and the lower reaches of Johnson Creek (near the Milwaukie/Portland boundary) have the least extensive riparian vegetation. The Boring Lava Domes area is more heavily forested than most of the rest of the watershed. By comparison, the headwater streams flowing through rural and agricultural lands in the upper watershed have very little riparian vegetation.

Riparian areas within the Johnson Creek watershed consist primarily of mixed forest with some coniferous forest and shrub areas. Forested riparian areas within the watershed include Douglas fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), black cottonwood (*Populus balsamifera trichocarpa*), and red alder (*Alnus rubra*) as dominant tree species. Other common tree species within the watershed include Oregon ash (*Fraxinus latifolia*), big-leaf maple (*Acer macrophyllum*), and Pacific willow (*Salix lasiandra*). Shrub habitats within the watershed include Himalayan blackberry (*Rubus discolor*), red-osier dogwood (*Cornus sericea*), hardhack (*Spiraea douglasii*), red elderberry (*Sambucus racemosa*) and salmonberry (*Rubus spectabilis*).

Sensitive species known to occur in the riparian areas of Johnson Creek include three salamander species (long-toed, northwestern, and Columbia), two frog species, and one toad species. Painted turtles have been identified in the upper watershed (east of 162nd Avenue) (Adolfson, 2000).

Riparian vegetation is either narrow, minimal or lacking throughout much of the watershed. Interestingly, riparian vegetation is as lacking in the upper watershed as it is in the lower watershed. Generally, existing riparian vegetation consists of areas dominated by blackberry or young native plants and lacks large mature trees. However, vegetation quality is improving as cities, other local agencies, and citizen groups have ramped up efforts to remove invasive and non-native plants and replant natives and as vegetation begins to grow and create more canopy closure. The highest quality riparian vegetation is found within Reach 16, in Gresham upstream of Regner Road (McConnaha 2002). In fact, the largest amount of intact riparian vegetation throughout the Johnson Creek drainage basin is found in the City of Gresham. The ODFW 2000 report noted the following comments concerning Reach 16: “Reach 16 is dominated by mixed coniferous and deciduous trees with a dbh of 50-90 cm, with few larger trees, and unlike the previous downstream reaches, this riparian zone exhibited favorable characteristics continually throughout the reach.” The riparian findings of the ODFW assessments are summarized in table format in the Action Plan in Appendix B.

2.8.4 Instream Habitat

The channelization of Johnson Creek has had a significant impact on the quality of instream physical habitat. Because the historical floodplain of Johnson Creek is disconnected or minimally connected through much of its length flood flows cannot spread out and attenuate on the floodplain. Rather they are directed and concentrated into the main channel, increasing scour and degrading instream habitat. In addition, disconnection and fill in the floodplain has eliminated off channel habitat along the mainstem. With the exception of the Brookside constructed wetland off-channel habitat is extremely rare in Johnson Creek (McConnaha 2002).

The ODFW findings generally indicate that Johnson Creek has extremely low wood volumes in stream, particularly large wood that is necessary for pool formation. This is due to the lack of large, mature riparian trees and active removal of woody debris from the creek by citizens and officials from city agencies trying to prevent obstruction of flows downstream (McConnaha 2002). ODFW also found a high percentage of hardened banks, lack of refugia through many reaches, channel incision, and high levels of fine sediment. The ODFW report found Reach 16 to have the highest quality instream channel habitat structure with the following description:

> *Multiple channel units with good complexity occur upstream of Regner Road, and downstream of Hogan Road. The complexity at Hogan Road is very diverse, and has many large woody debris jams associated with deep pools and multiple channels. Reach 16 contains the greatest refuge potential that we found within the main stem survey. This is due to the presence of large woody debris, backwaters, deep pools, and shade cover. Reach 16 is the most natural and the least disturbed setting found on Johnson Creek in the 1999 survey.*

ODFW also found that glides, which are generally uncommon in natural, healthy creeks, are widespread throughout the creek. This is an indication of the quality of instream habitat and is likely due to the deficiency of instream wood, a key element in breaking glides into pools and riffles. Existing pools and riffles are created not by woody debris but by existing geomorphic features that have evolved as energy is dispersed along the stream course (McConnaha 2002).

Habitat assessment of Kelley Creek reveals that there are a few small sections of higher quality habitat, while much of the creek is impacted or degraded. Most impacts are due to the lack of high quality riparian habitat and large quantity of stormwater draining to the creek as a result of tiling and other agricultural practices (ODFW 2000, BES 2001). Crystal Springs habitat is degraded as well. Much of the creek has been channelized and lacks healthy riparian buffers. The instream habitat findings of the ODFW assessments are summarized in table format in the Action Plan in Appendix B.

The Portland ESA Program assessed baseline conditions for habitat indicators in Johnson Creek (See Table 5). These indicators and their assessed base line condition compared to properly functioning conditions were incorporated into an Ecosystem Diagnosis & Treatment (EDT) Model. See Watershed Problems and Opportunities in Chapter 2 for discussion of this model and results of selected indicator attributes and their protection and restoration values.

Table 5. Habitat Indicators in the Johnson Creek Watershed

Indicator	Baseline Condition	Key Function	Key Process	Effect	Notes
Floodplain Quality	Not Properly Functioning	High-quality floodplains provide diverse habitats for salmonids and other species	Geology, hydrology, climate, and geomorphic processes create floodplains	Loss of high quality floodplains reduces habitat complexity and off-channel habitat.	In many places throughout the watershed, development has occurred within the floodplain, degrading the amount and quality of floodplain available.
Riparian Integrity: Width; Composition; and Fragmentation	Not Properly Functioning	Riparian areas provide channel compensation and dynamics, structural complexity and habitat connectivity. Riparian integrity also contributes to shading and microclimate regulation, organic matter, temperature regulation, pollution and sediment control, bank stabilization, habitat for terrestrial species, and buffer from human activity	Riparian composition and width depends on disturbance regimes, soil, geology, and hydrology. Many riparian plants are adapted to fluctuating water levels. Important to have a variety of vegetation classes and ages to create microhabitats, refugia, and diversity. Provides a variety of nutrient inputs at different times of the year.	Narrow, non-native, and fragmented riparian areas result in higher summer temperatures, increased sediment and run-off, decreased colonization of native trees and shrubs, and reduced organic inputs.	*Width*: 34 percent of the watershed has little or no riparian vegetation present; an additional 32 percent has riparian vegetation less than 100 ft. wide. *Composition*: Important data gap. What little information exists on composition is being evaluated. *Fragmentation*: The riparian corridors within Johnson Creek are highly fragmented by frequent road crossings.
Bank Condition	Criteria not developed yet.	Stable banks contain streamflow and withstand erosive forces. Vegetation plays role in bank integrity, formation of streambanks and gravel bars and promotes development and maintenance of undercut banks.	Roots of riparian vegetation secure banks and facilitate bank building by trapping sediments.	Unstable banks erode easily degrading instream habitat. Armored banks prevent establishment of vegetation, simplify habitat, and prevent exchange with groundwater.	There are extensive amounts of WPA bank hardening throughout the lower and middle mainstem. Overall, approx. 18 percent of the watershed is artificially hardened. Crystal Springs has the highest percentage of hardened banks (50 percent).

Indicator	Baseline Condition	Key Function	Key Process	Effect	Notes
Channel Substrate: Fine and Coarse Sediments	Not Properly Functioning	Salmonids require a balance of substrate types to complete their life cycle. Availability and size can impact viability of aquatic species.	Channel substrate is influenced by geology, hydrology, geomorphic processes and input from upstream reaches. A mix of gravel and rubble size can affect invertebrates.	Excess fines imbed and cover gravels/cobbles required for spawning and limit food production. Fine sediments can affect behavior and cause stress in aquatic species.	*Fines*: Twenty percent of the riffles throughout the watershed have percent fines > 11; riffles in Church (100 percent), Mitchell (66 percent), and Clatsop (61 percent) – all tributaries to Kelley Cr. frequently exceed that benchmark. *Coarse*: The Johnson Cr. mainstem and Kelley Cr. and its tributaries have inadequate levels of riffle gravels.
Depth Refugia	At Risk	Pools with varying depths provide refuge from high-flow areas and niches for numerous species. Pools also are important for channel composition and dynamics and contribute to structural complexity.	Pools are created from streamflow diversions such as logs or debris.	Low numbers and quality of pools may negatively affect the life cycle of salmonids and other fish and aquatic species.	Pools are relatively abundant and well dispersed throughout the watershed. Pool quality, however, as measured by residual pool depth and the number of complex pools is fair or poor throughout much of the watershed.
Off-Channel Habitat	Not Properly Functioning	Off-channel habitats provide connections to streams and interaction with the floodplain. Provides rearing, feeding, and spawning habitat for many aquatic species. Off-channel habitat also provides important refugia from disturbances such as high flows and sediment loading.	Off-channel habitat is created from lateral channel movement and overflows during flooding events.	Lack of off-channel habitat results in larger, downstream flood peaks, reduces refugia, and simplifies in-stream habitat.	Side channels, alcoves, and backwater areas are present in some reaches of Johnson Cr., but extensive bank hardening and channel alterations have greatly reduced the number, quality, and accessibility of off-channel habitats. Crystal Springs and Kelley Cr. provide much of the remaining off-channel habitat.

Indicator	Baseline Condition	Key Function	Key Process	Effect	Notes
Large Wood (LW)	Not Properly Functioning	LW influences channel dynamics by diverting flow, creating channel roughness, and stabilizing banks. LW also retains smaller debris and promotes the formation and maintenance of side channels, pools, and lower velocities. LW provides habitat and refugia for salmon and invertebrates.	LW enters the stream from adjacent riparian areas and modifies the channel resulting in pools, riffles, low velocity areas, and side channels	Lack of LW simplifies channel habitat and reduces fish refugia required for rearing or feeding.	Wood volume is extremely low throughout Johnson Cr.
Shoreline Complexity	Not Properly Functioning	Complex shorelines provide microhabitats for aquatic organisms including off-channel habitat. May provide important feeding and resting areas.	Shoreline complexity arises through natural stream meander and development of off-channel habitat following flooding events. Also includes large tree roots, and live trees and shrubs.	Lack of shoreline complexity results in low-quality, simplified aquatic habitat.	WPA and other bank hardening channel straightening, and channel maintenance (e.g., removal of large wood) have greatly reduced shoreline complexity.
Harassment (e.g., boat traffic; lights; and noise)	At Risk	The level of harassment is negatively correlated with habitat for many wildlife species.	Harassment within riparian and stream zones results from intense development and uninformed or insensitive human activity	Many aquatic and terrestrial organisms are sensitive to human disturbance. Results include decreased species richness and diversity and polluted habitat from trash / boat fuel.	Commercial, industrial, residential, and recreational uses are located close to the stream in many reaches.
Fish Passage / Access	Not Properly Functioning	Free-flowing, passable streams support larger salmonid populations and healthier resident populations. Access to all parts of the watershed can be critical for certain species during portions of their life cycle.	Culverts and other fish passage barriers arise from road and driveway crossings, dams, utilities, diversion structures, and other development.	Barriers may completely or partially block fish passage to high quality habitat to the detriment of the population. Culverts concentrate stream flow causing erosion or scour. Barriers may impact different life stages.	Some of the highest quality habitats within the watershed (Kelley Cr. upper Crystal Springs, and southern tributaries) have one or more culverts that limit access.

Source: Portland ESA Program and modified by Adolfson.

2.9 Water Quality

Numerous water quality studies have been conducted throughout the Johnson Creek watershed. Unfortunately, many were conducted with objectives other than characterizing the entire Johnson Creek watershed. Other sampling programs were designed to provide site-specific water quality data related to a capital improvement project or were of limited duration. As a result, there is no recent summary characterizing the water quality throughout the entire watershed. A brief summary is provided from recent data collected by local jurisdictions as well as efforts related to DEQ's development of the Total Maximum Daily Load (TMDL) and recent data collected by the USGS.

DEQ rates Johnson Creek water quality as poor. DEQ utilizes the Oregon Water Quality Index (OWQI) to analyze a set of water quality parameters to produce a score describing general water quality. Water quality parameters used in this index include temperature, dissolved oxygen (percent saturation and concentration), biochemical oxygen demand, pH, total solids, ammonia and nitrate nitrogen, total phosphorus, and fecal coliform bacteria. OWQI scores range from 10 (worst case) to 100 (ideal water quality). Table 6 summarizes the seasonal average OWQI results for the Lower Willamette Basin during the 1986 –1995 Water Years.

Table 6. Seasonal Average Oregon Water Quality Index (OWQI) Results for the Lower Willamette Basin (WY 1986-1995)

Site	River Mile	Summer Average	FWS Average	Minimum Seasonal Average
Tualatin River @ Rood Bridge	39	78	66	66
Tualatin River @ Hwy. 210 (Scholls)	26.9	50	48	48
Tualatin River @ Elsner Road	16.2	53	57	53
Tualatin River @ Boones Ferry Road	8.6	37	40	37
Beaverton Creek @ 216th Ave. (Orenco)	0.3	36	59	36
Fanno Creek @ Bonita Road (Tigard)	2.3	55	55	55
Clackamas River @ High Rocks	1.2	87	88	87
Johnson Creek @ SE 17th Avenue	**0.2**	**26**	**30**	**26**
Columbia Slough @ Landfill Road	2.6	30	22	22
Willamette River @ Hawthorne Bridge	13.2	79	74	74
Willamette River @ SP&S RR Bridge	7.0	74	75	74
Swan Island Channel (Willamette River)	0.5	63	77	63

WY = Water Year (October-September)

Summer = June –September FWS = (Fall, Winter, & Spring)

Scores = Very Poor 0-59, Poor 60-79, Fair 80-84, Good 85-89, Excellent 90-100

DEQ has been monitoring Johnson Creek at SE 17th Avenue since 1990. OWQI scores listed in Table 6 reveal that this site scored greater than 30 only twelve percent of the time. All results were in the "very poor" range of OWQI scores. Johnson Creek is impacted by very high concentrations of nitrate-nitrogen and high concentrations of total phosphates, fecal coliform bacteria, total solids, and biochemical oxygen demand also impair water quality at this location. These conditions occur throughout the year. On average, OWQI scores for Johnson Creek are very poor as indicated in the above table. Of all of the DEQ-monitored sites in the Willamette Basin, only the Columbia Slough scores are worse than Johnson Creek in terms of minimum seasonal averages (see DEQ web site at http://www.deq.state.or.us/lab/wqm/wqimain.htm).

2.9.1 Baseline Ambient

The City of Portland has been monitoring Johnson Creek in response to a number of programs and projects. Portland monitored ambient conditions within Johnson Creek at five main stem locations and two tributaries (Crystal Springs and Kelley Creek) during 1996-2000. Generally, the monthly grab samples revealed fair dissolved oxygen concentrations, and high temperatures and *E. coli* bacteria levels, as referenced above. Selected water quality results during the past five years during the summer season (July through October) are presented in a table in the Action Plan in Appendix C.

2.9.2 Storm Event Sampling

Most pollutants are washed off land surfaces and discharged to waterbodies during storm runoff events. Storm event monitoring can provide opportunities to identify nonpoint pollution sources and loadings. The City of Gresham has conducted water quality sampling programs at various locations in Johnson Creek since the early 1990's. During Permit Year 6 of their NPDES Permit, Gresham sampled four locations within Johnson Creek during 2000–2001 at the upstream and approximate downstream jurisdictional boundaries and two intermediate locations near Main City Park. Both routine monthly and storm event monitoring were conducted. Table 7 summarizes results from monitoring Johnson Creek at Palmblad Road (upstream jurisdictional boundary) during four storm events in 2000-2001.

Table 7. Storm Event Sampling Results in Johnson Creek at Palmblad Road (Gresham)

Water Quality Parameter	Maximum value	Mean value (four storms)
Turbidity	544 ntu	399 ntu
Total Suspended Solids	491 mg/L	199 mg/L
Total Phosphorus	930 ug/L	492 ug/L
E.coli bacteria	5,900 cfu/100mL	2,525 cfu/100mL

ntu = nephelometric turbidity unit
ug/L = micrograms per liter
mg/L = milligrams per liter
cfu = colony forming unit

Results from the above storm events reveal extremely poor water quality conditions as compared to "natural" conditions and state and federal standards and recommended guidelines. In fact, the mean values in Table 7 exceed state water quality standards or EPA guidelines ranging from 2.4 to 6.2 times more (EPA, 1999, and 1986; OAR, 1992). The maximum value for E.coli bacteria listed in Table 7 (5,900 cfu/100mL) is more than 14 times the state water quality standard of 406. Also, the desired phosphorus goal for the prevention of plant nuisances in streams is 100 µg/L (EPA, 1986). Finally, in a study downstream from the discharge of a rock quarry where inert suspended solids were increased to 80 mg/L, the density of macroinvertebrates decreased by 60 percent while in areas of sediment accumulation, benthic macroinvertebrate populations also decreased by 60 percent regardless of the suspended solids concentration (Gammon, 1970).

2.9.3 Dissolved Oxygen (DO)

While some studies reveal that oxygen levels in Johnson Creek do not generally fall below water quality standards, levels do decrease in the middle, flat section of the creek, possibly a result of the addition of oxygen depleted groundwater into the area. The City of Portland's Ambient Monitoring Program sampling during July though October, 1998-2002, revealed minimum DO values ranging from 5.5 to 9.8 mg/L with a mean value of 7.84 mg/L. A number of these values do not meet the state standard of 11.0 mg/l for spawning periods and 8.0 mg/L all the rest of the time. (See City of Portland Ambient Monitoring Results summary and DEQ Dissolved Oxygen and Intergravel D.O. Criteria DEQ Table 21 in Appendix C.)

2.9.4 Nutrients and Eutrophication

A number of studies of nutrient levels in Johnson Creek show high levels of phosphorus (P) and nitrogen (N) at various locations. Nitrate levels were found to increase downstream and particularly where there is low flow. Nitrate levels are also high in Crystal Springs, likely a result of leaching from septic tanks and input from the duck pond in Westmoreland Park (McConnaha 2002).

A 2002 study of the sources and hydrologic pathways of nutrients in an urbanizing landscape and their relative nutrient contributions to Johnson Creek revealed that Total Phosphorus (TP) concentrations did not vary significantly between urban and non-urban areas for the entire study period or during the wet season. This is thought to be the result of the continuous input of particulate P that is an unreactive form and transported by surface runoff from both urban and agricultural areas within the watershed (Heathwaite and Johnes, 1996). Other sampling results of this study found that surface and near-stream shallow groundwater have significantly higher phosphorus concentrations within urban areas, while stream water and near-stream groundwater nitrogen concentrations were higher in non-urban areas. Johnson Creek surface water had almost twice as much N than near-stream groundwater. These results indicate that Johnson Creek receives significant input of N to the stream from surface sources. Significantly higher stream water N levels were correlated with non-urban landuse areas, while elevated levels of P were highly correlated with urban land use.

2.9.5 Sediment and Turbidity

Turbidity has been monitored during both high and low flow conditions in Johnson Creek. Relatively high turbidity levels were measured during both high and low flow conditions, and are most likely a result of bank erosion, roadside ditch erosion, runoff from construction activities, and runoff from agricultural and nursery operations. Turbidity levels are high in the upper portions of the watershed indicating that sedimentation begins and sources are most likely originating in the upper watershed. See stormwater discussion below for more details on high turbidity and total suspended solids data in the upper Johnson Creek watershed area.

2.9.6 Metals

Johnson Creek has elevated levels of many metals and is classified as a "waterbody of concern" by the Oregon Department of Environmental Quality due to elevated levels of copper, chromium and nickel in water and sediments. Higher levels of copper and zinc are found when flows are high, most likely a result of runoff into the creek. Generally, metal concentrations increase downstream. When flows are high Johnson Creek may also be a source for chromium, copper, mercury and zinc in the Willamette River (McConnaha 2002).

2.9.7 Temperature, Toxics, Bacteria and 303(d) List

In general, water quality in Johnson Creek is considered poor. During 1998, Johnson Creek was placed on the 303(d) list by DEQ for summer temperature, bacteria, and toxics (DDT and Dieldrin). Temperature was listed, although data collected was obtained during a drought year. Temperature was de-listed during 2002, however, due to numerous data results showing temperature problems throughout the watershed, DEQ is currently moving forward with development of a Total Maximum Daily Load (TMDL) for temperature (Geist, 2003). In addition, DEQ added PCBs, and PAHs to the 2002 303(d) list. The 303 (d) listing includes the entire stream, from the mouth to headwaters.

Temperature

The numerous investigations of temperature in Johnson Creek over the years have consistently indicated that elevated temperatures are a problem throughout the watershed. Elevated temperatures, with some potential contribution from elevated nutrients, result in dissolved oxygen concentrations that frequently drop below guidelines in the summer.

While there is not a long-term temperature record for Johnson Creek the USGS has collected temperature records from 6 stations since 1998 (3 along mainstem, 2 in Crystal Springs and 1 in Kelley Creek). The existing data provides a good understanding of seasonal temperature patterns and dynamics. From an analysis of one year of data it appears that there are more total days with maximum temperature above 20 degrees when moving downstream. Kelley Creek had the fewest days above 20 degrees C (McConnaha 2002).

The City of Portland's Ambient Monitoring Program found that over a 4-year period, mean maximum summertime temperatures in Johnson Creek exceeded state standards (See City of Portland Ambient Monitoring Results summary table in the Action Plan in Appendix C.) For the Willamette Basin for which salmonid fish rearing is a designated beneficial use this standard is 17.8 degrees C. Data collected by BES as well as DEQ indicate that water temperatures in Johnson Creek peak between River Miles 5 and 6.5 – approximately 60th Avenue upstream to I-205 (Geist, 2003). (See City of Portland Ambient Monitoring Results summary table in the Action Plan in Appendix C.)

Although it is fed by cool groundwater springs, Crystal Springs Creek has warmer summer and wintertime temperatures than Johnson Creek and may present a source of high summer water temperatures in lower Johnson Creek. This may be attributed to solar warming in ponds along the creek located at Reed College, the Rhododendron Gardens, Eastmoreland Golf Course and Westmoreland Park (McConnaha 2002).

Bacteria

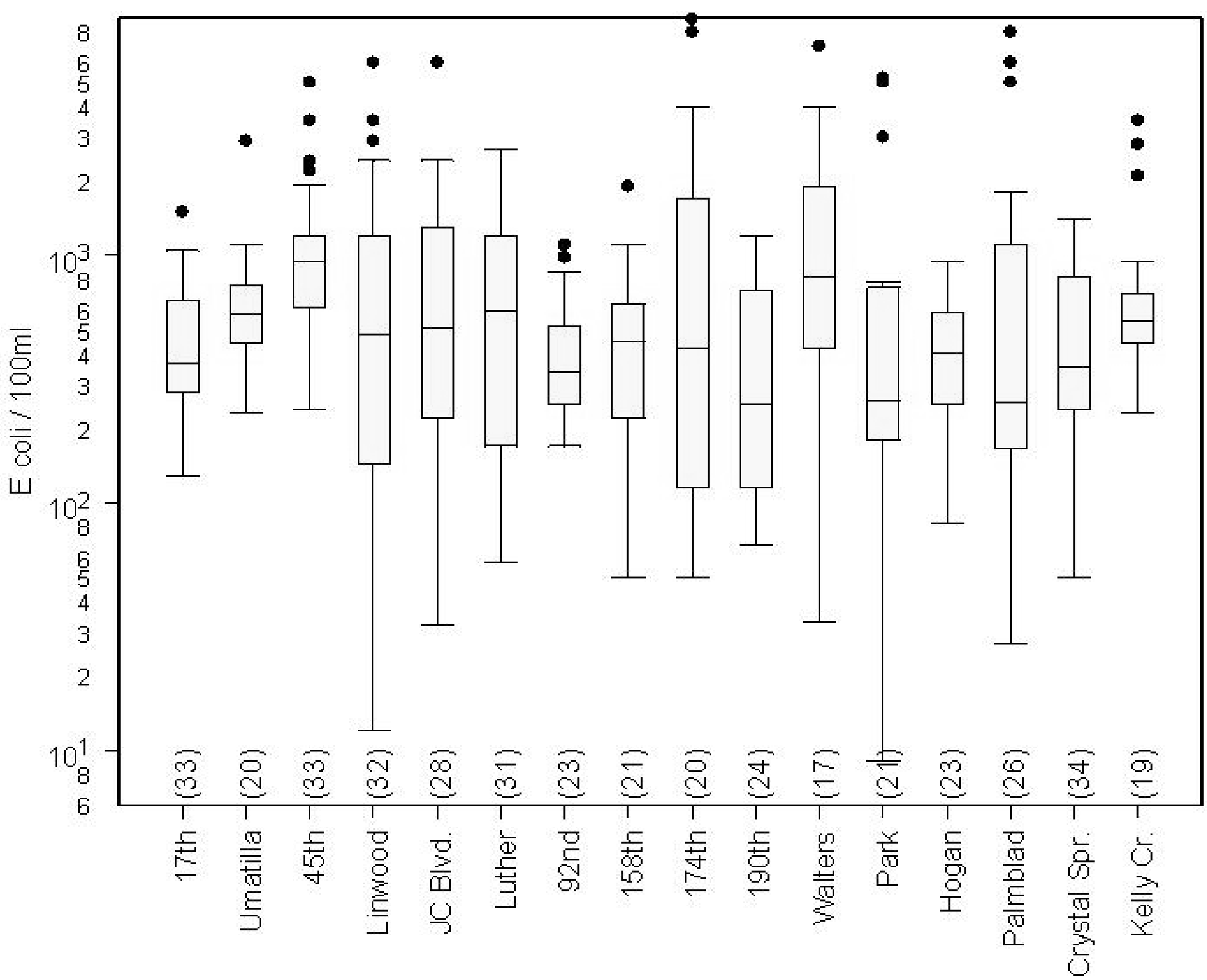
Several studies found that bacteria concentrations in Johnson Creek exceed state water quality criteria. Concentrations are highest during high flows, most likely a result of stormwater outfalls discharging surface runoff from areas with leaking septic tanks or cesspools or areas with high concentrations of animal wastes.

Routine monitoring by both Portland and Gresham reveal high bacteria levels throughout the Johnson Creek watershed. Data suggest that the bacteria levels exceed state water quality standards for *E. coli* bacteria. These standards include a 30-day log mean of 126 *E. coli* organisms per 100 mL, based on a minimum of five samples, and no single sample shall exceed 406 *E. coli* organisms per 100 mL. The City of Portland's Ambient Monitoring Program sampling revealed geometric mean values for *E. coli* bacteria ranged from a low of 44 to a high of 1,894 colonies/100mL with a mean of 553 colonies/100mL (See City of Portland Ambient Monitoring Results summary table in the Action Plan in Appendix C.) These exceedances occur both during winter storm events as well as during the dry summer periods.

From 1998 through 2001, Clackamas County Water Environment Services (WES) collected bacteria samples at three locations between 92nd and 45th Avenue in Johnson Creek. Results reveal relatively high *E. coli* values. Geometric means ranged between 321 and 1,423 and fecal coliform bacteria geometric mean values ranged between 741 to 1,093 organisms/100mL.

Figure 7 summarizes E. coli bacteria data throughout the Johnson Creek watershed. Results reveal exceedances of state standards throughout the drainage basin.

Figure 7. E. coli bacteria levels throughout the Johnson Creek watershed



Toxics

DDT was identified as a problem based on the results of a USGS investigation (Edwards 1994), which found high instream concentrations. In addition, the USGS is working on a toxics monitoring report from data collected during 2002. Additional investigations of DDT are planned to determine whether DDT concentrations have changed over time, and to provide further evaluation of the nature and sources of DDT concentrations throughout the watershed.

During May 2000, and August 2001, the City of Gresham obtained sediment samples within Johnson Creek. Table 8 summarizes selected toxics results from these sampling sessions.

Table 8. Sediment sample results in Johnson Creek

Sample Date	Sample Site	4,4' DDD	4,4' DDE	4,4' DDT	Alpha-Chlordane	Chlor-dane	PCB 1016	PCB 1221	PCB 1232	PBB 1242	PCB 1248	PCB 1254	PCB 1260	Dieldrin	Toxaphene
Detection Limit		13.4	13.4	13.4	13.4	300	67	67	67	67	67	67	67	13.4	400
05/30/00	JCI1	13.4	13.4	22.1	13.4	300	67	67	67	67	67	67	67	13.4	400
05/30/00	JCI2	14.8	29.7	15.4	13.4	300	67	67	67	67	67	67	67	13.4	400
08/28/01	JCI1	33.5	33.5	33.5	33.5	750	67	134	67	67	67	67	67	33.5	1000
08/28/01	JC12	89.4	60.7	89.4	89.4	2000	179	358	179	179	179	179	179	89.4	2670

Note: units are ug/Kg

JCI1 = Johnson Creek at 174th (downstream jurisdictional boundary)

JCI2 = Johnson Creek at Palmblad Road (upstream jurisdictional boundary)

Oregon does not currently have freshwater sediment standards. DEQ utilizes guidelines contained in the November 1998 Dredged Material Evaluation Framework-Lower Columbia River Management Area for evaluating freshwater sediments. This document uses a tiered evaluation process in a sequential manner for evaluating the suitability of dredged material for unconfined aquatic disposal. Table 9 presents dry weight interpretive guidelines for selected chemicals including a screening level, bioaccumulation level, and maximum level. A screening level (SL) value is listed that identifies chemical concentrations at or below which there is no reason-to-believe that dredged material disposal would result in unacceptable adverse effects due to toxicity measured by sediment bioassays. These screening values were developed for the marine environment. Freshwater values are under development. A second, higher Maximum Level (ML) is identified for each chemical above which there is reason-to-believe that the material would likely fail the standard suite of biological tests and thus be unacceptable for unconfined aquatic disposal. A third chemical screen, the bioaccumulation trigger (BT) has been determined for some chemicals of concern. This may be an important factor in determining sediment suitability for sediments at or above the ML. Bioaccumulation is defined as the accumulation of contaminants in the tissues of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, or dredged material. Although not directly applicable to Johnson Creek sediments, it provides a comparative summary for the relative concentrations of sediment results obtained in Table 8.

Table 9. Sediment guidelines – Dredged Material Evaluation Framework

Pesticides	Screening Level	Bioaccumulation Level	Maximum Level
Total DDT (sum of 4,4' – DDD, 4,4'-DDE, and 4,4' – DDT)	6.9*	50	69
alpha-Chlordane	10	37	---
Dieldrin	10	37	---
Total PCBs	130	38**	3,100

* Concentrations are ug/kg

** This value is normalized to total organic carbon, and is expressed in mg/kg (TOC normalized).

City of Gresham sediment sampling results from May 2000 and August 2001 in Johnson Creek at Palmblad Road reveals that sediment samples for Dieldrin, alpha-Chlordane, and PCBs exceed both the screening and bioaccumulation levels. DDT also exceeds the maximum level guideline at this location. Additional sediment samples should be obtained to confirm these results and to isolate source areas.

In addition, <u>water column</u> samples obtained in Johnson Creek for the following priority pollutants: DDT, Dieldrin, PAH, PCB and Chlordane. Water quality standards for selected priority pollutants are shown in Table 10 below and were obtained from Table 20 in –Water Quality Criteria Summary in Oregon Administrative Rules (OAR) Chapter 340, Division 41 – DEQ.

Table 10. Priority Pollutants and 303(d) listings in Johnson Creek

Compound Name or Class	Priority Pollutant	Carcinogen	303(d) List Date	Data Results to Support Listing	Fresh Acute Criteria* (ug/L)	Fresh Chronic Criteria * (ug/L)
DDT	Yes	Yes	1998	.001 ug/L – 0.1 ug/L	1.1	0.001
Dieldrin	Yes	Yes	1998	0.007 ug/L – 0.021 ug/L	2.5	0.0019
PAH	Yes	Yes	2002	0.0423 ug/L		
PCB	Yes	Yes	2002	0.02002 ug/L	2.0	0.014
Chlordane	Yes	Yes	Not listed	0.0016 ug/L	2.4	0.0043

ug = micrograms or one millionth of a gram (10^{-6})

ng = nanograms or one billionth of a gram (10^{-9})

pg = picograms or one trillionth of a gram (10^{-12})

* For protection of Aquatic Life

** For protection of Human Health

The above priority pollutants and associated supporting data results obtained by the USGS, DEQ, and other public agencies reveals that DDT, Dieldrin, and PCBs are exceeding state standards for chronic toxicity in Johnson Creek. Additional monitoring will be required to identify and control sources of toxic contamination in the watershed.

2.10 Biological Communities

2.10.1 Fish

As part of the Lower Columbia River Evolutionary Significant Unit, steelhead and Chinook are listed as threatened in Johnson Creek under the Endangered Species Act. Recent information on fish in the Johnson Creek watershed comes from several surveys, fish kill reports, and occasional observations made by volunteers, residents, and agency personnel. The City of Portland in 1992 and ODFW in 1993 conducted surveys of the fish community in Johnson Creek. The fish community is dominated by species tolerant of warm water and disturbed conditions, particularly redside shiners, reticulate sculpin, and speckled dace (McConnaha 2002, JCCC 1995). Large-scale suckers are abundant in the lower reaches.

Johnson Creek historically had large salmon populations. Numbers declined dramatically once urbanization began and particularly after the channelization work was completed (McConnaha 2002). However, adult salmonids have been observed in recent years, including: coho salmon, Chinook salmon, cutthroat trout, and steelhead (ODFW unpublished data, as cited in Portland BES, 1999). The 1995 Johnson Creek Resources Management Plan summarized the different salmonid life stages and species use in Johnson Creek. A summary of salmonid species occurrence follows.

Winter-run adult steelhead return to spawn in Johnson Creek from mid-November through May. Two separate runs appear to peak in January-February and again in April-May. Eggs or salmon fry can be present in the gravel from December to July. Juvenile steelhead can remain in Johnson Creek for one to two years before migrating as smolts to salt water. Steelhead are likely to use the mainstem and tributaries.

Historically, coho salmon were observed in the lower reaches of Johnson Creek and Crystal Springs Creek from late September through early November. Eggs or coho fry could be within Johnson Creek gravels between October and March. Fry attempt to establish territories and remain in streams as juveniles for one to two years before smolts migrate to salt water.

Chinook salmon probably enter Johnson Creek to spawn during mid-September through October. Fry emerge from gravels in January or February. Unlike steelhead or coho salmon, Chinook only spend a few weeks near spawning grounds before migrating to salt water, and are usually out of the freshwater systems by June.

Table 11. Water Quality Indicators in the Johnson Creek Watershed

Indicator	Baseline Condition	Key Function	Key Process	Effect	Notes
Temperature	Not Properly Functioning	Temperature is related to shading and microclimate functions, and amount of impervious surface. Temperature affects the amount of dissolved oxygen in a stream and, in turn, fish physiology and health. Salmonids require cold water (less than 17 degrees Celsius)	Temperature can be influenced by air temperature, cold water inputs such as seeps and springs, groundwater interactions, stormwater runoff, canopy cover, solar heating, and channel width-to-depth ratios. In addition, the orientation (such as east to west) of a stream can have significant effect on temperature regimes. High temperatures result from inputs of warm stormwater and a loss of riparian vegetation, which moderates stream microclimates.	Warm water temperatures impair native fish health by increasing their susceptibility to disease and parasites. Warm water also has a direct effect on the amount of dissolved oxygen it can contain. Warm water can act as a barrier and have a significant effect on reproduction success. Negatively affects productivity and activities of aquatic species.	Temperatures throughout Johnson Cr. exceed water quality standards during the summer months. Temperatures begin to exceed the spawning and incubation standard in April, although data is lacking to determine whether eggs and fry are still present within the gravel during this period. Temperatures at the mouth of Johnson Cr. are consistently higher than temperatures in the middle and upper watershed.
Thermal Refugia	Not Properly Functioning	Tributary streams and confluences, springs, seeps, and other groundwater inputs provide refuge areas for salmonids.	Development, barriers, groundwater usage, and climate changes can impact thermal refuge areas.	Lack of thermal refuge areas can have a significant impact on fish and aquatic species during critical times of their life cycles.	No extensive survey of thermal refugia has been conducted in Johnson Cr. However, two key tributaries within Johnson Cr. – Crystal Springs and Kelley Cr. fail to meet temperature standards during summer months. Crystal Springs has large inputs of 55°F groundwater and yet exceeds temperature standards.
Eutrophication: (Nutrients, D.O., and Chlorophyll a)	At Risk	Nutrients and chlorophyll provide energy requirements to living organisms. High eutrophication associated with sediment and nutrient loading is negatively correlated with fish and aquatic habitat functions.	Sources of eutrophication include erosion, and other human activities on the landscape including residential, commercial, agriculture, and others.	Low D.O. can cause stress and lethal impacts. High nutrient loads can contribute to excessive aquatic vegetation densities and large diurnal changes in D.O. levels. High Chlorophyll a concentrations can lead to visibility problems.	Nutrient concentrations exceed federal guidelines (Edwards, 1992; Reininga, 1994). D.O. concentrations frequently drop below 8.0 mg/L in summer; approximately thirty percent of the measurements throughout Johnson Cr. in August are below this value. Low dissolved oxygen concentrations are likely due to a combination of elevated temperatures and nutrient loading.

Indicator	Baseline Condition	Key Function	Key Process	Effect	Notes
Toxic Materials	At Risk	Toxic materials have negative correlation with fish and wildlife health.	Sources of toxic pollutants include agricultural, municipal, and industrial wastewaters, stormwater runoff, and chemical spills. Toxic chemicals bind to sediments, are ingested by aquatic organisms or are washed and deposited downstream.	Toxics can cause lethal or sub lethal effects in aquatic organisms. Sub lethal effects include impaired reproduction. Bioaccumulation of pollutants in fish can negatively impact human health and piscivorous birds. Toxins can become a chemical barrier for aquatic species.	Johnson Cr. is on the 303(d) list for DDT and Dieldrin. Instream DDT concentrations measured in a USGS study are among the highest measured in the region (Edwards 1994). Concentrations of PCBs and PAHs have also been recently observed exceeding state water quality standards, and are proposed for 303(d) listing.
Sediment	At Risk	Normal sediment inputs replenish scoured areas and contribute to bank creation.	Sediments originate from the landscape from overland flow / stormwater runoff or upstream. Sediments also originate normally from stream channels and from excessive high flows and erosion of streambed and banks.	High levels of sediment (or turbidity) can impair feeding and respiration and limit, impact, or destroy food resources. Turbidity abrades fish gills and skin leading to infection.	Fines in certain portions of Johnson Cr. are presently at levels that seriously limit fish food production or embed spawning areas.

Source: Portland ESA Program and modified by Adolfson

Coastal subspecies of cutthroat trout are also present in Johnson Creek. This coastal subspecies has both sea-run and resident forms. No current documentation of the sea-run form exists. Data from 1992 and 1993 indicated that cutthroat trout were present in low numbers throughout the mainstem of Johnson Creek, but were more abundant in many of the smaller headwater tributaries. Coastal cutthroat trout spawn from late December through February, and most fry emerge from the gravel by mid-April. This can vary depending on the spawning period and water temperature. Resident forms of coastal cutthroat trout typically remain in, or relatively close to their natal streams. Juvenile sea-run coastal cutthroat trout often spend a year in the small headwater streams and then move downstream into larger streams for the remainder of their freshwater residency. They can live in these larger stream systems for a period of two to nine years, but typically spend three years in freshwater before migrating to the ocean.

Clyde Brummel, a local resident, with the assistance of the Sellwood-Moreland Improvement League (SMILE), maintained a small hatchery (hatch box) on Crystal Springs Creek from 1981 to 2001(Ellis 1994, Caldwell 2003). From 1981 to 1993, an average of 15,000 coho and steelhead eggs were incubated in the hatch box then released as fry in the winter into upper Crystal Springs Creek to rear for approximately one year. Egg numbers dropped to 1,000 to 5,000 after 1993. From 1991 to 1997, a hatch box was maintained on lower Johnson Creek (RM 2.5) by a private landowner, Steve Johnson. An average of 15,000 to 20,000 coho and steelhead eggs were hatched from this box and released as fry in Lower Johnson Creek. ODFW supplied fertilized eggs for both hatch boxes through the Salmon and Trout Enhancement Program (STEP). In 1994, ODFW released substantial numbers of hatchery-reared juvenile fall Chinook salmon as part of an effort to support restoration. A “put and take” rainbow trout fishery was also maintained through spring stockings of hatchery-reared catchable rainbow trout downstream of S.E. 82nd Avenue. The fishery programs ended in 1997 with the ESA listings.

In 2001, ODFW and the City of Portland’s Endangered Species Act program began a project to inventory fish communities within Johnson Creek to determine salmonid presence, life history and habitat usage throughout the watershed (Graham and Ward, 2002). Fish surveys were conducted in eight Portland streams including Crystal Springs, Johnson, and Kelley. Study results also showed that native fish were observed in Johnson Creek (1,626), Kelley Creek (904), and Crystal Springs Creek (868). A total of 131 non-native fish were collected and identified, all from the lowest reach of each stream (Graham and Ward, 2002).

The largest reach sampled was Reach 16 in Johnson Creek, which included 1,330 m^2 or approximately 18 percent of the total area sampled. The largest catches of salmonids out of the eight study streams sampled this study were obtained in the Johnson Creek watershed (Johnson, Crystal Springs, and Kelley creeks). This is not surprising, because Johnson Creek is the longest stream sampled and had the highest flow (Graham and Ward, 2002). Johnson Creek had the greatest number of families including salmonids, lamprey, cottids, cyprinids, and centrarchids. Johnson Creek had both cutthroat trout and rainbow trout/steelhead. Coho salmon were only found in Johnson Creek. Lampreys were limited to reaches 8, 14, and 16 within Johnson Creek. Lampreys were most abundant in Kelley Creek with 132 individuals. Cutthroat trout was the most abundant salmonid present. Cutthroat trout populations in Kelley Creek are of particular interest because of several potential impassible barriers.

Table 12 summarizes the estimated number of salmonids per 100-m of selected reach sampled during the summer 2001 through spring 2002 surveys.

Table 12. 2001-2002 Fish Inventories in Johnson Creek Watershed

Stream, reach	Season	Cutthroat Trout	Rainbow trout/ Steelhead	Coho salmon	Chinook salmon
Crystal Springs 1	Winter	0	0	1	0
	Spring	0	0	3	2
Johnson 2	Fall	0	0	0	1
	Spring	0	1	1	14[a]
Johnson 4	Fall	1	0	0	0
Johnson 16	Summer	1	0	0	0
	Fall	8	0	0	0
	Spring	7	0	0	0
Kelley 1	Summer	8	0	0	0
	Fall	19	0	0	0
	Winter	12	0	0	0
	Spring	8	0	0	0
Kelley 2	Fall	1	0	0	0
	Winter	15	--	--	--
	Spring	31[a]	0	0	0

a = Data provided is upper confidence limit; distribution of catch among passes resulted in negative abundance estimate.

An index of biotic integrity (IBI) was calculated during the ODFW 2001 study for both the extensive summer sampling and intensive seasonal sampling. An IBI is a scoring criteria used to rank a stream based on current biological integrity (Hughes et al. 1998 in Graham and Ward, 2002). The IBI is useful for assessing the effects of humans on entire fish assemblages. Final scores indicated that 21 of the 23 reaches surveyed were severely impaired. Marginally impaired reaches were limited to Johnson Creek reaches 2 and 16. No scores were considered acceptable (Graham and Ward, 2002). Low IBI scores can probably be attributed to barriers and environmental disturbances. The study concludes that due to environmental disturbances in Johnson Creek, restoration efforts should be concentrated in middle reaches, which are deep, lack cover, and are channelized by WPA tiling (Graham and Ward, 2002).

Plans for 2002-2003 call for repeat sampling in all stream reaches. Multiple years of data will allow the monitoring and comparing of fish communities, comparison of data under variable flow and environmental conditions, and characterization of population dynamics such as age, growth, and rates of recruitment (Graham and Ward, 2002).

2.10.2 Culvert Crossing Inventory

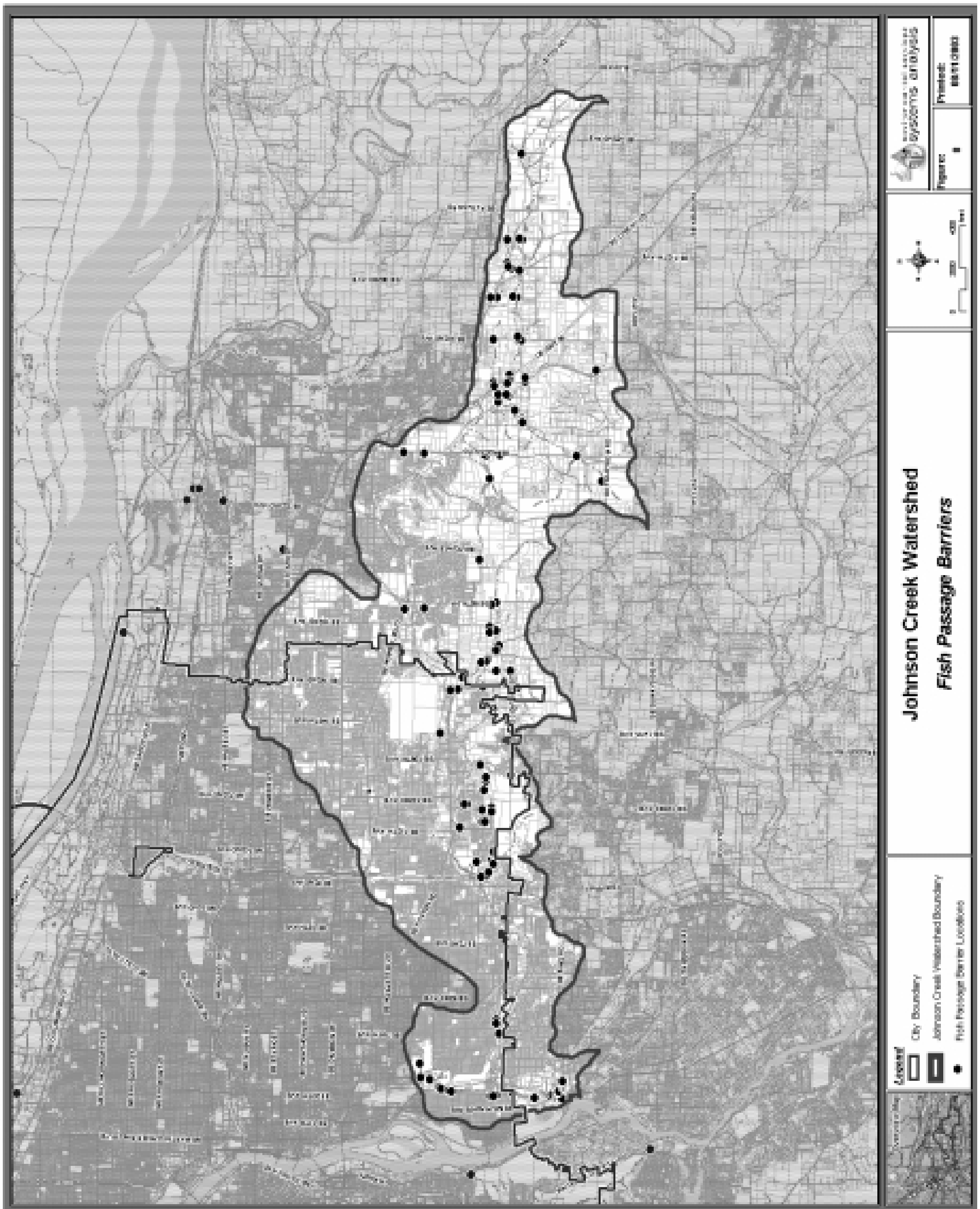
During 2000-2001, a committee composed of jurisdictions within the watershed (known as the Johnson Creek Joint Culvert Crossing Committee) was formed to identify and inventory culverts within the Johnson Creek watershed and to make an assessment of their condition and fish passability. In addition to culverts, other instream passage structures such as bridges and potential obstructions such as dams, weirs, or exposed pipes within the public right-of-way were also inventoried. Six jurisdictions were involved including Multnomah and Clackamas Counties, Oregon Department of Transportation (ODOT), and the cities of Portland, Gresham, and Milwaukie. Results were fed into Geographical Information System (GIS) analysis and mapped by Portland (Newel, 2002).

A total of 226 structures were inventoried watershed wide. Seventy-eight culverts were inventoried within Portland and a total of 38 structures were inventoried within Gresham. An assessment was made of the condition of each culvert in terms of degree of blockage and various maintenance considerations. In addition, ratings were given for conditions such as distance to next culvert, instream and riparian habitat quality, fish presence, and downstream access (City of Portland ESA, 2002). Due to timing restrictions on federal grant fund programs and other constraints, the jurisdictions completed only the first phase of the inventory. Additional assessment will be required to finalize the culvert prioritization process. Both Clackamas and Multnomah Counties have ranked public right-of-way culverts within their jurisdictional boundaries. A summary of the public right-of-way culvert crossing inventory database is provided in the Action Plan in Appendix D. Culverts and other fish passage barriers on private lands have not been assessed. See Data Needs.

The assessment shows that there are no culverts on the mainstem until high in the upper reaches of the watershed. Culverts are present, however, on nearly all the tributaries to Johnson Creek. Crystal Springs, an area used by local and migratory Willamette salmonids, has a series of partially impassable culverts along its length. Kelley Creek and its tributaries have a number of impassable culverts and dams. However, the City of Portland recently removed a partial passage barrier by installing a new culvert at SE 162^{nd} and Foster Road, providing fish access to lower Kelley Creek. Some of the least developed Johnson Creek tributaries along the southern side of the middle reach also have culverts along their confluences with the mainstem.

Apart from culverts additional passage barriers exist along Johnson Creek. Four instream structures within Johnson Creek have either recently been removed or plans are being finalized for removal. During 2000, Metro acquired property and removed a private instream dam on Johnson Creek above Hogan Road in Gresham. In 2002, BES began finalizing plans for removing a concrete sewer pipe within the streambed of Johnson Creek in Tideman Johnson Park. Multnomah County has also approved a permit to replace culverts in Johnson Creek mainstem above SE 282^{nd} with an arched culvert/bridge (See Appendix D and I). Figure 8 presents a preliminary list of known fish barriers throughout the Johnson Creek watershed.

Figure 8. Passage Barriers in the Johnson Creek watershed.



2.10.3 Refugia

Refuge areas for fish consist of both chemical and thermal refugia. Refuge areas for fish are local areas where fish can escape chronic or episodic events such as high turbidity flow events during the winter or high water temperatures during the summer and early fall. Thermal refugia areas generally include groundwater springs, seeps, confluences of tributaries, and in some stream systems, localized areas of intact healthy riparian shaded areas.

DEQ obtained both field temperature data and the Forward Looking Infrared Radar (FLIR) imaging data during 2002. These surveys were conducted during a very low period (approximately 1 cfs). Preliminary results yielded no significant coldwater refugia areas. This was due in part to the low flow conditions and the limits of the FLIR capabilities (E-mail communication with Greg Geist, DEQ, 2003). See Figure 9 for a preliminary plot of Effective Shade by River Mile showing the current and potential conditions. This plot was produced by DEQ for development of the Draft Total Maximum Daily Load (TMDL).

Currently, fish usage within the Johnson Creek watershed is not fully documented. Salmonids and lamprey have been observed in the following areas:

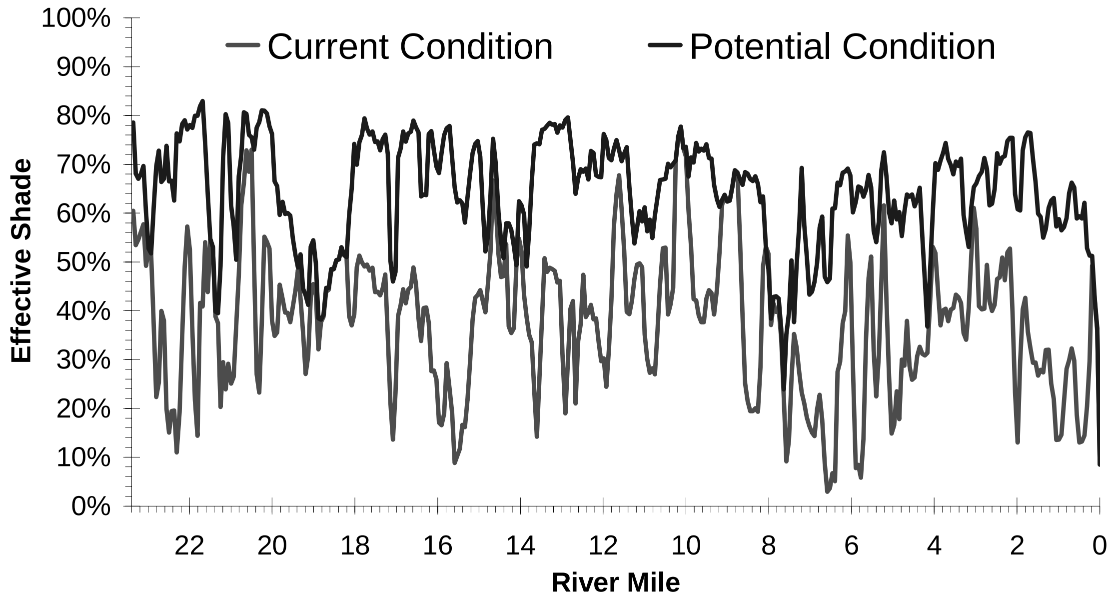
• Lower Kelley Creek and possibly Lower Hogan Creek	Steelhead
• Crystal Springs Creek	Rainbow/Steelhead
• Lower and Upper Kelley, Johnson Creek Reach 16	Cutthroat Trout*
• Lower Crystal Springs Creek, Johnson Creek Reach 1 and 2, Reach 5	Coho spawners
• Johnson Creek Reach 1 and 2	Chinook
• Kelley Creek, Crystal Springs Creek, and Johnson Creek Reaches 4, 6, 8, 12, and 16	Lamprey

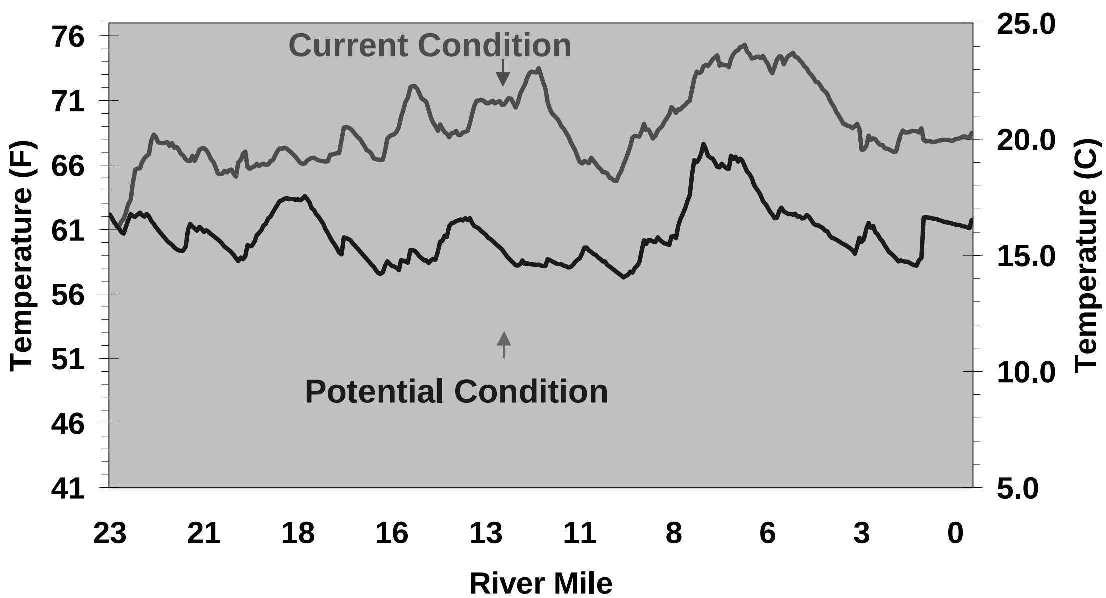
* Cutthroat Trout are likely in other areas of Johnson Creek and its tributaries.

2.10.4 Benthic Macroinvertebrates

During 1999, Portland State University (Pan, et. al, 2001) conducted a pilot bioassessment study of urban streams including Johnson for the City of Portland BES. The main objective of this study was to assess the spatial variation of biota in two urban streams (Johnson and Tryon Creek) and two adjacent rural ecosystems (Clear Creek and Deep Creek). A total of 65 sites were sampled for physical, chemical, and biological parameters during late August through early September 1999. Of 65 sites, 30 were in Johnson Creek, 25 of which were on the main stem. Sites were sampled monthly for diatoms, macroinvertebrates, and water chemistry. The results of the study found that benthic communities are degraded in comparison to regional reference creeks within the same ecoregion (Hoy 2001; Pan et al. 2001; Walker 2001). Specifically in Johnson Creek the results indicated marginal conditions for physical habitat, macroinvertebrates and lack of a quality food base .

Figure 9. Preliminary Draft Plot of Current and Potential Conditions for Effective Shade by River Mile in the Johnson Creek watershed





As expected, macroinvertebrate assemblages were significantly different between the urban and rural streams. Of 22 metrics, 14 were significantly different. Species diversity and total number of sensitive taxa (Mayfly, Caddisfly and Stonefly), which generally indicate the degree of stream health, in the two urban streams were significantly lower than those in the rural streams. Results also reveal that both macroinvertebrates and diatom assemblages were significantly different between urban and rural streams and that richness metrics were consistently different between urban and rural streams for two years. The scores also indicated that overall physical habitat conditions in Johnson Creek were marginal. Water quality variables such as conductivity, ortho-phosphate, and NO_3+NO_2 were greater and more variable at the urban than the rural site throughout the year.

The scores indicated that overall physical habitat conditions in Johnson Creek were marginal. Of the generally sensitive taxa found in Johnson Creek most were pollution tolerant species indicating marginal conditions for sensitive macroinvertebrates and the lack of a quality food base within Johnson Creek.

The Portland ESA Program assessed baseline conditions for biological indicators in Johnson Creek (Table 13). These indicators and their assessed base line condition compared to properly functioning conditions were incorporated into an Ecosystem Diagnosis & Treatment (EDT) Model. See Chapter 2.12.1 for discussion of this model and results of selected indicator attributes and their protection and restoration values.

2.10.5 Wildlife

Currently, no large or exhaustive database of information exists on wildlife resources and their habitats throughout the watershed. Overall, the diversity of wildlife species in the watershed has been significantly reduced. Large mammals were once common, such as black bear, bobcat, cougar, wolf, fox, elk, and coyote (JCCC, 1995). A cougar sighting was recently reported. Black-tailed deer and coyotes are likely the only large mammals that can still be commonly found in or near the remaining forested areas. Birds are the most abundant wildlife forms living in urban and rural areas within the watershed. Sensitive species known to occur in the riparian areas of Johnson Creek include three salamander species (long-toed, northwestern, and Columbia), two frog species, and one toad species. Painted turtles have been identified in the upper watershed (east of 162nd Street). Other sensitive species have been sited in the following specific areas: 1) 162nd and Kelley Creek (salamanders); 2) 182nd and Springwater Corridor, opposite Fairview Creek headwater wetlands area (great horned owls, red-legged frogs, hawks, and coyotes); and 3) Powell Butte (Tall bugbane, listed as a sensitive species on the ODFW state sensitive species list) (Portland ESA, 2000).

The wildlife habitat value of the Johnson Creek watershed is greatly diminished due to growth and development. Many different factors influence and generally reduce these values. Several important limiting factors listed the 1995 Johnson Creek Resources Management Plan include: lack of structural diversity; narrow and degraded riparian corridor; lack of dead wood, standing or snags, or down wood; limited connection or linkage between riparian and upland habitats; fragmentation, disturbance; and encroachment of non-native vegetation.

Table 13. Biological Indicators in the Johnson Creek Watershed

Indicator	Baseline Condition	Key Function	Key Process	Effect	Notes
Instream Communities	At Risk	Benthic and aquatic invertebrate, and other instream communities support higher orders of wildlife species and are widely used as indicators of stream health and condition. Many fish species rely on benthic organisms as a food source	Highly sensitive to pollutants, temperature, and flow changes.		Biotic integrity of Johnson Cr. is degraded. Many native fish species have been extirpated or greatly reduced, and many introduced or nuisance species currently occupy their habitat. Benthic communities in Johnson Cr. are significantly degraded in comparison to local reference streams (Hoy 2001; Pan et. al., 2001; and Walker, 2001).
Salmonids	Not Properly Functioning	Salmonids are important in stream ecosystems because they are often the largest species in the community and at the top of the food chain in the aquatic system.	The physical stream habitat, geographic location, and evolutionary history of the species determine the numbers and species composition of fish in a given stream.		The cumulative impacts of the factors listed above threaten salmonid survival and salmonid populations locally and upstream and have been greatly reduced from historical numbers.
Interspecific Interactions	At Risk	Non-native species compete with native species. Changes to the watershed system can increase the competitive advantages of some native species as well.	Non-native species may be directly introduced, such as certain game fish, or may be escaped species.		Competition with and predation by introduced and native species has been increased by 1) introductions of non-native species; 2) habitat alterations that provide hiding places for predators; and 3) increased temperature regime which provides competitive advantages to more tolerant species.

Source: City of Portland ESA Program

2.11 Watershed Problems and Opportunities

2.11.1 Overview

A focus for watershed management efforts in urban areas is to protect the remaining high quality habitats first (e.g., opportunities), and than restore the rest in a prioritized approach (e.g., problems or challenges). Opportunities are watershed conditions or features that are currently in a healthy, properly functioning condition and that are considered key to sustaining important watershed functions. Problems or challenges are watershed conditions or features that are not properly functioning or that contribute to impairment of watershed health. Furthermore, one method of analysis suggests that restoration of these conditions will result in significant benefits for indicator species that depend on those conditions (See ESA Framework for Watershed Health, pages 5-8, Portland BES 2002). Analyzing existing conditions and comparing them to reference conditions determine problems and opportunities. The following discussion highlights the analyses used to identify well-established problems and opportunities, what those problems and opportunities are, and where they are located in the watershed.

Fixing problems and restoring functioning conditions within the watershed will require an assessment of limiting factors. The assessment will focus on key processes that contribute to the limiting factors. Problems range from local to watershed-wide and solutions will vary in scale and in length of time necessary to achieve results. For example, much of Johnson Creek is devoid of large woody debris (LWD). LWD plays an important function in providing habitat and diversity to the channel, aids in pool formation, and provides structure for other aquatic insects. LWD can be placed and anchored into targeted site-specific locations where it is missing, but for long-term sustainability, wood recruitment is the key process involved in maintaining future wood deposition. Revegetation of the riparian corridor involves all of the upstream contributing watershed area, time to attain a suitable growth size, and time for trees to decay and eventually fall into the creek. This is a long-term restoration action given the growth rates of trees.

A list of the most outstanding data gaps is presented below first followed by a discussion that summarizes the areas of risk in terms of human activities, urbanization, and other foreseeable threats. An examination of significant results from an Ecosystem Diagnosis and Treatment (EDT) model output follows that will assist in focusing restoration actions and protection activities. Key functions and limiting factors are highlighted for each of five major sections of the watershed including: 1) Lower Johnson Creek; 2) Middle Johnson Creek; 3) Upper Johnson Creek; 4) Crystal Springs Creek; and 5) Kelley Creek. And finally, a summary of the highest priority areas and actions needed for protection, restoration, inventorying and monitoring, public policy and rules; and public involvement and education.

2.11.2 Data Needs

Although a wealth of information is available for many functional elements of the Johnson Creek watershed there are a few areas where data is missing or inadequate. These information gaps include:

- Specific WPA locations and condition;
- Toxics sampling and analysis (sediment and fish tissue);
- Bacteria identification and tracing;
- Fish usage areas and locations of refugia areas;

- Outfall discharge characterization;
- Upper watershed tributary instream habitat conditions;
- Fish barriers on private lands;
- Vegetation classes;
- Pollutant sources and loadings;
- Upland habitat and wildlife resources;
- Crystal Springs Creek and Kelley Creek EDT ranking results of survival factors for successful coho salmon trajectories, capacity, and productivity;
- Cutthroat trout EDT Model results
- Water rights information

2.11.3 Assessment of Risks

Watersheds face a multitude of risks. These include risks from human population growth and associated activities as well as natural and anthropogenic climatic changes. Risks from human activities generally include development practices, agricultural and industrial land practices, vegetation removal, and changes to the landscape including filling of wetlands, drainage course alterations, the addition of impervious surfaces and resultant increase in stormwater runoff, debris and refuse, and point and nonpoint pollution loadings. Natural and human-induced climate changes can alter watershed hydrology through increased flooding or droughts.

Urbanization of watersheds continues to be one of the leading causes of degradation. Impacts to riparian areas and the increase of impervious surfaces including sidewalks, driveways, rooftops, and roadways contribute to significant hydrologic alterations. Removal of vegetation can lead to increased runoff, sediment loading and sedimentation. As a result, stream hydrology can be altered for both high flows where flooding can become more frequent and severe and where baseflows can be reduced earlier and remain problematic longer during the dry season.

In addition, agricultural uses can significantly contribute to water quality problems. Removal of riparian vegetation, streambank erosion, and instream water diversions can result in excessive sedimentation and increases in water temperatures. Other foreseeable threats to watershed health in Johnson Creek include continued growth and development pressures and associated increases in stormwater runoff and potential for erosion with urbanizing areas including Pleasant Valley, Springwater, and Damascus. Climate changes as well as new nonnative invasive species may also pose a threat in the long-term. Other threats include inadequate or poorly enforced erosion prevention and sediment control policies and programs.

The City of Portland has identified linkages between indicators of human influences and their impacts on Riverine-Riparian indicators for use in measuring watershed health. These indicators and linkages are summarized in Table 14.

Table 14. Linkages between the Indicators of Human Influences and Activities and their impacts on the Riverine-Riparian Indicators

Indicators of Human Influences and Activities	Riverine – Riparian Indicator Categories			
	Streamflow and Hydrology	Physical Habitat	Water Quality	Biological Communities
Land Use	X	X	X	X
Impervious Surfaces	X	X	X	X
Dam Impacts	X	X	X	X
Water Withdrawals	X	X	X	X
Drainage Network	X	X	X	X
Channel Alterations	X	X	X	X
Vegetation Removal and Wetland Destruction	X	X	X	X
Outfall Discharges	X	X	X	X
Spills and Illicit Discharges	X	X	X	X
Erosion		X	X	X
Exotic Species		X		X
Harrassment				X

Source: City of Portland Internal and IST Review Draft - A Summary of the Framework for Integrated Management of Watershed and River Health. 2002.

2.12 Key Limiting Factors (Problems)

2.12.1 Ecosystem Diagnosis and Treatment (EDT) Modeling

EDT, or Ecosystem Diagnosis and Treatment, is a system for rating the quality, quantity, and diversity of habitat along a stream. The model uses a probe or indicator species, such as Coho or Chinook salmon, to identify the most significant problems in a stream and to identify reaches for protection and restoration. The methodology includes a conceptual framework for decision-making and a set of modeling tools with which to organize environmental information and rate the habitat elements with regard to the focal species. In effect, EDT describes how the fish would rate conditions in a stream based on our scientific understanding of their needs. The value of EDT is that it can identify the potential for a stream under a set of conditions such as those that occur now or those that might occur in the future. The result is a scientifically based assessment of conditions and a prioritization of restoration needs.

EDT was developed by Mobrand Biometrics, Inc. to provide a practical, science-based approach for developing and implementing watershed plans. It is a salmonid life history based procedure for rating the quality, quantity, and diversity of stream habitat. The model uses rating curves to relate habitat conditions to life stage survival and capacity. These life stages are then linked to form life history trajectories (or the path of a salmonid through space or a chosen or taken migratory course). Because habitat is described by reach and month, many potential trajectories can be formed. All successful trajectories are combined to form an overall estimate of capacity and productivity at a population level. The range of successful trajectories is a measure of life history diversity.

Each reach of a stream has a certain *capacity* or number of fish that can be supported for each life stage depending on the quantity of key habitat; a certain number of fish can spawn in the riffles while the pools can support a number of juveniles. Each pool or riffle has a quality that affects the survival of a life stage in that habitat. Quantity of habitat is thus measured as *capacity*. When capacity and survival over the course of a fish's life history is integrated, an overall *capacity* for the species as a measure of the quantity of habitat can be derived. Overall survival is measured as the number of adult fish that return for each fish that spawns. This is termed *productivity* and is a measure of habitat quality.

The value of EDT is that it can identify the potential for a stream under a set of conditions such as those that occur now or those that might occur in the future. The result is a scientifically based assessment of conditions and a prioritization of restoration needs. Because each segment, or stream reach, is rated individually, we can systematically examine conditions along a stream from the perspective of the fish. In this way, we locate areas where conditions are particularly good or bad and identify things that need to be fixed. In particular, EDT identifies the "*restoration potential*" and the "*protection value*" of each reach. This helps us prioritize actions and focus them on areas with identified problems and where the potential for benefit is highest.

The model provides the flexibility to incorporate the effects of up to 45 specific variables reported to affect fish survival. Functional relationships between conditions and rates are described in series of rule curves derived from an extensive review of the scientific literature. Effects of specific habitat conditions are used to scale stage-specific survival rates between normal ranges reported from empirical data.

EDT represents the state of the art in salmon habitat-fish modeling. It is in wide spread application for salmon recovery planning efforts throughout the Pacific Northwest. Many other approaches attempt to relate fish population characteristics to habitat conditions, based on a subset of the relationships incorporated into EDT has the flexibility of emulating a variety of alternative approaches depending on data inputs.

The following strengths and weaknesses of EDT are listed in the Lower Columbia Fish Recovery Subbasin Plan: Proposed Analytical Framework (The JD White Company, Inc. and SP Cramer & Associates, 2003):

Strengths of EDT

- Data input structure provides a systematic means of describing basin-wide habitat conditions, qualifying the quality of the input data, and identifying reach-specific limiting factors based on a comprehensive review of the state of salmon knowledge.
- Extensive documentation of underlying relationships and assumptions is available.
- Detailed representation of stream habitat conditions and effects of habitat on fish provides flexibility in representing factors of concern and projecting fish benefits of specific changes.
- Sender-based approach to estimating survival rates protects against unrealistic estimates of population productivity and capacity.
- Estimates of population response to habitat changes are robust even where specific inputs are uncertain.
- One of the few realistic alternatives for inferring historic, current, and future fish population characteristics where empirical estimates based on fish data are not available.

- Provides a means for estimating fish sensitivity to departures from Properly Functioning Conditions.
- Life cycle approach at the core of EDT facilities linkage with life cycle-based population viability approach for integrated analysis.

Weaknesses of EDT

- Highly mechanistic nature requires extensive data that is often unavailable.
- Model complexity can obscure transparency in underlying assumptions, which has led to characterization as a *black box.*
- Complex interactions of habitat effects on fish can bias projected fish response to change where habitat inputs are unrealistic.
- Incomplete inputs can produce very specific results that are difficult to corroborate without independent data.
- Does not provide explicit estimates of uncertainty in results based on input assumptions.
- Model accessibility is limited by system requirements and specialized expertise.
- Description of equilibrium population conditions does not allow for consideration of risk assessments based on random variables such as ocean conditions.
- Not developed for detailed evaluations of mainstem, estuary, and ocean limiting factors.

Much of the EDT modeling performed to date by the city of Portland has focused on coho salmon. Preliminary results for steelhead were recently completed. Additional work will continue including EDT analysis of other salmonid species, assessment of sources, and project effectiveness. The EDT analysis indicated that in a restored condition, Johnson Creek would probably operate differently than it does today. Many more successful population trajectories (as characterized within the EDT model) would begin from the lower sections of the creek. Also, a portion of the trajectories starting in upper reaches of Johnson Creek would rear in the middle sections, which would provide abundant habitat for juvenile rearing.

EDT Model results revealed the top five ranking of various survival attributes for three scenarios when set to a reference condition. These scenarios include successful trajectories, change in capacity, and productivity for coho salmon and are summarized by watershed section in Table 15. Additional modeling results are provided in Appendix E.

Table 15. EDT Model Results for Coho Trajectories, Capacity, and Productivity

Watershed Section	Successful Coho Trajectories when attribute set to reference condition (percent)	Change in Coho capacity when attribute set to reference condition (percent)	Change in Coho productivity when attribute is set to reference condition (percent)
Lower Johnson Creek	Habitat Diversity 23.5	Habitat Diversity 5.6	Temperature 9.3
	Sediment 5.5	Key Habitat 5.6	Channel Stability 6.5
	Channel Stability 2.5	Food 4.0	Habitat Diversity 2.7
	Flow 2.1	Temperature 1.2	Chemical Pollution 0.6
	Temperature 1.7	Sediment 0.8	Sediment 0.4

Middle Johnson Creek	Habitat Diversity 66.0	Habitat Diversity 14.3	Habitat Diversity 2.4
	Sediment 30.9	Food 9.0	Sediment 1.9
	Flow 17.0	Key Habitat 7.1	Temperature 1.5
	Temperature 10.3	Temperature 3.0	Channel Stability 1.0
	Channel Stability 5.2	Flow 2.6	Flow 0.7
Upper Johnson Creek	Sediment 66.7	Food 20.1	Sediment 9.8
	Habitat Diversity 30.2	Habitat Diversity 10.6	Flow 9.4
	Flow 11.1	Key Habitat 8.5	Food 7.7
	Channel Stability 1.6	Flow 4.8	Habitat Diversity 5.5
	Temp., Food, and Harassment 0.8	Sediment 3.6	Temperature 4.3
Crystal Springs Creek	**Not complete as yet. See notes below.**		
Kelley Creek	**Not complete as yet. See notes below.**		

Source: E-mail communication and meeting handouts from Chip McConnaha (Mobrand Biometrics and the Portland ESA Program).

EDT modeling and analyses continues on Crystal Springs Creek and Kelley Creek. The following preliminary conclusions were obtained from Chip McConnaha (Mobrand Biometrics) delivered via e-mail to Ali Young (Portland BES) on June 20, 2003:

There are three overarching habitat restoration priorities for Crystal Springs Creek including:

1) *Temperature*. Need to reduce summer temperatures down to a reasonable level. Refugia may be present that would allow for some summer rearing of salmonids. A temperature budget should be performed to more completely understand the temperature regime.

2) *Access*. Crystal Springs has numerous culverts, most of which inhibit if not block fishery access.

3) *Structure*. Crystal Springs, like most of the Johnson Creek watershed, has very little structure. In fact, Crystal Springs Creek has appreciably less structure than Johnson Creek even accounting for the WPA work in Johnson Creek. Many sections are totally lined by concrete and wood is almost non-existent.

The overarching habitat restoration priorities for Kelley Creek include:

1) Create larger contiguous habitat areas rather than isolated pockets of habitat. Connect habitat in Kelley Creek with the relatively good areas in Johnson Creek just above the Kelley Creek confluence.

2) Protect and improve upper Kelley Creek tributaries for water quality (temperature and sediment).

For more information on restoration strategies for both Crystal Springs and Kelley Creek see Section 2.13.2 – Restoration.

Figures 10 and 11 summarize Preliminary EDT Model results for Coho and changes in number of successful life history trajectories, total productivity, and total capacity within the Willamette and various subwatersheds of the Johnson Creek basin.

The EDT Model was also run for steelhead. Preliminary results indicate that Steelhead are not doing as well as Coho, and although the overall degradation impacts/restoration potential patterns are similar, they are more exaggerated for steelhead. Restoration efforts show the most potential for steelhead in the middle Johnson Creek segments. EDT Model results for steelhead trajectories, diversity, productivity, capacity, and abundance are summarized in Table 16.

Table 16. Preliminary EDT Model Results for Steelhead

	Number of Trajectories	Number of Sustainable Trajectories	Diversity (percent)	Productivity (No. of fish)	Capacity (No. of fish)	Abundance (No. of fish)
Degraded	1232	0	0	0	0.50	0
Current	1232	39	3	2	41.3	20.6
Restored	1232	1227	100	17.75	411	388

Source: Portland ESA Program

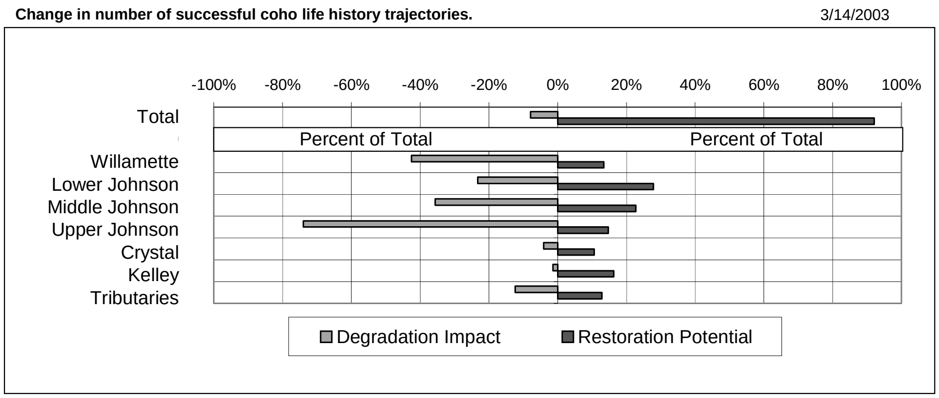
Figures 12 and 13 summarize Preliminary EDT Model results for winter steelhead and changes in number of successful life history trajectories, total productivity, and total capacity within the Willamette and various subwatersheds of the Johnson Creek basin. Note, that although the capacity is very small for Kelley Creek, the productivity increase in a restored condition is extremely important.

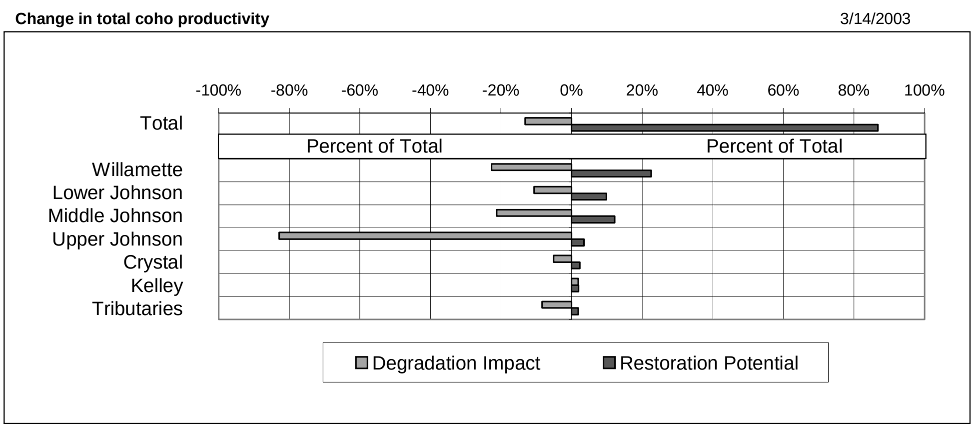
The EDT Modeling project identified the following key limiting factors that are most critical for coho salmon in the Johnson Creek watershed : 1) low habitat diversity due in part to a lack of wood; 2) simplified channel structure; 3) degraded banks including WPA rock work, bank grading, and channel lining; 4) degraded riparian areas; 5) high summer water temperatures; 6) excessive sedimentation; 7) lack of food (aquatic benthic macroinvertebrates); and 8) toxics. In addition, high bacteria levels throughout the watershed are considered problematic and should also be classified as a priority. The following section summarizes the key functions and processes that are associated with theses limiting factors.

Habitat diversity is a primary limiting factor in Johnson Creek resulting from channelization and confinement due to the WPA works and the lack of large woody debris. Recommendations from researchers who developed the EDT Model include: a) wherever possible, removal of the WPA channelization should be prioritized; and b) large woody debris should be introduced through both new, anchored wood and through maturation of a healthy riparian area.

Simplified channel structure is caused by a lack of streamside complexity and a lack of microhabitats. Channels that are allowed to meander form off-channel complex habitats. Large wood and boulders promote shifts in flow changes and velocity currents that help support channel structure and roughness and riffle-pool sequences.

Figure 10. EDT Model Results for Coho Trajectories, Productivity, and Capacity for the Willamette, Johnson Creek segments, and major tributaries





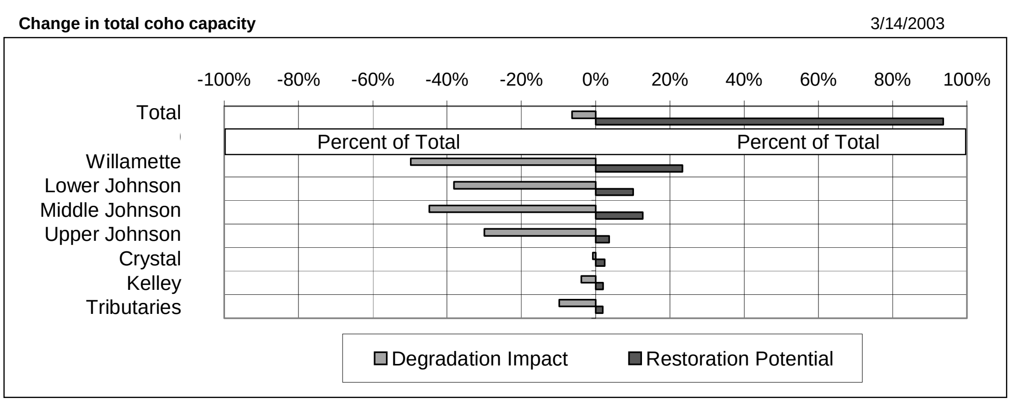


Figure 11. EDT Model Results for Coho Trajectory Productivity for Johnson Creek Reaches

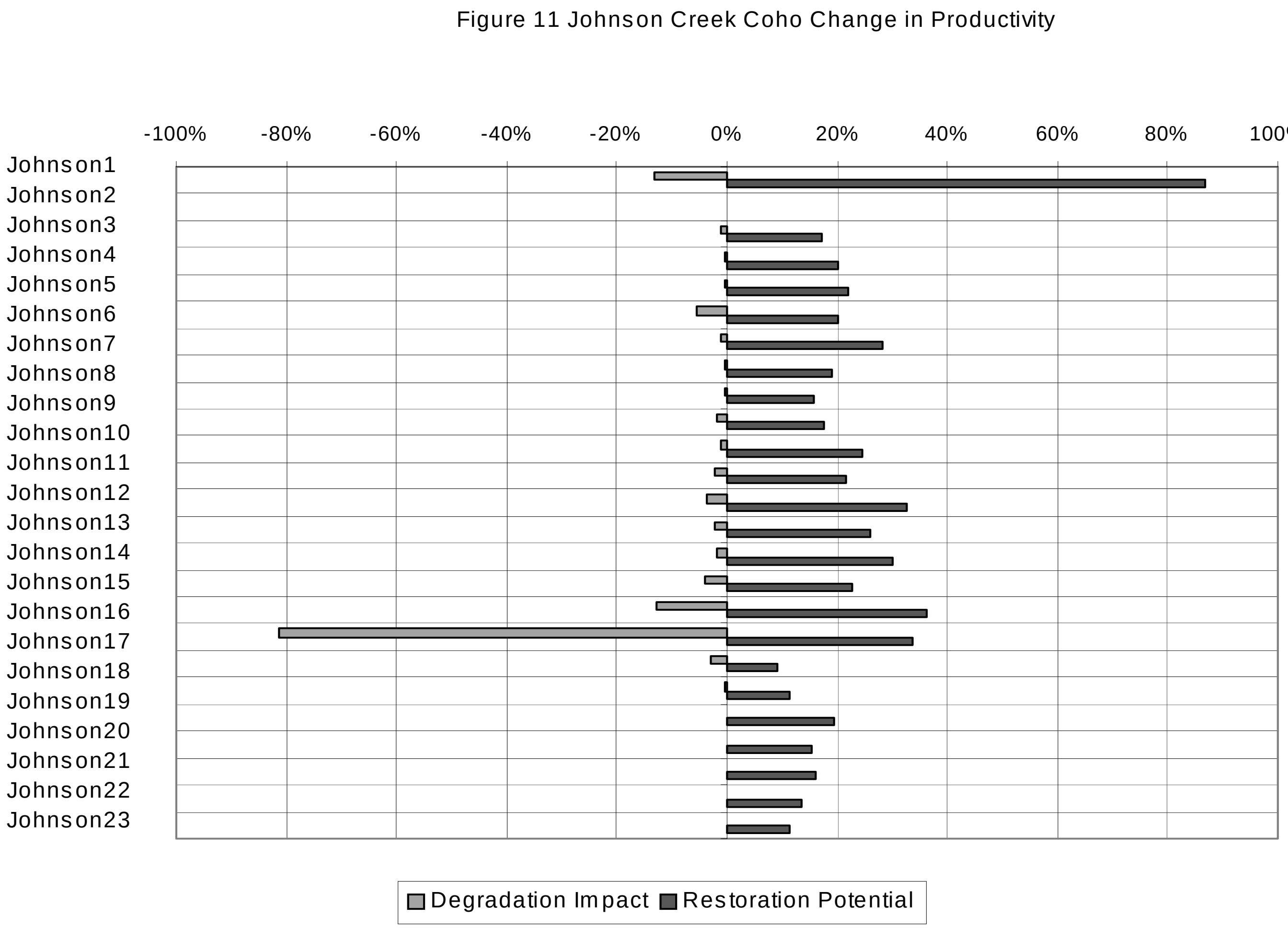
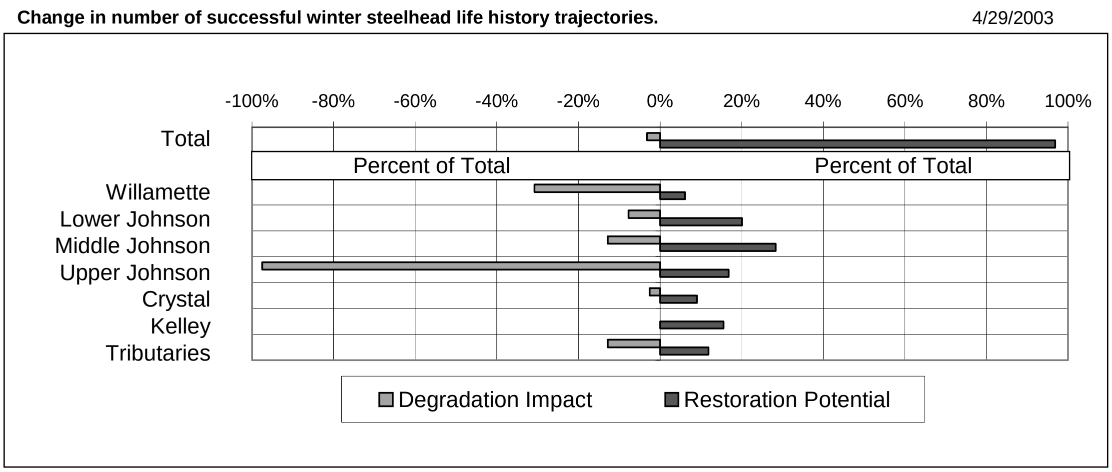
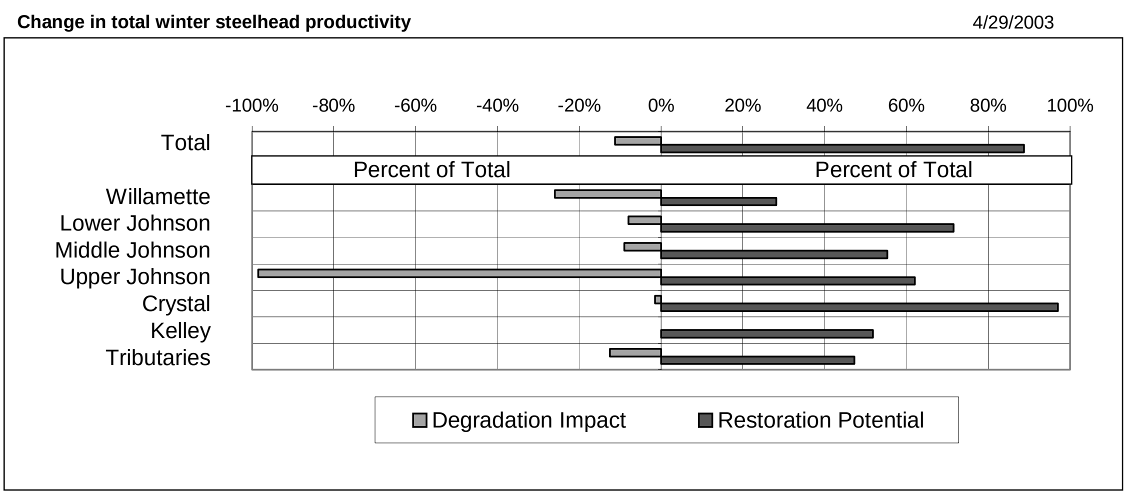


Figure 12. EDT Model Results for Steelhead Trajectories, Productivity, and Capacity for the Willamette, Johnson Creek segments, and major tributaries.





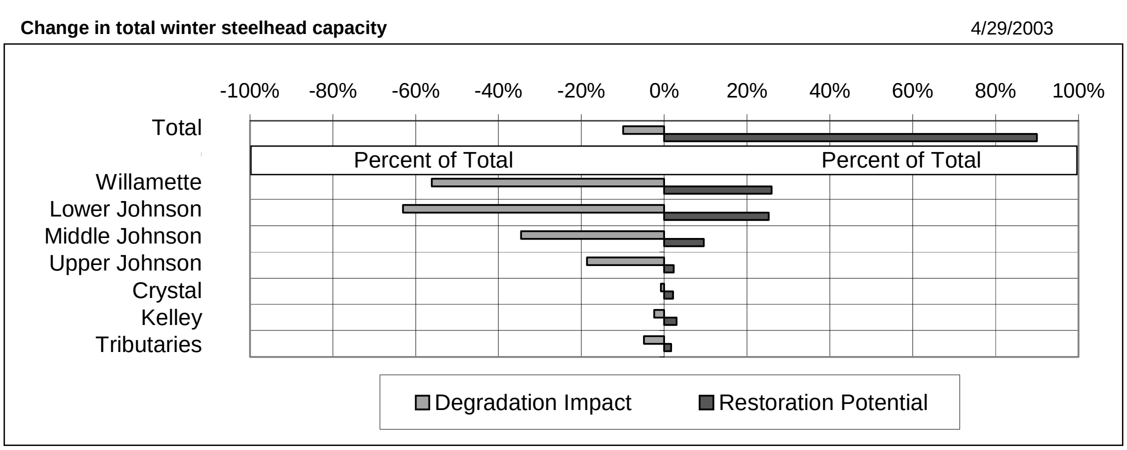
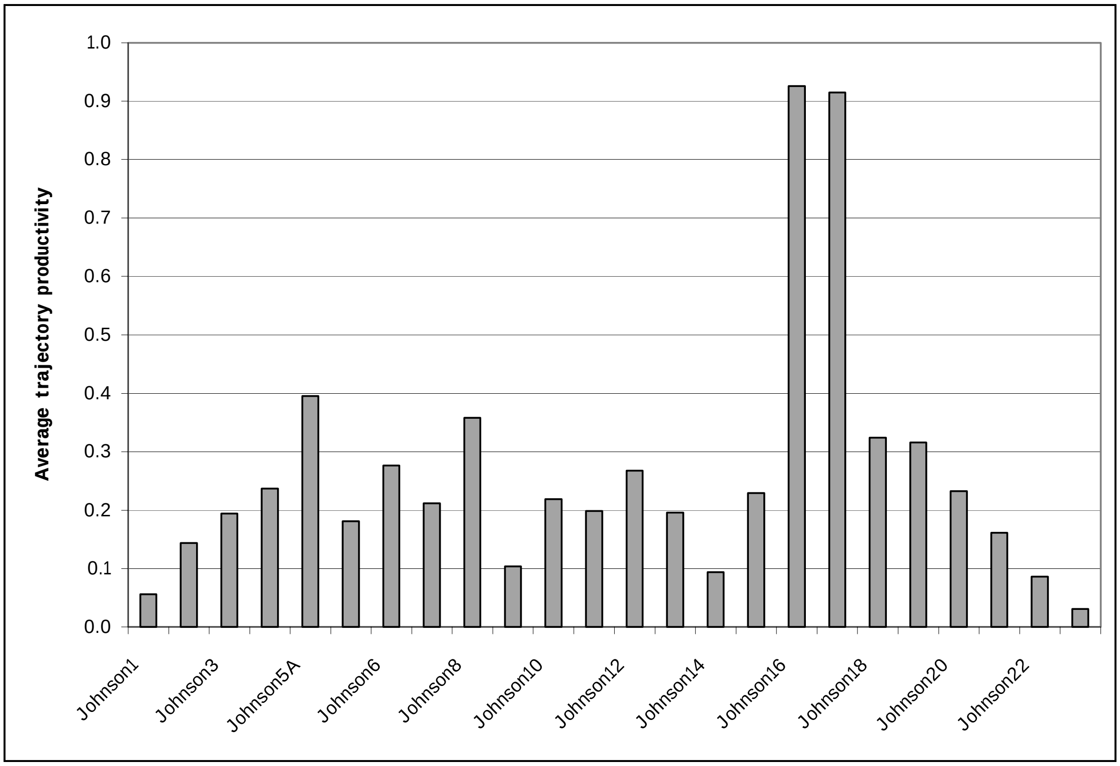


Figure 13. EDT Model Results for Steelhead Trajectory Productivity for Johnson Creek Reaches



	NumberTraj	TrajSustainable	DI	Productivity	Capacity	Neq_Abundance
Degraded	1232	0	0.00%	0.00	0.50	0.00
Current	1232	39	3.00%	2.00	41.30	20.60
Restored	1232	1227	100.00%	17.75	411.60	388.40

Degraded banks are not able to contain flows and withstand erosive forces. Vegetation and especially root systems play a key role in the integrity of stream banks.

Degraded riparian areas are not able to promote channel compensation and integrity. Healthy riparian areas provide structure and complex habitats and connectivity to uplands. Disturbance regimes can result in changes to vegetative classes.

EDT Model results also reveal the importance of restoring **floodplain connectivity**. Particular emphasis should be placed on supporting the following Portland projects in Middle Johnson Creek: Kelley Creek Meanders, Alsop Brownwood, West Lents Restoration, East Lents Restoration including south of Foster and Springwater Wetland Complex Restoration projects. Lower Johnson Creek projects including Tideman Johnson/Errol Heights Restoration, Bell Station Flood Mitigation, and the Westmoreland Park Restoration project should also be a high priority (Portland ESA, 2002).

Excessive sedimentation and **high summer water temperatures** limit production of coho salmon throughout Johnson Creek. Therefore, sediment and water temperature sources should be investigated and riparian buffers should be established to complete shading and provide natural biofiltration.

Lack of food in the Johnson Creek watershed is a function of the lack of habitat (overhanging vegetation and substrate structure) for aquatic species such as benthic macroinvertebrates. Additionally, high flow disturbances and poor water quality conditions including excessive sedimentation are contributing to a lack of food sources and availability.

Recent information on pesticides and other **toxics** that were not incorporated into the EDT Model indicate that water quality may be of greater importance, especially during storm runoff events and the potential for both chronic and acute toxicity levels for aquatic organisms throughout the watershed.

Both animal and human wastes cause high fecal coliform and E. coli bacteria levels. A wide variety of animals utilize habitats throughout the Johnson Creek watershed - both native (wildlife) and domestic (pets and livestock). Human wastes can contribute to high bacteria levels through failing onsite septic systems and wastewater spills and overflows.

2.13 High Priority Areas and Actions

Implementation funds for watershed protection and restoration projects in the near future will be scarce. It is important therefore, to prioritize efforts to achieve the most benefit. To begin focusing efforts of the Johnson Creek Watershed Council in terms of restoring watershed processes to maintain a healthy and sustainable watershed, high priority areas were defined and include:

1) Areas of existing high quality core habitats and refuge areas. These areas will be the focus of **protection** efforts to ensure no further degradation.

2) Areas that contribute to or affect processes and watershed functions and provide the highest **restoration** benefit.

3) Areas that are expected to see significant benefit if protected or restored and where **existing opportunities** exist:

    a. Implementation funds exist or significant planning efforts are already underway or

b. A key watershed function can currently be protected or restored and could significantly reduce future risks or

c. A focused concentrated effort could greatly benefit, open other doors, or provide additional opportunities.

4) Areas that are known **contributors of water quality problems** or degradation to downstream core habitat areas or refuge areas.

High priority areas are shown on Figure 14.

2.13.1 Protection

Protection values as used within the EDT model are the values of protecting a stream section from further degradation. The protection value indicates the decline in abundance in Johnson Creek coho salmon populations that would occur if the section were degraded, and represents the habitat value presently provided by the section.

Evaluations of habitat conditions in Johnson Creek indicate that the best remaining habitat occurs in upper and middle Johnson Creek sections. One of the highest priorities for bringing back salmon in Johnson Creek is to protect these areas from further degradation. Priority areas for protection include Reaches 4-5 (Tideman-Johnson), Reach 8 (82nd to I-205), 10 (SE 106th to SE 110th), and Reaches 12-16 (Brookside to Palmblad Road). Preliminary findings from the EDT Model point to the middle and upper sections of the creek as providing the greatest capacity and productivity for salmonids, and therefore the best areas for habitat protection efforts. Specifically, the section of Johnson Creek from Butler Creek to Hogan Creek (ODFW Reach 16) has the highest quality habitat along the entire mainstem and should receive additional protection measures. In fact, the EDT assessment of Johnson Creek habitat relative to coho salmon indicated that virtually all successful life history trajectories calculated originated from a two-mile stretch of the creek from about Gresham's Main City Park up to Hogan Creek. Due to the fact that overall productivity within Johnson Creek is relatively low and nearly all the production is somewhat dependent on these areas, protecting them is a high priority (McConnaha, 2002). The City of Gresham is proposing to develop an industrial area just upstream of this reach. Planning efforts are underway for this area and are critical for proactively protecting and minimizing downstream impacts to high priority protection reaches.

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Figure 14. High Priority Areas within the Johnson Creek watershed.

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Other priorities include the protection of additional high quality reaches in the middle sections of Johnson Creek, finding additional funds for the willing seller programs, and ensuring that future development in the Pleasant Valley, Damascus, and Springwater annexation areas do not degrade habitat (Mudbug/Prescott 2002).

The highest priority protection needs include:

1) Protect the highest quality habitat core areas and current fish usage areas

   a. Johnson Creek (Tideman-Johnson – Reach 4-5)
   b. Johnson Creek (Butler Creek to Hogan Creek - Reach 15-16)
   c. Crystal Springs Creek
   d. Kelley Creek (mouth to Clatsop Creek), and
   e. Lower Hogan Creek
   f. Other refugia areas

2) Protect those areas that are threatened by future development within the urban growth boundary and expansion areas.

3) Protect to ensure a diversity of habitats exist so that there are multiple nodes with high quality habitat dispersed along Johnson Creek and throughout the watershed.

4) Protect existing off-channel and known over-wintering habitat or areas with stable wintertime flows (Crystal Springs Creek, Brookside, etc.)

5) Protect remaining “pristine” areas on slopes.

2.13.2 Restoration

Restoration value as described within the EDT modeling process is the benefit that could be gained by restoring a given section. It indicates the increase in abundance in Johnson Creek coho salmon populations that would occur if the section were restored, and represents the increase in watershed function gained by restoring each section. Evaluation of habitat conditions in Johnson Creek indicate that middle and lower Johnson Creek have lost much of their historical habitat potential, and would provide the greatest benefit to salmon in Johnson Creek if restored. Specific reaches that will provide the most benefit from restoration include Reaches 4-5, 8, and 12-14 in Johnson Creek, Crystal Springs Creek, Kelley Creek from the mouth to Clatsop Creek, and those areas that are presently contributing known and ongoing water quality problems downstream including Johnson Creek Reaches 17-23, Sunshine Creek, and Kelley Creek. Additional findings from the EDT Model point to the middle and lower sections of Johnson Creek as the best locations to receive the benefit of restoration efforts located nearby or upstream. Restoration activities should address the lack of large wood in the creek, grading of banks and lining of channels as a result of WPA work, high summer water temperatures, excessive sediment loading and sedimentation, and lack of food sources. Restoration priorities include funding projects identified in the Johnson Creek Restoration Plan, especially those in the middle section of Johnson Creek, implementing the Westmoreland Park Restoration project to remove a duck pond, and addressing other well-known heat sources in Crystal Springs Creek (Middaugh/Prescott 2002).

The highest priority restoration needs include:

1) Expand and restore core habitat areas including Johnson Creek Reaches 4-5 and expand outward to include Crystal Springs Creek, and Johnson Creek Reaches 15-16 and expand outward to include Kelley Creek;

2) Restore off-channel and over-wintering habitat areas;

3) Improve quality of reaches that connect habitat core areas including Johnson Creek Reaches 12-14, and off-channel habitats to the main channel;

4) Address watershed wide water quality problems such as sediment, temperature, toxics, and bacteria (focus on upstream sources including Johnson Creek Reaches 17-23, Sunshine Creek, and Kelley Creek that are contributing to problems in downstream habitat core, refuge, and high priority areas). Start with small early action and demonstration projects aimed at sediment and temperature control once sources are identified.

The following is a brief summary of Habitat Attribute Priorities from EDT Model Analysis:

<u>Lower Johnson Creek Segment</u>

1)	Habitat Diversity	- removal of WPA - add Large Wood - restore riparian
2)	Temperature	- cool Crystal Springs
3)	Sediment	- probably derived from upstream sources but need to identify any local sources
4)	Channel Stability	- removal of WPA lining - add large wood
5)	Pollutants	- identify local sources

<u>Middle Johnson Creek Segment</u>

1)	Habitat Diversity	- removal of WPA lining - add large wood - restore riparian
2)	Sediment	- many upstream sources contributing to depositional areas
3)	Temperature	- poor riparian areas - no low flow channel due to WPA lining
4)	Flow	- little winter flow refugia. Remove WPA lining to form low flow channel

5) Food - minimal and more than likely a reflection of significant sediment and water quality problems

Upper Johnson Creek Segment

1) Sediment - many local sources need to be identified and controlled
2) Habitat Diversity - need to increase large wood
3) Flow - summer base flows are a problem
   - could be buffered by increasing habitat, complexity, and protecting and restoring riparian areas
4) Food - minimal and more than likely a reflection of significant sediment and water quality problems
5) Temperature - downstream temperature problems start here. Protect and restore riparian especially in headwaters and tributaries.

2.13.3 Inventorying and Monitoring

The top-tier priority inventorying and monitoring activities identified by the Watershed Assessment include (see Chapter 5 for a list of all high priority monitoring projects):

1) Conduct Total Suspended Solids (TSS) and Turbidity monitoring to identify point and nonpoint pollution sources.
2) Baseline monitoring of E. coli bacteria levels to support establishment and implementation of Total Maximum Daily Load (TMDL).
3) Identification of sources of toxics.
4) Perform EDT modeling for Cutthroat Trout.
5) Additional fish surveys to determine presence and extent of use of all tributaries.

2.13.4 Public Policy and Rules

The top-tier priority activities for developing or implementing public policies and rules include (see Chapter 5 for a list of all high priority public policies and rules):

1) Participate in creation of concept and implementation plans for the Springwater Concept Plan.
2) Support implementation of Clackamas County Water Environment Services (WES) new Development Standards related to Erosion Prevention and Sediment Control.
3) Support implementation of new Development Standards related to City of Portland Title 10 – Erosion Control
4) Participate in creation of concept and implementation plans for the Damascus Concept Plan.
5) Participate in creation of concept and implementation plans for the Pleasant Valley Concept Plan.

In addition, provide long-term sustainable funding sources for conservation programs and land acquisition. Priority Land Protection and Acquisition areas include:

a. Confluence of Sunshine, Badger, North Fork Johnson Creek and the mainstem of Johnson Creek
b. Just downstream in Reach 17 to connect to Reach 16
c. Large wetland complex in the middle of Sunshine Creek
d. Errol Heights Creek and Johnson Creek Oxbow areas
e. Small perennial unnamed tributary (referred to as "Wheeler Creek") and the confluence of the mainstem Johnson Creek
f. Lents area east of Freeway Land Company and south of Foster
g. Lents area west of I-205

2.13.5 Public Involvement and Education

The top-tier priority activities to reach out and engage the public include (see Chapter 5 for a list of all high priority public policies and rules):

1) Implement Lower Willamette Agricultural Water Quality Plan.

2) Implement Landowner Outreach Program in Upper Johnson Creek.

3) Work with private landowners to restore creek and riparian areas to provide flood storage and improve habitat and water quality in Middle Johnson Creek.

4) Implement watershed wide construction BMP program.

5) Implement a comprehensive stormwater/watershed Public Involvement & Education program that includes information, education, involvement, and stewardship.

2.13.6 Summary

For watershed action implementation to be successful, restoration and protection actions need to be prioritized in terms of need, effectiveness, and effect on future actions and programs. Actions need to be sequenced so that implementing one doesn't impact the effectiveness of another. As suggested in the City of Portland's Framework for Integrated Management of Watershed and River Health the following elements and their order is a matter of importance:

1) **Protect existing populations and their habitats.** Rebuilding an existing population is far more likely to be successful than reintroducing a population that has been lost.

2) **Reconnect favorable habitats.** This allows existing populations to provide 'colonists" that can reestablish satellite populations in nearby habitat where populations have been extirpated.

3) **Identify and control sources of degradation.** Causes of degradation should be identified and quantified before their impacts within the watershed are addressed.

4) **Restore the processes that maintain watershed health.**

   a. Normalize flow and hydrology;
   b. Restore physical habitat;
   c. Improve water quality; and
   d. Reestablish biological communities.

Other activities that require attention, program development, additional assessment and need to be implemented generally include:

- Water quality improvements in areas that are upstream and contributing to high priority areas;
- Low flow augmentation and irrigation efficiency improvements;
- Channel and floodplain reconnection;
- Fish passage improvement and connectivity.

CHAPTER 3.0 PRIORITY REACHES, GOALS AND OBJECTIVES

Introduction

The Johnson Creek Technical Advisory committee selected priority areas based on ODFW habitat surveys, the Ecosystem Diagnosis and Treatment (EDT) model, the Johnson Creek Watershed Assessment, and the best professional judgment of the Technical Advisory Committee. These areas were identified to distribute limited resources towards a strategy to protect, expand, and connect key refugia. Protection of existing functions is the highest priority because it is more economically and ecologically efficient to prevent degradation than correct it.

Core Habitat areas were identified to protect the most functional reaches in the watershed. Restoration areas were identified as areas of high restoration potential or high need to expand nearby functions. Connectivity areas are those areas needed to provide access to habitat areas from other refugia and from the Willamette. Special opportunities also exist where significant funding or planning is underway and opportunities for collaboration should not be missed. Finally, the committee targeted upper Johnson Creek as a Source Identification area because more information is needed to begin controlling sources of water quality degradation in that area.

It is important to note that other areas within the watershed are also important, and that projects that influence or take place in those areas should continue. Because the Johnson Creek Comprehensive Watershed Action Plan (WAP) is adaptive, the location of these priority areas is subject to change based on additional information and study or as objectives are met for an area. Likewise, the targets and benchmarks for these areas will change as knowledge of the watershed improves.

The WAP uses salmonids as an indicator of watershed health because their health, abundance and productivity are highly responsive to all components of watershed health including hydrology, habitat and water quality. While other nonaquatic indicators exist, salmonids were chosen for the City of Portland Framework for Integrated Management of Watershed and River Health (2002). There is more available information about the life histories of salmonids and the relationships between stream conditions and salmonid health than most other species in the Pacific Northwest. However, to provide a complete plan for improving watershed health, future updates of the Framework Plan will include scientific principals for terrestrial, non-aquatic species and the WAP will be updated to include objectives, targets and benchmarks focused around terrestrial indicators.

Goals and Objectives

Each priority area has an overall watershed health vision. In addition four watershed health goals are broadly applied to all priority areas. While these goals are not intended to reestablish pre-development conditions they do aim to establish a healthy, ecologically functioning watershed. They are also intended to provide guidance for areas where current conditions may be substantially different from historical conditions. They include the areas of hydrology, physical habitat, water quality and biological communities:

- **Hydrology-** Move towards historical flow conditions to protect and improve watershed and stream health, channel function and public health and safety, while protecting infrastructure.
- **Physical Habitat-** Protect, enhance and restore aquatic and terrestrial habitat conditions to support key ecological functions and improved productivity, diversity, capacity and distribution of native fish and wildlife populations and biological communities.

- **Water Quality-** Protect and improve surface water and groundwater quality and meet or surpass state and federal water quality standards and regulations.
- **Biologic Communities-** Protect, enhance and restore target aquatic and terrestrial species and biologic communities to maintain biodiversity in the watershed.

For each priority area, objectives were developed related to these four goals. Each objective has one or more indicators to measure the level of function. Many of the same indicators can be used to measure different objectives. For each indicator, the reference condition, baseline condition, and target are defined.

The reference condition is defined by what the indicator would be if no impact or degradation had occurred[1]. In some cases, the reference condition may be similar to pre-development conditions. The baseline condition is the indicator under current conditions[2]. In many cases, more information is needed about baseline conditions. The target is the condition pursued to meet the objective. Targets are established to match reference conditions as closely as possible while taking into account what can realistically be achieved given conflicting uses.

Each target contains a series of benchmarks is defined to guide progress toward the target. The benchmarks are based on known opportunities and constraints such as landowner participation, identified funding sources, current projects and plans, and urban growth. The benchmark numbers are highly susceptible to change, and will be updated as more information is available regarding baseline conditions and program effectiveness.

Finally, in some priority areas key actions are identified that may help meet targets and benchmarks. These kinds of actions lead into projects outlined in chapter 6. Actions are not identified for each target and benchmark. Rather, they are pointed out where it is apparent that the action may lead to achievement of a benchmark or target.

While the following objectives, targets and benchmarks address the highest priority limiting factors in each area, it is important to note that the projects identified to meet targets and benchmarks may not be located in that area. Some limiting factors such as sedimentation and pollutants in the creek can be attributed to sources upstream or in the uplands. Once those sources are located, the contributing areas or catchments may receive their own set of objectives, targets and benchmarks addressing these watershed-wide problems.

[1] Much of the information for reference conditions is based on Framework for Integrated Management of Watershed and River Health, City of Portland, Oregon, November 2002.

[2] Data on baseline conditions is drawn from GIS analysis and Aquatic Inventories Project Physical Habitat Surveys 1999/2000, Oregon Department of Fish and Wildlife.

3.1 Core Habitat Areas

Introduction

Core habitat areas are areas of relatively high function within the Johnson Creek Basin and offer the highest level of productivity. These areas are close to meeting the standards for hydrology and physical habitat. Functionality in terms of water quality and biological communities, while still important, are difficult to address on a reach-by reach basis.

The overall watershed health vision for Core Habitat Areas is to protect existing areas of high productivity from activities that could degrade hydrology, physical habitat, water quality and biological communities and provide restoration as necessary to increase productivity.

The following Objectives and Indicators apply to the four watershed health goals:

3.1.1 Goal 1: Hydrology

Core Habitat Area Objective 1

Protect existing floodplain habitat from degradation and development.

Indicator 1(a): Acreage of floodplain protected through public acquisition, conservation easements or other landowner stewardship agreements.

Core Habitat Area Objective 2

Improve stream flow and availability of over-wintering habitat by improving access of flows to the floodplain.

Indicator 2(a): Area of connected floodplain

Core Habitat Area Objective 3

Improve hydrologic conditions and stream flow to more closely match predevelopment conditions.

Indicator 3(a): Hydrograph alteration

Core Habitat Area Objective 4

Improve summertime base flows.

Indicator 4(a): Amount of water removed or impounded during summertime[3].

3.1.2 Goal 2: Physical Habitat

Core Habitat Area Objective 5

Improve salmonid productivity by restoring summer and winter spawning and rearing habitat.

Indicator 5(a): Large Wood

Indicator 5(b): Riparian Integrity

Indicator 5(c): Channel and Bank Hardening

Indicator 5(d): Percent of Fine Sediment in Riffle Substrate

Indicator 5(e): Removal or Improvement of Passage Barriers[4]

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[3] Volume of summertime base flow may be used as an alternate indicator in future revisions

[4] Miles of stream habitat accessible to juvenile salmonids may be used as an alternate indicator in future revisions

Indicator 5(f): Acreage of riparian area protected through public acquisition, conservation easements or other landowner stewardship agreements.

3.1.3 Goal 3: Water Quality

Core Habitat Area Objective 6

Water Quality meets or exceeds standards for protection of human health and fish safety. DEQ set TMDL standards to be met throughout the watershed. Therefore, until additional baseline information is collected and sources are identified, the baseline conditions and targets will be the same for all core habitat reaches.[5]

Indicator 6(a): Toxics (Surrogate to be used is Total Suspended Solids)

Reference Condition: Low levels of toxics and sediment. No exceedances of state water quality standards (see Assessment, Chapter 2.9.7).

Baseline Condition: Routine and storm event monitoring has revealed high levels of both TSS and Turbidity. Relatively high turbidity levels were measured during both high and low flow conditions, and are most likely a result of bank erosion, roadside ditch erosion, runoff from construction activities, and runoff from agricultural and nursery operations. Toxics (DDT, Dieldrin, PAH, and PCBs) have been detected in both water column and sediment samples with some exceedances of standards. DDT was identified as a problem based on the results of a USGS investigation. Pollutant concentrations detected in 1989 had been reduced by an order of magnitude by 1994.

Target:___ mg/L TSS during stormwater conditions by 2020*

___mg/L TSS during other times throughout the basin by 2020*

* Specific target concentrations forthcoming in Draft TMDL currently in preparation and due in December 2003.

Benchmarks: ___ mg/L TSS during stormwater conditions by 2010

___ mg/L TSS during stormwater conditions by 2015

___ mg/L TSS during stormwater conditions by 2020

___ mg/L TSS during other times throughout the basin by 2010

___ mg/L TSS during other times throughout the basin by 2015

___ mg/L TSS during other times throughout the basin by 2020

Indicator 6(b): Temperature (System potential effective shade level)

Reference Condition: 7-day average maximum daily temperature is below 17.8˚C; below 12.8˚C during spawning and incubation periods, and system potential meets 80% effective shade level.

Baseline Condition: Temperature standards are frequently exceeded throughout the Johnson Creek watershed during the summer months. There are more total days with

[5] Indicators are based on DEQ Total maximum daily loads.

maximum temperature above 20˚C when moving downstream. More information is needed on temperatures in the target reach.

Target: 80% Effective Shade Site Potential by 2040*

* This percentage is preliminary and may be revised in the Draft TMDL currently in preparation and due in December 2003.

Benchmarks: 50 % Effective Shade Potential by 2015

60% Effective Shade Potential by 2025

75 % Effective Shade Potential by 2030

Indicator 6(c): Bacteria

Reference Condition: Low levels of bacteria throughout the watershed with no exceedances of state water quality standards (see Assessment, Chapter 2.9.7).

Baseline Condition: Routine monitoring has revealed high bacteria levels that exceed state water quality standards (see Assessment, Chapter 2.9.7) throughout the Johnson Creek watershed. Exceedances occur both during winter storm events as well as during the dry summer periods.

Target: 75 – 80 percent reduction in bacteria levels by 2020*

* This percentage is preliminary and may be revised in the Draft TMDL currently in preparation and due in December 2003.

Benchmarks: 25 percent reduction in bacteria levels by 2010

40 percent reduction in bacteria levels by 2015

60 percent reduction in bacteria levels by 2018

Indicator 6(d): PAH's

Reference Condition: Extremely low levels not hazardous to aquatic or terrestrial life.

Baseline Condition: PAHs were proposed for listing as a pollutant of Johnson Creek in 2002 based on sampling data of 42.3 ng/L. The human health standard for water and fish ingestion is 2.8 ng/L. New studies indicate that fish are sensitive at lower rates.

Target: More information is needed on levels safe for fish. Human health standards should be met by 2040

Benchmarks: More information is needed on sources and current levels

Work with DEQ to develop TMDLs by 2010

3.1.4 Goal 4: Biological Communities

Core Habitat Area Objective 7

Improve environmental conditions to increase habitat for macroinvertebrates and salmonids. Insufficient data exists to support development of targets and benchmarks for individual reaches. General targets and benchmarks for core habitat areas are based on available data.

Indicator 7(a): Benthic Index of Biological Integrity (B-IBI)

Reference Condition: B-IBI score of 50. A balanced, integrated adaptive assemblage of organisms having species composition, diversity, and functional organization comparable to that of natural habitats in the region. High biological integrity.

Baseline Condition: IBI scores obtained at three locations in Johnson Creek within Gresham during the late summer of 2001 ranged between 12 and 20. Scores in 2001 that were <20 indicated severe impairment and conditions present were indicative of a high level of disturbance.

Target: B-IBI of 38 or higher by 2030

Benchmarks: B-IBI of 25 or higher by 2015

B-IBI of 30 or higher by 2020

B-IBI of 35 or higher by 2025

3.1.5 Core Habitat Area 1: Lower Kelley Creek (H1)

Lower Kelley Creek Core Habitat Area is comprised of two distinct areas, ODFW Reach 1 below Foster Road, and ODFW Reach 2 from Foster Road to Clatsop Cr confluence. Reach 1 is heavily channelized and has impacted riparian zones consisting of broad floodplains and drained wetlands. It also offers high potential for off-channel and overwintering refugia. The City of Portland owns land at the confluence of Kelley and Johnson Creeks and plans to begin construction of backwater channels and stormwater detention facilities in summer of 2004. With those improvements and the riparian plantings that will accompany them, this area will become a key refuge, rearing and spawning habitat area along Johnson Creek.

In Reach 2, Kelley Creek is largely confined to a narrow canyon, which has inhibited development and allowed a mature second growth canopy to form. The canopy has some openings, which the landowner (the Hawthorne Ridge Homeowner's Association) is currently working to fill. Physical habitat is functional in this area, and steelhead and cutthroat have been sampled. Water quality and flow are problematic, and should be addressed.

The Kelley Creek watershed was added to the Urban Growth Boundary in 1997 and in 2002. Concept planning was completed in 2002 for half the watershed, and annexation is scheduled to begin by 2005. This will inevitably alter the condition of the Kelley Creek system. It is anticipated that urbanization will provide an opportunity to protect and restore riparian habitat, address passage barriers, and reduce erosion. Additional planning work is necessary for the areas of the watershed added into the UGB in 2002.

Target salmonid populations:

- Coho, Steelhead, and Cutthroat spawning and rearing habitat
- Resident Cutthroat and Rainbow

Indicator 1(a) & 5(f): Acreage of floodplain and riparian area protected through public acquisition, conservation easements or other landowner stewardship agreements.

> **Baseline Condition**: 5.22 Acres owned by City of Portland and Hawthorne Ridge Homeowners Assn
>
> **Target**: Approximately 15 acres. Because the area is within the Pleasant Valley District Plan, which identifies riparian corridors as Environmentally Sensitive/Restoration Areas, as these areas are annexed there will be excellent protection opportunities working with current landowners and potential developers.
>
> **Benchmarks**:
>
> **10 acres by 2010**
>
> **15 acres by 2015**

Indicator 2(a): Area of connected floodplain

> **Reference Condition**: Narrow valley floor with multiple, braided channels at low flow. At high flow, significant backwater channels and some flooding.
>
> **Baseline Condition:** Below Foster Rd. Culvert, Creek is rock lined, or has incised to significantly reduce floodplain access. Potential habitat areas are open fields owned by City of Portland, and a large groundwater-fed pond. This pond could provide excellent over-wintering and rearing habitat if conflicts with existing uses can be addressed. Above Foster Road, Kelley

Creek is in a constrained canyon. Some incising has occurred, limiting access to the narrow floodplain. Multiple channels exist in some areas during low flows. Little off-channel refuge.

Target: Create at least one area of off-channel refuge above Foster Rd. and major complex below Foster Rd.

Benchmarks: Lower area: Design and construction by 2010

Upper area: design and construction by 2020

Indicator 3(a): Hydrograph alteration

Reference Condition: Annual hydrograph mimics historical hydrograph

Baseline Condition: Hydrograph altered – extremely high flows associated with storm events. Additional information needed to quantify flow patterns.

Target: Manage stormwater from existing and new development such that there is no runoff from small storms leading to further incision

Benchmarks: All new development manages a minimum of 90% of the annual rainfall such that there is no runoff from impervious surfaces.

Actions:

Necessary codes and manuals established or updated to reach target by 2004.

Enforcement and maintenance system established by 2006.

Indicator 4(a): Amount of water removed or impounded during summertime

Reference Condition: Impoundments are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: More information is needed on withdrawals from Kelley Creek system. As urbanization proceeds in this area, water withdrawals and on-channel impoundments will likely decline. More information is also needed on contributions to surface water from ground water sources related to wells and irrigation.

Target: Minimum base flow meets state and federal standards for salmon.

Benchmarks: Additional Baseline information is needed.

Indicator 5(a): Large Wood

Reference Condition: >20 pieces/ 100m stream length

Baseline Condition: Wood is low at 1.3 pieces per 100 m (ODFW survey) below Foster Rd and 1 piece per 100 m above.

Target: >20 pieces/ 100m stream length by 2050

Benchmarks: >5 pieces/ 100m stream length by 2020

>10 pieces/ 100m stream length by 2030

>15 pieces/ 100m stream length by 2040

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft, composed of mature native vegetation, with > 2 stream crossings/ KM of stream length.

Baseline Condition: Of the 48 acres of riparian corridor, 24.9 acres are fields, roads, houses, and other development. Approximately 9 acres of this area could be planted if landowners allow. The remaining 23.1 acres have a mix of mature riparian vegetation and invasive Blackberry and English ivy. Surrounding rural residential land use has potential to encroach on riparian areas

Target: Continuous corridor of up to 300 ft composed of mature native vegetation as feasible based on constraints of development. Vegetated areas are in free to grow condition with invasive species under control. Adjacent landowners participate in protecting and restoring quality riparian areas.

Benchmarks: Remove all invasive species by 2010

Plant 25% of available areas by 2010

Plant 50% by 2020

Plant 100% by 2040

Stewardship agreements with landowners by 2020

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: Below foster: 23% silt/sand/organics in riffle substrate; Above foster, 25% silt/Organics in riffle substrate

Target: 20% or less by 2020; maintain at 20% or less during and after urbanization.

Benchmarks:

Implement agricultural rules on appropriate properties by 2005

Erosion control and stormwater master plan in place by 2005 (when annexation begins upstream)

All developers make public pledge to use best erosion control available as construction begins

Indicator 5(e): Removal or improvement of passage barriers

Reference Condition: Barriers are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: Steps built by WPA for grade control create summertime barrier.

Target: Remove summertime barriers by 2005

Benchmarks: Remove summertime barriers by 2005

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets

3.1.6 Core Habitat Area 2: Upper Mitchell Creek (H2)

Upper Mitchell Creek is among the most pristine areas within the Johnson Creek Watershed. A well-formed second-growth forest serves the creek well. Flow is moderated by the forest and by instream structure. Temperatures are cool and water quality is impacted primarily by a point source scheduled for decommissioning. Fish presence has been noted, and 36 acres of the riparian area is publicly owned and protected.

Target salmonid populations:

- Steelhead, and Cutthroat spawning and rearing habitat
- Resident Cutthroat and Rainbow

Indicator 1(a) & 5(f): Acreage of floodplain and riparian area protected through public acquisition, conservation easements or other landowner stewardship agreements.

Reference Condition:

Baseline Condition: 68.7 acres protected in Metro owned parcels

Target: 25 additional acres by 2040

Benchmarks: 5 additional acres by 2015

15 additional acres by 2025

20 additional acres by 2035

Indicator 3(a): Hydrograph alteration

Reference Condition: High-gradient stream with backwater channels; during low flows, pools provide fish habitat while subsurface flow keeps temperature cool.

Baseline Condition: Upper Mitchell Creek is a high-gradient stream; refuge is provided by several small backwater channels, and by instream structure.

Target: Maintain flow regime

Indicator 5(a): Large Wood

Reference Condition: >20 pieces/ 100m stream length

Baseline Condition: Wood is low at 6 pieces per 100 m (ODFW survey).

Target: >20 pieces/ 100m stream length by 2050

Benchmarks: >5 pieces/ 100m stream length by 2020

>10 pieces/ 100m stream length by 2030

>15 pieces/ 100m stream length by 2040

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft, composed of mature native vegetation, with > 2 stream crossings/ KM of stream length.

Baseline Condition: Of the 71 acres within the riparian buffer zone, 3.4 acres are developed or deforested. This portion of the Mitchell Creek watershed is possibly the most pristine in the Johnson Creek system with a mature, multi-layered canopy.

Target: Continuous corridor of up to 300 ft composed of mature native vegetation as feasible based on constraints of development. Vegetated areas are in free to grow condition with invasive species under control. Adjacent landowners participate in protecting and restoring quality riparian areas.

Benchmarks: Remove all invasive species by 2010

Plant 100% of available areas by 2010

Stewardship agreements with adjacent landowners by 2020

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: Riffles account for 34% of stream length. Silt and organics comprise 9% of riffle substrate; sand accounts for 21%. On average, silt/Organics and sand comprise 11 and 22% of the overall substrate.

Target: 20% or less by 2040. Protect from degradation by identifying and addressing sediment sources.

Indicator 5(e): Removal or improvement of passage barriers

Reference Condition: Barriers are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: No known artificial passage barriers. Concrete debris in stream channel scheduled for removal by summer 2004.

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets

3.1.7 Core Habitat Area 3 Kelley Creek Reaches 7 and 8 (H3)

Core Habitat Area 3, Kelley Creek ODFW Reach 8 and part of 7, is home to a self-sustaining population of cutthroat trout. While several barriers downstream make this habitat no more than a fragment, it is functional for resident cutthroat. The functional riparian corridor composed of second-growth forest and pastures provides shade, organic and woody input, and stormwater filtration. Instream complexity is good, with some secondary channels, wood and some boulders providing refuge. Floodplain access is good, though off-channel habitat is limited.

The Urban Growth Boundary expansion of 2002 added this area for future urbanization. As urbanization proceeds, it will be critical to protect this resource from increased flow, decreased water quality, and riparian encroachment.

Target salmonid populations:

- Coho, Steelhead, and Cutthroat spawning and rearing habitat
- Resident Cutthroat and Rainbow

Indicator 1(a) & 5(f): Acreage of floodplain and riparian area protected through public acquisition, conservation easements or other landowner stewardship agreements.

Baseline Condition: 15.6 acres of riparian area owned by Metro

Target: 12 additional acres in Johnson Creek riparian area and floodplain by 2040. Urban redevelopment may provide protection opportunities.

Benchmarks: Work with landowners and developers to develop stewardship agreements, conservation easements or acquisition of

5 additional acres by 2010

10 addition acres by 2025

12 additional acres by 2040

Indicator 2(a): Area of connected floodplain

Reference Condition: Multiple braided channels with some lateral motion within broad floodplain and wetland complex.

Baseline Condition: Floodplain access is good in these reaches, though off channel habitat is sparse. High flows downstream are nonetheless common.

Target: Maintain creek access to floodplain; protect instream complexity. Protect terraces from development that would compromise floodplain and backwater channels.

Indicator 3(a): Hydrograph alteration

Reference Condition: Annual hydrograph mimics historical hydrograph

Baseline Condition: Hydrograph altered –high flows associated with storm events. Additional information needed to quantify flow patterns.

Target: Manage stormwater from existing and new development such that there is no runoff from small storms leading to further incision

Benchmarks: All new development manages a minimum of 90% of the annual rainfall such that there is no runoff from impervious surfaces.

Actions:

Necessary codes and manuals established or updated to reach target by 2008.

Enforcement and maintenance system established by 2010.

Indicator 4(a): Amount of water removed or impounded during summertime

Reference Condition: Impoundments are formed by deposition of large wood, beaver activity, or other natural methods. Summer low flows provide adequate cool water for fish survival.

Baseline Condition: impoundments are caused by private driveways in these reaches and upstream. More information needed on summer flows to determine adequacy.

Target: Minimum base flow meets state and federal standards for salmon.

Benchmarks: Additional Baseline information is needed.

Indicator 5(a): Large Wood

Reference Condition: >20 pieces/ 100m stream length

Baseline Condition: Reach 8 had low wood at 1.87 pieces per 100 meters, though the existing wood was highly functional. Reach 7 had very low wood content at .4 pieces per 100m.

Target: >20 pieces/ 100m stream length by 2040. Total reach length is approximately 670m (2200ft).

Benchmarks: >5 pieces/ 100m stream length by 2010

>10 pieces/ 100m stream length by 2020

>15 pieces/ 100m stream length by 2030

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft, composed of mature native vegetation, with > 2 stream crossings/ KM of stream length.

Baseline Condition: Of the 37 acres of riparian corridor, approximately 27.4 have forested canopy. Of the remaining 9.4 acres, 2 are occupied by houses, roads and trails.

Target: Continuous corridor of up to 300 ft composed of mature native vegetation as feasible based on constraints of development. Vegetated areas are in free to grow condition with invasive species under control. Adjacent Landowners participate in protecting and restoring riparian areas.

Benchmarks: Remove all invasive species by 2010

Plant 25% of available areas by 2010

Plant 50% by 2020

Plant 100% by 2040

Stewardship agreements with Landowners by 2020.

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: 14% silt/sand/organics in riffle substrate (ODFW). 47% gravel in riffle.

Target: Maintain at 20% or less by 2040.

Benchmarks: More information needed on sources of sediment to reduce risk of additional fine sediment accumulation. Critical to prevent sediment runoff and instability from south slope.

Indicator 5(e): Removal or improvement of passage barriers

Reference Condition: Barriers are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: Alder Rd presents .7 m drop. Many downstream barriers.

Target: address culvert on Alder rd by 2010. Development of this area may present upgrade opportunities.

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets

3.1.8 Core Habitat Area 4: Johnson Creek Reach 16 (H4)

Core Habitat Area 4, Johnson Creek ODFW Reach 16, is the most functional reach on the main stem of Johnson Creek. The functional riparian corridor composed of second-growth forest and well-managed pastures provides shade, organic and woody input, and stormwater filtration. Instream complexity is good, with some secondary channels, wood and some boulders providing refuge. Water quality and flow, however, are impaired by upstream uses. The Ecosystem Diagnosis and Treatment model indicates that Reach 16 is the only reach in Johnson Creek that functions sufficiently to support coho trajectories.

The Urban Growth Boundary expansion of 2002 added this area and some upstream areas for future urbanization. As urbanization proceeds, it will be critical to protect this resource from increased flow, decreased water quality, and riparian encroachment.

Target salmonid populations:

- Coho, Steelhead, and Cutthroat spawning and rearing habitat
- Resident Cutthroat and Rainbow

Indicator 1(a) & 5(f): Acreage of floodplain and riparian area protected through public acquisition, conservation easements or other landowner stewardship agreements.

Baseline Condition: 90.9 acres owned by the City of Gresham and Metro along Johnson Creek

Target: 33 additional acres in Johnson Creek riparian area and floodplain by 2050. Development of Springwater Development area may provide protection opportunities.

Benchmarks: Work with landowners and developers to develop stewardship agreements, conservation easements or acquisition of

10 additional acres by 2010

20 addition acres by 2025

30 additional acres by 2040

Indicator 2(a): Area of connected floodplain

Reference Condition: Multiple braided channels with some lateral motion within broad floodplain and wetland complex.

Baseline Condition: Backwater channels and deep pools are prevalent in this reach, although entrenchment is evident as well. Protection from further downcutting is critical in this reach.

Target: Maintain creek access to floodplain; protect instream complexity. Protect terraces from development that would compromise floodplain and backwater channels.

Benchmarks:

Indicator 3(a): Hydrograph alteration

Reference Condition: Annual hydrograph mimics historical hydrograph

Baseline Condition: Hydrograph altered – extremely high flows associated with storm events. Additional information needed to quantify flow patterns.

Target: Manage stormwater from existing and new development such that there is no runoff from small storms leading to further incision

Benchmarks: All new development manages a minimum of 90% of the annual rainfall such that there is no runoff from impervious surfaces.

Actions:

Necessary codes and manuals established or updated to reach target by 2008.

Enforcement and maintenance system established by 2010.

Indicator 4(a): Amount of water removed or impounded during summertime

Reference Condition: Impoundments are formed by deposition of large wood, beaver activity, or other natural methods. Summer low flows provide adequate cool water for fish survival.

Baseline Condition: More information is needed on withdrawals from Johnson Creek system. As urbanization proceeds upstream, water withdrawals and on-channel impoundments will likely decline. More information is also needed on contributions to surface water from ground water sources related to wells and irrigation.

Target: Minimum base flow meets state and federal standards for salmon.

Benchmarks: Additional Baseline information is needed.

Indicator 5(a): Large Wood

Reference Condition: >20 pieces/ 100m stream length

Baseline Condition: With 4.8 pieces per 100m, this reach is among the highest within Johnson Creek. Nevertheless, wood is low compared to the reference condition, and boulders are absent. (ODFW survey)

Target: >20 pieces/ 100m stream length by 2040. Total reach length is approximately 4100m.

Benchmarks: >5 pieces/ 100m stream length by 2010

>10 pieces/ 100m stream length by 2020

>15 pieces/ 100m stream length by 2030

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft, composed of mature native vegetation, with > 2 stream crossings/ KM of stream length.

Baseline Condition: Of the 167 acres of riparian corridor, approximately 117 have forested canopy. Of the remaining 50 acres, all but 6.7 are occupied by houses roads and trails. 24.9 acres are fields, roads, houses, and other development.

Target: Continuous corridor of up to 300 ft composed of mature native vegetation as feasible based on constraints of development. Vegetated areas are in free to grow condition with invasive species under control. Adjacent Landowners participate in protecting and restoring riparian areas.

Benchmarks: Remove all invasive species by 2010

Plant 25% of available areas by 2010

Plant 50% by 2020

Plant 100% by 2040

Stewardship agreements with Landowners by 2020.

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: 18% silt/sand/organics in riffle substrate (ODFW).

Target: Maintain at 20% or less by 2040.

Benchmarks: More information needed on sources of sediment to reduce risk of additional fine sediment accumulation.

Indicator 5(e): Removal or improvement of passage barriers

Reference Condition: Barriers are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: No known artificial passage barriers.

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets

3.1.9 Core Habitat Area 5: Hogan Creek ODFW Reach 1 (H5)

Length: 870 feet

Riparian area total: 18 acres

Forested: 15 acres

Developed: 2

Public: 16 acres

Core Habitat Area 5, Hogan Creek Reach 1, is a functional confluence area where Hogan Creek drains into Core Habitat area 4. The functional riparian corridor composed of second-growth forest. Upstream detention ponds help prevent sedimentation, but also contribute to higher water quality. More information is needed on water quality and in-stream structure, though the reach is promising due to public ownership of riparian resources.

The Urban Growth Boundary expansion of 2002 added this area and some upstream areas for future urbanization. As urbanization proceeds, it will be critical to protect this resource from increased flow, decreased water quality, and riparian encroachment.

Target salmonid populations:

- Coho, Steelhead, and Cutthroat spawning and rearing habitat, refuge from Johnson Creek
- Resident Cutthroat and Rainbow

Indicator 1(a) & 5(f): Acreage of floodplain and riparian area protected through public acquisition, conservation easements or other landowner stewardship agreements.

Baseline Condition: 16 acres owned by the City of Gresham along Johnson Creek

Target: Develop stewardship agreements with two residents by 2005.

Indicator 2(a): Area of connected floodplain

Reference Condition: Multiple braided channels with some lateral motion within broad floodplain and wetland complex.

Baseline Condition: More information needed.

Target: More information needed

Benchmarks: More information needed

Indicator 3(a): Hydrograph alteration

Reference Condition: Annual hydrograph mimics historical hydrograph

Baseline Condition: Hydrograph altered –high flows associated with storm events possibly due to upstream development. Additional information needed to quantify flow patterns.

Target: Manage stormwater from existing and new development such that there is no runoff from small storms leading to further incision

Benchmarks: All new development manages a minimum of 90% of the annual rainfall such that there is no runoff from impervious surfaces.

Indicator 4(a): Amount of water removed or impounded during summertime

Reference Condition: Impoundments are formed by deposition of large wood, beaver activity, or other natural methods. Summer low flows provide adequate cool water for fish survival.

Baseline Condition: At least one impoundment in this area exists for detaining stormwater. Continued work to ensure low sediment and temperature loading will protect downstream reaches. More information is needed to determine adequacy of summertime flow.

Target: Minimum base flow meets state and federal standards for salmon.

Benchmarks: Additional Baseline information is needed.

Indicator 5(a): Large Wood

Reference Condition: >20 pieces/ 100m stream length

Baseline Condition: With 4.8 pieces per 100m, this reach is among the highest within Johnson Creek. Nevertheless, wood is low compared to the reference condition, and boulders are absent. (ODFW survey)

Target: >20 pieces/ 100m stream length by 2040. Total reach length is approximately 4100m.

Benchmarks: >5 pieces/ 100m stream length by 2010

>10 pieces/ 100m stream length by 2020

>15 pieces/ 100m stream length by 2030

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft, composed of mature native vegetation, with > 2 stream crossings/ KM of stream length.

Baseline Condition: Of the 167 acres of riparian corridor, approximately 117 have forested canopy. Of the remaining 50 acres, all but 6.7 are occupied by houses roads and trails. 24.9 acres are fields, roads, houses, and other development.

Target: Continuous corridor of up to 300 ft composed of mature native vegetation as feasible based on constraints of development. Vegetated areas are in free to grow condition with invasive species under control. Adjacent Landowners participate in protecting and restoring riparian areas.

Benchmarks: Remove all invasive species by 2010

Plant 25% of available areas by 2010

Plant 50% by 2020

Plant 100% by 2040

Stewardship agreements with Landowners by 2020.

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: 18% silt/sand/organics in riffle substrate (ODFW).

Target: Maintain at 20% or less by 2040.

Benchmarks: More information needed on sources of sediment to reduce risk of additional fine sediment accumulation.

Indicator 5(e): Removal or improvement of passage barriers

Reference Condition: Barriers are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: No known artificial passage barriers.

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets

3.2 Restoration Areas

Introduction

Priority Restoration areas are those areas that offer high potential for salmon and trout production if functions are restored. In many cases, these are areas that are close to reaching one or more key functional goals. Opportunities to address flow and hydrology, physical habitat, and water quality are evident. Surveys may have indicated high fish presence in these areas.

The overall watershed health vision for Priority Restoration Areas is to add to existing areas of high productivity (Core Habitat Areas) by restoring additional spawning and rearing areas.

The following Objectives and Indicators apply to the four watershed health goals:

3.2.1 Goal 1: Hydrology

Restoration Area Objective 1

Improve stream flow and availability of over-wintering habitat by improving access of flows to the floodplain.

Indicator 1(a): Area of connected floodplain

Indicator 1(b): Impervious Surfaces

Indicator 1(c): Vegetation Removal

Restoration Area Objective 2

Restore wetlands and backwater channels to improve flood storage capacity and over-wintering habitat in the floodplain.

Indicator 2(a): Acres of restored wetlands and backwater channels

Restoration Area Objective 3

Improve hydrologic conditions and stream flow to more closely match predevelopment conditions.

Indicator 3(a): Hydrograph alteration

Indicator 3(b): Impervious Surfaces (cross-reference 1(b))

Restoration Area Objective 4

Improve summertime base flows.

Indicator 4(a): Amount of water removed or impounded during summertime[6].

3.2.2 Goal 2: Physical Habitat

Restoration Area Objective 5

Improve salmonid productivity by restoring summer and winter spawning and rearing habitat.

Indicator 5(a): Large Wood

Indicator 5(b): Riparian Integrity

Indicator 5(c): Channel and Bank Hardening

Indicator 5(d): Percent of Fine Sediment in Riffle Substrate

Indicator 5(e): Removal or Improvement of Passage Barriers[7]

Indicator 5(f): Acres restored wetlands and backwater channels (Cross-reference Indicator 2(a))

3.2.3 Goal 3: Water Quality

Restoration Area Objective 6

Water Quality meets or exceeds standards for protection of human health and fish safety. DEQ set TMDL standards to be met throughout the watershed. Therefore, until additional baseline information is collected and sources are identified, the baseline conditions and targets will be the same for all priority restoration reaches.8

Indicator 6(a): Toxics (Surrogate to be used is Total Suspended Solids)

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[6] Volume of summertime base flow may be used as an alternate indicator in future revisions

[7] Miles of stream habitat accessible to juvenile salmonids may be used as an alternate indicator in future revisions

[8] Indicators are based on DEQ Total maximum daily loads.

Reference Condition: Low levels of toxics and sediment. No exceedances of state water quality standards (see Assessment, Chapter 2.9.7).

Baseline Condition: Routine and storm event monitoring has revealed high levels of both TSS and Turbidity. Relatively high turbidity levels were measured during both high and low flow conditions, and are most likely a result of bank erosion, roadside ditch erosion, runoff from construction activities, and runoff from agricultural and nursery operations. Toxics (DDT, Dieldrin, PAH, and PCBs) have been detected in both water column and sediment samples with some exceedances of standards. DDT was identified as a problem based on the results of a USGS investigation. Pollutant concentrations detected in 1989 had been reduced by an order of magnitude by 1994.

Target:___ mg/L TSS during stormwater conditions by 2020*

___mg/L TSS during other times throughout the basin by 2020*

* Specific target concentrations forthcoming in Draft TMDL currently in preparation and due in December 2003.

Benchmarks: ___ mg/L TSS during stormwater conditions by 2010

___ mg/L TSS during stormwater conditions by 2015

___ mg/L TSS during stormwater conditions by 2020

___ mg/L TSS during other times throughout the basin by 2010

___ mg/L TSS during other times throughout the basin by 2015

___ mg/L TSS during other times throughout the basin by 2020

Indicator 6(b): Temperature (System potential effective shade level)

Reference Condition: 7-day average maximum daily temperature is below 17.8˚C; below 12.8˚C during spawning and incubation periods, and system potential meets 80% effective shade level.

Baseline Condition: Temperature standards are frequently exceeded throughout the Johnson Creek watershed during the summer months. There are more total days with maximum temperature above 20˚C when moving downstream. More information is needed on temperatures in the target reach.

Target: 80% Effective Shade Site Potential by 2040*

* This percentage is preliminary and may be revised in the Draft TMDL currently in preparation and due in December 2003.

Benchmarks: 50 % Effective Shade Potential by 2015

60% Effective Shade Potential by 2025

75 % Effective Shade Potential by 2030

Indicator 6(c): Bacteria

Reference Condition: Low levels of bacteria throughout the watershed with no exceedances of state water quality standards (see Assessment, Chapter 2.9.7).

Baseline Condition: Routine monitoring has revealed high bacteria levels that exceed state water quality standards (see Assessment, Chapter 2.9.7) throughout the Johnson

Creek watershed. Exceedances occur both during winter storm events as well as during the dry summer periods.

Target: 75 – 80 percent reduction in bacteria levels by 2020*

* This percentage is preliminary and may be revised in the Draft TMDL currently in preparation and due in December 2003.

Benchmarks: 25 percent reduction in bacteria levels by 2010

40 percent reduction in bacteria levels by 2015

60 percent reduction in bacteria levels by 2018

Indicator 6(d): PAH's

Reference Condition: Extremely low levels not hazardous to aquatic or terrestrial life.

Baseline Condition: PAHs were proposed for listing as a pollutant of Johnson Creek in 2002 based on sampling data of 42.3 ng/L. The human health standard for water and fish ingestion is 2.8 ng/L. New studies indicate that fish are sensitive at lower rates.

Target: More information is needed on levels safe for fish. Human health standards should be met by 2040

Benchmarks: More information is needed on sources and current levels

Work with DEQ to develop TMDLs by 2010

3.2.4 Goal 4: Biological Communities

Restoration Area Objective 7

Improve environmental conditions to increase habitat for macroinvertebrates and salmonids. Insufficient data exists to support development of targets and benchmarks for individual reaches. General targets and benchmarks for priority restoration reaches is based on available data.

Indicator 7(a): Benthic Index of Biological Integrity (B-IBI)

Reference Condition: B-IBI score of 50. A balanced, integrated adaptive assemblage of organisms having species composition, diversity, and functional organization comparable to that of natural habitats in the region. High biological integrity.

3.2.5 Priority Restoration Area 1: Crystal Springs Creek (R1)

The Crystal Springs Creek Priority area includes the entirety of Crystal Springs Creek. The 4200m (2.6 mile) creek is fed by two sets of springs; one at Crystal Springs Rhododendron Garden and Eastmoreland Golf Course, and one at Reed College Canyon. The springs provide a steady cold water source of about 10 cfs throughout the year. Crystal Springs Creek receives very little stormwater runoff, as its highly urbanized watershed is drained by storm sewers and sumps. A flood in the area in 1998 is blamed on several years of unusually high precipitation, which eventually flowed out through the Reed Canyon springs.

Prior to development, most of the Crystal Springs system existed as a broad wetland complex with little or no distinct recurrent channel. Development, agricultural drainage, and finally channelization created the Crystal Springs system we know today. Therefore, it is irrelevant to refer to historical conditions. Targets are based on reference conditions and desired outcomes for watershed function in Crystal Springs. The subwatershed exhibits potential to function as a low-gradient, spring-fed wetland headwaters. The diversity of channel types provides an array of spawning, rearing, and refuge habitats.

The springs provide a cold water source, but impoundments on the creek negate that effect, with the result that Crystal Springs Creek is a warming influence on Johnson Creek by the time it reaches the confluence. In addition, there are a number of culverts and instream structures that inhibit access and the is little habitat structure in most of the creek. Several factors, however, recommend Crystal Springs Creek for restoration: its proximity to the mouth of Johnson Cr.; the high percentage of publicly owned land in its watershed; and its potential for cold, stable base flows, potentially making it key refugia for summertime rearing.

Two key restoration efforts are ongoing in this area: Reed College has restored access to Reed Lake and is actively reforesting the canyon; and Portland Parks is working with the US Army Corps of Engineers to replace the shallow pond in Westmoreland park with a wetland channel.

Target salmonid populations:

- Coho, Steelhead, and Cutthroat spawning and rearing habitat and migratory summer and winter rearing habitat
- Chinook migratory summer and winter rearing habitat

Indicator 1(a): Area of connected floodplain

Reference Condition: No creek channelization

Baseline Condition: Creek channel is lined; Low relevance due to flow stability. At least 50% of creek length has floodplain access; remaining 50% is inhibited by buildings and roads.

Target: Reconnect floodplain where it is inaccessible as opportunities arise over the next 50-100 years.

Benchmarks: To be determined.

Actions: Modify artificial structures and bank and floodplain alterations that preclude access of flows to the floodplain.

Indicator 5(a): Large Wood

Reference Condition: >20 pieces in each 100m stream length

Baseline Condition: Upper Crystal Springs (Reaches 2, 3, 4): 4.4/ 100m

Lower Crystal Springs (Reach 1): .7 / 100m

Target: >20 pieces/ 100m stream length by 2050

Benchmarks:

>20 pieces/ 100m stream length by 2020 in upper Crystal Springs

>5 pieces/ 100m stream length by 2020 in lower Crystal Springs

>15 pieces/ 100m stream length by 2030 in lower Crystal Springs

>20 pieces/ 100m stream length by 2040 in lower Crystal Springs

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft., composed of mature native vegetation, with < 2 stream crossings/ KM of stream length.

Baseline Condition: Of the 187 acres of riparian corridor, 0-5% is mature forest. 71 acres is urban development; 7 acres is developed on Reed College Campus; and 66 acres is on Eastmoreland golf course, where 85-90% of the area is dedicated recreation space.

Approximately 34 acres have been recently planted or are targeted for planting in the next 5 years.

Target: Continuous corridor of mature native vegetation up to 300 ft by 2030 where possible. Approximately 62 acres of mature native vegetation. There is no target for stream crossings.

Benchmarks:

50% of available areas planted by 2010

75% planted by 2020

100% planted by 2030

Indicator 5(c): Channel and Bank Hardening

Reference: Channel bed consists of appropriate percent of sediments and gravels and is not lined. Sediment transport and recruitment results in channel realignment.

Baseline Condition: Some bed lining is evident. Bank hardening eliminates channel realignment. More information is needed.

Target: Reduce channel lining to 25% of reach by 2050

Benchmarks: Depends upon baseline condition

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: Currently, approximately 15% of the stream is riffles; glides and pools dominate the stream**.**

Reach #	% Sand Silt Organics (SSO) in Riffles	% SSO all substrates
Reach 1	17	50
Reach 2	No riffles	56
Reach3	18	58
Reach 4	40	49

Target: 20% or less by 2040

Benchmarks: 35% by 2015

30% by 2020

25% by 2030

Actions: Reduce sedimentation in channel substrate caused from bank erosion and erosion off upland areas

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets.

3.2.6 Priority Restoration Area 2: Tideman-Johnson/Errol Heights (R2)

R2 is bounded by Tacoma St to the west, and 45th Ave to the East. The restoration area also includes Errol Creek and Errol Heights wetland and a large oxbow of Johnson Creek. The restoration area includes ODFW Reaches four and five of Johnson Creek and Reaches one and two of Errol Creek. Total length: 2432m (7981 feet).

The creek is channelized through this reach with the exception of the stretch through Tideman Johnson Park. Errol Creek flows out of a spring-fed wetland complex into a lined channel conveying the flow through several backyards before draining to Johnson Creek's oxbow. Prior to development, several large wetlands occupied this valley, and surveyors recorded the width of the creek at about 80 feet, including multiple side channels.

While erosion takes its toll on the unarmored banks of Johnson Creek in this reach, this area provides a key refugia opportunity for salmon. Fish can escape high winter flows into the protection of Errol Creek. Significant areas of publicly-held land in this area offer opportunities for more backwater channels and off-channel habitat areas for rearing. Unlined channels in Johnson Creek and Errol Heights offer potential spawning grounds as well.

Target salmonid populations: Coho, Steelhead, and Cutthroat spawning and rearing habitat

Indicator 1(a): Area of connected floodplain

Reference Condition: No creek channelization

Baseline Condition: Creek has access to the floodplain in 50 percent of its length in the area. Channelization heavy in Reach 4 of Johnson Creek. Deep channel and proximity of infrastructure limit floodplain reconnection opportunities. Channelization heavy in oxbow near fish ladder; approximately 4858 feet of the reach's 7981 foot length is channelized (60%); floodplain is accessible in Tideman Johnson Park during higher flows but there is little off channel habitat. Flow in Errol Creek is very stable due to spring source; floodplain access less relevant. Errol Creek is channelized and there are large amounts of fill in areas that were likely once wetlands.

Target: Improve amount and frequency of floodplain access in Tideman Johnson Park, the oxbow and parts of Reach 4 by 2030. Remove channelization and fill in wetlands on Errol Creek by 2010.

Benchmarks: Improve frequency of floodplain access in Tideman Johnson by 2010

Remove channelization in Errol Creek and fill in wetlands by 2010 (5% of creek length)

Remove channelization in wetland west of oxbow and north of Springwater Corridor by 2015 (~5% of creek length)

Where opportunities exist remove infrastructure impediments in Reach 4 by 2030.

Indicator 1(b): Impervious Surfaces

Indicator 1(c): Vegetation Removal

Indicator 2(a): Acres of restored wetlands and backwater channels

> **Reference Condition**: Approximately 40 acres historic wetlands and backwater channels
>
> **Baseline Condition:** Over-wintering habitat exists in Errol Creek but there are few side channels. Errol Heights Park and associated publicly owned properties offer 4 acres of wetland; however, there may be opportunities to restore additional wetlands in areas that are filled. Approximately 1 acre of wetland exists within Tideman Johnson Park with no connection to creek. There are no backwater channels within Tideman Johnson Park. Publicly owned area north of Springwater

corridor and west of the oxbow has 5.25 acres of wetland not connected to creek. Oxbow island contains approximately 2 acres of potential wetland mixed with urban development.

Target: Restore 11 acres of historic wetlands and backwater channels by 2050

Benchmarks: Restore wetlands and backwater channel in Errol creek complex by 2010

Restore floodplain access to wetland area north of Springwater by 2020

Create backwater channels in Tideman Johnson by 2020

Restore Tideman Johnson wetland by 2030

Indicator 5(a): Large Wood

Reference Condition: >20 pieces in each 100m stream length

Baseline Condition:

JC Reach 4:	2.2 per 100m
JC Reach 5:	1.9
Errol Reach 1:	0
Errol Reach 2:	1.8

Target: >20 pieces in each 100m length of stream by 2050

Benchmarks:

>20 pieces/ 100m stream length by 2010 in upper Errol Creek

>5 pieces/ 100m stream length by 2020 in lower Errol Creek

>15 pieces/ 100m stream length by 2030 in Reach 5.

>20 pieces/ 100m stream length by 2040 in Reach 5.

>5 pieces/ 100m stream length by 2020 in Reach 4.

>10 pieces/ 100m stream length by 2040 in Reach 4.

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft., composed of mature native vegetation, with < 2 stream crossings/ KM of stream length.

Baseline Conditions: 5-10% of riparian corridor is in mature second-growth forest. Of the 260 acres within the riparian corridor, 95 (37%) are developed urban areas including streets, yards, buildings, and parking lots. Approximately 21 acres have been planted in the past 7 years.

Target: Continuous corridor of mature native vegetation up to 300 ft where possible; 165 acres of mature forest. There is no target for stream crossings.

Benchmarks: 40% of available area planted by 2010

65% planted by 2020

100% planted by 2040

Indicator 5(c): Channel and Bank Hardening

Reference: Channel bed consists of appropriate percent of sediments and gravels and is not lined. Sediment transport and recruitment results in channel realignment.

Baseline Condition: Some bed lining is evident, especially in oxbow areas and upstream. Bank hardening eliminates channel realignment. While spawning gravels occur in some areas, it is unknown whether there is lining underneath. More information is needed.

Target: Reduce channel lining to 25% of reach by 2050

Benchmarks: Depends upon baseline condition

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: Currently, approximately 42% of the Johnson Creek reaches are riffles; approximately 37% of Errol creek is riffles.

Reach #	% Sand Silt Organics (SSO) in Riffles	% SSO all substrates
JC Reach 4	19	26
JC Reach 5	19	29
Errol Reach 1	24	55
Errol Reach 2	71	72

Target: 20% or less by 2040. Protect from degradation by identifying and addressing sediment inputs upstream.

Benchmarks: Reduce Errol Creek to 35% by 2015

30% by 2020

25% by 2030

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets.

3.2.7 Priority Restoration Area 3: Kelley to Middle Mitchell Creek (R3)

Introduction

In Restoration Area 3, middle Kelley Creek (ODFW Reach 3) and lower Mitchell Creek (ODFW Reaches 1 and 2) expand on the core habitats located in Lower Kelley and Upper Mitchell Creeks (Core Habitats 1 and 2). This restoration area has high potential value for cutthroat, however parts of it suffer from severe incision and downcutting. While this area is not highly functional in the key areas, it is critical for expanding the core habitat areas and providing a larger contiguous area of cutthroat refugia.

The Kelley Creek watershed was added to the Urban Growth Boundary in 1997 and in 2002. Concept planning was completed in 2002 for half the watershed, and annexation is scheduled to begin by 2005. This will inevitably alter the condition of the Kelley Creek system. It is anticipated that urbanization will provide an opportunity to protect and restore riparian habitat, address passage barriers, and reduce erosion. Additional planning work is necessary for the areas of the watershed added into the UGB in 2002.

Target salmonid populations:

- Steelhead, and Cutthroat spawning and rearing habitat
- Resident Cutthroat and Rainbow

Indicator 1(a): Area of connected floodplain

Reference Condition: Little incision and seasonally accessible floodplain.

Baseline Condition: Excessive drainage has caused incision of creek. This combined with fill of wetlands in the floodplain result in very little floodplain access. Connected floodplain area less than one acre.

Target: Creek has floodplain access in 70% of reach. Other areas are constrained by infrastructure.

Benchmarks: Restore floodplain access in 35% of reach by 2020

Restore access in 70% by 2040

Indicator 3(a): Hydrograph Alteration

Reference Condition: Annual hydrograph mimics historical hydrograph

Baseline Condition: Hydrograph altered – extremely high flows associated with storm events. Current condition: Most fields tiled with drainage directed into ditches and then to creek.

Target: Manage stormwater from existing and new development such that there is no runoff from small storms leading to further incision

Benchmarks: All new development manages a minimum of 90% of the annual rainfall such that there is no runoff from impervious surfaces.

Actions:

Necessary codes and manuals established or updated to reach target by 2004.

Enforcement and maintenance system established by 2006.

Indicator 4(a): Amount of water removed or impounded during summertime

Reference Condition: Impoundments are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: Currently there are several impoundments and water diversions upstream of the restoration area in Kelley Creek. There is a 1.7m dam in the Restoration Area on Kelley Creek (Reach 3), and a 1.4m dam at a culvert on Mitchell (Reach 2). More information is needed to quantify amount of diversion and impoundment.

Target: Minimum base flow meets state and federal standards for salmon by 2050.

Benchmarks: To be determined based on additional baseline information.

Actions: Work with holders of water rights to find efficiencies to reduce draw from creek.

Indicator 5(a): Large Wood

Reference Condition: >20 pieces/ 100m stream length

Baseline Condition:

Kelley Cr Reach 3: 2 pieces per 100m

Mitchell Cr Reach 1: 2.9/ 100m

Mitchell Cr Reach 2: 11.8/ 100m

Target: >20 pieces/ 100m stream length by 2050

Benchmarks:

>5 pieces/ 100m stream length by 2020

>10 pieces/ 100m stream length by 2030

>15 pieces/ 100m stream length by 2040

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft., composed of mature native vegetation, with > 2 stream crossings/ KM of stream length.

Baseline Condition: Of the 88.5 acres of riparian corridor, approximately 15.5 acres are forested. Six acres are developed as roads and buildings.

Target: Continuous corridor of up to 300 ft composed of mature native vegetation as feasible based on constraints of development. Up to 82 acres of mature forest canopy.

Benchmarks:

Plant 25% of available area by 2010

Plant 70% by 2020

Plant 100% by 2030

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: Riffles account for 48% of the Kelley Creek reach, and for 38% of Mitchell Creek reaches one and two.

Reach #	% Silt Sand Organics in Riffles	Ave % SSO in all substrates
Kelley Reach 3	16	13
Mitchell Reach 1	65	75
Mitchell Reach 2	48	73

Target: 20% or less by 2040; protect from degradation by identifying and reducing sources of fine sediment.

Benchmarks: 35% by 2015

30% by 2020

25% by 2030

Indicator 5(e): Removal or Improvement of Passage Barriers

Reference Condition: Barriers or impoundments are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: One 1.7m metal dam. One 1.4m dam. One impassible culvert at 162nd and Mitchell Creek.

Target: No impassable barriers by 2020.

Benchmarks: Work with landowners to remove dams or build fishway around them by 2015; work with county and, after annexation, with city to replace culvert by 2020.

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets.

3.2.8 Priority Restoration Area 4: Johnson Creek Reach 15 (R4)

Priority Restoration area 4 in Gresham offers high restoration value, particularly from the Coho and steelhead perspectives. The large riparian forest to the south of the creek, high potential for off-channel and over-wintering habitat, and proximity to the high quality habitat in reach 16 (core habitat area 3) make this area especially noteworthy. The reach is 4484 m in length (14,711 ft).

Target salmonid populations:

- Coho, Steelhead, and Cutthroat spawning and rearing habitat

Indicator 1(a): Area of connected floodplain

Reference Condition: Little incision and seasonally accessible floodplain

Baseline Condition: No WPA channelization however much of the creek is incised. Wide floodplain available but inaccessible to creek.

Target: Creek has floodplain access in 40% of reach by 2040. Other areas are constrained by infrastructure.

Benchmarks: Restore floodplain access in 20% of reach by 2020

Restore access in 40% by 2040

Indicator 2(a): Acres restored wetlands and backwater channels

Reference Condition: More than 100 acres historical wetlands and backwater channels

Baseline Condition: Approximately 40 acres existing wetlands and backwater channels

Target: Restore existing 40 acres and restore an additional 50 acres historical wetlands and backwater channels by 2050

Benchmarks:

Restore 40 acres existing wetlands and backwater channels by 2010

Restore 10 acres historical wetlands and backwater channels by 2010

Restore 20 acres historical wetlands and backwater channels by 2020

Restore 30acres historical wetlands and backwater channels by 2030

Restore 40 acres historical wetlands and backwater channels by 2040

Indicator 5(a): Large Wood

Reference Condition: >20 pieces in each 100m stream length

Baseline Condition: Approximately 4 pieces per 100 meters

Target: >20 pieces in each 100m length of stream by 2040

Benchmarks: >5 pieces/ 100m stream length by 2010

>10 pieces/ 100m stream length by 2020

>15 pieces/ 100m stream length by 2030

>20 pieces/ 100m stream length by 2040

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft., composed of mature native vegetation, with < 2 stream crossings/ KM of stream length.

Baseline Conditions: 43 acres of riparian corridor is in mature second-growth forest. Of the 179 acres within the riparian corridor, approximately 61 (34 %) are developed urban areas including streets, yards, buildings, and parking lots. Approximately 40 acres have been planted in the past 5 years.

Target: Continuous corridor of mature native vegetation up to 300 ft where possible by 2040; 75 acres of mature forest.

Benchmarks:

25 % of available area planted by 2010

50 % planted by 2020

75 % planted by 2030

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: Riffles account for 15% of the stream's length. Sand silt organics comprise 17 percent of the riffle substrate, and average 35% of all substrates.

Target: 20% or less by 2040; protect from degradation by identifying and reducing sources of fine sediment.

Benchmarks: 35% by 2015

30% by 2020

25% by 2030

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets.

3.2.9 Priority Restoration Area 5: Lower Sunshine Creek (R5)

Restoration area five is the lower reaches of Sunshine Creek, which drains into Johnson Creek's Reach 17, just upstream of Core Habitat Area 4. This restoration area has high potential value for cutthroat and steelhead, although vegetation in some parts of the riparian buffer is nonexistent. Erosion and lack of riparian cover upstream contribute to high levels of TSS and temperature. Despite these shortcomings, several areas of excellent riparian vegetation and wetland areas offer a promising habitat area. Erosion and severe downcutting in this area need to be addressed.

Major parts of the Sunshine Creek watershed were added to the Urban Growth Boundary in 2002. This will inevitably alter the condition of the Sunshine Creek system. It is anticipated that urbanization will provide an opportunity to protect and restore riparian habitat, address passage barriers, and reduce erosion. Additional planning work is necessary for the areas of the watershed added into the UGB.

Target salmonid populations:

- Steelhead, and Cutthroat spawning and rearing habitat
- Resident Cutthroat and Rainbow

Indicator 1(a): Area of connected floodplain

Reference Condition: Little incision and seasonally accessible floodplain. Broad valley floor with multiple, braided channels and broad wetlands.

Baseline Condition: Incision of Sunshine Creek results in very little floodplain access. The creek is completely confined within a single terrace. Multiple channels exist in some areas during low flows. Tiled and drained agricultural areas intermingle with remnant wetlands.

Target: Create ¼ mile of floodplain access in low gradient reach 1. Create 2 backwater channels.

Benchmarks:

Restore floodplain access in Reach 1 by 2020

Create backwater channels by 2040

Indicator 3(a): Hydrograph alteration

Reference Condition: Annual hydrograph mimics historical hydrograph

Baseline Condition: Hydrograph altered – extremely high flows associated with storm events. Additional information needed to quantify flow patterns.

Target: Manage stormwater from existing and new development such that there is no runoff from small storms leading to further incision

Benchmarks: All new development manages a minimum of 90% of the annual rainfall such that there is no runoff from impervious surfaces.

Actions:

Necessary codes and manuals established or updated to reach target by 2008.

Enforcement and maintenance system established by 2010.

Indicator 4(a): Amount of water removed or impounded during summertime

Reference Condition: Impoundments are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: Unknown.

Target: Minimum base flow meets state and federal standards for salmon by 2050.

Benchmarks: Additional Baseline information is needed.

Indicator 5(a): Large Wood

Reference Condition: >20 pieces/ 100m stream length

Baseline Condition: Wood is low at 3 pieces per 100 m

Target: >20 pieces/ 100m stream length by 2050

Benchmarks: >5 pieces/ 100m stream length by 2020

>10 pieces/ 100m stream length by 2030

>15 pieces/ 100m stream length by 2040

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft, composed of mature native vegetation, with > 2 stream crossings/ KM of stream length.

Baseline Condition: of the 108 acres of riparian corridor, 36 acres are fields, roads, houses, and other development. Approximately 10 acres have mature riparian vegetation.

Target: Continuous corridor of up to 300 ft composed of mature native vegetation as feasible based on constraints of development.

Benchmarks:

Plant 10% of available area by 2010

Plant 40% by 2020

Plant 70% by 2030

Plant 100% by 2040

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Conditions: Riffles comprise 19% of the length of reach 1, and 5% of reach 2. Reach 1 riffles are 18% sand silt and organics and 82% gravel and cobble. Reach 2 riffles are 34% sand silt and organics and 66% gravel and cobble.

Target: 20% or less by 2040 in reach 2. Upstream construction during urbanization threatens to increase sedimentation, while increased protection for riparian areas may reduce erosion in the long term.

Benchmarks: 35% by 2015

30% by 2020

25% by 2030

Indicator 5(e): Removal or improvement of passage barriers

Reference Condition: Barriers are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: No known artificial passage barriers. More information is needed on the passability of road culverts.

Target: Address any existing passage barriers.

Benchmarks: Depends on baseline data.

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets.

3.2.10 Priority Restoration Area 6: Lower Badger Creek (R6)

This short creek section serves as a key refuge area off of Johnson Creek's Reach 17, just upstream of Core Habitat Area 4 (Reach 16). Restoration of this area as a key refuge in the upper part of Johnson Creek will eventually develop into core habitat for spawning and rearing if water quality and erosion from upstream sources can be minimized. Significant riparian vegetation is impacted by rural residential use, but shows high potential for riparian function.

This area is within the 2002 urban growth boundary expansion, which will provide key opportunities for restoration and protection of resources in this area. Upstream areas in Badger Creek are not within the urban expansion area, though implementation of proposed Lower Willamette Agricultural Water Quality rules will help address pollution.

Indicator 1(a): Area of connected floodplain

Reference Condition: Little incision and seasonally accessible floodplain

Baseline Condition: Incising of Badger Creek resulting in little floodplain access. More information is needed to determine the extent of incision.

Target: Creek has floodplain access in 70% of reach. Other areas are constrained by infrastructure.

Benchmarks: Restore floodplain access in 35% of reach by 2020

Restore access in 70% by 2040

Indicator 3(a): Hydrograph alteration

Reference Condition: Annual hydrograph mimics historical hydrograph

Baseline Condition: Hydrograph altered – extremely high flows associated with storm events. More information is needed to quantify flow information.

Target: Manage stormwater from existing and new development such that there is no runoff from small storms leading to further incision

Benchmarks: All new development manages a minimum of 90% of the annual rainfall such that there is no runoff from impervious surfaces.

Actions:

Necessary codes and manuals established or updated to reach target by 2008.

Enforcement and maintenance system established by 2010.

Indicator 4(a): Amount of water removed or impounded during summertime

Reference Condition: Impoundments are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: Information is needed

Target: Minimum base flow meets state and federal standards for salmon.

Benchmarks: Additional Baseline information is needed.

Indicator 5(a): Large Wood

Reference Condition: >20 pieces/ 100m stream length

Baseline Condition: Wood volume is low. More information is needed to quantify this information.

Target: >20 pieces/ 100m stream length by 2050

Benchmarks: Depends on baseline;

>5 pieces/ 100m stream length by 2020

>10 pieces/ 100m stream length by 2030

>15 pieces/ 100m stream length by 2040

Indicator 5(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft., composed of mature native vegetation, with > 2 stream crossings/ KM of stream length.

Baseline Condition: Of the 24 acres of riparian corridor, approximately 7.5 are forested. 8 acres on the north side of the creek are constrained by major roads, the Springwater corridor trail, and other infrastructure.

Target: Continuous corridor of up to 300 ft composed of mature native vegetation as feasible based on constraints of development.

Benchmarks:

Plant 25% of available area by 2010

Plant 70% by 2020

Plant 100% by 2030

Indicator 5(d): Percent of fine sediments in riffle substrate

Reference Condition: 12% or less

Baseline Condition: Substrate composition is unknown. More information needed to establish baseline conditions.

Target: 20% or less by 2040

Benchmarks: Depends on baseline condition.

Indicator 5(e): Removal or improvement of passage barriers

Reference Condition: Barriers are formed by deposition of large wood, beaver activity, or other natural methods.

Baseline Condition: More information is needed on barriers and the passability of road culverts.

Target: Address any existing passage barriers.

Benchmarks: Depends on baseline data.

Indicators 6 and 7: See Priority Restoration introduction for watershed wide targets.

3.3 Connectivity Areas and Special Opportunities

Introduction

Connectivity areas are those areas with lesser restoration potential, but which are critical to connecting the high quality areas and areas with high restoration potential (Core Habitat areas and Restoration Areas, respectively). Critical connection areas exist from the mouth of Johnson Creek through lower Crystal Springs (JC Reaches 1 and 2, CS Reach 1), Johnson Creek Reach 3; the North Clackamas Reaches (6 and 7); the Middle Johnson Creek Segment (Reaches 8 to 14); and Middle Kelley (Reaches 4 to 6).

The overall vision for Connectivity Areas is to provide summer and winter migratory corridors. Restoration actions are focused on creating cool summertime water temperatures and providing enough off-channel over-winter resting areas during high winter flows.

The high level of public investment and a high potential for restoration in the Middle Johnson Creek Segment recommend Middle Johnson Creek as a Special Opportunity area as defined in Section 2.19. Pursuit of public health and safety goals by the City of Portland offers unique opportunities to improve connectivity and watershed health by integrating off-channel refuge areas into stormwater detention and retention facilities. However, as additional opportunities arise new special opportunity areas will be identified.

The following Objectives and Indicators apply to the four watershed health goals:

3.3.1 Goal 1: Hydrology

Connectivity Area Objective 1

Improve stream flow and availability of over-wintering habitat by improving access of flows to the floodplain.

Indicator 1(a): Area of connected floodplain

Connectivity Area Objective 2

Restore wetlands and backwater channels to improve flood storage capacity and over-wintering habitat in the floodplain.

Indicator 2(a): Acres of restored wetlands and backwater channels

3.3.2 Goal 2: Physical Habitat

Connectivity Area Objective 3

Improve salmonid capacity by providing cover and refuge from high flow events

Indicator 3(a): Large Wood

Indicator 3(b): Riparian Integrity

Indicator 3(c): Acres restored wetlands and backwater channels (Cross-reference Indicator 2(a))

3.3.3 Goal 3: Water Quality

Connectivity Area Objective 4

Water Quality meets or exceeds standards for protection of human health and fish safety

Indicator 4(a): Toxics

Indicator 4(b): Temperature

Indicator 4(c): Bacteria

Indicator 4(d): PAH's

3.3.4 Goal 4: Biological Communities

Connectivity Area Objective 5

Improve environmental conditions to increase habitat for macroinvertebrates and salmonids.

Indicator 5(a): B-IBI

3.3.5 Special Opportunity Area: Middle Johnson Creek (S1)

Middle Johnson Creek is characterized by its low gradient and relatively high level of development. Floodwater conveyance is a critical issue in this area as many floodplain areas are developed and do not offer safe floodwater storage or conveyance. Nonetheless, the extensive floodplain and low gradient in this area offers potential for over-wintering habitat, particularly in areas with a large amount of public land ownership. In addition, this area contains some contiguous areas with mature riparian coverage that could be expanded to improve water temperatures. However, additional areas not already in public ownership that do not conflict with existing uses may still need to be identified for overwintering and summer migration.

Target salmonid populations:

- Coho, Steelhead, and Cutthroat migratory corridor and winter refugia

Indicator 1(a): Area of connected floodplain

Reference Condition: No creek channelization

Baseline Condition: Most of creek is channelized and rock lined. Wide floodplain available but inaccessible to creek.

Target: Improve floodplain access in 50 % of creek by 2050.

Benchmarks:

Reconnect 10% of floodplain by 2010

Reconnect 20% of floodplain by 2020

Reconnect 30% of floodplain by 2030

Reconnect 40% of floodplain by 2040

Indicator 2(a): Acres restored wetlands and backwater channels

Reference Condition: **More than 350 acres historical wetlands and backwater channels**

Baseline Condition: Approximately 100 acres existing wetlands and backwater channels

Target: Restore existing 100 acres by 2040 and restore an additional 250 acres historical wetlands and backwater channels by 2100.

Benchmarks:

Restore 25 acres existing wetlands and backwater channels by 2010

Restore 50 acres existing wetlands and backwater channels by 2020

Restore 75 acres existing wetlands and backwater channels by 2030

Restore 100 acres existing wetlands and backwater channels by 2040

Restore 50 acres historical wetlands and backwater channels by 2020

Restore 100 acres historical wetlands and backwater channels by 2040

Restore 150 acres historical wetlands and backwater channels by 2060

Restore 200 acres historical wetlands and backwater channels by 2080

Indicator 3(a): Large Wood

Reference Condition: >20 pieces in each 100m stream length

Baseline Condition: Approximately 4 pieces per 100 meters (ODFW survey).

Target: >20 pieces/ 100m stream length by 2015

Benchmarks: >5 pieces/ 100m stream length by 2005

>10 pieces/ 100m stream length by 2010

Indicator 3(b): Riparian Integrity

Reference Condition: Riparian corridor is a continuous corridor of 300 ft., composed of mature native vegetation, with < 2 stream crossings/ KM of stream length.

Baseline Conditions: 100 acres of riparian corridor is in mature second-growth forest. Of the 354 acres within the riparian corridor, approximately 42 (12 %) are developed urban areas including streets, yards, buildings, and parking lots. Approximately 25 acres have been planted in the past 8 years.

Target: Continuous corridor of mature native vegetation up to 300 ft where possible; 212 acres of mature forest.

Benchmarks:

Plant 25% of available area by 2010

Plant 70% by 2020

Plant 100% by 2030

Indicator 4(a): Toxics (Surrogate to be used is Total Suspended Solids)

Reference Condition: Low levels of toxics and sediment. No exceedances of state water quality standards (see Assessment, Chapter 2.9.7).

Baseline Condition: Routine and storm event monitoring has revealed high levels of both TSS and Turbidity. Relatively high turbidity levels were measured during both high and low flow conditions, and are most likely a result of bank erosion, roadside ditch erosion, runoff from construction activities, and runoff from agricultural and nursery operations. Toxics (DDT, Dieldrin, PAH, and PCBs) have been detected in both water column and sediment samples with some exceedances of standards. DDT was identified as a problem based on the results of a USGS investigation. Pollutant concentrations detected in 1989 had been reduced by an order of magnitude by 1994.

Target: ___ mg/L TSS during stormwater conditions by 2020*

___mg/L TSS during other times throughout the basin by 2020*

* Specific target concentrations forthcoming in Draft TMDL currently in preparation and due in December 2003.

Benchmarks: ___ mg/L TSS during stormwater conditions by 2010

___ mg/L TSS during stormwater conditions by 2015

___ mg/L TSS during stormwater conditions by 2020

___ mg/L TSS during other times throughout the basin by 2010

___ mg/L TSS during other times throughout the basin by 2015

___ mg/L TSS during other times throughout the basin by 2020

Indicator 4(b): Temperature (System potential effective shade level)

Reference Condition: 7-day average maximum daily temperature is below 17.8˚C; below 12.8˚C during spawning and incubation periods, and system potential meets 80% effective shade level.

Baseline Condition: Temperature standards are frequently exceeded throughout the Johnson Creek watershed during the summer months. There are more total days with maximum temperature above 20˚C when moving downstream. More information is needed on temperatures in the target reach.

Target: 80% Effective Shade Site Potential by 2040*

* This percentage is preliminary and may be revised in the Draft TMDL currently in preparation and due in December 2003.

Benchmarks: 50 % Effective Shade Potential by 2015

60% Effective Shade Potential by 2025

75 % Effective Shade Potential by 2030

Indicator 4(c): Bacteria

Reference Condition: Low levels of bacteria throughout the watershed with no exceedances of state water quality standards (see Assessment, Chapter 2.9.7).

Baseline Condition: Routine monitoring has revealed high bacteria levels that exceed state water quality standards (see Assessment, Chapter 2.9.7) throughout the Johnson Creek watershed. Exceedances occur both during winter storm events as well as during the dry summer periods.

Target: 75 – 80 percent reduction in bacteria levels by 2020*

* This percentage is preliminary and may be revised in the Draft TMDL currently in preparation and due in December 2003.

Benchmarks: 25 percent reduction in bacteria levels by 2010

40 percent reduction in bacteria levels by 2015

60 percent reduction in bacteria levels by 2018

Indicator 4(d): PAH's

Reference Condition: Extremely low levels not hazardous to aquatic or terrestrial life.

Baseline Condition: PAHs were proposed for listing as a pollutant of Johnson Creek in 2002 based on sampling data of 42.3 ng/L. The human health standard for water and fish ingestion is 2.8 ng/L. New studies indicate that fish are sensitive at lower rates.

Target: More information is needed on levels safe for fish. Human health standards should be met by 2040

Benchmarks: More information is needed on sources and current levels

Work with DEQ to develop TMDLs by 2010

Indicator 5(a): Benthic Index of Biological Integrity (B-IBI)

Reference Condition: B-IBI score of 50. A balanced, integrated adaptive assemblage of organisms having species composition, diversity, and functional organization comparable to that of natural habitats in the region. High biological integrity.

CHAPTER 4.0 CRITERIA DEVELOPMENT

The types of projects to be considered and ranked were divided into four distinct categories based on the nature of the project. The four project categories are:

- Monitoring and data management;
- Policies and programs;
- Public outreach and education; and
- Restoration projects

Criteria were developed for ranking and prioritizing projects utilizing a three-step iterative process. In the first step, science-based criteria were developed for the monitoring and data management, policies and programs, and public outreach and education project categories. In the second step, science-based criteria were developed separately for restoration projects. This was due to the fact that restoration projects and actions were different in many ways to the other categories of projects in terms of scope, intensity, and watershed coverage (i.e., more localized versus watershed-wide). Furthermore, the science-based criteria for addressing limiting factors and properly functioning conditions were more applicable to restoration activities.

The third step came after the TAC review of the initial criteria and involved adding additional criteria for evaluating restoration projects, based on the TAC recommendations. The added criteria were developed to more accurately reflect and assess a project's size and intensity to determine effectiveness at addressing limiting factors, and minimizing or controlling degradation to downstream core habitat, refuge, or other high priority areas.

Additional criteria were also developed to evaluate policy and monitoring projects. The supplemental criteria evaluated whether the project contributed to preventing further degradation, addressing a significant data gap, or whether or not a monitoring effort would significantly add to the existing body of knowledge about potential problems and opportunities in the watershed.

4.1 Ranking Criteria for Projects

The ranking criteria are divided into two general categories: one for watershed health, and the second for social and economic considerations. Criteria were developed for each of the scores - 0, 1, 3, or 5. The larger point spread of this system provides for greater project differentiation. The total points for both watershed health and social and economic considerations were added and then averaged to determine the total score and final ranking for monitoring, protection, and public outreach projects.

Restoration projects were evaluated utilizing separate criteria and incorporating results from the EDT model. Numerical scoring (0, 1, 3, or 5) was similar to the above project ratings except restoration projects were prioritized using only the watershed health total scores. Scores for social and economic considerations were summarized only for informational purposes only. The TAC believed that a restoration project should be evaluated on its watershed health score first, and the social and economic score should be considered secondary. The TAC also noted that the social and economic scores, although important, could be applied later to further differentiate and prioritize “competing” projects or those where the watershed health scores were the same.

The criteria developed to rank the projects are described on the following pages.

Criteria were revised for re-ranking restoration projects and focused on changes to the limiting factors and multiple benefits criteria. For limiting factors a project received credit for impacting a limiting factor if it was one of those factors that resulted from EDT model results showing coho attribute priorities for lower, middle, and upper Johnson Creek (see Chapter 2 - Watershed Assessment). Rankings were based on significant, partial, and moderate effects on limiting factors. Significant effect was based on extent to which the project covers the specific opportunities outlined for the limiting factors on the attribute priorities noted above. Significance was also based on the size of the project and the extent to which it could significantly affect limiting factors in its location reach. Moderate effects were based on where projects were less than 2 acres. It needs to be acknowledged that it is sometimes difficult to measure the size of a project depending upon the type, location, and what is actually considered to be the project and corresponding size area. The JCWC believes that the criteria and projects associated with this Action Plan will evolve in the future with the flushing out of proposed projects and the addition of new ones. See Table 20 and Figure 15 for a list of ranked restoration projects utilizing these criteria and their watershed locations.

	Score of **5**	Score of **3**	Score of **1**
WATERSHED HEALTH			
A. Urgency/Timing (Policy Projects only)	Need for policy is critical. Opportunity is present and policy may not be implemented if opportunity lost.	Need for policy is high. Opportunities are possible but have not been assessed.	Need for policy is minimal. No opportunities have been identified.
B. Significance of Potential Degradation (Policy Projects Only)	Without the policy in place there will be a significant loss of watershed functions.	Without the policy in place there will be a moderate loss of watershed functions.	Without the policy in place there will be a minimal loss of watershed functions.
C. Addresses Key Limiting Factors	Significantly resolves/eliminates two or more top limiting factors in the target reach after project matures; directly controls sources of local or downstream degradation. To qualify as significant in a target reach, project should make up a significant area of that reach.	**Score of 4** = Significantly resolves/eliminates one top limiting factor in the target reach after project matures; directly controls sources of local or downstream degradation. **Score of 3** = Partially resolves two or more limiting factors, indirectly controls sources of degradation through policy planning or regulatory/program implementation.	**Score of 2** = Partially resolves one top limiting factor, indirectly controls sources of degradation through policy planning or regulatory/program implementation. **Score of 1** = Minimally resolves one or more limiting factors or sources of degradation.
D. Project Location - Core Habitat, or High Priority Restoration Area (See Figure 14).	Project located in core habitat or high priority restoration area or affects function of one.	Project located in restoration linkage or connection area of affects one.	Project located upstream of a core habitat area, or high priority restoration area, but objectives are localized and does not significantly affect functions of one.
E. Meets Multiple Objectives/Properly Functioning Conditions (PFC) Functions	Significantly enhances conditions for three or more watershed functions as an explicit goal of the project (flow/hydrology; physical habitat; water quality; or biological communities).	Significantly enhances conditions for two watershed functions as an explicit goal.	**Score of 0** = Significantly enhances conditions for only one watershed function as an explicit goal.

	Score of **5**	Score of **3**	Score of **1**
F. Connectivity to Upland Habitats	Benefits an upland habitat area or is located in same Protects or restores connectivity or provides linkage; Protects an upland habitat area, reduces risk, or improves function of upland habitat area;	Protects or restores connectivity to upland habitats or provides link to corridor;	Other connectivity or linkage project
G. Identifies Problems or Opportunities (Monitoring Projects only)	Data collected from project will significantly add to the body of knowledge about potential problems and opportunities (where problems occur) and was identified as a significant data need in the watershed assessment.	Data collected from project will partially add to the body of knowledge about potential problems and opportunities and was not identified as a significant data need in the watershed assessment.	Data collected from project will minimally add to the body of knowledge about potential problems and opportunities.
H. Identifies Sources of Degradation (Monitoring Projects only)	Project identifies underlying source(s) of water quality and/or habitat problems listed in the 303(d) list or as a limiting factor impacting Core Habitat or High Priority Restoration Areas.	Project partially identifies an underlying source(s) of water quality and/or habitat problems listed in the 303(d) list or as a limiting factor impacting Core Habitat or High Priority Restoration Areas.	Project minimally identifies an underlying source(s) of water quality and/or habitat problems listed in the 303(d) list or as a limiting factor impacting Core Habitat or High Priority Restoration Areas.
I. Provides Trend Information (Monitoring Projects only)	**Score of 3 =** Data provides essential trend information (new or existing).	**Score of 1** = Continues an existing data record or establishes new continuous data record.	**Score of 0** = Does not continue and existing data record or establishes new continuous data record.
SOCIO/ECONOMIC			
A. Near Term Benefit (Protection and Stewardship Projects only)	Provides immediate benefit the first year.	Provides near-term benefit for 1-3 years.	Provides benefit after 5-years or more.
B. Likelihood of Success or Technical Feasibility	Experience shows that this type of project has been successfully undertaken before or has reasonable likelihood of success; permitting is reasonably straightforward; and no phasing or sequencing is required	Likelihood for success is not as great; permitting may be more complex and difficult; and phasing or sequencing may be required;	Project is experimental and unproven, permit conditions are difficult to predict or assess *or needs a code change*; and phasing or sequencing is required.

	Score of **5**	Score of **3**	Score of **1**
C. Degree of Urgency or Opportunity	Project urgency is critical Opportunity is present and project may not be implemented if opportunity lost	Project urgency is high Project completion would create opportunities for multiple additional projects; Opportunities are possible but have not been assessed	Project urgency is moderate No opportunities have been identified.
D. Landowner Support (Protection and Monitoring Projects only)	Project includes public or one private property and landowner support; or project includes multiple private or public properties and has a critical mass of landowner support.	Project includes public or one private property and landowner's support is mixed or has not been assessed; or project includes multiple private or public properties and has a mix of landowner support.	Project includes public or one private property and landowners are not generally supportive; or project includes multiple private or public properties and has little landowner support.
E. Stakeholder Support	General stakeholder support for project is evident. Stakeholders include: cities, resource and regulatory agencies, volunteers, schools, local citizens or groups, etc.;	General stakeholder support has not been assessed	General stakeholder support includes some opposition.
F. Partners Identified	Implementing Partners have been identified and are supportive of the project;	Implementing Partners have been identified but support has not been assessed	Implementing Partners have not been identified as yet. Partners could include local, state, or federal agencies; non-profit, community, or neighborhood groups; schools and students; businesses; or other volunteers.
G. Educational Opportunities	Project is highly visible Access is easily attained (e.g., adjacent to Springwater Trail); Educational objectives are included in project design or objectives; Project related to top limiting factors; Educational opportunities are watershed-wide;	Project is not highly visible; Access is moderate; Project is local;	Educational opportunities have not been identified
H. Funding Opportunity ID	Funding opportunities have been identified and secured and include: capital; project budget, donations, grants, other outside funds, etc.;	Funding opportunities have been identified but not secured	Funding opportunities have not been identified

4.2 Criteria for Fish Passage Projects

Water Environment Services (WES) staff have inventoried, assessed, and prioritized culverts throughout Clackamas County. The Joint Johnson Creek Committee also performed a phase I project to inventory the culverts, barriers, dams, and other structures throughout the Johnson Creek watershed. For more details on this project please see Chapter 2 – Watershed Assessment and Appendix D. For a list of fish passage projects that were recommended but not ranked as part of this Action Plan - see Appendix I.

The City of Portland is attempting to gather additional information on privately owned culverts, culverts that are not directly located beneath roads, and on other instream passage obstructions such as dams, weirs, and exposed pipe crossings. Criteria have not been developed for fish passage projects as part of this Action Plan. These projects will require a separate evaluation. As part of its response to the listing of salmonids under the ESA, the City of Portland and other local municipalities have been investigating the degree to which culverts obstruct salmonid access and movement within local watersheds. The City of Portland is evaluating culverts for the purpose of prioritizing impassable or partially passable culverts for replacement. Preliminary criteria for rating culverts and other passage obstructions have been developed by the City of Portland ESA Program's Riparian and Waterbody Construction and Maintenance technical team.

It is recommended that the Joint Johnson Creek Crossing Regional Inventory Group reconvene and perform a second phase of this project to include a ranking of all fish passage projects throughout the Johnson Creek watershed using similar criteria (see Appendix D).

CHAPTER 5.0 PROPOSED PROJECTS AND ACTIONS

The following projects and actions are numerically ranked using the criteria discussed in Chapter 4. Because of the level of detailed information available is different for each project, the scores assigned for each criterion were somewhat subjective. Actual effectiveness in addressing limiting factors will depend on specific project design and construction. For this reason, the highest scoring projects in each category are grouped together as top-tier projects. A slightly lower score therefore does not necessarily indicate that a given project should not be implemented prior to a slightly higher scoring project. All the top-tier projects will provide significant contributions toward improving watershed health.

5.1 Protection (Policies and Programs) Projects

Twenty-five projects to protect functions from degradation including land use, advocacy, policy, transportation, and planning were identified by TAC members, stakeholders, and the public. The following protection projects were evaluated against the criteria and ranked as the top tier projects (Table 17). See Appendix I for a complete listing of protection projects and individual ranking scores.

Table 17 Top Tier Protection (Policies and Programs) Projects

Project Title	Location	Project Description
Implementation Code for the Springwater Concept Plan	Upper Johnson Creek	Creation of concept and implementation plans for land use code, street network, public facilities plan, annexation plan, and natural resources protection, restoration and enhancement plan. Ensure that code is adopted and implemented.
Clackamas County Water Environment Services (WES) New Development Standards	Clackamas County Service District (CCSD) #1	Implement CCSD #1 R&R: Erosion control which provides for a comprehensive, district wide erosion and construction site pollutant control program; provide training and other support as needed.
New Development Standards – actions under Portland's MS4 permit	Lower and Middle Johnson Cr	Implement City Code Title 10: Erosion Control, which provides a comprehensive, citywide erosion and construction site pollutant control program; provide training and other support as needed.
Implementation Code for the Damascus Concept Plan	Johnson Creek tributaries	Creation of concept and implementation plans for land use code, street network, public facilities plan, annexation plan, and natural resources protection, restoration and enhancement plan. Ensure that code is adopted and implemented.
Implementation Code for the Pleasant Valley Concept Plan	Kelley Cr.	Creation of concept and implementation plans for land use code, street network, public facilities plan, annexation plan, and natural resources protection, restoration and enhancement plan. Ensure that code is adopted and implemented.
Illicit Discharges Controls – actions under MS4 permit	Watershed Wide	Implement all elements of the Illicit Discharge Elimination Program to prevent, search for, detect, and control illicit discharges to the MS4; continue to evaluate existing properties and non-stormwater discharges.
Healthy Portland	Lower and	Environmental Zone remapping and code revision to ensure that

Project Title	Location	Project Description
Streams	Middle Johnson Creek	environmental zoning adequately protects streams, wetlands, riparian areas and uplands and that restoration efforts are promoted.
Metro Goal 5	Watershed Wide	Fish and wildlife protection regulation including uplands and restoration opportunities.
Clackamas County Water Environment Services (WES) Illicit Discharge Control Program	Bell Station Area-Reaches 6-7	Implement the Illicit Discharge Elimination Program in the District to prevent, search for, detect, and control illicit discharges to the MS4. Continue to evaluate non-stormwater discharges.
Stormwater Master Plan	Kelley Cr.	Create Master Plan to accompany the Public Facilities Plan for stormwater. Determine appropriate size and design for conveyance swales and regional stormwater management facilities. Determine appropriate location and release rates for stormwater management.
Implementation and restoration of ESRA's	Kelley Cr.	Develop plans and/or programs to protect those areas of the Environmentally Sensitive Resource Areas (ESRA) that are not protected by environmental zoning and to address potential takings involved where properties have lost all development potential. Also, develop plans and or programs to revegetate.
Other Activities – actions under MS4	Lower and Middle JC	Continue implementation of the Stormwater Monitoring Plan. Continue program management evaluation and reporting activities.
Three Bridges Project	Lower Johnson Cr.	Extend the Springwater Corridor by building three bridges, one over Johnson Cr., one over McLoughlin Blvd., and one over Union Pacific RR.
Fallen Tree Policy	Lower and Middle JC	Develop City policy for dealing with fallen trees in creeks. When to remove, where to place, and how to protect.
Clackamas County Water Environment Services (WES) Proposed Green Development Policies	Bell Station Area-Reaches 6-7	Encourage use of green development practices and evaluate incentives.

The top tier Protection (Policies and Programs) Projects (PP) were further characterized below by highlighting preliminary implementation attributes including: expected lead entity, potential partners and project sponsors, project description, goal and objectives, limiting factors addressed, targeted benefiting area, rationale for priority rating, planning level cost estimates, sequencing, and anticipated future monitoring or maintenance needs.

5.2 Monitoring Projects

Thirteen projects to improve understanding of watershed functions including monitoring, modeling, and database management were identified by TAC members, stakeholders, and the public. The following monitoring, modeling, and data management projects were evaluated against the criteria and ranked as the top tier projects (Table 18). See Appendix I for a complete listing of monitoring and database management projects and individual ranking scores.

Table 18 Top Tier Monitoring Projects

Project Title	Location	Project Description
Sediment Monitoring	Upper Johnson Cr	Conduct Total Suspended Solids (TSS) and Turbidity monitoring to identify point and nonpoint pollution sources.
TMDL Bacteria	Watershed Wide	Baseline monitoring of E.coli bacteria levels at eight locations along Johnson Cr. to support establishment and implementation of TMDLs.
Toxics Source ID	Watershed Wide	Identification of sources of toxics.
Cutthroat Trout EDT Modeling	Watershed Wide	Cutthroat Trout EDT Model Results
Fishery Survey	Tributaries	Additional fish surveys to determine presence and extent of use of all tributary streams.
Fish Passage Barriers Inventory on Private Lands	Watershed Wide	Complete inventory of passage barriers to include private lands; characterize severity and rank.
Upland habitat and wildlife resources	Watershed Wide	Characterize upland habitat problems and opportunities.
Upland watershed tributary habitat and water quality	Upper JC	Characterize habitat and water quality conditions in upper watershed tributaries; focus on tributaries suspect to provide refuge; collect similar level of data available for Kelley and Crystal Springs Cr.
Vegetative Monitoring	Watershed Wide	Create volunteer structure to monitor revegetation sites for water quality, habitat, and other objectives.
Water Rights Information	Watershed Wide	Locate legal and illegal water rights information including diversions and quantify the extent of water withdrawals.
Fill data gaps to ID sources in high priority areas	Watershed Wide	Address key data gaps, ID rock wall locations, toxics sources, refugia areas, pollutants of concerns, and water rights.
Outfall discharge characterization	Watershed Wide	GPS specific outfall locations and collect and characterize pollutant loading information.
Fish Passage Prioritization (Public Right-of-Ways)	Watershed Wide	Prioritization of fish passage barrier removal/replacement on public right-of-ways within the entire watershed (may supercede other proposed fish passage projects).
ID specific WPA locations and conditions	Lower and Middle JC	GPS specific locations of bank and channel lining and condition.
Portland Operations and Maintenance	Lower and Middle Johnson Cr.	Review and update the implementation of a Stormwater Maintenance Program that includes elements needed to successfully maintain and enhance performance of MS4 conveyance and treatment facilities within the City's urban services boundary
Johnson Cr. Ambient Monitoring	Watershed Wide	Baseline monitoring of Johnson Cr. to support TMDL process. Include chemical, physical, and biological parameters.
Identification of Fish Refugia	Watershed Wide	Identify fish refugia area that provide cool waters or conditions that support areas for avoiding hot spots, or chemicals.

Areas		
Groundwater Monitoring	Middle Johnson Cr.	Install two staff gages in wetland complex along Springwater Corridor to monitor seasonal surface water fluctuations. Install two piezometers south of Foster and one in wetland complex to monitor groundwater fluctuations.

The top tier Monitoring (M) Projects were further characterized below by highlighting preliminary implementation attributes including: expected lead entity, potential partners and project sponsors, project description, goal and objectives, limiting factors addressed, targeted benefiting area, rationale for priority rating, planning level cost estimates, sequencing, and anticipated future monitoring or maintenance needs.

5.3 Public Outreach and Education Projects

Nine projects to inspire stewardship behavior including public outreach and education were identified by TAC members, stakeholders, and the public. Ranking of Public Outreach and Education Projects are included in Table19. See Appendix I for a complete listing of Public Outreach and Education projects and individual ranking scores.

Table 19. Ranking of Public Outreach and Education Projects

Project Title	Location	Project Description
Lower Willamette Enhanced Agricultural Water Quality Rule Implementation	Upper Johnson Cr	Coordinate with East Multnomah Soil & Water Conservation District (EMSWCD), Clackamas County Soil & Water Conservation District (CCSWCD), and the Oregon Department of Agriculture (ODA) to enhance education and technical assistance programs towards meeting WQ Management Area rules and minimize need for enforcement and fines.
Landowner Outreach	Upper Johnson Cr Reaches 17-18	Contact all landowners in these reaches, especially in the confluence area of N.F. Johnson Cr., Badger Cr., and Sunshine Cr. ID and prioritize all project opportunities in this high priority area. Apparent large-scale project opportunities for channel reconstruction, floodplain, wetland reclamation, addition of large wood structure, revegetation, etc. Plan and implement pilot project to initiate interest.
Community Restoration Project	Middle Johnson Cr	Work with private property owners to restore creek and riparian area to provide flood storage and improve habitat and water quality.
Construction BMPs	Watershed Wide	Offer assistance to regulatory agencies, builders and developers, to ensure adequate erosion prevention and sediment control and other construction site BMPs.
Public Involvement and Participation	Watershed Wide	Implement a comprehensive stormwater/watershed Public Participation Program that includes information, education, involvement, and stewardship.

Project Title	Location	Project Description
Program		
Car trip reduction	Watershed Wide	Reduce car trips in watershed through education program in order to reduce petroleum aromatic hydrocarbons and other pollutant levels.
Signage Program	Watershed Wide	Develop an educational signage program for stormwater treatment facilities, creek crossings, and other sensitive areas, and along Springwater Corridor.
Annual Watershed Report	Watershed Wide	Annually monitor, report, and publicize stream health and status report by subwatershed.
Exotic Fish Education	Watershed Wide	Develop and disseminate educational program on exotic fishes and ID potential areas for removal.

The top tier Public Outreach and Education Projects (POE) were further characterized below by highlighting preliminary implementation attributes including: expected lead entity, potential partners and project sponsors, project description, goal and objectives, limiting factors addressed, targeted benefiting area, rationale for priority rating, planning level cost estimates, sequencing, and anticipated future monitoring or maintenance needs.

5.4 Restoration Projects

Fifty-three projects to restore and enhance watershed functions including revegetation, habitat improvement or recovery, floodplain connectivity and flow management, etc. were identified by TAC members, stakeholders, and the public. Restoration projects were ranked by Total Watershed Health Scores. Total Social/Economic Scores were ranked and summarized only for informational purposes. Ranking of the top tier Restoration Projects are included in Table 20. See Figure 15 for the location of the top tier ranked restoration projects. See Appendix I for a complete listing of monitoring and database management projects, their limiting factors that are addressed, targeted areas that the project benefits, and their individual ranked scores.

Table 20. Ranking of top tier Restoration Projects

Project Title	Location	Project Description
Reed Branch Habitat Restoration/Fish Passage	Crystal Springs	Replacement of culvert at 28th Avenue; Large wood placement upstream in Reed Canyon. Revegetation in Reed Canyon for temperature reduction; this is a possible subsurface channel.
Alsop/Brownwood Flood Mitigation and Habitat Restoration	Middle Johnson Cr	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmonids and water quality improvements.
Kelley Cr. Confluence flood mitigation/ habitat improvements	Middle Johnson Cr/Kelley Creek	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmonids and water quality improvements.
Tideman Johnson/Errol Heights Flood Mitigation	Lower Johnson Cr Reach 4-5	Purchase frequent flooded properties and create flood storage to mitigate nuisance flooding. Rehabilitate over 50-acres of wetlands. Create off-channel habitat for salmonids and water quality improvement.
SE 7th Street Br.	Middle Johnson Cr Reach 15	Develop two wetlands, reconnect floodplain, remove invasives, and stabilize bank and toe.
Main City Park Improvements (B)	Upper Johnson Cr at Main City Park Reach 15-16	Implement Master Plan. Large project with channel reconstruction, daylighting a tributary, wetland and floodplain creation.
West Lents Flood Mitigation	Middle Johnson Creek	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmon and water quality improvement. Purchase frequently flooded properties to move people out of the floodplain.
Freeway Land Company Flood Mitigation	Middle Johnson Creek	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmon and water quality improvement.
Springwater Wetlands Complex	Middle Johnson Creek	Create and restore wetlands habitat for flood storage, aquatic and wildlife habitat, and water quality improvement.
East Lents South of Foster Flood Mitigation	Middle Johnson Creek	Create flood storage to mitigate nuisance flooding. Create off-channel habitat for salmon and water quality improvement. Purchase homes to move residents out of floodplain.
Habitat Restoration	Kelley Creek (Mitchell to mouth); Richey through Bliss property	Large wood placement/enhancement of instream habitat complexity and floodplain connectivity/revegetation.
SW 14th Street Riparian Corridor	Butler Creek and Upper JC Reach 15	Control erosion by re-grading banks of JC and install soil bioengineering. Remove invasive and install natives. Add large wood. Address streambank instability and erosion.
Main City Park Improvements (A)	Middle Johnson Cr Reach 15	Remove island and dig out a pond and create wetland for flood storage, remove invasives and plant natives.
Westmoreland Park Improvements	Crystal Springs	Master planning effort to create a variety of habitat enhancements, including establishing Crystal Spring's channel and revegetation the banks to create a more naturalistic riparian edge. Other improvements may include adding boardwalks and viewpoints.
Habitat Restoration	Reach 17	Restore channel with large wood. Enhance instream habitat complexity and floodplain connectivity and revegetate.

Several of the top tier Restoration (R) Projects will be further characterized below by highlighting preliminary implementation attributes including: expected lead entity, potential partners and project sponsors, project description, goal and objectives, limiting factors addressed, targeted benefiting area, rationale for priority rating, planning level cost estimates, sequencing, and anticipated future monitoring or maintenance needs.

CHAPTER 6.0 PUBLIC INVOLVEMENT & EDUCATION

Community investment is a cornerstone of the Johnson Creek Watershed Council's effort to protect and enhance the Johnson Creek Watershed. The Council will be requesting investment of time and resources from community agencies and organizations as well as individuals to implement the actions identified in this plan. JCWC staff, committees and board worked with Adolfson Associates, Inc. and subcontractor Jeanne Lawson Associates, Inc. to develop a public outreach plan (see Appendix G) to provide opportunities for public involvement in the development of this Action Plan.

This involvement was accomplished through five major avenues:

1. Participation of community members on the Technical Advisory Committee;
2. Stakeholder interviews;
3. Stakeholder survey;
4. Public review of action plan documents; and
5. Development of a Landowner Participation Strategy.

1) The Technical Advisory Committee

The Technical Advisory Committee consisted of five representatives from jurisdictional stakeholders: the Cities of Gresham, Portland, and Milwaukie; and Clackamas and Multnomah Counties. These advisors provided key insights into the needs, roles, and ongoing processes of the jurisdictions, as well as critical information regarding their respective areas of the watershed. The technical capacity of these partners was also helpful in developing meaningful criteria.

This participation was complemented by participation of four watershed stakeholders, two of whom were watershed residents. These people contributed technical skills and provided a public interface with the technical advisory committee. Their participation helped shape the plan by providing project ideas, critical first hand knowledge of the watershed, and information about public support and feasibility.

2) Online Survey

A survey instrument was developed to assess community opinion and support (see Appendix G). The survey was publicized in community newspapers; on JCWC website, newsletter, and emails; on sister websites; through email listserves; by personal invitation; and by word of mouth. The survey was available from March 1 to May 1, 2003. See 5) Landowner Participation Strategy for the survey result summary.

3) Stakeholder Interviews

In order to assess stakeholder values and interests, interviews were conducted with a small number of individual stakeholders. These interviews were designed to complement the online survey with more in-depth, qualitative information. The interviews were also intended to reach audiences less likely to participate in the online survey. Interviews were conducted with:

- Creek-side property owners (urban/suburban Portland);
- Small Farm owner in Sunshine Creek subwatershed (unincorporated Clackamas Co.);
- Nursery Operations Manager in upper watershed (unincorporated Clackamas Co);
- Creek-side property owner (unincorporated Multnomah County); and
- Developer (Portland).

Following is a summary of their comments on major issues:

Johnson Creek Values:

- Natural Beauty;
- Open Space creates housing demand;
- Opportunity/Uniqueness of urban stream;
- Habitat elements; and
- Education opportunities.

Problems or threats:

- Pollution, especially horse manure;
- Invasive Species;
- Sediment;
- Flow: highs and lows associated with development;
- Forest Canopy & Shade; and
- Erosion.

Protection or restoration measures supported (not supported):

- Public Education;
- Get to know people and work with them;
- Increase awareness through signage; and
- Flood retention through rechannelization
- (Removal of rip-rap); and
- (Regulations and zoning).

<u>Funding</u>:

- Bond measure; and
- Government (or city) should pay.

<u>Volunteers</u>:

- Work with schools and children;
- Neighborhood Associations;
- Create incentives for participation;
- Demonstration Projects; and
- Increase awareness.

4) Public Review of Action Plan Documents

As each element of the Action Plan has been completed in draft form, it has been made available to the Council, to jurisdictions through the TAC, and to the public at large. This process has produced useful feedback, which has been incorporated into the document. The draft action plan in its completed form will be available for review by City Council members and jurisdictions for one month, prior to one month of review by the general public. In addition, the document is intended to be a living plan that can be updated on a regular basis. To this end, the document will be turned into a series of web pages to be hosted on the JCWC website for continual review and refinement.

5) Landowner Participation Strategy

Strategy Overview

This section outlines key elements of a strategy to engage landowners and managers in cooperatively implementing Action Plan projects. The strategy is based on the belief that landowners are the best stewards when armed with information and assistance. This belief is founded on the principle that stewardship is in their own economic and ethical interest - that a healthy, functioning system is good for the individual and for us all.

The strategic model set forth here is based on educating, encouraging and supporting private and public landowners in undertaking voluntary actions to meet action plan goals. The basic effort is to spread the idea that watershed health is good for the landowner and good for the community. Voluntary cooperation has been applied by non-profits and non-regulatory government agencies for several years with various levels of success. Some things have been learned from this experience however, voluntary cooperation is typically more time-consuming to accomplish than regulatory compliance but once underway generates a momentum of its own. It results in more broadly based, longer-term improvements without the enforcement cost and distress of regulatory control. The trick has always been how to reach out effectively to start the voluntary cooperation bandwagon.

Armed with the information and analysis contained in this Action Plan, property owners will be able to increase their understanding of and appreciation for the Johnson Creek watershed. The Action Plan itself initiates a new round of opportunities for encouraging voluntary action by explaining the benefit for the individual site and the watershed as a whole stemming from the targeted resource area projects. The landowner strategy must capitalize on the momentum and publicity generated by the technical and outreach activities associated with developing the Action Plan.

The landowner participation strategy that follows is divided into two parts. The first is a watershed scale look at key public values and concerns derived from a recent web poll conducted by JCWC and comparing those findings with other public values and behavior research undertaken in the Tualatin Basin.

In part one, the Johnson Creek general findings are assembled and interpreted providing overall communication and implementation guidance. Part two dissembles the watershed into target resource areas. Each area is briefly characterized by limiting factors, general land use and potential obstacles to implementation. Poll results from residents of the area are also displayed and analyzed. By combining the resource, demographic and values understandings an approach is designed to increase cooperation, connection and coordination with the target area. The strategy is customized to provide specific first steps in initiating the tipping landowners in that target area toward implementing action plan projects.

All recommendations are made with an explicit recognition of the resource limits of the Johnson Creek Watershed Council. Increasing the organization's outreach capacity and effectiveness is part of this strategic program.

Public Values about Watershed Restoration and Health

A web-based survey was conducted during March – May 2003. The survey attracted a total of 176 respondents. Respondents sorted themselves into self-described categories. Many identified themselves in more than one category. The survey was not a random sample nor is it statistically valid. The results, listed in Table 21, are however, quite useful and suggestive in designing an effective outreach and involvement program.

Identifier	No. Of Responses (Also Resident)
Resident of watershed	114
Farmer/Nursery	2 (1 resident)
Business	8 (7 resident)
Public Agency	22 (6 resident)
Other	Common entries: JCWC Board or member, supporter, volunteer, member of nonprofit, student, teacher, interested individual, citizen (no residents)

Table 21. Participant Profile

Johnson Creek Functions and Values

Participants were asked to rate the value of a list of watershed values based on the question, "How valuable is each of the following functions or assets of Johnson Creek to you?" See Table 22 below for the listed functions.

Respondents clearly indicated that they differentiate among functions. Some are significantly more highly prized than others. Clean water, supporting fish, wildlife habitat, and open space received substantially higher valued ratings than the others. Wildlife habitat was rated highest followed closely by clean water. Supporting fish and open space were also notably higher prized than other functions. Flood protection, education, aesthetics are grouped together with significantly lower ranking with recreation following into the lowest ranking as the least essential and valued watershed function.

It should be noted that all the functions received positive ratings indicating that survey participants believe that the entire complex of watershed functions is important. It may also indicate that respondents understand the interconnected nature of watershed functioning.

Table 22. Values Ranking

Function	Essential	Important	Inconsequential
Wildlife Habitat	123	18	
Clean Water	119	22	
Support Fish	110	29	2
Open Space	102	39	1
Flood Protection	59	70	12
Education	59	77	4
Aesthetics	58	76	8
Recreation	41	84	15

Seriousness of Threat

Participants also rated a list of potential threats to Johnson Creek. Table 23 shows the resulting threat ranking.

Table 23. Perceived Threats

Threat	Serious	Moderate	Low	Not A Problem
Water Pollution	105	33	3	0
Loss of Habitat	102	34	5	0
Fish Population Decline	102	38	2	0
Loss of Wetlands	99	37	6	0
Loss of Vegetation or Increase of Invasive Plants	98	36	7	0
Loss of Wildlife	84	44	12	0
Loss of Open Space	60	69	12	1
Flooding	39	67	27	6
Limited Recreational Opportunities	10	56	59	15

Serious threats sort into 2 groups. The most serious threats in order of ranking are water pollution, fish population decline, and loss of habitat. A lower level of seriousness but still quite highly ranked are loss of wetlands, loss of vegetation or increase in invasive plants and loss of wildlife.

Of more moderate concern is flooding with more moderate ratings than serious. Of minimal or low concern are limited recreational opportunities. It has more low ratings than any of its other ratings and more not a problem ratings than serious ratings.

Threats seem to parallel the most highly prized values in rank order. Clean water, habitat and fish populations are the most highly prized functions as well. It is possible that the most highly prized values are automatically considered under the most threat because participants want them protected first or there may be a coincidental link between highly prized values and the threats to those values. At any rate a strong case is indicated for looking at projects that produce water quality, habitat and fish population benefits.

Further investigation about public understanding of threats is needed. It would be useful to understand what sources of water pollution are perceived to be the prime causes of watershed threat. Among the contributors to water pollution that might be considered are industrial, residential, urban streets or agricultural sources. Public perceptions can be compared with the technical findings of the Action Plan to assess the level of match between public perception and technical understanding.

Priorities for Implementation

Participants were asked to allocate $100 among the following list of watershed improvement actions. (Table 24) Totals for all respondents indicate level of priority for the following:

Table 24. Action Priorities

Watershed Health Action	Total $	Out of $100
Clean Water	3788	27
Supporting Fish	2547	18
Wildlife Habitat	2424	17
Open Space	2057	14
Flood Protection	1524	11
Education	985	7
Recreation	542	4
Aesthetics	333	2

Ranking again reconfirms the most important, most threatened and most highly valued issues in Johnson Creek generally are clean water, fish and habitat. Least important for allocating resources are education, recreation and aesthetics.

Flooding is consistently ranked below the middle of each of the value, threat and resource allocation ratings. Follow-up with streamside landowners might prove interesting as a comparison to these general findings.

Tualatin Basin Surveys

Recent public values and behavioral surveys were conducted by Clean Water Services in Washington County, Oregon. Johnson Creek and the Tualatin have many similar characteristics as rural-urban interface systems. The information derived from these random, statistically significant surveys is useful as a comparison to the findings from the Johnson Creek poll.

The Tualatin Basin surveys demonstrate a high level of consistency in deeply held basic values regarding watersheds. Significant support exists among the general population for clean rivers and streams. This value is most ardently reflected in residents' desire for clean drinking water. Even in local streams that are not directly used for municipal supplies, clean water is rated as the highest value. It is interesting to note that the Tualatin survey also asked respondents to rate the sources of water pollution. Their rankings put industrial pollution way out in front followed by development and/or buildings too close to streams. There seemed to be little recognition of personal behavior and impacts on streams – like car washing, lawn and garden chemicals or pet waste. The general public, as compared to streamside residents, were more likely to indicate that run-off from farms, lawns and stormwater as serious threats.

Public values also tend to agree on the values they find least important. Those are protecting property from flooding, increasing the water supply, healthy fish populations in local streams and adequate water in streams for fish and wildlife. All these findings are consistent with the Johnson Creek polling.

Property rights protection is an important value. It is depicted as a competing value with efforts to restore and maintain water quality.

The Tualatin Basin survey separated respondents into streamside property owners, general public and homebuilders/developers. There are some important values distinctions worth noting here.

Streamside property owners' values:

- Water quality is the principal issue. The value of clean drinking water and clean rivers and streams is ranked above all others associated with the Tualatin River and streams. Property owners believe these twin values have central importance to the health of the waters. When other values are paired against them – whether healthy fish populations or adequate water supply – clean water consistently leads in importance.

- Protection of property rights is also key. Next to clean water, property rights protection is the most important value for the streamside owners you are targeting with this outreach. The concerns associated with this value – both positive and negative – must be addressed forthrightly.

- Development and building too close to streams is viewed as a major threat. Given the disconnection found between the impact of personal behavior and threats to the waters, recognition that their own building and improvements are a potential issue may be a difficult gap to bridge.

Homebuilders and developer values were revealed through focus groups. While not as reliable as polling data, similar values to streamside property owners were identified. Specifically a high value was placed on clean rivers and streams and property rights protection. The latter was a particularly important value for this constituency. An added dynamic is the inherent skepticism this group had about the intentions and execution of watershed protection policies, no matter how well intended or explained.

Communication Lessons

- Lead with the message that a central goal of the Action Plan is protecting and improving water quality. Arguments about conservation and restoration of water resources, meeting federal requirements, or supporting aquatic life or recreation will not garner the necessary attention of these residents.

- Treat property owners and developers as partners and ensure communication values property owners' stewardship values and ethics. Language implying yet another pronouncement about more ways to limit their use (or their own creative stewardship) of their property will be met with resistance. Arguments about compliance with federal law are not often viewed as a clarion call for property owners' support.

- Buffer zones and revegetation efforts along the affected corridors can be viewed as a threat to property rights. In addition, it will likely to be a stretch for individual streamside owners to see their own actions as part of that threat.

- Flooding issues need to be addressed in a holistic watershed wide approach.

The lessons noted above should guide a re-examination of existing outreach materials – newsletters, web site and brochures. Emphasizing Action Plan implementation benefits consistent with highly held values, simplifying messages by excluding legitimate but lower valued benefits, straightforwardly addressing property rights concerns, and eliminating references to requirements are the essential elements of this recasting of the materials.

The importance of clean water and fish/wildlife habitat need to be central to all messages and communications about the Action Plan or any other JCWC activity. Promoting buy-in is a direct result of tying action plan goals to the highest values and most threatened functions.

The surveys demonstrate that arguments about conserving and restoring water or meeting government requirements do not have the power of simply demonstrating that action plan projects are aimed at achieving clean water. Protecting and cleaning up Johnson Creek is what people want to do. Streambank restoration and revegetation are most straightforwardly justified as clean water efforts regardless of their other benefits.

Implementation Lessons

- Build partnerships around the mutual clean water desire. Local action implies addressing a local issue however. Emphasize information targeted to the individual landowner's area rather than watershed-wide data. Use property owners' natural desire to do the right thing in their local area. Don't debate water quality issues. Listen to what landowners think. There is usually a clean water solution to any watershed health issue.

- Look for innovators and early adopters by giving property owners there due as stewards. Find out what they are already doing. Expect creative and non-standard approaches invented by adaptive landowners. These practices might not be approved as Best Management Practices but could turn out to be the most appropriate, or most acceptable, technology for the area. Innovators and early adopters are not likely to follow the rules. They may have "the different idea" that will be more widely and/or easily adopted than the standard approach. Take what you can get even if it isn't the Cadillac of practices.

- While property owners are inclined to do the right thing for clean water, property rights arguments are powerful. Defuse these concerns by being transparent and open about them. Your non-regulatory status allows you to remove the Action Plan from that issue and focus entirely on doing what is good for the landowner and the rest of us.

- Clean water is the high ground in this effort – not fish, not habitat, not recreation, not even flooding or education. While improving fisheries rated equally high as clean water as a value and perceived threat, when it comes to allocating dollars clean water is alone at the top. This discriminator clearly places achieving clean water at the top of the heap.

- Flooding issues need to be addressed in a holistic watershed wide approach.

Finding Innovators and Early Adopters

The Action Plan breaks the watershed into targeted resource areas. Identifying and partnering with innovators and early adopter is important to successful implementation of Action Plan projects. Knowing the audience is key to developing an effective participation strategy. The following sections provide demographic and land use characterizations for the target areas.

General Landowner Group Area 1 – Upper Johnson Creek Main Stem

Upper Johnson Creek main stem generally includes reaches 16-23 (Main City Park in Gresham to headwater area). Resource and habitat quality is wide-ranging consisting of some of the best quality and functioning habitat (Reach 16) with multiple channel units with good complexity, large woody debris jams associated with deep pools, and backwater areas and shade cover.

The ongoing development of the lower Willamette Agricultural Water Quality Rules provides an opportunity to work with state and local regulators to increase use of best management practices on agricultural land on a semi-voluntary basis. While landowners are required to follow the Agricultural Water Quality Rules for their area, they are allowed to decide which methods to use on their property in order to be in compliance with the rules. They can voluntarily work with a local Soil & Water Conservation District to develop a "Voluntary Water Quality Plan" for their property. Property owners tend to fear/dislike regulatory approaches and are generally skeptical of government and non-profit programs.

General Landowner Group Area 2 – High Priority Restoration/Connection Areas

3A - Lower Johnson Creek (Reaches 4-5). This area is generally located from the Old Tacoma Bridge to the Johnson Creek Boulevard Bridge including Tideman Johnson Park. Land use mainly consists of residential with some commercial properties.

Potential Obstacles: Habitat diversity improvement will be difficult due to concerns about liability, erosion, and trash build up. Homes and actively used yards are very close to the creek in some parts. However, opportunities exist in large publicly owned areas such as Tideman Johnson Park, and Errol Heights Nature Preserve. Landowners are generally supportive on the south side of creek through Tideman Johnson Park reach. WPA wall considered historic cultural asset , and neighbors may be concerned about removal or alteration.

3B – Middle Johnson Creek (Reach 8, 12-14). This area is generally located between SE 82nd Avenue and I-205, and Brookside Restoration area up to SE 190th in Gresham. Land use mainly consists of residential with commercial and several industrial properties.

Many of the same constraints will be encountered in this area as in other as noted in other urban areas. Bank erosion is prevalent here on private and public properties, both where WPA wall is absent and where it has filled in with sediment. Strongly skeptical attitudes exist in this area due to historic conflicts with City of Portland and other entities on previous public works projects. Many mature second growth trees mean high landowner valuation of natural resources.

3C – Crystal Springs Creek. Crystal Springs Creek is a major tributary of Johnson Creek located in the lower portion of the watershed. Due to its eastside location, surrounding urban development, and existing dedicated park usage, upland and riparian habitats are quite fragmented and poorly connected with nearby habitats.

Opportunities exist for capitalizing on Portland Parks/Army Corps of Engineers work on Westmoreland Park and Reed College work on Reed Canyon. Portland Parks staff have expressed interest and enthusiasm in continuing the habitat recovery projects at Eastmoreland Golf Course. Patrons and supporters of the Crystal Springs Rhododendron Gardens may become concerned about any alterations to the lake. Passage on private property will require intensive and long-term outreach campaign – resistance is notable. Support for environmental issues/quality-of-life investments is high in this area.

3D – Kelley Creek. Kelley Creek is a major tributary of Johnson Creek located in the middle sections. Land use in the Kelley Creek subwatershed is mainly residential and rural agriculture. Pleasant Valley and Damascus urban growth developments are currently being planned for in this area of the watershed. Kelley Creek has both excellent habitat areas and very poor and degraded reaches. Kelley Creek suffers from a lack of habitat diversity to high flows and pollutant loads. Riparian areas are degraded and several water storage ponds and impassable barriers exist. The Pleasant Valley Implementation Plan is currently being drafted and individual properties have been identified for both protection and developable areas.

JCWC has been working to increase visibility and identity in this area for two years. Many landowners are familiar with the issues, though many are also threatened by urban growth and fear loss of property value due to environmental regulation.

General Landowner Group Area 3 – Water Right Holders (Watershed Wide)

This grouping of landowners consists of businesses, nurseries, and residential landowners throughout the watershed that currently have or applied for water rights. These include 32 claims and three applications for obtaining groundwater from wells that total more than 18 cubic feet per second (cfs), and 65 groundwater well permits for a total of 62 cfs; 53 permits for withdrawing surface water totaling 31 cfs; and 27 permits, applications, or certificates for storing water in ponds or reservoirs totaling more than 115 acre-feet.

Key Elements of the Landowner Strategy

- Start small. Find those people in a target area that are the landowner leaders. Identify innovators and early adopters. Listen to what they do. Adopt those practices as your own whenever possible. Enlist them to begin spreading the watershed health virus.

- Focus on clean water. People value numerous watershed functions and are concerned about a variety of threats but clean water trumps them all when it comes to allocating resources. Make clean water a consistent part of all messages - especially in general public outreach.

- Find out about streamside property owners concerns regarding flood control. Johnson Creek may be a special case that deviates some by placing a higher value on flood control among those directly impacted. Dual flood control and clean water practices may be especially attractive to these participants.

- Take yourself out of the property rights debate. Look for ways to demonstrate the value of adopting practices or changing behavior to help with water quality even if it means re-landscaping some streambank.

CHAPTER 7.0 ACTION PLAN IMPLEMENTATION

7.1 Action Plan Participants

Parts of the Johnson Creek Watershed Action Plan will be implemented by various actors and stakeholders within the watershed. The roles these actors will play will depend upon the resources available, the planning interests of the organization, and the regulatory environment. Different actors experience different constraints and opportunities to take action to improve watershed health. The Johnson Creek Watershed Council and agencies with which it works will be among the key actors in implementing the action plan.

7.1.1 Johnson Creek Watershed Council

As a community based organization, the Johnson Creek Watershed Council recognizes the value of working in partnerships with other public and private organizations. Many organizations are actively working on Johnson Creek projects, including monitoring, restoration and enhancement, education, and land use planning. The Johnson Creek Watershed Council enjoys partnerships with many of these organizations, collaborating to increase the scope, scale, and intensity of efforts. These partnerships have provided the basis for the success of several projects in the watershed. The Johnson Creek Watershed Council occupies a particular niche among the many committed organizations and individuals in that its decisions are guided by a board of directors representing the diverse interests in the watershed; it takes the entire watershed as its focus; and in that involving the public in its activities is a fundamental part of its mission.

The Johnson Creek Watershed Council Action Plan provides a tool to assist JCWC and its partners in identifying and prioritizing projects to improve watershed health and sustainability. The JCWC and other organizations working on Johnson Creek projects may play a variety of roles in these projects, from advising on project planning and design to implementing projects from start to finish. The JCWC will utilize the Johnson Creek Watershed Action Plan, together with the Johnson Creek Watershed Council's Strategic Management Plan, to direct its programs and projects in order to have the greatest beneficial effect on watershed health.

7.1.2 Local Municipalities

Six local jurisdictions are located within the Johnson Creek watershed. These include: The cities of Portland, Gresham, Milwaukie, Happy Valley; Multnomah and Clackamas Counties. Portland, unincorporated Clackamas County, and Gresham contain the largest share of the watershed at 38, 24, and 23 percent respectively, and collectively account for 85 percent of the total watershed. Multnomah County, Milwaukie, and Happy Valley contain the remaining 11, 4, and 0.1 percent respectively. These percentages have provided the basis for cooperatively funded watershed-wide programs through the Johnson Creek Interjurisdictional Coordinating Committee. The most recent of such programs are the ODFW Aquatic Habitat Inventories project and water quality monitoring efforts associated with the TMDL development. Several of these jurisdictions have also been able to provide financial support for the activities of the JCWC, especially programs such as Within Your Reach, the newsletter of the JCWC, the annual Watershed Wide Event, the Johnson Creek Summit, and the Springwater Festival.

Roles and opportunities for local jurisdictions and state and federal resource and regulatory agencies are numerous and varied. Local jurisdictions and resource agencies continue to implement numerous programs and activities that affect the watershed and its health including: planning; operations and maintenance; permit review and approvals; public involvement and education programs; design and construction of capital improvements, public works projects, and restoration activities; land acquisitions; and response, compliance, and monitoring programs.

As in the past, successful implementation of some Action Plan projects and programs will depend to some extent on the collaboration of JCWC partners and relevant agencies. The JCWC acknowledges the historical and ongoing programs and projects that local jurisdictions have conducted throughout the Johnson Creek watershed. Roles and involvement will vary from project to project, depending on the resources and strategies developed by individual agencies. It is hoped that this plan will provide a tool to assist in developing the resources and strategies, and in some case, in developing increased coordination. Overall, depending on the jurisdiction's resources and plans, opportunities for project involvement will probably follow a similar structure as the JCWC.

7.1.3 Other Stakeholders

Other stakeholders in the drainage basin include watershed residents, schools, businesses, environmental organizations, and state and federal resource and regulatory agencies. All of these groups have a significant role to play in the watershed. A few selected roles and responsibilities include: education, volunteering, stewardship, best management practices, plan and permit review, monitoring, and advocating for the health and sustainability of the watershed.

7.2 Roles and Opportunities

7.2.1 Participation Levels

Projects identified in the Action Plan vary in detail – some are well-defined projects with concrete goals and objectives and preliminary designs. Others are more general, necessitating further review and study. For this reason, it is difficult to define precise roles for each actor or player at this juncture. This plan therefore defines a range of potential participation levels or roles for the Council and other actors or players:

Implement: In this scenario, the JCWC takes full responsibility for implementing the project, working with various partners and stakeholders as necessary and desirable. Staff and volunteers may serve as project lead, working with contractors, volunteers, and others to oversee the project from beginning to completion.

Facilitate: The JCWC works to assist others to implement the project, by recruiting volunteers and expertise, providing publicity, or connecting organizations and groups to needed resources. In many cases, the project leader or leaders may approach the JCWC to ask for assistance, though the initiative for the project comes from them.

Inspire: In certain cases, the JCWC may advocate for other organizations to engage in a project. This scenario is most likely to occur when the JCWC cannot act as the implementing organization for lack of resources, jurisdiction, property access, or other factor.

Advise and consent: In working on many projects, the project lead entity or individual may turn to the JCWC for technical assistance, feedback, or commentary. The JCWC does not play a critical role in implementing of these projects, though the Council's participation and approval may assist in resource acquisition.

7.2.2 Implement Council Projects and Actions for Accountability and Leadership

The JCWC will proactively implement projects and actions to raise awareness about the challenges and opportunities that face the Johnson Creek watershed. Strategies to achieve this outcome include:

- ✓ Continue to solicit articles, develop quarterly newsletters, and disseminate public involvement and educational materials.
- ✓ Identify interested riparian property owners who are looking for assistance to restore or improve their properties.
- ✓ Seek additional new federal and private funding sources for the purchase of equipment and to assist in implementing volunteer projects.
- ✓ Maintain a computer database of projects and GIS maps to track implementation of all JCWC projects and other significant local jurisdictional sponsored projects throughout the watershed. And, participate in OWEB's Statewide Strategy development process and provide critical watershed information into OWEB's future information clearinghouse process. OWEB's clearinghouse is a common network to support the sharing of information among agencies and other users. When developed, this system is expected to promote the use of data protocols, identify critical data gaps, and incorporate new information into a statewide assessment of watershed conditions.
- ✓ Prepare new educational materials to be directed at targeted landowners throughout the watershed.
- ✓ Work collaboratively with local municipalities to distribute through billings and other public notice mailings.
- ✓ Promote the JCWC and fill the current openings on the Board.
- ✓ Implement and complete strategies and actions contained within the JCWC Strategic Plan.
- ✓ Identify and prioritize key properties for acquisition based on research of water rights and cooperation with local agencies.

7.2.3 Facilitate Restoration Projects and Actions through Partnerships

The JCWC will facilitate restoration projects and actions by continuing efforts to effectively communicate and coordinate with existing partners. Strategies to achieve this outcome include:

- ✓ Continue to collaborate and strengthen existing partnerships and identify and seek out new partners including universities, business organizations, regional governments, and local neighborhood groups.

- ✓ Collaborate with the Oregon Department of Agriculture, Clackamas County Soil & Water Conservation District, and the East Multnomah Soil and Water Conservation District to identify landowners who are willing to implement demonstration projects on their properties. Assist with sponsorship of water quality management plan implementation and water quality demonstration projects.

- ✓ Continue to support local municipalities with grant applications by providing local match volunteer hours and other support for implementation of restoration projects.

7.2.4 Inspire Stewardship Behavior Projects for Understanding:

The JCWC will initiate and inspire stewardship behavior projects to reach out to all residents and stakeholders throughout the Johnson Creek watershed to provide a better foundation and understanding of the key limiting factors impacting the current health and long-term sustainability of the watershed. Strategies to achieve this outcome include:

- ✓ Continue to inspire and facilitate community awareness and investment by developing and hosting watershed wide events, such as Springwater Festival, and others.

- ✓ Prepare an Annual State of the Watershed Report and report on implementation progress of the Action Plan.

- ✓ Facilitate and assist with implementation of the Landowner participation strategies identified in this Action Plan.

- ✓ Support workshops for teachers interested in developing, learning about, or implementing watershed based curriculum. Identify monitoring, volunteer, and other local projects schools can participate in.

- ✓ Support workshops for landowners on innovative approaches to land conservation and watershed restoration.

7.2.5 Advocate for Projects and Protection

The JCWC will advocate for projects that will protect watershed functions from degradation. Strategies to achieve this outcome include:

- ✓ Proactively review and provide comments on draft Concept and Implementation Plans and other documents related to planning projects in the Urban Growth Boundary expansion areas.

- ✓ Assist local governments by lending support for watershed friendly policies, incentives and other new programs, resolutions, and ordinances.

- ✓ Actively recruit neighborhood association representatives to participate in the JCWC Land Use Advocacy Committee and provide training on reviewing land use permit applications.

- ✓ Assist in actively promoting cooperative efforts between governments and groups to achieve common understanding. Advocate for more frequent and effective communication between stakeholders and facilitate information sharing.

Actions that involve private property owners and land acquisitions can be sensitive and may not fit into the project schedule. Tax incentives, technical assistance, cost sharing and collaboration with other local governments and private entities can be useful in obtaining support, assistance, and momentum. See landowner participation strategies in Chapter 6, Public Involvement and Education.

7.3 Restoration Principles and Guidelines

Restoration can mean the reestablishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics. Restoration is different than habitat creation, reclamation, or rehabilitation – it is a holistic process not achieved through the isolated manipulation of individual elements. Restoration can also be defined as the return of an ecosystem to a close approximation of its condition prior to disturbance. In restoration, ecological damage to the resource is repaired. Both the structure and functions of the ecosystems are recreated. The goal should be to emulate a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs (National Research Council, 1992).

The City of Portland has developed a scientific foundation for their watershed management process as part of the Framework for Integrated Management of Watershed and River Health. The goal of the Framework is to achieve watershed health while taking into account the realities of the urban area. The scientific foundation revolves around principles and guidelines that will influence the City's watershed and habitat protection, restoration, and conservation efforts. The scientific foundation is aligned with a view that species and habitats exist in an integrated ecological system. A scientific foundation provides a consistent and clearly defined approach to restoration, where assumptions and hypotheses underlies that approach so that they can be scientifically tested and refined over time (City of Portland Internal and IST Draft Framework, 2002).

The principles and guidelines that represent the City of Portland's scientific foundation for achieving watershed and river ecosystem health are grouped into four categories: 1) primary ecological principles; 2) riverine ecology principles; 3) salmonid ecology principles; and 4) restoration guidelines. Table 25 summarizes these categories and their associated principles or guidelines. The Johnson Creek Watershed Council should also utilize these principles and guidelines in directing the implementation of this Action Plan.

Table 25. Principles and Guidelines – City of Portland's Scientific Foundation

Category	Principle or Guideline
Primary ecological principles	1. Ecosystems are dynamic, resilient, and develop over time. 2. Ecological systems operate on various spatial and time scales that can be viewed hierarchically. 3. Habitats develop, and are maintained, by processes related to climate, geology and hydrology. 4. The abundance, productivity and diversity of organisms are integrally linked to the characteristics of their ecosystems. 5. Species play key roles in developing and maintaining ecological conditions. 6. Ecosystem function, habitat structure and biological performance are affected by human actions. 7. Biological diversity allows ecosystems to accommodate environmental variation.
Riverine ecology principles	1. Rivers are not separate from the lands they drain. 2. Watersheds are defined by and operate across the spatial and temporal dimensions of river ecosystems. 3. Hydrologic modification can reduce habitat diversity, decrease native biodiversity, increase nonnative species and exacerbate water pollution.
Salmonid ecology principles	1. Life history diversity, genetic diversity and metapopulation organization are ways salmonids adapt to their complex and connected habitats and are the basis of salmonid productivity and salmonids' ability to cope with environmental variation. 2. Sustained salmonid productivity requires a network of complex, diverse, and interconnected habitats that are created, altered, and maintained by natural physical processes in freshwater, estuarine, and ocean environments. 3. Salmonid restoration must address the entire natural and human ecosystem, encompassing the continuum of freshwater, estuarine, and ocean habitats where salmonids complete their life histories.

Category	Principle or Guideline
Restoration guideline	1. View the whole picture: Watershed restoration efforts need to be placed within the context of the entire watershed; species recovery efforts must be placed within the context of complete life cycles. 2. Characterize existing conditions and use the results to inform the entire restoration planning process. 3. When planning restoration actions, prioritize and sequence them to maximize long-term success. • 3.1 Begin species recovery efforts by protecting and restoring existing populations. • 3.2 Build outward from existing populations. • 3.3 Place priority on controlling sources of degradation before attempting to address the impacts of those sources. • 3.4 In prioritizing restoration actions, first understand how watershed processed affect watershed health. Focus initial restoration actions on the processes that create and maintain watershed health. Sequence restoration actions for maximum effectiveness. Consider the importance of hydrology, habitat creation and maintenance and water quality; which are key, interlinked processes for restoring watershed health. To the maximum extent practicable, use natural processes to achieve ecological and societal functions.

Implementing strategies to carry out the Council's Action Plan fall into several categories based on project type including: implementing projects and actions on their own; facilitating the implementation of the project, or inspiring stewardship or advocating for the project or action.

Implementing actions involves effective communication and coordination, comprehensive planning, proactive leadership, and developing partnerships. Bringing all stakeholders to the table in the beginning will facilitate consensus building. Other important tasks involve administrative, planning and design, permitting and funding, and ongoing operations, maintenance, and monitoring activities.

It is recommended that the Johnson Creek Watershed Council undertake the following strategies to assist in moving the Action Plan forward for successful implementation:

7.3.1 Prioritization and Sequencing

For watershed action implementation to be successful, restoration and protection actions need to be prioritized in terms of need, effectiveness, and effect on future actions and programs. Actions also need to be sequenced so that implementing one doesn't impact the effectiveness of another. Project priorities were discussed above in Chapter 3 (Identification of High Priority Areas), Chapter 4 (Criteria

Development), and Chapter 5 (Proposed Projects and Actions). Evaluating problems and opportunities, addressing limiting factors, and assessing the goals and expected benefits of potential projects established prioritization. As suggested in the City of Portland's Framework for Integrated Management of Watershed and River Health, the following elements and their order is a matter of importance:

1) **Protect existing populations and their habitats.** Rebuilding an existing population is far more likely to be successful than reintroducing a population that has been lost.

2) **Reconnect favorable habitats.** This allows existing populations to provide 'colonists' that can reestablish satellite populations in nearby habitat where populations have been extirpated.

3) **Identify and control sources of degradation.** Causes of degradation should be identified and quantified before their impacts within the watershed are addressed.

4) **Restore the processes that maintain watershed health.**

    a. Normalize flow and hydrology;

    b. Restore physical habitat;

    c. Improve water quality; and

    d. Reestablish biological communities.

In some cases, higher priority projects might be scheduled or completed after a lower priority project due to the following circumstances:

1) More time is needed to secure partners or acquire properties, or implementation funds;

2) Other projects are required to be completed first to achieve desired results or expected benefits;

3) Timing is outside local control of project lead or sponsor; and

4) Opportunities are present or become available.

It is important to acknowledge that developing criteria for ranking projects (with differing goals and a wide array of objectives) fairly and consistently, even though they are grouped together, is difficult at best. All of the criteria may not be appropriate or applicable for some types of projects. A final review is appropriate using best professional judgment to allow for review and editing of the final ordering of projects.

A good case for this can be made in the Stewardship Projects where the Annual Report project was rated below both the Watershed Signage and the Car Trip Reduction Program. Although the total watershed health score for the Annual Report project was lower than these other two programs, the total social/economic score for the Annual Report project was higher than for the other two projects. As a result, one could argue based on professional judgment that an Annual Report on health indicators of the Watershed may be more important than these other two projects and thus should be rated higher.

Sequencing of projects and implementation of actions are critical for the success of the Council's Action Plan. Sequencing projects and actions should be based on several key components including but not limited to:

1) Severity of the problem;
2) Goals and objectives of the project and the assumed or known effectiveness of the project or action;
3) Technical feasibility;
4) Timing;
5) Funding; and
6) Other local and regional planning efforts and implementation project

7.4 Monitoring

Monitoring and applying adaptive management techniques is crucial to assessing trends, effectiveness, and ensuring the Action Plan continues to evolve and transform over time. The Johnson Creek watershed like all urban watersheds is a dynamic constantly changing ecosystem. The establishment of environmental baseline conditions and utilizing the Ecosystem Diagnostic and Treatment (EDT) model will aid in assessing future conditions and allow more fine-tuning of project implementation.

Monitoring is often overlooked and usually the first item cut in Watershed Action and Management Plans at the local level when funding is limited. Monitoring plans and programs can vary in terms of purpose, goals, and objectives. Monitoring programs need to be scientifically designed and focused to provide direct evidence of the effectiveness of management actions in both the institutional and biophysical environments. Monitoring programs can be used to: 1) gathering baseline data and assess existing conditions; 2) identifying sources and cause-and-effect relationships; 3) assessing long-term trends; 4) assessing seasonal or spatial variability; 5) assessing project or BMP effectiveness, or success of restoration efforts; or 6) educate residents, stakeholders, and policymakers.

Attempting to conduct long-term monitoring programs and assess trends requires a significant commitment and investment of staff and resources. Monitoring programs can be simple and straightforward and cost-efficient such as implementation monitoring to report the success of the restoration activity. Effectiveness monitoring is more complex due to the fact that a connection needs to be made between an action and an outcome.

One outcome of the watershed assessment is the identification of missing information that can assist in forming the monitoring program for the Action Plan**.** Missing information (data gaps) identified in the Watershed Assessment included:

- Water rights information
- Toxics sampling and analysis (sediment and fish tissue);
- Bacteria identification and tracing;
- Pollutant sources and loadings;
- Fish usage areas and locations of refugia areas;

- Outfall discharge characterization;
- Crystal Springs Creek and Kelley Creek EDT ranking results of survival factors for successful coho salmon trajectories, capacity, and productivity;
- Cutthroat trout EDT Model results
- Upper watershed tributary habitat;
- Fish barriers on private lands;
- Vegetation classes;
- Upland habitat and wildlife resources;
- Specific WPA locations and condition;

Monitoring is needed for watershed management and salmonid recovery efforts and is an important element of adaptive management. Monitoring usually includes collecting, maintaining, and analyzing data needed to plan, prioritize, and evaluate projects and activities related to watershed restoration and salmonid recovery. For stormwater management and land use planning, monitoring should rely on maps of drainage systems, and land uses, descriptions of watershed characteristics, collection of flow and precipitation data, and assessment of biological indicators. Monitoring programs for specific projects or actions may or many not include traditional analysis of physical, chemical, or biological constituents depending on its value for adaptive management.

Monitoring of a restoration effort should include both structural (state) and functional (process) attributes, and should generally not be restricted to one level of biological organization. Monitoring of attributes at population, community, ecosystem, and landscape levels is appropriate for restoration projects. Scientifically credible monitoring protocols and evaluation methodologies can be used to address the following three questions (Tri-County, 2001):

1) Implementation/compliance monitoring: Are institutions carrying out management activities?

2) Effectiveness monitoring: Are actions effective in accomplishing management objectives?

3) Validation/recovery monitoring: Are management strategies on track to achieve overall salmonid recovery goals?

Implementation/compliance monitoring would confirm whether actions have been taken in the time and manner specified. Effectiveness monitoring would be conducted strategically to measure whether specific policy decisions or restoration activities are achieving specified habitat objectives. Validation/recovery monitoring would focus on whether the region's actions, as a whole, provide a long-term trajectory to support overall recovery of salmonids.

Monitoring information can be used to evaluate actions and revise those that are not achieving desired outcomes in the expected timeframe. Such a strategic process will aid in prioritizing investments effectively and efficiently.

Tri-County (King, Snohomish, and Pierce County, WA) developed a Model 4(d) Rule Response Proposal in 2001. The following discussion highlights monitoring elements from their Salmon Conservation

Program. The JCWC Action Plan should develop similar monitoring elements in addition to the Monitoring Plan described below.

Direct effectiveness monitoring would measure whether specific actions are achieving the anticipated objectives. Scientifically sound studies would be designed to provide management data in the most efficient manner to expedite decision-making and salmonid recovery. Monitoring would than be designed to provide information for management decisions, but timeframes will vary by study element as required for statistical error. Participating local jurisdictions could potentially monitor their local programs and projects for effectiveness and make the results available for a watershed-wide process and cumulative effectiveness-monitoring program. Monitoring programs for effectiveness however, are complex and are a potentially far reaching effort. Multiple jurisdictions are currently partnering with DEQ and working out the dynamics of effectiveness monitoring.

Validation/recovery monitoring would focus on whether the region's actions, taken as a whole, are on a long-term trajectory to support overall recovery of salmon. A multi-stakeholder jurisdictional group, in consultation with co-managers of the resource, would need to agree on a minimum number of indicators necessary to measure the success of the Lower Columbia and Willamette watersheds towards achieving their respective portion of the Evolutionary Significant Unit (ESU) recovery goals. Validation/recovery monitoring would need to be conducted at the region (ESU) scale.

7.4.1 Monitoring Plan

Developing a monitoring plan is an important component of the Watershed Action Plan. A monitoring plan describes the objectives, identifies staffing needs, equipment requirements, funding, and summarizes the monitoring details. The following five-step procedure is listed in the OWEB's Oregon Watershed Assessment Manual:

Step 1 Goals and Objectives

The first step in developing a monitoring plan is to clearly identify the goals and objectives of the monitoring program. A statement with regards to the data gap or question to be answered should also be included. This should be followed by the parameters to be sampled; monitoring methods including field and laboratory quality assurance/quality (QA/QC) protocols if appropriate, study design, sampling locations, duration, and frequency.

Step 2 Resources

The next step is to evaluate resources needed. This includes staff or people needed, budget requirements, field equipment, laboratory analysis, and supplies.

Step 3 Monitoring Details

Next step involves identifying the monitoring details including the specific set of environmental indicators or parameters, the methodology to be utilized, the sample frequency required, and the monitoring locations.

For a water quality sampling and QA/QC program, monitoring details could also include the following elements:

- Background Information
- Problem Statement
- Site Description
- Project Description
- Project Objectives
- Data Quality Objectives and measurement performance criteria
- Project Organization
- Experimental Design
- Sample Collection including itemized sample list, sample handling, and chain of custody
- Analytical Methods including consideration of analyte list, detection limit requirements, method accuracy (precision and bias), data comparability requirements, and ability of the method to function under anticipated project conditions,
- Quality Control Procedures and Samples
- Data Review, Validation, and Assessment
- Data Archiving and Storage

Quality assurance/quality control (QA/QC) procedures are necessary to ensure that environmental data achieve an acceptable level of quality and that the level of quality attained is documented adequately. QA/QC protocols should be followed when samples are collected in the field, shipped or delivered to laboratories, and stored or distributed within labs and during analyses. The effectiveness of any monitoring program depends on its QA/QC program. The QA/QC program provides quantitative measurements of the "goodness" of the data. For some variables, QA/QC may involve calibration of instruments with known standards. To obtain measures of accuracy and precision, QA/QC may further involve analysis of blanks, replicate samples, control samples, and spiked samples.

Step 4 Pilot Project

Conduct field reconnaissance of all monitoring sites to ensure access is obtained and secured and that conditions are safe (especially at night or during storm events) throughout the monitoring period. OWEB recommends to plan on conducting a pilot project for a short period of time or to complete a trial run prior to committing to a long-term monitoring program.

Step 5 Review and Revise

Review the data collected after a short or pilot period to determine if the information collected will answer the monitoring objectives, and that it will meet QA/QC protocols and objectives.

7.4.2 Recommended additional elements of the JCWC Action Plan Long-term Monitoring Program

In addition to the prioritized data gaps listed above that should be included in any long-term monitoring program, the following three additional elements are recommended:

EDT Modeling Follow-up

The EDT Model will be utilized to model additional runs to evaluate different species such as Cutthroat trout. The EDT model will also be used to assist in source area identification and restoration project effectiveness. Restoration projects can be "inserted" into the model and model attributes can be evaluated to see how effective the project would be (prior) to implementation as well as for updating the model inputs and baseline conditions (post implementation).

Water Quality (TMDL)

The Johnson Creek Total Maximum Daily Load (TMDL) will be completed in December 2003. TMDL Implementation Plans will need to be developed by all jurisdictions and parties identified with load and wasteload allocations. TMDL Water Quality Management Implementation plans generally need to include:

- Proposed management measures;
- Implementation schedules and roles;
- "Reasonable assurance" measures for implementation;
- Selected water quality indicators;
- Monitoring plan water quality indicators and whether management measures are implemented;
- Plan for evaluating results including water quality trends assessment and adaptive management techniques;
- Public involvement process; and
- Estimated costs and funding.

Biological (Fish and Benthic Macroinvertebrates)

Biological sampling of fish presence and use should continue as part of the City of Portland ESA Program. Additional funding will be required to conduct existing surveys and for any expansion. In addition, the JCWC Restoration Committee's use of volunteers to monitor and collect spawning surveys also needs to be coordinated with future fishery monitoring programs.

Benthic macroinvertebrate sampling should be conducted in a comprehensive program to establish a baseline throughout the watershed. Additional monitoring should be conducted annually or at least every several years.

7.4.3 Annual Reporting

For the purpose of tracking progress with Action Plan implementation, an annual report should document the projects implemented and the monitoring conducted annually. These annual reports should be published on the JCWC Web site. Results from the Strategic Planning process should be incorporated into the strategy for long-term monitoring and tracking of watershed health.

7.5 Adaptive Management

JCWC and the TAC acknowledge that this Watershed Action Plan is a living plan and is designed to be flexible to integrate changes, updates and additional projects in the future. This includes integrating new information in the science of watershed ecology, new information on the health of the watershed, and progress towards reaching watershed health goals and objectives.

Ultimately by implementing projects designed to address these limiting factors, watershed processes will begin to function properly. However, it is critical that projects are monitored during and after construction and that overall watershed health continue to be monitored to determine the success of projects in achieving watershed health goals. Monitoring work may lead to modification of goals, objectives, targets or benchmarks, modification of project scopes or the addition of new projects to the plan.

It may take years or decades to determine the total effect of combined protective and restorative actions. To address this challenge, the adaptive management plan must include sustained monitoring and research in collaboration with public agencies, universities, and other organizations. The Action Plan's adaptive management process allows for new findings and knowledge to inspire adjustments to the plan to ensure its long term success. The development of the plan will incorporate ideas and input from the City of Portland's Framework for Integrated Watershed Management, and other planning documents.

The Adaptive Management plan for the Action Plan consists of the following sequential elements adapted from the Seattle Urban Blueprint, 2001 and incorporating key concepts from the Framework Plan:

1) Assess the resource and/or the problem. New information must be incorporated into the Watershed Assessment, especially where identified data gaps have been filled. This additional information will come from several key sources:

    - Information passed to the TAC from implementing committees (monitoring, restoration, stewardship and land use)
    - Information developed by jurisdictions and public agencies to meet regulatory requirements and for species recovery
    - New models and projects from the academic community
    - Information and feedback from the public

Information that will start to become available in 2003 and 2004 includes data from TMDL development, toxic source monitoring conducted by the Interjurisdictional Coordinating Committee, and additional EDT modeling by City of Portland ESA program. In addition, implementation of projects will determine how accurate or feasible the targets and benchmarks are for each priority area.

2) Decide on the goals, policies and actions, and develop hypothesis that need testing. New information may lead to better understanding of the watershed's processes, including limiting factors, high quality habitat areas, and areas with high restoration potential. Priority areas and criteria will be updated to reflect this information. With more information regarding source identification, projects which specifically target known sources of pollutants identified as limiting factors will become more important. These projects will be based on hypotheses about the impacts of specific areas and processes on downstream function. These hypotheses can be tested in the Ecosystem Diagnosis and Treatment model to verify their expected effectiveness in improving productivity, capacity, and diversity of fish species.

3) Implement actions and develop/conduct monitoring programs. As projects are implemented, careful record-keeping will allow correlation between stated objectives and progress on indicators. Monitoring must occur on a project by project basis, especially regarding indicators of key limiting factors.

4) Evaluate results. Detailed monitoring for specific attributes will allow the TAC to evaluate how successful the Action Plan's approach is in improving watershed health.

5) Decide on adaptations and adjustments. After evaluating the projects and their impacts, the TAC will have the opportunity to change the priority areas, targets, benchmarks, and the objectives. The TAC will also be able to make recommendations to the committees to improve their work plans and project design to ensure objectives and benchmarks are met.

Implementation of the Action Plan will involve all stakeholder groups. The Adaptive Management Plan will be implemented by several key constituent groups including: 1) JCWC Council; 2) Action Plan Technical Advisory Committee (TAC); 3) JCWC Committees; and 4) the public. Each group is highlighted below in terms of their general roles and responsibilities. See Chapter 7 in the Action Plan for additional details on roles and responsibilities and implementation activities. Time frames are listed generally and will be revised as necessary.

JCWC

The role of the JCWC is to facilitate the implementation of the Watershed Action Plan. Council members will ensure that JCWC Committees have the necessary information and tools needed to scope out and develop work plans for project implementation. The JCWC will review and adopt revisions to the plan proposed by the TAC. One of the first work items for the JCWC will be to promote the Action Plan and provide guidance on work plan development with the Committees.

Technical Advisory Committee (TAC)

The role of the TAC is to check on progress and propose changes to the Action Plan. The TAC will review the annual work plans of the Committee's and new information on projects, studies, and monitoring results. The TAC will be responsible for adjusting restoration objectives, and if necessary, the targets and benchmarks. One of the first work items of the TAC will be to provide additional details on proposed projects.

JCWC Committee's

The JCWC currently has four committees to implement projects and programs to accomplish the mission of the Council including: Administrative, Land Use Advocacy, Restoration, and Outreach.

The role of the committees is to develop work plans and implement projects to meet the targets and benchmarks set in the Action Plan. The committees will identify potential partners, and take on the appropriate role for project implementation. One of the work items for the committees will be to further refine the draft objectives, and to provide feedback to the TAC about project implementation, targets and objectives. Commitees will also liaison with other active project implementers and partners to develop new information and project proposals.

A monitoring committee needs to be established. The monitoring committee, like the other committees, will work with public agencies and the IJC on a project by project basis, identifying opportunities for collaboration and facilitation. The Monitoring committee will have many opportunities to work with the National Pollutant Discharge Elimination System (NPDES) Stormwater Discharge Permit Program, and TMDL programs, and activities of the ESA Coordinators.

All Committees will designate Committee Chairs who will report to the Council on a monthly basis. Committee monthly meeting dates may need to be revised in order to submit timely monthly updates for Council review.

Public Stakeholders

The public has an important role in assisting the above-mentioned groups in implementing projects where appropriate. In addition, the public has a role in reviewing progress, and providing comments on watershed health conditions and projects to the JCWC.

Implementation Schedule

Implementation of the Action Plan is an ongoing process. Development of committee work plans should be completed within six months of completion of the Action Plan. An update of the Action Plan should occur six months later, followed by annual review and updating. Implementation schedule is listed below:

Date	Implementation Activity
Sep 03	Action Plan Completed
Feb 04	Committee's complete Work Plans
Sep 04	Action Plan Revised as needed
Annually	Action Plan Reviewed and Revised as appropriate

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7.6 Funding Opportunities

Federal, State, and Local

The JCWC has been successful in the recent past in obtaining outside funds and grants to hire staff, purchase equipment and office supplies, facilitate forums, conduct public and organizational meetings, develop educational programs, print materials, and implement restoration and volunteer projects. A cooperative approach with a number of partners has led to this success.

Funding opportunities are currently limited at the local and state levels. State funding has been severely reduced and in some instances eliminated for watershed councils. Federal funding opportunities and grants exist, but the competition has become more numerous and intense. Private monies from businesses and foundations need to be targeted in the future and alternative funding sources need to be explored. Listed below is a brief summary of some of the funding opportunities that presently exist. It is recommended that the JCWC develop and implement a short-term action plan to secure additional and new funding sources that are geared towards stability and sustainability.

Funding for habitat restoration projects is available through NOAA Restoration Center's Community-based Restoration Program and its partners. There were three solicitations open in March 2003. The following were included:

1) National Oceanic and Atmospheric Administration Restoration Center.

   More information can be found at http://www.nmfs.noaa.gov/habitat/restoration/ or Restoration Ecologists for Oregon are Matthew Kimble (503-872-2738) or Megan Callahan Grant (503-231-2213).

2) Request for Community-based Habitat Restoration proposals (American

   Sportfishing Association's (ASA) FishAmerica Foundation in partnership).

Funding requests typically fall within the range of $5,000 to $30,000. For more information contact the FishAmerica Foundation at http://www.fishamerica.org. 3) Five Star Restoration Challenge Grants

   The National Association of Counties, the National Fish and Wildlife Foundation and the Wildlife Habitat Council, in cooperation with the U.S. Environmental Protection Agency, the Community-based Restoration Program within NOAA Fisheries, and other sponsors. In 2002, 52 projects received grants of on average $10,000 out of approximately 200 applications received. For more information contact EPA's website: http://www.epa.gov/owow/wetlands/restore/5star.

OWEB provides a funding directory on their web page. Fifteen federal and interstate sponsors are listed including: Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation, Cooperative State Research Education and Extension Service, Environmental Protection Agency, Farm Service Agency, Federal Emergency Management Agency, Federal Highway Administration, National Fish & Wildlife Foundation, National Forest Foundation, National Oceanic and Atmospheric Administration, Natural Resources Conservation Service, U.S. Army Corps of Engineers, U.S. Fish & Wildlife Service, and the U.S. Forest Service. In addition, OWEB lists several categories of funding sources and their associated types of assistance including: cooperative agreement programs, cost-share programs, grants and matching grant programs, and other financial and technical assistance programs.

During May 2003, the OWEB Board funded 63 projects totaling approximately $ 5.5 million. An additional 61 projects were not funded and two projects were deferred during this most recent funding cycle.

Grants

To support community-driven initiatives that protect habitat, improve water quality, and enhance outdoor recreation, EPA awarded $15 million in grants in May 2003, to 20 watershed organizations selected as part of a new Watershed Initiative. Funds were going towards restoration and protection projects, such as stream stabilization and habitat enhancement, implementing agricultural best management practices, and working with local governments and homeowners to promote sustainable practices and strategies. Regional and national experts selected the winners from a highly competitive field of more than 176 nominations. According to EPA, the winners were chosen because they best demonstrated the ability to achieve on-the-ground environmental results in a short time frame. Each of the watershed organizations exhibited strong partnerships with a wide variety of support, showed innovation, and demonstrated compatibility with existing governmental programs. The grants ranged from $300,000 to $ 1 million. For more information see http://www.epa.gov/owow/watershed/initiative.

For the Sake of the Salmon (4SOS) and the Oregon Watershed Enhancement Board (OWEB) are partnering to disburse funding through a Technical Assistance Small Grant Program. Approximately $30,000 is available for distribution for each of the three grant cycles (March 3, 2003; July 1, 2003, and November 3, 2003). Individual awards will not exceed $5,000. There is no requirement for matching funds. Eligible types of technical assistance include:

- Technical development and design for individual on-the-ground restoration projects including, but not limited to, fish passage, stream restoration, alternative diversion structures, water quality protection, range conservation, erosion control, and upland restoration;
- Site inspections; and
- Project permitting.

Forms can be obtained on the OWEB web site at http://www.oweb.state.or.us or on the 4SOS web site at http://www.4sos.org. Contact Deb Merchant at 4SOS at 503-223-8511, ext. 6 or e-mail at dmerchant@4sos.org.

DEQ was successful in teaming with local municipalities to obtain U.S. EPA Section 319 Nonpoint Pollution Source grant to conduct a toxics monitoring program throughout Johnson Creek. Results will be used to further develop and refine the TMDL.

Private Foundations

The Environmental Grant making Foundations directory is a comprehensive list of foundations that support environmental activities and programs. These foundations primarily give grants to nonprofit 501(c)(3) organizations. The ninth edition (2001) profiles 900 foundations. The 2003 edition is available for $110. The directory features include: officers, directors, and key personnel, environmental programs in depth, analyses drawn from Resources for Global Sustainability (RGS) databases, and listing of recent grants. Indexes list foundations by: recipient and activity region, environmental topics and activities, emphases and limitations, and location, issues, and deadlines. For more information, contact http://www.environmentalgrants.com.

Other Funding Sources

Conservation Reserve Enhancement Program (CREP)

The U.S. Department of Agriculture's (USDA) Farm Service Agency (FSA), Commodity Credit Corporation (CCC), and the State of Oregon have agreed to implement a voluntary Conservation Reserve Enhancement Program (CREP) to improve water quality of streams providing habitat for nine salmon and two trout species listed under the ESA. Unique state and federal partnerships will allow landowners to receive incentive payments for installing specific conservation practices. Through the CREP, farmers can receive annual rental payments and cost-share assistance to establish long-term, resource-conserving covers on eligible land. The project area includes all streams in Oregon providing habitat for ESA salmon and trout species that cross agricultural lands. Goals of the Oregon Enhancement Program include:

- Reducing water temperatures to natural levels;
- Reducing by 50 percent the sediment and nutrient pollution from agricultural lands adjacent to streams;
- Stabilizing streambanks along critical salmon and trout streams; and
- Restoring natural hydraulic and stream channel conditions on 2,000 miles of streams.

The Oregon Enhancement Program is authorized to enroll up to 95,000 acres of riparian buffers and filter strips, plus 5,000 acres of wetlands for a total maximum acreage of 100,000. The total program cost is estimated at $250 million. Of this, CCC will provide 80 percent and the State of Oregon or other non-Federal sources will provide 20 percent of the total cost. CCC will pay applicable land rental costs, 50 percent of the cost of establishing conservation practices, and annual maintenance incentive, and a portion of the costs of providing technical assistance. The State of Oregon will pay 25 percent of the cost of establishing conservation practices, all the costs of the annual monitoring program, and a portion of the technical assistance costs.

Eligible practices include filter strips, riparian buffers, and wetland restoration. In addition to offering acreage along salmon and trout streams, applicants must satisfy basic eligibility criteria including:

- Land must be cropland that has been cropped two out of the past five years that is physically and legally capable of being cropped.
- Marginal pastureland is also eligible to be enrolled provided that it is suitable for use as a riparian buffer planted to trees.
- Producers are eligible if the land has been owned or operated for at least one year prior to enrollment.

Wildlife Habitat Incentive Program (WHIP)

The Wildlife Habitat Incentive Program (WHIP) is a voluntary program designed to help owners of non-federal lands improve wildlife habitat on their property. USDA, Natural Resources Conservation Service (NRCS) administers this program and provides free technical assistance to implement wildlife habitat improvement practices to approved applicants. Project costs can be reimbursed up to 75 percent.

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CHAPTER 9 GLOSSARY

Adaptive Management: A dynamic planning and implementation process that involves applying scientific principles, methods and tools to improve management activities incrementally, as decision makers learn from experience and better information and analytical tools become available. Involves frequent modification of planning and management strategies – and sometimes goals and objectives – in recognition of the fact that the future cannot be predicted perfectly. Requires frequent monitoring and analysis of the results of past actions and application of those results to current decisions.

Anadromous fish: Fish that hatch in fresh water, migrate to the ocean to grow and mature and return to fresh water to spawn; includes salmon, steelhead, and sea-run cutthroat trout.

Backwater pool: Found along channel margins; created by eddies around obstructions such as boulders, root wads, or woody debris. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble.

Basin: See Drainage area.

Bedload: Sediment moving on or near the streambed and frequently in contact with it.

Benthos: Organisms living on or within a stream's substrate.

Best Management Practice: Nonstructural and low-structural measures that are determined to be the most effective, practical means of preventing of reducing pollution inputs from nonpoint sources in order to achieve water quality goals.

Canopy: That overhead branches and leaves of streamside vegetation.

Canopy cover: The vegetation that projects over the stream. Can arbitrarily be divided into two levels: **Crown canopy** is more than 1 m above the surface. **Overhanging cover** is less than 1 m above the water surface.

Canopy density: The percentage of the stream covered by the canopy of plants, sometimes

Carrying Capacity: The maximum average number of biomass of organisms or a given species that can be sustained on a long-term basis under a given flow regime by a stream or stream reach.

Cascade: Habitat type characterized by swift current, exposed rocks and boulders, high gradient and considerable turbulence and surface agitation, and consisting of a stepped series of drops.

Channel: A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks, which serve to confine the water.

Channel confinement: Ration of bankfull channel width to width of modern floodplain. Modern floodplain is the flood-prone area and may correspond to the 100-year floodplain. Typically, channel confinement is a description of how much a channel can move within its valley before it is stopped by a hill slope or terrace.

Channelization: Straightening of a stream or the dredging of a new channel to which the stream is diverted.

Confluence: The junction or union of two or more streams; a body of water produced by the union of several streams.

Cover: Anything that provides protection form predators or ameliorates adverse conditions of streamflow and/or seasonal changes in metabolic costs. May be instream cover, turbulence, and/or overhead cover, and may be for the purposes of escape, feeding, hiding, or resting.

Degradation: The geologic process by which stream beds and floodplains are lowered in elevation by the removal of material. It is the opposite of aggradation.

Deposition: The settlement or accumulation of material out of the water column and onto the streambed. Occurs when the energy of flowing water is unable to support the load of

Discharge: Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per second (cfs) or m^3/second.

Dissolved oxygen: The concentration of oxygen dissolved in water, expressed in mg/L or as a **percent saturation**, where saturation is the maximum amount of oxygen that can theoretically be dissolved in water at a given altitude and temperature. Dissolved oxygen is absorbed by fish and other aquatic organisms through gills or membranes.

Diversion: A temporal removal of surface flow from the channel.

Diversity index: The relationship of the number of taxa (richness) to the number of individuals per taxon (abundance) for a given community.

Drainage area: Total land area draining to any point in a stream, as measured on a map, aerial photo or other horizontal plane. Also called catchment area, watershed, and basin.

Ecological services: The functions that a natural resource provides to benefit the environment and human uses.

Ecosystem: The living and nonliving components of the environment that interact or function together; includes plant and animal organisms, the physical environment and the energy systems in which they exist.

Embeddedness: The degree that larger particles (boulders, rubble, or gravel) are surrounded or covered by fine sediment. Usually measured in classes according to percentage of coverage of larger particles by fine sediments.

Endangered Species Act: A law passed by the U.S. Congress in 1973 that established programs for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service maintain the list of threatened and endangered species.

Enhancement: An improvement of conditions that provide for the betterment over natural conditions of the aquatic, terrestrial, and recreational resources.

Fine Sediment: The fine-grained particles in stream banks and substrate. These have been defined by diameter, varying downward from 6 millimeters (mm).

Fish habitat: The aquatic environment and the immediately surrounding terrestrial environment that, combined, afford the necessary biological and physical support systems required by fish species during various life history stages.

Flood: Any flow that exceeds the Bankfull capacity of a stream or channel and flows out on the floodplain; greater than bankfull discharge.

Floodplain: Any flat, or nearly flat lowland that borders a stream and is covered by its waters at flood stage.

Flow: (a) The movement of a stream of water and/or other mobile substances from place to place. (b) The movement of water, and the moving water itself. (c) The volume of water passing a given point per unit of time. See **Discharge**.

> **base flow:** The portion of the stream discharge that is derived from natural storage i.e., groundwater outflow and the drainage of lakes and wetlands or other source outside the net precipitation that creates surface runoff; discharge sustained in a stream channel, not a result of

direct runoff and without the effects of regulation, diversion, or other works of humans. Also, called sustaining, normal, ordinary or groundwater flow.

instream flow: Streamflow regime required to satisfy a mixture of conjunctive demands being placed on water while it is in the stream.

intragravel flow: That portion of the surface water that infiltrates the streambed and moves through the substrate pores. Also known as **interstitial flow**.

low flow: The lowest discharge recorded over a specified period of time. Also called **minimum flow**.

mean flow: The average discharge at a given stream location, usually expressed in m^3/sec, computed for the period of record by dividing the total volume of flow by the number of days, months, or years in the specified period.

minimum flow: (a) The lowest discharge recorded over a specified period of time (preferred definition). (b) Negotiated lowest flow in a regulated stream that will sustain an aquatic population at agreed upon levels. This flow may vary seasonally. Also known as **least flow**.

peak flow: The highest discharge recorded over a specified period of time. Often thought of in terms of spring snowmelt, summer, fall or winter rainy season flow. Also called maximum flow.

Fry: The early life stage of salmon and trout after the yolk sac is absorbed.

Geomorphologic: Relating to the form or surface features of the earth.

Glide: An area with generally uniform depth and flow with no surface turbulence. Low gradient, 0-1 percent slope. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. Generally deeper than riffles with few major flow obstructions and low habitat complexity. There is a general lack of consensus regarding the definition of glides (Hawkins et al. 1993).

Gradient: (a) The general slope, or rate of change in vertical elevation per unit of horizontal distance, of the water surface of a flowing stream. (b) The rate of change of any characteristic per unit of length.

Habitat: The place where a population lives and its surroundings, both living and nonliving; includes the provision of life requirements such as food and shelter.

Habitat type: A land or aquatic unit, consisting of an aggregration of habitats having equivalent structure, function, and responses to disturbance.

Hydrograph: A graph showing, for a given point on a stream, the discharge, stage, velocity, or other property of water with respect to time.

Impervious surface: An impermeable ground coverage or surface, such as paved roads, sidewalks and structures, that alters the natural flow and quality of water.

Indicator Organism: Organisms that respond predictably to various environmental changes, and whose presence or absence, and abundance, are used as indicators of environmental conditions.

Instream Cover: Areas of shelter in a stream channel that provide aquatic organisms protection form predators or competitors and/or a place in which to rest and conserve energy due to a reduction in the force of the current.

Large organic debris: Any large piece of relatively stable woody material having at least a diameter greater than 10 cm and a length greater than 1 m that intrudes into the stream channel. Also known as LOD, large wood debris, log.

Macroinvertebrate: An invertebrate animal (without backbone) large enough to be seen without magnification.

Mainstem: The principal, largest, or dominating stream or channel of any given area or drainage system.

Microhabitat: That specific combination of habitat elements in the locations selected by organisms for specific purposes and/or events. Expresses the more specific and functional aspects of habitat and cover. Separated from adjoining microhabitats by distinctive physical characteristics such as velocity, depth, cover, etc.

Nonpoint source: Sources of pollution from diffuse sources such as stormwater runoff from agriculture, logging, and roadways.

Opportunities: Watershed conditions or features that are currently in a healthy, properly functioning condition and that are considered key to sustaining important watershed functions.

Optimal value: A value that reflects either a desired condition or response in an environmental indicator or the level below which ecological functioning is likely to be impaired.

Overbank storage: Flow of water out of the stream channel and onto the valley floor floodplain during flood flows.

Overhead cover: Material (organic or inorganic) that provides protection to fish or other aquatic animals from above; generally includes material overhanging the stream less than a particular distance above the water surface. Values of less than 0.5 m and less than 1 m have been used.

Permeability: A measure of the rate at which water can pass through a given substrate. Depends upon composition and degree of compaction of the substrate (usually gravel). The apparent velocity per unit of hydraulic gradient. Units: cm/hr.

Pool: (a) A portion of the stream with reduced current velocity, often with water deeper than the surrounding areas, and which is frequently usable by fish for resting and cover. (b) A small body of standing water, e.g., in a marsh or on the flood plain.

Pool-riffle ratio: The ration of the surface area or length of pools to the surface area or length of riffles in a given stream reach, frequently expressed as the relative percentage of each category.

Productivity: (a) Rate of new tissue formation or energy utilization by one or more organisms. (b) Capacity or ability of an environmental unit to produce organic material. (c) The ability of a population to recruit new members by reproduction.

Problems: Watershed conditions or features that are not properly functioning or that are contributing to impairment of watershed and river health.

Reach: A section of stream defined by some functional characteristic and possessing similar physical features such as gradient and confinement. A reach may be simply the distance surveyed. More frequently, reaches are defined as: stream segments between named tributaries, changes in valley and channel form, major changes in vegetation type, or changes in landuse or ownership.

Refugia: Locations and habitats that support populations of organisms limited to small fragments of their previous geographic range.

Restoration: Return of an ecosystem to a close approximation of its condition prior to disturbance.

Riffle: Fast, turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Generally broad, uniform cross section. Low gradient; usually 0.5-2.0 percent slope, rarely up to 6 percent.

Riparian: Pertaining to anything connected with or immediately adjacent to the banks of a stream or other body of water.

Riparian area: The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Riparian vegetation: Vegetation growing on or near the banks of a stream or other body of water on soils that exhibit some wetness characteristics during some portion of the growing season.

Riprap: A layer of large, durable materials (usually rock but sometimes broken concrete, etc.) used to protect a stream bank from erosion. May also refer to the materials themselves.

Rootwad: The root mass of the tree. Similar to butt ends.

Sediment: Fragmental material that originates from weathering of rocks and decomposition of organic material that is transported by, suspended in, and eventually deposited by water or air, or is accumulated in beds by other natural phenomena.

Sediment discharge: The mass or volume of sediment (usually mass) passing a stream transect in a unit of time. The term may be qualified, for example, as suspended-sediment discharge, bedload discharge, or total-sediment discharge, usually expressed as tons per day.

Sediment load: A general term that refers to sediment moved by a stream, whether is suspension (suspended load) or at the bottom (bedload). It is not synonymous with either discharge or concentration (see **bedload**).

Seep: An area of minor groundwater outflow onto the land surface or into a stream channel. Flows are too small to be a spring.

Stream Corridor: A stream corridor is usually defined by geomorphic formation, with the corridor occupying the continuous low profile of the valley. The corridor contains a perennial, intermittent, or ephemeral stream and adjacent vegetative fringe.

Substrate: The mineral and/or organic material that forms the bed of the stream.

Terraces: An embankment, or combination of an embankment and channel, constructed across a slope to control erosion by reducing the slope and by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.

Total suspended solids: The organic and inorganic material left on a standard glass fiber filter (0.45 µ filter); after a water sample is filtered through it; often referred to as Non-Filterable Residue.

Toxic metals: Metals present in industrial, municipal, and urban runoff, including lead, copper, cadmium, zinc, mercury, nickel, and chromium, in quantities that are harmful to humans or aquatic life.

Toxic substances: Any substances present in water, wastewater, or runoff that may kill fish or other aquatic life or could be harmful to public health. The substance may exhibit chronic toxicity or buildup in the food chain (biomagnification), or it may show acute toxicity and result in immediate death. Ammonia, acids, cyanides, phenols, toxic metals, and chlorinated hydrocarbons, among others, are examples of toxic substances.

Tributary: A stream feeding, joining, or flowing into a larger stream.

Turbidity: (a) Relative water clarity. (b) A measure of the extent to which light passing through water is reduced due to suspended materials. Measured by several non-equivalent standards (e.g., Nephelometric Turbidity Units, NTU; Formazin Turbidity Units, FTU; and Jackson Turbidity Units, JTU).

Watershed: A topographically discrete unit or stream basin that includes the headwaters, main channel, slopes leading to the channel, tributaries and mouth area. See Drainage area.

Weir: (a) A notch or depression in a levee, dam, embankment, or other barrier across or bordering a stream, through which the flow of water is measured or regulated. (b) A barrier constructed across a stream to divert fish into a trap. (c) A dam (usually small) in a stream to raise the water level or divert its flow.

Wetland: Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin et al., 1979). Wetlands include features that are predominantly wet, or intermittently water covered, such as swamps, marshes, bogs, muskegs, potholes, swales, glades, slashes, and overflow land of river valleys. According to the 1989 federal wetlands delineation manual, wetlands include lands saturated for at least 7 days to a depth of 12 inches. A newly proposed definition by the Bush Administration would be lands that have 15 days of standing water and 21 days of surface saturation. Land areas where excess water is the dominant factor determining the nature of soil development and the types of plant and animal species living at the soil surface. Wetland soils retain sufficient moisture to support aquatic or semi-aquatic plant life. An area subject to periodic inundation, usually with soil and vegetative characteristics that separate it from adjoining non-inundating areas.

Woody Debris: See large organic debris.