Watershed Management:
An Evaluation of the Mullen Slough Capital Improvement Project Study and Action Plan
King County, Washington, USA

by

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B.Sc. McGill University 1995

RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF NATURAL RESOURCE MANAGEMENT

in the

School of Resource and Environmental Management

Report No. 321

SIMON FRASER UNIVERSITY

July 2003

Approval

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Degree: Master of Resource Management in the School of Resource and Environmental Management

Report No. 321

Title of Research Project: Watershed Management: An Evaluation of the Mullen Slough Capital Improvement Project Study and Action Plan, King County, Washington, USA

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Abstract

A watershed management process, for a sub-basin in King County, WA is examined and evaluated using a new watershed management framework created from four existing frameworks and the natural and social science literature. The watershed management process disagreed with the framework by failing to: explain causes and mechanisms of issues in the sub-basin; characterize the local or regional human community and land-use effects in the sub-basin; involve stakeholders in the process; define and evaluate data type and quality; identify data gaps and address uncertainty; adequately synthesize the information; adequately integrate potential outcomes of recommended actions; and create action, implementation, or monitoring plans and a planning and management framework. It is argued that by failing to include the above principles as part of the process, the chance of attaining and sustaining the desired state in the watershed as determined by laws, and societal and stakeholder values, is less than if they had been included. Important lessons learned from this case study are that the framework does not provide a structure for, or adequately guide, the major challenge of integrating natural and social sciences. Therefore the framework does not evaluate the level of integration between the natural and social sciences as there are no key elements or principles outlining how this integration should occur. It is noted, that most watershed management frameworks lack these structures and principles, but that use of decision-making trees, matrices, or models can help guide the process of integration. The second important lesson learned from this case study is that the sponsor's history of internal ways of doing things as well as their reputation among stakeholders, has a major effect on the process. Stakeholder willingness to participate and trust of the process is largely influenced by the sponsor's reputation, while the sponsor's internal policies, biases, and de facto practices affect what aspects of the watershed the process will focus on. These problems can be ameliorated through early and on-going stakeholder involvement and input.

To my mother and father

Christina and David McNair

for their devotion and dedication.

“Experience is the name everyone gives to their mistakes.”

Oscar Wilde, Lady Windermere's Fan, 1892, Act III

Acknowledgements

I am grateful and eternally indebted to the following characters who have colored the pages of my life:

To my parents, who value my education but more so me.

To Troy Fields and the staff and Board of Mid Sound Fisheries Enhancement Group, who granted me leave to write this report.

To Jennifer Knauer at King County for being patient with my endless questions and for helping with match dollars.

To Jonathon Smith and Mike Scuderi at the US Army Corps of Engineers for letting me rummage through their files and for spending hours on the phone with me.

To the administrative staff at REM for their understanding and flexibility.
To Murray Rutherford and Evelyn Pinkerton, for guiding, advocating, and persisting.

To Matthew, editor, critic, and coach. Night and Day.

Thank you, Merci, Gracias

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADAP	Agricultural Drainage Assistance Program (King County)
BMP	Best Management Practice (see glossary for definition)
CAC	Citizen's Advisory Committee (from the Special Area Management Plan)
CIP	Capital Improvement Project • Draft CIP: refers to document *Mullen Slough Capital Improvement Project Study and Action Plan (Draft)* (King County 2001) • CIP process: refers to the process of watershed management that went into creating the Draft CIP • CIP: refers to both the process and the document
CWA	Clean Water Act
DDES	Department of Development and Environmental Services (King County)
DNRP	Department of Natural Resources and Parks (King County)
DSS	Drainage Services Section (King County)
EPA	Environmental Protection Agency (United States)
ESA	Endangered Species Act
FPP	Farmland Preservation Program (King County)
FSA	Farm Service Agency
GIS	Geographic Information Systems
GMA	Growth Management Act (Washington Code)
LWD	Large woody debris
MIT	Muckleshoot Indian Tribe
NMFS	National Marine Fisheries Service (NOAA, Department of Commerce)
NOAA	National Oceanic and Atmospheric Administration (Department of Commerce)
NPF	Not Properly Functioning (see glossary for definition)
RCW	Revised Code of Washington (Washington State Law/Code)
SAMP	Special Area Management Plan

List of Abbreviations (continued)

SEPA	State Environmental Policy Act (see Appendix 1.2.2.2)
SRFB	Salmon Recovery Funding Board (see Appendix 1.1.2)
SWEES	Surface Water Engineering and Environmental Services (King County)
TEK	Traditional Ecological Knowledge
USACE	United States Army Corps of Engineers (Department of the Army)
USDA	United States Department of Agriculture
USFS	United States Forest Service (Department of Agriculture)
USFWS	United States Fish and Wildlife Service (Department of the Interior)
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDOE	Washington Department of Ecology
WDFW	Washington Department of Fish and Wildlife
WLRD	Water and Land Resources Division (King County)
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
WSDNR	Washington State Department of Natural Resources

Measurements

a	acre
ha	hectare
km	kilometer
km^2	square kilometers
mi.	mile
$mi.^2$	square miles
R.K.	river kilometer (number of kilometers upstream from river mouth)
R.M.	river mile (number of miles upstream from river mouth)

Glossary

Basin - A smaller-scale watershed (see Watershed definition) that can stand alone or be within another watershed. The Mill Creek Basin is part of the Green River Watershed, and has an area of 57 km^2 (22 $mi.^2$).

Best Management Practice (BMP) - an approach or technology that has been shown to be effective for the purpose it was intended. Often used to specify standards of practice when a regulation is not descriptive enough.

Ecosystem – An ecosystem can be defined as a geographic area including all living organisms, the physical elements or structures within and the natural cycles that sustain them. A more bio-centric viewpoint would state that the ecosystem boundaries are probabilistic and flexible as they are based on the home-ranges of particular target species (Yaffee 1999).

Ecosystem Management - A management system that strives to understand the biological (including human) and physical elements and the processes that sustain them within a defined management area in order to either minimize human impacts or to foster sustainable human use of that environment (Yaffee 1999).

Not Properly Functioning (NPF) - The National Marine Fisheries Service (NMFS), the agency that administers the Endangered Species Act for marine fish, has written a document outlining an analysis model for determining the effects of human actions on salmon habitat in a consistent and accurate way (NMFS 1996). NMFS uses this term to describe a category of function for riparian systems. A watershed's riparian systems will be NPF if they are fragmented and poorly connected or have less than 70% of potential (historic) habitats and refugia for sensitive aquatic species. The riparian vegetation will be composed of less than 25% of the potential natural community (NMFS 1996).

Properly Functioning Condition (PFC) - The National Marine Fisheries Service (NMFS), the agency that administers the Endangered Species Act for marine fish, has written a document outlining an analysis model for determining the effects of human actions on salmon habitat in a consistent and accurate way (NMFS 1996). NMFS uses this term to describe a category of function for riparian systems. A watershed's riparian systems will be in PFC if they provide adequate shade, large woody debris recruitment, and habitat protection and connectivity in all subwatersheds. Aquatic habitats and refugia for sensitive aquatic species should be greater than 80% intact and the riparian vegetation should be composed of greater than fifty percent of the potential natural community. In more general terms a system in PFC is one that has natural habitat forming processes necessary for the long-term survival and recovery of the species (NMFS 1996).

Sponsor – In this report this word is used to refer to the agency, organization, or administrative body that manages the watershed management process. In the literature it often is used to refer to the group funding the watershed process. In reality the managing body may not fund the process.

Stakeholder - A stakeholder is an entity that will be affected by the outcome of the watershed management plan. This includes public agencies, tribes, private companies, environmental and social groups, landowners, and private citizens.

Sub-basin – The area of land that drains to a common tributary within a basin (see Basin definition). Mullen Slough sub-basin is a component of the Mill Creek basin and has an area of 9.7 km^2 (6$mi.^2$).

Tributary Drainage - A drainage area for a tributary within a sub-basin. Tributary 0046 is a tributary to Mullen Slough with an approximate area of 1.8 km^2 (1.1$mi.^2$).

Water Resource Inventory Area (WRIA) - In Washington State, Water Resource Inventory Areas (WRIA) are watersheds with formalized administrative and planning boundaries. There are 62 in Washington State. WRIAs were formalized under Washington Administrative Code (WAC 173-500-040) and authorized under the Water Resources Act of 1971 (Revised Code of Washington 90.54). WRIA boundaries represent the administrative management units for WDOE. In 1970 WRIA boundaries were created collaboratively by Washington State's natural resource agencies including WDOE, Department of Natural Resources, and Washington Department of Fish and Wildlife.

Watershed - A specific geographic area where the only input of water is precipitation and all the water drains to a common outlet (river, lake, or ocean). In this paper watershed is used to refer to large areas such as the Green River Watershed with an area of 910 km^2 (566 $mi.^2$).

Watershed Component – An ecological, physical, or human sub-set of the watershed such as hydrology, water quality, land use, or fish abundance and habitat (WPN 1999).

Watershed Management – Ecosystem management that focuses public and private sector efforts to address the highest priority problems within hydrologically defined geographic areas (EPA 1996a). It is an iterative process of integrated decision-making concerning uses and modifications of lands and waters within a watershed (MDEQ 1997).

Wetland - Areas inundated or saturated by surface or ground water at a frequency and or duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (WDOE 1993).

Measurement Units and Conversions

Metric

1 kilometer	0.6215 miles
1 square kilometer	0.386 square miles
1 meter	3.28 feet
1 cubic meter	35.7 cubic feet
1 hectare	2.471 acres

American

Mile - 5280 feet

Acre - 43,560 square feet

Square mile - 640 acres

Stream Discharge

Cubic feet per second (cfs) = 0.028 meters cubed per second (m^3/s)

1 Introduction

The Mullen Slough sub-basin drains 15.5 km^2 (6 $mi.^2$) of the Mill Creek basin (57 km^2 or 22 $mi.^2$) in the lower section of the Green River watershed, in south King County, Washington (Figure 1). Settlers first came to farm the valley of the Mullen Slough sub-basin in the early 1800's (King County 2001; USACE 2000b). Currently the sub-basin supports multiple land uses including residential, commercial, industrial, agricultural, and open space. The northern tip of the sub-basin is 8.8 km (5.5 mi) south of Seattle's urban growth boundary. There is strong pressure for development in the sub-basin.

In the Mill Creek basin, from the mid 1950-60's, there was rapid loss of wetlands and open spaces from expanding urban development with little federal regulation of wetland filling (USACE 2000b). Local governments re-zoned many of the wetlands in the lower valley for commercial and industrial purposes. Wetlands in the Mullen Slough sub-basin valley were not re-zoned as they are part of an agricultural preservation program. By the mid 1980's the United States Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA) were regulating the development of most kinds of wetlands, including isolated wetlands and wetlands above headwaters (King County 1999a; USACE 2000b). Developers were concerned about limitations on growth that were slowing economic expansion and, in their view, infringing on the rights of private property owners. Citizens in the basin were concerned about problems associated with rapid development such as increased occurrence and extent of flooding from improper storm water control and infrequent drainage watercourse maintenance, declines in salmon runs, and water quality degradation (USACE 2000b). The same concerns existed in the Mullen Slough sub-basin.

Before the USACE can issue a permit for filling or developing a wetland, they must illustrate that they have given thorough consideration to less environmentally damaging practicable alternatives. In addition, one of their major principles is to develop and use an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and human impacts (USACE 2002a). In the 1980's

Figure 1. Mill Creek Basin and Mullen Slough Sub-basin

there was no comprehensive land use plan for the Mill Creek Basin outlining the current and future projected economic, ecological, physical, and social components of the watershed including positive and negative effects of various scenarios (USACE 2000b). Without this plan, it was difficult for USACE to grant permits to fill wetlands.

In the late 1980's, with sponsorship and technical support from King County and the cities of Kent and Auburn, USACE initiated a Special Area Management Plan (SAMP) in the Mill Creek Basin. Their goals were to address the conflict between development and preservation interests, streamline the permit process, and improve consistency of aquatic management, flood damage reduction, and water quality improvement efforts of the local, state, and federal governments (USACE 2000b). The SAMP outlined projects, maintenance programs, and permit and policy changes, none of which were formally adopted by local municipalities or the County. Shortly after the SAMP process was brought to a close, King County Water and Land Resources Division (WLRD) planned to continue it by compiling information and conducting further studies in a Mill Creek Basin Plan. However, funding was not available for a project of that scale and so an in-depth series of studies for the Mullen Slough sub-basin was begun instead (King County 2001). These studies were undertaken and the report written in an attempt to plan and initiate projects to try to solve some of the problems in the sub-basin. The results were published in draft form for internal review within King County in *Mullen Slough Capital Improvement Project (CIP) Study and Action Plan (Draft)* (King County 2001). I will refer to this document as the Draft CIP throughout this report.

This report will evaluate the CIP process so far, including the Draft CIP, and make recommendations for future actions.

1.1 Objectives of the Report

The report has five purposes

1. review the history of watershed planning in the Mill Creek basin and Mullen Slough sub-basin

2. create a framework for evaluating a watershed management program, using the main steps and principles from four respected watershed management frameworks described in the literature, with additional support from other publications
3. evaluate the King County CIP process using this framework
4. make recommendations for King County concerning future research and management
5. assess the usefulness of the evaluative framework.

1.2 Methodology

I collected information on the Mill Creek SAMP and Mullen Slough CIP processes from government documents, unpublished government files, and interviews with key individuals involved in the processes. I located the relevant documents by consulting King County and USACE staff, conducting searches of Biological Abstracts, Aquatic Sciences and Fisheries Abstracts, and Agriocola databases, and through the references sections of the SAMP and Draft CIP documents. I created an evaluative framework using the main steps and principles from four watershed management frameworks (EPA 1996a; RIEC 1995; WFPB 1997; WPN 1999) and drawing on the recommendations made in other publications about watershed management. I then compared the key steps in the King County CIP process to the principles and processes in the evaluative framework.

1.2.1 Usefulness and Limitations of a Case Study Approach

I used the case study method to describe and evaluate the CIP process. Generally, the advantages of this method are that case studies are empirical and non-theoretical as far as actions and outcomes (in this report, though, the ultimate outcomes are still theoretical as the plan has not been implemented yet). Case studies are real-world examples that provide practical learning. They provide information from a number of sources and over a period of time, thus permitting a more holistic study of complex social, physical and biological networks (Orum et al. 1991). This permits the analyst to develop a solid empirical basis for specific concepts and generalizations (Orum et al. 1991). Case studies are a basic form of social science that are particularly useful when the experience under investigation is not easily distinguishable from its context-specific conditions (Yin 1993). Their weakness is that extrapolation to cases elsewhere or future cases in the same location can be difficult to perform as each situation occurs within its own spatial and temporal context of social, political, ecological, and physical structures and systems (Frissell and Bayles 1996). However, it is possible to extract lessons and build broader theoretical understanding from a group of individual case studies. For these reasons I do not attempt to use the CIP case to predict the outcomes of future watershed planning processes, but rather I describe common principles and practices of past successful watershed planning processes and argue that adoption and use of a greater number of these principles and practices will increase the likelihood of success in any given case. In this report success is defined as attaining and sustaining the desired state in the watershed as determined by laws, and societal and stakeholder values. Then, I use the principles and practices in the framework to evaluate the Mullen Slough CIP process. The framework is generalized and does not dictate step by step, but instead points out key elements of past successful frameworks. The evaluative framework should be relevant for other watershed management processes.

The remainder of this report is organized as follows. Chapter 2 outlines the geography of the Green River watershed, Mill Creek basin and Mullen Slough sub-basin. Management issues, goals, and recommended actions for the Mill Creek basin as described in the SAMP are also discussed. Chapter 3 describes the history and current use of watershed management and documents the development of an evaluative framework for watershed management. Chapter 4 describes the watershed studies and planning that led to the creation of the Mullen Slough Capital Improvement Project Study and Action Plan (Draft) document (Draft CIP) (King County 2001). In Chapter 5 I evaluate the Draft CIP, using all four phases and all fourteen key elements of the evaluative framework, and then go on to make recommendations for future action. In Chapter 6 I evaluate the evaluative framework and in Chapter 7 I make final remarks.

2 Geography and Management Issues of the Green River Watershed, Mill Creek Basin, and Mullen Slough Sub-basin

The Mill Creek SAMP process was initiated in the 1980's to attempt to solve several natural resource and land management conflicts. The process was initiated during a period of relatively rapid changes in the geographical, legal, and political attributes of the basin. Section 2.1 describes the geography of the Green River watershed. The geography, historical land use, and biological features of the Mill Creek basin are described in Section 2.2. Section 2.3 describes the geography, physical description, and current conditions of the waterways of the Mullen Slough Basin. Section 2.4 summarizes the management issues for the Mill Creek basin as they were identified in the SAMP and Section 2.5 describes the Mill Creek SAMP process. This sets the context for my discussion of the Mullen Slough CIP process in later chapters.

2.1 Geography of the Green River Watershed

The Green River drains 910 km^2 (566 mi^2) with an outlet into Puget Sound at Elliott Bay in downtown Seattle. The Green River watershed is centered approximately 48 km (~30 mi.) east of the City of Tacoma and 56 km (35 mi.) north of Mount Rainier (WSCC 2000a). The watershed is divided into four sub-watersheds. Starting in the headwaters, the sub-watersheds are known as the Upper Green River (Headwaters to Howard Hanson Dam), Middle Green River (Dam to City of Auburn), Lower Green River (City of Auburn to City of Tukwila), and the Duwamish River (City of Tukwila to Elliott Bay in downtown Seattle). The Mill Creek basin is in the Lower Green River sub-watershed (WSCC 2000a).

Like most major river basins in the developed world, the Green River hydrology has been significantly altered by human activity. In order to reduce flooding, supply water, and make way for agricultural, residential, and commercial development, entire rivers have been diverted into adjacent watersheds, a dam has been constructed, revetments have been built, and the Green River channel itself has been straightened.

Historically the Green River watershed was much larger, and included the White, Black, and Cedar Rivers. In 1906, the White River, which drained into the Green River several miles upstream of the City of Auburn, was diverted south into the Puyallup River for flood control purposes. In 1916 the Cedar and Black Rivers, which drained into the Green River at Tukwila approximately 8 miles downstream of Mill Creek, were diverted north into Lake Washington for navigational purposes (Kruckeberg 1991). The watersheds of these three rivers made up sixty percent of the Green River watershed. Due to the glacial origins of the White River, its diversion reduced the mean summer flow of the Green River by 40% (WSCC 2000b). The City of Tacoma built a diversion dam at river kilometer (R.K.) 98 (river mile R.M. 61) in 1911 to secure water for municipal and industrial supply. It diverts water at a rate of 3.2 m^3/s (113 cfs), which is approximately twelve percent of the flow at the point of the diversion, or 5.5 percent of the total Green River average annual flow (WSCC 2000a).

In order to protect agricultural lands and homes from floodwaters, dikes were constructed along the banks of the Lower and Duwamish sub-watersheds of the Green River from 1895 to 1980. Approximately 51 km (32 mi.) of dikes now augment the banks of the Green River from the mouth to the City of Auburn (WSCC 2000a). The dikes have simplified the system from a braided and unconstrained system of multiple channels into a single large, homogeneous, and deep canal. The dikes have significantly reduced yearly flood events, which historically delivered fine sediments rich in minerals to the valley floor, and recharged adjacent isolated sloughs, wetlands and side-channels. In 1962, USACE completed construction of Howard Hanson Dam at R.K. 103.8 (R.M. 64.5) for flood control purposes. The dam, combined with extensive revetment construction, further reduced flooding in the Green River valley.

Many of the changes in the Green River hydrology had negative impacts on fish habitat. The dam is a passage barrier for fish. Upstream of the dam, there are 46 km (29 mi.) of main stem and hundreds of kilometers of tributaries with suitable spawning habitat for salmon. The dam retains all gravel transported by the river from the headwaters and hence the area downstream of the dam has become significantly depleted of spawning gravel (USACE 2001; WSCC 2000a). Since construction of the dam, the Green River peak flows in November and February are higher while peak summer flows are lower. In May the peak and average flows are lower than flows before dam construction (WSCC 2000a). The Green River hydrology is influenced by many factors other than Howard Hanson Dam. Revetments, filled wetlands, impervious surfaces, and land use and land cover changes all impact water storage and releases in the Green River watershed. These changes in flow, combined with the physical changes to the channel and channel processes, adversely affect natural salmonid production (USACE 2001; WSCC 2000a).

2.2 Geography of the Mill Creek Basin

The Mill Creek basin drains 57 km^2 (22 $mi.^2$) of the Lower Green River Sub-watershed (Figure 1). The northern tip of the basin is 8.8 km (5.5 mi) south of Seattle's urban growth boundary while the urban growth boundaries of the municipalities of Auburn, Kent, Federal Way, and Algona extend into the Mill Creek Basin. There are four stream systems in the Mill Creek basin, Mill Creek (Washington stream catalog number 09.0051), Mullen Slough (09.0045), Midway Creek (09.0041) and Auburn Creek (09.0056) from largest to smallest respectively (Williams et al. 1975; WSCC 2000a). The main stem of Mill Creek is 13.4 km (8.35 miles) in length (Williams et al. 1975). All of these streams drain directly into the Green River, and are not tributaries to each other. The only exception to this is during high flows a tributary to Mill Creek (0053) over tops its banks and drains into Mullen Slough. The north and eastern portions of the basin consist of flat valley floor. The headwaters of Mullen Slough and Mill Creek are in the western section of the basin, which consists of rolling hills and plateaus 90-120 m (300-400 ft) above the valley floor (USACE 2000b).

The hydrology of the Mill Creek basin has been continuously altered by humans since the early 1800s. The stream channel of Mill Creek has been relocated in several places for agricultural, transportation, or industrial development and straightened for improved drainage or property boundary demarcation. Mill Creek crosses under 21 road bridges and culverts before it drains into the Green River (WSCC 2000a). Mullen Slough, which historically existed as a series of dendritic channels and wetlands is now a straightened drainage watercourse for much of its length (Koester 2001; Shapiro and Associates Inc. 1990).

2.2.1 Mill Creek Basin Land Use History

Pre-1800's the Mill Creek valley was a wide cedar forested wetland with multiple meandering channels. Historical records indicate the existence of several open plain wetlands of sedge and rush (Koester 2001; USACE 2000b). In the 1800's, settlers from across the United States were offered "free land" in Washington. Each person could receive 65 acres (130 per couple) with the stipulation that one would "improve the land" by clearing the forests and draining the land, to create productive farmland (Cohen 1986). Many sections of Mullen Slough as well as tributaries of Mill Creek were channelized to facilitate drainage. Until the late 1970's, land use in the basin was primarily agricultural except for the small municipalities of Auburn and Algona. By the late-1900's, Seattle's booming aviation industry, followed by rapid growth in the high technology sector, attracted thousands of new residents to Puget Sound every year (Kruckberg 1991). Business and private residence development were becoming increasingly popular in the Mill Creek basin as the urban boundaries of Seattle, Auburn, and Kent grew.

Currently, the eastern portion of the basin is the most heavily impacted by urban development. Hwy 167 runs North/South and closely follows the path of Mill Creek for approximately 80 percent of its length. Warehouses have sprung up along Hwy 167. East of Hwy 167 is the City of Auburn which has a high percentage of impervious surfaces related to roads, houses, and businesses, and inadequate or ineffective storm water management. The north central valley is in agricultural use and is the least impacted by impervious surfaces. The western hills and plateaus have been developed for residential use and are experiencing pressure for more growth. The basin currently supports a variety of land uses including agriculture, open space, commercial, industrial, and residential, half of which is high density.

Currently, 75 percent of the Mill Creek basin is within the urban growth boundary of the City of Auburn. The rest is under the jurisdiction of the cities of Kent, Federal Way, and Algona and King County (King County 1999a).

2.2.2 Biological Description of the Mill Creek Basin

The basin supports populations of chum (*Oncorhynchus keta*), coho (*Oncorhynchus kisutch*), and chinook salmon (*Oncorhynchus tshawytscha*) as well as cutthroat (*Oncorhynchus clarki*), steelhead (*Oncorhynchus mykiss*), and resident rainbow trout (*Oncorhynchus mykiss*) (USACE 2000a). Mill Creek drains into the Green River 38 km (23.7 mi.) from the mouth. It is the first significant tributary of the Green River which provides unrestricted salmonid access. The next significant tributary is Soos Creek, which is 53 km (33 mi.) upstream from the mouth.

Migrating waterfowl, shorebirds and passerines use the Mill Creek basin wetlands and lakes each winter (USACE 2000b). This basin supports 40 percent of the estimated wintering waterfowl population using the Green River Valley. Seasonal flooding of fields provides hundreds of acres of over-wintering and resident habitat for waterfowl. There is a great blue heron rookery with approximately forty pairs in the southern basin. Raptors such as red-tailed and rough-legged hawks, bald eagle, peregrine falcon, and other falcons such as merlins and kestrels use the woodland edges adjacent to the wetlands (USACE 2000b).

2.3 Geography of the Mullen Slough Sub-basin

The Mullen Slough sub-basin encompasses 15.5 km^2 (6 $mi.^2$) of the northwest corner of the Mill Creek Basin and consists of five tributaries and one main stem reach (Figures 1 and 2) (King County 2001). The main stem of Mullen Slough is a 3.2 km (2 mi.) low gradient stream that joins the Green River at R.K. 34.8 (R.M. 21.6). It is a wide, deep, and straight slough running through the Mill Creek basin valley that looks and functions more like a large drainage watercourse than a stream (King County 2001). The sub-basin's headwaters (and tributaries) drain residential areas, up on rolling hills and plateaus 90-120 m (300-400 ft) above the valley floor, while the middle and lower

Figure 2. Mullen Slough Sub-basin

reaches drain flat agricultural land. Tributary 0053 is a tributary to Mill Creek; however, during high flows it tops over its banks and floods into the main stem of Mullen Slough near S. 287th and West Valley Highway. This is the only consistent connection between the Mullen Slough and Mill Creek sub-basins (King County 2001).

King County and the municipalities of Federal Way and Kent have jurisdiction in the sub-basin (King County 2001). Land use in the sub-basin includes residential, commercial/industrial, agricultural, and forest. The Mullen Slough sub-basin supports similar land uses as the Mill Creek basin and the Lower Green River Sub-Watershed. However, in the Mill Creek basin and Mullen Slough sub-basin King County's Agricultural Preservation Program (see Appendix 1.3.3) has slowed the conversion of agricultural and forestland to commercial/industrial uses (Table 2.1).

Table 2.1. Comparison of Land Use / Land Cover in the Lower Green River Sub-watershed, Mill Creek Basin, and Mullen Slough Sub-basin
(WSCC 2000b; King County 2001)

Land Use / Land Cover	Green River Lower Sub-watershed	Mill Creek Basin	Mullen Slough Sub-basin
Agriculture	5 %	11 %	21 %
Forest	12 %	12 %	21 %
Commercial and Industrial	27 %	22 %	6 %
Residential	50 %	48 %	48 %

2.3.1 Current Conditions of Mullen Slough Tributaries

The Mullen Slough tributaries originate in residential neighborhoods in the upland plateaus. Some sections of the tributaries pass through metal or plastic piping under houses or roads or around corners to slow erosion (King County 2001). The sections of the tributaries flowing down the steep ravines along the Green River valley wall have eroded and down cut streambeds. In addition many of the banks have been eroded. Increased storm water flow is hypothesized to be the cause of this erosion. When the tributaries reach the alluvial fan, they deposit much of the sediment that has been mobilized in the ravines. This sediment fills in the channels, decreasing the hydraulic capacity, and causing the flow to over top banks and floodplains. On tributary 0049 a culvert perched 1.2m (4 feet) above the channel impedes passage of all fish upstream. There is also a partial fish barrier at the mouth of Mullen Slough where the steep incline and lack of resting spots impedes passage of salmonids during certain flows (King County 2001).

2.3.2 Current Conditions of Main Stem Mullen Slough

From RM 0 to 0.05 the gradient of the channel is steep and riparian vegetation consists of alder and invasive blackberry (NHC 2002). There are no flooding problems in this reach. From RM 0.05 to 1.0 the riparian zone of Mullen Slough is composed of small to large patches of willow, red alder, and salmonberry with dense blackberry bushes through some sections. The gradient is flat and chronic flooding in fields is worst at RM 0.7. There is beaver activity in this reach, and a history of dam removal by landowners (Koester 2001; NHC 2002). From RM 1.0 to 1.8 the channel is a straightened watercourse with an average width of 5.8 m (19ft) and an average depth, from channel bottom to top of bank, of 1.6 m (5.3 ft) (MSFEG 2001). The measured depth does not include the thick compressed layer of sediments at the bottom. Approximately one third of the measured depth does include soft sediments, manure, and organic matter from decaying reed canary grass. Riparian zone vegetation in this section consists of reed canary grass (*Phalaris arundinacea*) and sparse patches of five native species (MSFEG 2001). Along this reach only 15% of the length has native shrubs or trees growing on the banks and the widest buffer is 7.6 m (25 ft).

2.3.2 Salmonid Habitat

Although an analysis of the habitats and refugia for sensitive aquatic species in the Mullen Slough sub-basin has not been completed, based on a qualitative assessment of the tributaries and main stem Mullen Slough, it is apparent that its riparian systems are not properly functioning (NPF), (see glossary for definition). The main reasons for this are poor water quality which restricts salmonid and other aquatic species use in late summer, lack of in-stream habitat, lack of large woody debris, a channelized system in the valley, and lack of a mature forested riparian corridor (King County 2001, 2002; WSCC 2000a).

2.4 Mill Creek Basin Management Issues Identified in the SAMP

The Mill Creek SAMP identified five main management issues in the Mill Creek basin. These issues include flooding, salmonid habitat degradation, water quality degradation, wetland loss, and development needs.

2.4.1 Flooding

Each year, 1000-3000 acres of the basin's valley are subject to flooding from the combined effects of plateau runoff and back-watering from the Green River (King County 2000a). Standing water one to twelve inches deep is present in fields around Mullen Slough from November to April (Koester 2001). High winter flows, combined with the narrow diked channel of the Green River, cause waters to rise and back-up into Mill Creek basin tributaries flooding the surrounding land (King County 1999a). Land use practices which contribute to the flooding problems are increased impervious surfaces, improper storm water management, undersized or blocked culverts, improper maintenance of stream channels combined with increased sedimentation problems, and reduced hydraulic capacity related to channel straightening and a reduced number of channels (USACE 2000b).

2.4.2 Salmonid Habitat

Off-channel rearing and spawning habitats are limiting factors for salmonid production in the Green River watershed (WSCC 2000a). Because human activities have cut off the Green River flows from most adjacent sloughs and wetlands, streams of the Mill Creek basin provide rare and important off-channel salmonid habitat in the Green River watershed. These streams have some reaches with suitable vegetation, cover, and channel morphology for salmon spawning or rearing. Through regular maintenance and habitat restoration projects, the streams of Mill Creek could offer significant spawning and off-channel rearing habitat. Mill Creek provides 10.9 km (6.8 mi.) of unrestricted access for salmonids (USACE 2000b). Mullen Slough's main stem is 5.1 km (3.2 mi) long, with an additional 14.5 km (9 mi) of tributaries. Many reaches in the basin are channelized and devoid of vegetation and habitat structures, such as wood. Increased storm water flow and subsequent sedimentation have degraded the quality of the spawning and rearing habitat for salmonids. Nine fish passage barriers were identified in the basin resulting from flap gates, failed or perched culverts, and steep inclines at tributary mouths (King County 1999a).

2.4.3 Water Quality

In 1990 the streams of Mill Creek basin were rated the most polluted in the Green-Duwamish watershed (King County 1990). Water quality parameters of concern are high temperatures, high levels of nutrients and resulting excess plant growth, high fecal coliform counts, high ammonia, suspended sediment creation and deposition, low concentrations of oxygen, and localized metal contamination from roads and commercial developments. The causes of these problems are decaying organic material such as reed canary grass and livestock manure, non-point and point source pollution from hobby and commercial farms, failing septic tanks, illegal discharges, storm drain connections, and general storm water run-off (King County 1993).

Water quantity problems have seriously affected water quality. High-density residential developments in the western hills have decreased floodplain and wetland storage leading to an increase in surface runoff causing erosion in the ravines and flooding in the valley floor. In addition, the decreased floodplain and wetland storage has decreased infiltration leading to reduced summer low flows.

Fish surveys of Mill Creek have indicated that there is a short period of time in late summer (late August and September) when the water temperature is so high and the oxygen levels so low that fish either die or exhibit avoidance behavior (Malcolm 2002). These observations demonstrate that any improvements made to the high temperature and low oxygen level problems in the basin will increase the time that fish can use the channel and perhaps transform it into a year-round rearing system. These observations also point out that water quality problems need to be addressed in concert with any other efforts to improve fish habitat.

2.4.4 Wetland Preservation

The Mill Creek basin has approximately 1036 ha (2560 acres) of wetlands and lakes (USACE 2000b). 890 ha (2200 acres) of these wetlands occur in the flat valley floor, where many parcels of land are zoned for commercial or industrial development. Many of the 360 acres of wetlands and lakes in the upper plateau are zoned for residential use. Developers and some urban planners want to be able to fill many of these wetlands, while some residents and local environmentalists want some or all of the wetlands preserved. This conflict was the main reason for initiating the SAMP process. The wetlands function as wildlife habitat, salmonid rearing habitat, storm water control, and ground water recharge (USACE 2000b).

2.4.5 Development

As stated above developers want to be able to fill many of the wetlands in the Mill Creek basin in order to construct homes and businesses. Many of the landowners in the basin purchased land before changes to the Clean Water Act (CWA 33 U.S.C. s/s 1251 et seq. 1977) gave USACE jurisdiction over the wetlands on their property (USACE 2000b). The City of Auburn is economically depressed and the pressure to allow development within its urban growth boundary is high (Clark 2001).

Development is an issue throughout the entire basin and is relevant to the other four management issues. Construction of residential, commercial or industrial buildings and the land management practices of the people living or working in those buildings ultimately affect the hydrology and quality of natural resources in the basin. Human activities such as urbanization and road development affect the routing of water (Brooks et al. 1997; WPN 1999). An increase in impervious surface causes a decrease in infiltration of water into and through the soil. The water that no longer infiltrates the soil becomes runoff and is quickly carried to storm water detention ponds or enters stream systems through drains and drainage watercourses. With increasing urbanization the quality of this runoff decreases as more sediments and automobile fluids from roads, and fertilizers and pesticides from lawns, are carried away by the water. A decrease in infiltration reduces the amount of water that is stored in the basin, unless this is addressed through storm water detention ponds that act to temporarily store water and recharge the groundwater (Brooks et al. 1997). If groundwater levels drop this reduces stream flows during the summer causing an increase in temperature, a decrease in oxygen concentration, and a reduction in the quantity of salmon habitat, especially summer rearing habitat which is the main limiting factor for coho salmon in the Green River watershed (WSCC 2000a).

2.5 Mill Creek SAMP

The SAMP process is not evaluated in this report; however, it is important to introduce it here because the Draft CIP, which will be evaluated, is a continuation of the SAMP (King County 2001). When the CIP document is completed, it and all past studies and management plans for the Mill Creek basin including the SAMP and its supporting studies (King County 2001, 2000, 1999a, 1993; Knauer 2002; Shapiro and Associates Inc. 1990; USACE 2000a, 2000b) will be used as references for creation of the Mill Creek Basin Plan (Clark 2002; Knauer 2002). The Mill Creek Basin Plan process is being managed and the document written by a small team within King County WLRD (Knauer 2002).

In the late 1980's, with sponsorship from King County and the cities of Kent and Auburn, USACE initiated a Special Area Management Plan (SAMP) in the Mill Creek basin (Scuderi 2002; USACE 2000b). Their goals were to address the conflict between development and preservation interests, streamline the permit process, and improve consistency of aquatic management, flood damage reduction, and water quality improvement efforts of the local, state, and federal governments. The most significant part of the SAMP was a wetland inventory and rating process that determined which wetlands should be preserved and which allowed to be filled in (USACE 2000b).

The Mill Creek SAMP has eleven appendices and supporting documents consisting of management plans, studies, technical reports, cost estimates, and memorandums of agreement. Three of the supporting documents are specific management plans for flood prevention (King County 1999a, 1999b), aquatic resource restoration (USACE 2000a), and water quality improvement (King County 1993). Consideration of consistency with all other Mill Creek basin planning documents was a priority during the creation and evaluation of each of these plans. The SAMP establishes which wetlands should be preserved and which slated for development, while creating a streamlined permit process and mitigation requirements. Each of the flood, aquatic resource, and water quality management plans identifies actions or specific projects necessary to solve the specific management problem it addresses (King County 1993, 1999a, 1999b; USACE 2000a).

2.5.1 Players

The interagency committee for the SAMP process included the participation, sponsorship, and technical support of the Cities of Kent and Auburn, King County, USACE, the US Fish and Wildlife Service (USFWS), the US Environmental Protection Agency (EPA), the Washington Department of Ecology (WDOE), and the Muckleshoot Indian Tribe (MIT) (USACE 2000b). King County, because of its adequate budget, good relationship with the USACE, jurisdiction over much of the Green River Watershed, and regulatory authority over clean water, sensitive areas, and flood zones was seen as the obvious local entity to coordinate SAMP implementation (Clark 2001; USACE 2000b).

2.5.2 Public Involvement

The SAMP had a public involvement component involving four public workshops and bi-weekly meetings of a citizen advisory committee (CAC) (Scuderi 2002; Smith 2002). The workshops served to introduce the SAMP, scope issues and concerns, and educate the community about the basin's physical and biological systems. The CAC served to review proposals created by USACE, WDOE, and King County (Scuderi 2002; Smith 2002).

The SAMP public involvement process started with four public workshops in 1988, 1990, 1991, and 1992 (Scuderi 2002; Smith 2002). At these workshops the SAMP concept was introduced and input was solicited for the following: scope for the SAMP, goals, landowner and business compensation, flooding, financial plan, and definition of the public's interest in participating in the development of the SAMP. Educational displays at the workshops included historic and current wetland distribution, wetland functions and values in the Mill Creek Basin, flooding, restoration plan, and tools for planning for wetlands (Smith 2002). Jonathan Smith, the second project lead for the SAMP, stated that the USACE, from past complaints associated with permits, had a good idea what the public concerns were before these workshops. The main purpose of the workshops was to consult the public to verify those concerns and inquire about additional concerns (Smith 2002).

In October of 1992 a response form was sent out to all residents, farms, and businesses in the Mill Creek Basin asking people if they wanted to be on a Citizen Advisory Committee (CAC) for the SAMP process (Smith 2002). Because the Mill Creek Basin is small scale, only six volunteers were chosen to be on the citizen committee, from the private landowner, business, and environmental sectors. Members were chosen by the first project lead, Mike Scuderi, based on their willingness, availability, and ability to represent their societal sector. In January of 1993 the first CAC meeting was held. From 1993 through 1996 CAC meetings were held twice a month. There were some periods of inactivity during the four years the CAC was meeting. The CAC sometimes met with the SAMP Interagency Committee, or research team, but most often they met alone. The CAC had input on all aspects of the SAMP process including wetland evaluation and scoring, project prioritization criteria, restoration plan review, funding, and trade-off determination (Scuderi 2002; Smith 2002). Mike Scuderi, senior planning engineer for the USACE and first project lead for the SAMP, described the CAC's role as more of a review body than an initiator of plans (Scuderi 2002).

2.5.3 Goals

The USACE, King County, and the Cities of Auburn and Kent determined that the purpose of the SAMP process is to

> . . . protect and restore aquatic resources in the Mill Creek basin to ensure no net loss of aquatic resource functions and values, while recognizing the need to accommodate projected growth in population and employment in the region. (USACE 2000b: 1.6)

Based on input from the public and other participating organizations and agencies, they created eight overall goals for the Mill Creek basin SAMP. The eight goals are to improve the performance of aquatic resource functions and values, provide flood storage, improve water quality, accommodate development, provide greater predictability for development and environmental interests, provide for long-term maintenance and management of aquatic resources, secure funding for conservation easements or acquisition, and provide recreational and educational opportunities (USACE 2000b: 1.6).

The specific goals of the flood management plan are to reduce the hazard and improve the predictability of flooding, manage impacts to wetlands, improve water quality, protect and enhance aquatic habitat, be consistent with current planning and policy documents, coordinate with other agencies and tribes, and address concerns of private property owners (King County 1999a: ES-1). The goal for the water quality management plan is to: "Identify specific corrective measures for known water quality problems in the Mill Creek planning area." (King County 1993: 3). For the aquatic resource restoration plan, the goal is to " . . re-establish an interconnected system of wetlands and adjacent transitional uplands centered on Mill Creek, Mullen Slough, and their tributaries" (USACE 2000a: pg 1.3). Economic development was addressed qualitatively in all three documents in that positive and negative economic impacts were considered by the interagency committee and CAC for each proposed action (King County 1993, 1999; USACE 2000a, 2000b).

2.5.4 Recommendations and Action Plans

The reports on flooding, aquatic resource and water quality management plus the SAMP discuss several solution options recommended by participating agencies with public input. The reports evaluate and recommend implementation of specific alternatives in each management category.

Based on scientific, economic, and social studies along with public comment, SAMP participants created a list of all wetlands in the Mill Creek Basin and ranked them based on their fish and wildlife habitat potential, hydraulic functionality, potential to be restored, development restrictions, location, and size (USACE 2000b). Using this list the SAMP Interagency Committee proposed nine alternatives ranging from no development to filling all wetlands without development restrictions. The Committee recommended an alternative that protected the Mill Creek corridor of wetlands with and without development restrictions closest to the principal streams in the Mill Creek basin (USACE 2000b). The SAMP Interagency Committee chose to protect the Mill Creek corridor because it was the most realistic approach for financing protection and restoration of the greatest number of wetland areas. This approach was the most realistic as it did not propose to protect very desirable developable areas and the mitigation dollars from development of low grade wetland would fund the improvement of the wetlands on the stream corridor. This proposal maximizes the acreage available for development while maintaining and improving aquatic resources.

2.5.4.1 Flood Management Action Plan

Five alternative action plans are evaluated in the *Flood Management Plan* by the participating agencies, organizations, and the CAC (King County 1999a). These alternatives range from major capital works such as gated creeks and pump stations, to low-impact alterations that improve flooding problems while minimizing impacts to aquatic resources (King County 1999a).

The recommended flood management alternative proposes flood-proofing for certain homes and businesses, raising Hwy 181, conducting conveyance improvements in streams and drainage watercourse, culvert replacements, repair and maintenance, sediment trap construction, construction of storm water detention ponds, construction of overflow channels, and a slide gate at the mouth of Auburn Creek. The estimated cost was $48,340,000 (King County 1999a).

The recommended action plan controls flooding in the areas zoned for future development but not in wetlands recommended for protection under the SAMP (USACE 2000b). It would not eliminate flooding in the valley at the mouth of Mill Creek and Mullen Slough. To do so would require significant land acquisitions to construct storm water detention ponds for collecting hillside runoff or construction of gates and pumping stations. A gated creek approach was not recommended for Mill Creek and Mullen Slough because of the cost and impacts on fish habitat and fish passage. The areas targeted for flood protection are few and produce the greatest benefits. A flood proofing and buy-out program would reduce the impact of flooding on homes and businesses in the valley. Five homes and one dairy would be flood proofed, via berm construction, while seven homes would be purchased (King County 1999a).

2.5.4.2 Water Quality Action Plan

The water quality study identified many sources of sediments, manure, and other pollutants, both discrete and non-point (King County 1993). It recommended implementation of Best Management Practices (BMPs) or regulatory action at these sites as well as the creation of riparian forest corridors next to all waterways and wetlands. Specific storm water detention facilities were recommended. It was noted that maintenance of all local, regional, and private drainage watercourses needed to be improved including specific maintenance scheduling for government agencies and facilitation of permitting for private land owners (King County 1993).

2.5.4.3 Aquatic Resources Restoration Action Plan

The aquatic resources restoration action plan recommended restoration of as much as possible of the basin to forested wetland, augmentation of the existing channel systems by creation of dendrites, expansion of connectivity by restoring interconnected stretches of forested riparian areas, and reduction of fragmentation by restoring or protecting large patches of forested habitat (USACE 2000a). Larger patches are more resilient to disturbance and can support microhabitats with metapopulations of small mammals, amphibians, fish, and birds (Hanski and Gilpin 1991).

2.5.5. SAMP Outcomes

The SAMP process was completed and a draft document was published in 1999 (USACE 2000b). The Cities of Federal Way and Algona had not participated even though they had been invited (Smith 2002). The Cities of Kent and Auburn signed a Memorandum of

Understanding endorsing the SAMP as a concept, but not its specific actions. They then participated in finalizing the SAMP with the Technical Committee. Once the SAMP was finalized the listing of Puget Sound Chinook Salmon in 1999 created a new set of priorities for staff time at the USACE Seattle District, as they are a federal permitting agency that must consult with NMFS under the ESA for all permit actions that could affect Puget Sound Chinook (Smith 2002). Consequently the USACE did not have time to attempt to get the finalized SAMP formally adopted by the Cities of Kent and Auburn, which would involve them committing to all the proposed actions such as zoning and comprehensive plan changes (Clark 2001; Scuderi 2002; Smith 2002). Thus, the SAMP failed to create a coordinated land use planning process involving all relevant jurisdictions. However, it did create a series of guiding documents for relevant jurisdictions to use in isolation. Paul Krauss, a Planner for the City of Auburn, believes that the SAMP was somewhat of a success because of this fact (Krauss 2001).

Developers did not get their desired streamlined permit process; however, the USACE uses the SAMP as a guiding document to review each application for the filling of wetlands, speeding up evaluation of alternatives and determinations for mitigation and Endangered Species Act (ESA) compliance (Scuderi 2002). Sadly, these reviews are conducted separately from local jurisdiction review. From the perspective of local citizens wanting flood control and better management of water quality and fish habitat, the failure of the SAMP meant there would be no binding and consistent policies created throughout the basin or coordinated action to control storm water, improve maintenance of waterways, reduce pollution, and preserve and restore fish and wildlife habitat (Clark 2001).

King County had invested a lot of money in studies for flooding, fisheries, and water quality management in the Mill Creek basin (King County 2000a, 1999a, 1999b, 1993). They had a stake in seeing the recommended actions of the SAMP implemented. With a limited budget, they decided to continue the SAMP process, but at a smaller scale, looking only at the Mullen Slough sub-basin. They synthesized existing documents and information, conducted hydrologic and biological studies, and recommended a series of actions to reduce flooding and improve water quality and fish habitat. The results were published in draft form for internal review within King County in *Mullen Slough Capital Improvement Project (CIP) Study and Action Plan (Draft)* (King County 2001).

3 Watershed Management: History, Current Use, and Development of an Evaluative Framework

This chapter introduces the history and current use of watershed management and outlines the construction of an evaluative framework and its use in evaluating the Mullen Slough CIP process. Watershed Management is defined in Section 3.1. Section 3.2 introduces watershed management in terms of its history, current practices, and where it is headed. Section 3.3 summarizes the construction of the framework and Section 3.4 describes and justifies each key element of the framework.

3.1 What is Watershed Management?

Water as a resource or commodity, and its routing of energy and materials, is at the center of watershed management (Water Resources Center 2000). Broadly defined, watershed management is ecosystem management that focuses public and private sector efforts to address the highest priority problems within hydrologically defined geographic areas (EPA 1996a). It is an iterative process of integrated decision making concerning uses and modifications of lands and waters within a watershed. The framework for decision making should be based on a sound understanding of the physical, biological, social, and economic structures and systems of the watershed so that the effects of various alternative actions can be considered (MDEQ 1997). Watershed management is necessary because human modifications of land and water alter the movements of water, sediments, and nutrients in turn affecting terrestrial and aquatic systems both in the source watershed and watersheds connected to it (Brooks et al. 1997). People with a stake in a certain watershed may have a wide diversity of values and goals concerning the uses of local land and water resources. Stakeholders such as landowners, business owners, politicians, agency personnel, or anyone else with a stake in the outcome of the watershed management process, should be involved throughout the process as they will help define problems, set goals and priorities, select technologies and policies, and monitor and evaluate impacts (Johnson et al. 2002; Swallow et al. 2002).

3.2 History and Current Use of Watershed Management

In the United States, rather than one consistent methodology for watershed management there are many standardized and non-standardized ways to inventory, assess, and manage a watershed's land use and resource features and issues (EPA 1996a; RIEC 1995; USACE 1986; WDOE 1999; WFPB 1997; WPN 1999). There is a need for this diversity of approaches due to the variety of concerns and issues facing modern society. Though no single standard for watershed management is the correct one, there are some underlying key elements that if followed can increase the likelihood of success (EPA 1996a; Pinkerton 1991). As discussed earlier, in this report success is defined as attaining and sustaining the desired state in the watershed as determined by laws, and societal and stakeholder values. I argue that success depends, at least partially, on the processes followed, as both attaining and sustaining desired states will require stakeholder participation and satisfaction, clear goal definition, and an adaptive long term management plan.

3.2.1 History of Watershed Management

I have not conducted a thorough analysis of the history of watershed management, as this report focuses on the current uses of the process. Below, a brief history of the disciplines and practices that led to the development of watershed management in its current form is described.

The concept and practice of watershed management has come about through collaborations between scientists, engineers, resource managers, and the public working together to solve land and water use issues that are best resolved using a hydrology-based perspective (EPA 1996b). Watershed management today is a combination of the principles and practices of ecosystem management and water and water resource management (EPA 1996a).

3.2.1.1 Ecosystem Management

The term "ecosystem" was first applied in 1935 by Sir Arthur George Tansley, a British plant ecologist (1871-1955). He formed the word ecosystem as a contraction of "ecological system" and published it in a scientific paper clarifying the meaning of other ecological terms in use at the time (Tansley 1935). An ecosystem can be defined as a geographic area including all living organisms, the physical elements or structures within and the natural cycles that sustain them. A more bio-centric viewpoint would state that the ecosystem boundaries are probabilistic and flexible as they are based on the home-ranges of particular target species (Yaffee 1999).

Ecosystem management became popular in the 1990's as a new land management paradigm that would solve the age old conflict of species survival and resource use (Montgomery et al. 1995). Ecosystem management can be defined as a management system that strives to understand the biological (including human) and physical elements and the processes that sustain them within a defined management area in order to either minimize human impacts or to foster sustainable human use of that environment (Yaffee 1999). Whether ecosystem management's purpose is to minimize human impacts (continue with status quo while attempting to reduce impacts) or promote sustainable human use (change practices and look for alternatives which do not harm the ecosystem functions in the long term) depends on the values and interests of the sponsor and stakeholders for the process (Yaffee 1999). Yaffee (1999) argues that natural resource management paradigms have evolved from single-use to a more ecosystem-based approach (landscape-scale ecosystem functions) because of a change in social values and interests as well as an increase in knowledge of biological and physical systems. Yaffee also argues that ecosystem management as it is practiced today in the United States encompasses the full range of resource management paradigms (Yaffee 1999).

In the United States, in the 1800's and early 1900's, land based resources, such as timber, minerals, soil, and wildlife, and aquatic resources, such as fish, shellfish, and water were all managed as separate units (Meffe and Carroll 1997; Singleton 1998; Swallow et al. 2002; Wilkinson 2000). The goals of resource management have changed over time as have the goals of society in general. In the late 1800's on the west coast of the United States, resource management goals were based primarily on resource extraction (Kruckberg 1991). As society relies less directly on resource extraction, and people become more affluent, natural environments are valued not only for their extractable resources but for other values they provide such as clean water, wildlife viewing and quality of life (Lackey 1998; Pinkerton 1991). In 1936 the term “wildlife” as separate from “game” came into common usage and wildlife management emerged as a distinct profession (Meffe and Carroll 1997).

Aldo Leopold introduced the idea that wild animal and plant species should be studied and their habitat preserved as part of management programs (Leopold 1933). About this same time, in the states of Washington and Oregon, conflicts between salmon fishermen and the agricultural and grazing sectors led to some regulations that attempted to protect salmon and their habitat (43 U.S.C. 315 et seq. 1934) (Lichatowich 1999). In 1974 the Boldt decision (U.S. v. Washington, 384 F. Supp. 312) included demands for the Washington Department of Fisheries to monitor fish stocks, keeping track of catches by the different user groups and to study more of the ecology and habitat needs of salmon and other fish (Cohen 1986; Wilkinson 2000).

The concept of ecosystem management was embraced and adopted by elected and appointed public officials throughout much of North America in the 1990’s, and although its popularity in the United States may be beginning to fade, it is being implemented or at least attempted within resource management frameworks of varied disciplines such as fisheries, forest, and wildlife management (Slocombe 1993). The science of ecosystem management introduced new words and phrases to the vocabulary of public officials, activists, developers, and resource extractors. Examples of these terms are ecosystem, community sustainability, ecosystem health, ecosystem integrity, biological diversity, social values, and social principles (Slocombe 1998). These terms have complex and often site-specific definitions and can be powerful uniting or dividing forces. Some scientists feel that in order to attain successful ecosystem management society needs to move beyond debates over rhetoric and focus on policy issues and the role of science in ecosystem management (Slocombe 1998; Lackey 1998). What is successful ecosystem management? According to Lackey’s definition it is achieving desired social benefits within a defined geographic area and over a specified period (Lackey 1998).

3.2.1.2 Water Management

In the United States land/water managers initially adopted a watershed focus to manage water-based issues such as flood control, drinking water protection, and water supply allocation between competing uses from agriculture, industry, municipalities, and wildlife.

The USACE were managing flooding along the Mississippi river starting in the mid-1800's using structural solutions like dams and dikes. Flood protection for the entire country was added to the USACE's mission through The Flood Control Act (33 U.S.C. 701a et seq. 1936). After the floods of 1993 on the Mississippi, they re-evaluated their flood control strategies and took more of a watershed perspective, restoring some natural channel and floodplain functions (Brooks et al. 1997).

In the early 1900's, drinking water facilities in the United States focused on the treatment of water supplies for public health reasons and were not concerned with managing the source of the drinking water (AWWA 1999). In 1996, amendments to the federal Safe Drinking Water Act of 1974 called for the creation of source water assessment programs (EPA 1999). Each state was to conduct an assessment of its drinking water sources to assess existing and potential sources of contamination. The study area for these assessments is the recharge area for the drinking water source. If the drinking water is taken from surface water sources such as rivers and reservoirs, the recharge area is a watershed (Bice et al. 2000).

The history of water allocation in Washington State provides a good example of the evolution of attitudes from single to multiple resource management. In Washington State, water allocation is based on the common law doctrine of prior appropriation, which dictates that the first to put water to a beneficial use has a senior right to all subsequent appropriators (Territorial Legislature of 1873, P. 520, S 1). Early water rights were also established under the doctrine of riparianism, and derived from the ownership of land contiguous to or traversed by a watercourse. A water right is a property right and thus is subject to the Fifth Amendment prohibition on takings without just compensation (DOE

V. Adsit, 694 P.2d 1065 (Wash. 1985)). In 1917, these concepts were formalized in a state water code (RCW 90.03.005 -.610). Ground water was not brought under the state water rights system until 1945 (RCW 90.44). In 1971 the Water Resources Act (RCW 90.54.010-020) recognized that protection of fish, wildlife, and other instream values should be part of a water allocation scheme.

3.2.1.3 Watershed Management

The concept of watershed management was a joining of the practices of water management, mostly site-specific and single purpose, and ecosystem management (EPA 1996b). Watershed management emphasizes the integrated management of land and water resources over a watershed area for multiple purposes (EPA 1996a, 1996b; MDEQ 1997). In the 1990's the role of watersheds as units for ecosystem management and analysis gained support and recognition in many countries around the world (Brooks et al. 1997; EPA 1996a; Hooper 1999). Increasingly, State and Tribal water resource professionals are turning to watershed management as a means for achieving greater results from their programs (EPA 1996a). A survey in the Pacific Northwest, of 140 ecosystem management organizations, watershed councils and coalitions, and county planning agencies found that 50% of respondents used hydrology (watershed or other hydrologic boundary) to define their management unit (Johnson and Campbell 1999).

Currently, watershed management is often an iterative process of: determining stakeholder goals; characterizing, assessing, analyzing, and integrating the physical, ecological, social, and economic components of the watershed relevant to those goals; creating recommendations, action plans, and implementation plans; communicating this information to stakeholders; and continuing to get input from stakeholders as new information and analyses about the watershed and associated management options flow in (EPA 1996a; RIEC 1995; USACE 1986; WDOE 1999; WFPB 1997; WPN 1999).

3.2.2 Current Use of Watershed Management in the United States

3.2.2.1 Federal

In the United States, federal agencies with diverse land and water stewardship mandates, such as USFS, USGS, USFWS, EPA, and USACE have adopted the watershed approach to ecosystem management. The United States Departments of Agriculture (e.g. USFS) and Interior (e.g. USGS and USFWS) have adopted watershed analysis as the tool for identifying environmental needs and opportunities (Reid et al. 1994). This is discussed more in Section 3.3.2. EPA actively encourages and supports state, tribal and other local stakeholder watershed approach strategies. They set out a series of guiding principles including stakeholder involvement and input, a geographic focus, and strong management techniques based on sound science and data. EPA defines the watershed approach as: "A coordinating framework for ecosystem management that focuses public and private sector efforts to address the highest priority problems within hydrologically-defined geographic areas, taking into consideration both ground and surface water flow" (EPA 1996a:2). The USACE uses a watershed approach to conduct Special Area Management Plans (SAMPs) when the goals of the management process are best addressed within management regions defined hydrologically (USACE 1986).

3.2.2.2 Washington State

In Washington State the watershed approach has been adopted by all state land and water management agencies for their planning and analysis frameworks (WDFW 2001; WDOE 1999; WFPB 1997; WSDOT 1996). When chinook salmon were listed as threatened under ESA in 1999, legislation like the Washington State Watershed Planning Act (RCW 90.82) created a framework and a funding source for setting up water and land resource planning units at a watershed level.

WDOE uses watershed characterization to model the relative changes to major basin processes caused by development (WDOE 1999). These processes include the movement of heat, nutrients, toxicants, water, sediment, and large woody debris through the basin. Changes to these processes are a major cause of ecosystem degradation. The goal of watershed characterization is to describe past and present alterations and to predict future alterations (WDOE 1999). In addition, WDOE houses the Puget Sound Water Quality Action Team, a body responsible for developing and implementing action plans for watersheds in need of corrective and/or preventive actions. The planning process encourages collaborative problem solving among local, state, tribal, and federal interests (WAC 400-12 and RCW 90.71.020). The Washington State Department of Transportation (WSDOT) Environmental Affairs Office is applying a watershed-based approach to transportation project delivery (WSDOT 1996). The goal of the program is to integrate transportation planning and project delivery into statewide watershed planning and recovery efforts so that mitigation dollars can be directed toward high priority watershed recovery efforts (WSDOT 1996). WDFW is involved in the WRIA planning process, and conducts its research and management programs from a watershed perspective (WDFW 2001). The Washington State Department of Natural Resources (WSDNR) manages timber and shellfish resources on state-owned lands. They use the watershed analysis approach as described in Section 3.3.1 (WFPB 1997).

WDOE, WSDNR, WSDOT, and WDFW are all members of the Washington Watershed Coordinating Council, a ten-member council composed of state agencies, with a 14-member public advisory group, composed of tribes, affected landowners, timber industry and environmentalists (WDFW 1997). The purpose of this council is to establish a process for coordinating watershed planning and restoring and protecting fish and wildlife and their habitats, including water quality, on all lands in the state. The council's goal is to foster better coordination between state agencies in order to provide better service to the locally-based watershed efforts (WDFW 1997).

3.2.3 Benefits and Challenges of Watershed Management

Watersheds are naturally geographically defined by topography and hydrology, and thus represent a logical basis for managing water resources (EPA 1996b). Many cumulative impacts, the spatially and temporally compounded effects, of land management practices are tied to water and hydrologic processes and can therefore often be determined and solved most easily from a watershed perspective. The watershed approach facilitates the examination of the interrelationships between land and water uses and resulting environmental effects (Brooks et al. 1997).

Federal laws addressing water quality problems have focused on certain sources, pollutants, or water uses and have not addressed the cumulative impacts of multiple large and small inputs or modifications to a system over time. Watershed management frameworks encourage a more interdisciplinary and comprehensive management framework that can make use of existing pollution prevention and natural resource programs (Brooks et al. 1997; EPA 1996a).

Operating and coordinating programs on a watershed basis makes good sense for environmental, financial, social, and administrative reasons (EPA 1996a). Watershed management helps determine the most critical problems within each watershed and the cumulative effects of various human activities. The ranking of risks and prioritization of benefits helps public and private managers allocate limited resources to address the most critical needs. Monitoring of environmental, social, and economic indicators measures success and helps managers determine how and when a management framework should be changed to better solve stakeholder goals. The watershed approach can lower costs by recruiting local volunteers, leveraging financial support from local business, and reducing redundant and conflicting actions. Permit application review can be improved through process simplification and more efficient impact and mitigation assessment. Watershed management can provide people a meaningful role in management of resources and ways of life important to them (EPA 1996a). Committed and open involvement in the watershed approach can build a sense of community, reduce conflicts, and increase commitment to the measures necessary to meet stakeholder and societal goals (EPA 1996a; Pinkerton 1991).

A watershed approach is not without challenges. A sense of community or place will most likely not encompass an entire watershed, especially if it is large with defined basins. Communities may actually be divided by rivers or large streams, and may fight over scarce water resources. Politics can play a beneficial role but only if the goals of the politicians are in line with those of stakeholders. Coordination of multiple jurisdictions is a difficult task as each have their own laws, mandates, constituencies, and issues. Economic sustainability may involve trade-offs between certain sectors as economic goals may directly compete. For example, the construction industry may want to build on salmon habitat while commercial fisheries may want the habitat preserved.

There is some skepticism that agencies talk about comprehensive studies and integrative science but continue in practice to look at issues from a single-species or single-resource perspective (Frissell and Bayles 1996). In addition, there is concern that when scientific descriptions and analyses are integrated, this new information is not effectively integrated with the social, economic, and political landscapes resulting in poor planning and management frameworks that do not accomplish stakeholder goals (Lackey 1998; Montgomery et al. 1995; Slocombe 1998).

3.2.4 Conclusion

The concept of watershed management was a joining of the practices of water management and ecosystem management (EPA 1996b). It directs public and private efforts to address the highest priority concerns within hydrologically-defined areas (EPA 1996a). Since its development as a management practice, watershed management has evolved from a process focused on a single resource or issue to one of multiple resource and issue management, with the involvement of multiple stakeholders (EPA 1996a, 1996b; RIEC 1995; WFPB 1997; WPN 1999).

Hydrologically defined management units facilitate the examination of processes and structures to discern the interrelationships between land and water uses and resulting environmental effects (Brooks et al. 1997). Cumulative impacts of land management practices which are tied to water and hydrologic processes can be best identified and addressed from a watershed perspective (EPA 1996b). Thus, a watershed perspective is best for addressing erosion, sedimentation, flooding, water quality, and water resource issues (WPN 1999). Watersheds and their sub units, basins and sub-basins, can possess an inherent sense of place, community, and solidarity; thus facilitating stakeholder engagement and involvement.

Self-interest driven politics, strong special interests, and the medley of difficult trade-offs are all serious challenges for ecosystem and watershed management. The significant challenges associated with making decisions collectively in a structured manner, however, may be less daunting than the potential negative ecological, physical, social, political, and economic consequences of the many jurisdictions and stakeholders making decisions about particular pieces of a watershed in isolation.

3.3 Evaluative Framework: Origins of Key Elements

Watershed approaches vary in terms of specific goals, objectives, priorities, factors, timing, and resources; however, there are some common principles and practices used by watershed managers and recommended by academics that have been shown to increase the likelihood of success (EPA 1996a, 1996b; RIEC 1995; WFPB 1997; WPN 1999). In this section, key elements of the watershed management approaches from Oregon State, Washington State and the United States federal government are summarized and synthesized to create the backbone of an evaluative framework. Each recommended key element is further supported using the planning, resource management, and social and natural scientific literature, as well as government agency reports and reviews.

3.3.1 Watershed Analysis in Washington State

In Washington State watershed analysis is a state mandated process led by timber harvesting companies or agencies, in cooperation with tribes (WFPB 1997). It is a process for developing a watershed-based forest practices plan tailored to each watershed and based on scientific understanding. The process is funded by either private landowners or the Washington Department of Natural Resources (WSDNR). It determines the sensitive areas in a watershed using a set of questions developed by experts from the disciplines of geomorphology, geology, hydrology, and forest and fisheries ecology. Prescriptions are negotiated among the tribes, WSDNR, the forest landowner (if land is privately owned), and the public once agreement has been met on the acceptable extent of data gaps and scientific uncertainty. The prescriptions outline actions that will minimize the impacts of forest harvest on public resources such as salmonids and water quality. The Washington Forest Practices Board (WFPB) adopted watershed analysis into regulation in 1992 (WFPB 1997).

3.3.2 Watershed Analysis at the Federal Level

Watershed analysis is also conducted by federal agencies for management of federally-owned lands (RIEC 1995). This version of watershed analysis is more descriptive than prescriptive and addresses multiple uses instead of timber harvest alone. The specific analysis procedures outlined in the Washington watershed analysis manual are suited for Washington's environment and are not applicable for federal use, not being flexible enough to apply to the diversity of ecosystems and climates under federal ownership in the United States. However, the major phases and steps in the Washington manual are used in the federal process. People have different expectations of what a federal watershed analysis should include. In general, federal analyses will depend primarily on existing data and will not replace analyses necessary for project-level planning. At least in the federal arena it "will be an information-gathering and analysis process, but will not be a comprehensive inventory process" (RIEC 1995).

3.3.3 Watershed Assessment

In Oregon, watershed assessment is a process undertaken primarily by watershed councils that includes steps for identifying issues, examining the history of the watershed, describing its features, and evaluating various resources within the watershed (WPN 1999). Watershed assessment is similar to watershed analysis; however, it is more generalized and simplified, and has more opportunities for public involvement. A watershed assessment's goals are to identify features and processes important to fish and water quality, then determine how natural processes and human activities are influencing or affecting these resources. Finally, an evaluation of the cumulative effects of land management practices over time is completed.

The process has been highly standardized. A 500 page manual serves as a textbook, cookbook, and reference guide. The process begins with Start-Up where issues in the watershed are identified. Then a watershed description is completed, describing the history, geographic regions, and stream channel habitat types. The watershed characterization looks at the "watershed components"[1] of the watershed, such as hydrology and water use, riparian and wetland habitats, sediment sources, channel modification, water quality, and fish and fish habitat. Once the watershed components of concern have been characterized the condition of the watershed is evaluated. The data is reviewed for gaps and information from each component is integrated and synthesized. After synthesis, a Watershed Management Plan is produced through creation and evaluation of recommendations, and creation of action, implementation, and monitoring plans. Stakeholders are involved in the process throughout. Overall, the process determines potential and existing sources of impacts on aquatic resources and water quality, and prescribes methods to reverse, prevent, or minimize the impacts (WPN 1999).

3.3.4 Watershed Approach: United States Environmental Protection Agency (EPA)

EPA has adopted the watershed approach as a way to restore, maintain, and protect water resources in the United States, in partnership with local agencies, tribes and other stakeholders (EPA 1996a). EPA delegates some of its permitting and oversight responsibilities to the states. To help the states with these tasks EPA provides training, technical support and guidance for conducting community-based environmental assessment, planning, and protection at a watershed level.

EPA supports states in their efforts to independently develop watershed approaches to fit their distinctive conditions. In reviewing the frameworks created by the states, EPA summarized nine key elements in common. The nine key elements are: management units; management cycles; stakeholder involvement; strategic monitoring; assessment;

[1] This term is used in the evaluative framework's Watershed Characterization

prioritization and targeting; development of management strategies; management plans; and implementation of the plans.

EPA considers these to be common elements rather than steps, and believes they do not need to necessarily occur in order. Some processes are over-arching and iterative such as stakeholder involvement. In its support literature, EPA stresses that it is not necessary or desirable to create an additional layer of oversight, but that instead the focus should be on improving the coordination of existing programs and processes (EPA 1996a).

3.3.5 Conclusion

The above watershed management frameworks are all essentially ecosystem analysis and management at the watershed scale; however, they vary in terms of the number of ecosystem components that are characterized. For example, Washington's Watershed Analysis only looks at effects of timber harvest on landslides, erosion, water quality, and fish, while it does not address other animals or physical processes. The analyses include humans as part of the ecosystem. Characterization of the human, biological, and physical features, processes, and interactions, allows an estimation of the direct, indirect, and cumulative effects of human management activities and natural disturbances within the watershed. An integration of this information facilitates the creative and decisive phase of choosing management options. Implementation of action plans and evolution of the management plan over time is essential for the process to be successful through time.

The above four frameworks share a number of common key elements. Whether this means that they used each other as models, used other similar sources, or came up with the same elements convergently cannot be ascertained easily. Using the literature, I will argue that these key elements can improve the likelihood of success of a watershed management process. The common elements also serve to further standardize watershed management within the United States.

3.4 Evaluative Framework: Explanation and Justification of Key Elements

Table 3.1 shows the phases and key elements of the framework. The main steps and principles from the four frameworks above were summarized and compared. Fourteen steps and principles from the four frameworks which had significant support in the literature were included in the evaluative framework presented here (see Appendix 2). The key elements were placed within four main phases, Start-Up, Watershed Characterization, Watershed Condition Evaluation, and Watershed Management Plan, derived from the four frameworks above. The key elements need not be followed in the exact order shown in Table 3.1; however, the phases need to occur in order because successful completion of later phases is dependent on completion of earlier phases. Additionally, some elements are best completed or initiated early, such as public involvement. The explanation of and justification for each key element is given below.

Table 3.1 Watershed Management Evaluative Framework

Phase	Key Element
Start-Up	Identification and designation of those stakeholders who will conduct the research and manage the process: sponsor, project manager, and research team members
	Definition of management region and boundaries
	Coordination of involvement and participation of stakeholders who will conduct tasks other than scientific research or management
	Definition of broad goals and identification of major issues
	Creation of more specific goals
Watershed Characterization	Identification of data gaps and statement of assumptions Define what level of uncertainty is acceptable.
	Historical characterization of the watershed
	Identification and characterization of dominant physical, biological, and human processes and features of watershed. *Determine the underlying processes and begin to sort out some potential causes for key issues in the watershed.*
Watershed Condition Evaluation	Synthesis and interpretation of information from Watershed Characterization. Determination of those trends moving away from stakeholder goals. *What historical, current, and future projected trends (process and structure changes) differ from stakeholder goals? i.e. What is wrong? What are the causes?* *What can humans do to influence those causes in order to move trends towards stakeholder goals within the physical, biological, social and economic constraints?*
Watershed Management Plan	Development of specific management options, recommendations, and scenarios. Establishment of decision-making process and evaluative criteria. Prioritization and selection of best option.
	Creation of action plan
	Creation of implementation plan. *The implementation plan takes the action plan a step further by assigning responsibility for each action and each step to facilitate an action.*
	Creation of monitoring plan
	Creation of a planning and management framework

3.4.1 Start-Up

The Start-Up phase of the watershed assessment is an iterative process in which the roles of individuals and institutions are defined, the region to be assessed is determined, stakeholders are identified, and the goals of the watershed analysis are determined. Each of these key elements is dependent on the other elements in this phase. Thus, as progress is made on a given start-up element, the others may be reevaluated. In this section, key elements of the Start-Up phase are described and justification of their inclusion in the evaluative framework is provided.

3.4.1.1 Identification and Designation of Those Stakeholders Who Will Conduct the Research and Manage the Process

The sponsor is the institution responsible for overseeing implementation and completion of the Watershed Management Plan (RIEC 1995; WFPB 1997; WPN 1999). The sponsor needs to be able to provide and coordinate funding, oversight, and technical support while creating a flexible structure that allows stakeholder input concerning process (Pinkerton 1991). The goals of the process and the depth of analysis required to determine actions to address those goals will determine the human, technical, and financial resources that the sponsor should possess (WPN 1999; WDOE 1999). Sponsors can vary greatly in size and level of human, technical, and financial resources. If the willing sponsor does not have the necessary resources, other entities can provide funding and technical support (Pinkerton 1991). Co-sponsors can share responsibility as long as each one's role and responsibilities are defined and agreed on early in the process. However, it is the sponsor's responsibility to carry the process through to implementation (Pinkerton 1991).

A sponsor with legal or regulatory authority to implement the plan is helpful; however, an entity may be able to effectively and efficiently implement a Watershed Management Plan without technical legal authority if it resonates with the stakeholders (Pinkerton 1991; Slocombe 1998). Singular authority of a given entity is probably insufficient without buyoff from other stakeholders as most watersheds cross multiple administrative boundaries. If it is determined that the sponsor does not have the authority to implement the plan or the ability to engage stakeholders effectively then another body can be chosen, a watershed council can be formed, or the existing sponsor can be supported through signed agreements (Pinkerton 1991). The sponsor should begin soliciting support for the process from outside stakeholders, public officials, and agency administrators as early in the process as possible. The final management plan will only be as good as the public's willingness to implement it (Pinkerton 1991).

The process should have a qualified manager and facilitator (RIEC 1995; WFPB 1997; WPN 1999). The facilitator is responsible for running meetings and coordinating communication between and within stakeholders and technical teams. Hence, a person with skills to focus discussion, and resolve conflicts to generate consensus is desirable (Pinkerton 1991; WPN 1999). The project manager is responsible for leading the teams and committees through the process, making sure each step or key element is completed. Hence a person with good communication skills, both verbal and written, and good organizational skills with the ability to pay attention to details while still seeing the big picture is desirable (Pinkerton 1991). The roles of project manager and facilitator may be filled by one or two persons depending on the size of the project and available resources (WPN 1999).

The sponsor should organize the formation of a research team, composed of people who will do the technical tasks to analyze the watershed (RIEC 1995; WPN 1999; WFPB 1997). Members of this technical team need to have skills relevant to characterizing a particular watershed component. In addition, team members need to have at least some integrative skills for pulling the results of the studies for different disciplines and watershed components together. The depth of characterization, and thus the skills necessary, will depend on goals of the process and available resources (WPN 1999).

The sponsor, project manager, facilitator, and research team represent the scientific and management stakeholder component. It is the responsibility of the project manager and team members to identify and educate the stakeholders from the general public who will represent the local values and priorities. Therefore an additional responsibility of the project manager is to ensure inclusion of all concerned parties (i.e. stakeholders, discussed further in Section 3.4.1.3 below) (Pinkerton 1991; WFPB 1997; WPN 1999).

3.4.1.2 Definition of Management Region and Boundaries

Definition of the scale of analysis and watershed boundaries needs to occur early in the process, as this will determine the spatial extent for gathering information and stakeholder involvement (EPA 1996a; RIEC 1995; WDOE 1999; WFPB 1997; WPN 1999). If the sponsor initiates the process, they will perform this task and then consult the stakeholders once they have been identified. The goals and watershed processes to be characterized determine the scale (boundaries) which in turn determines the appropriate sponsor and stakeholder involvement. Each of these points is discussed further below.

The scale chosen for analysis should be appropriate to the scale of the watershed processes that need to be assessed (WPN 1999). For example, the effects of dam construction on gravel recruitment depend on main stem river processes and thus would require assessment at a main stem watershed scale. All scales of analysis can to a certain extent forecast responses of processes, populations, or ecosystems to natural disturbances and human modifications of the system. The ability to forecast complex watershed processes will decrease with increasing scale (Frissell and Bayles 1996), but there are also benefits of larger scale analyses, which are discussed below. The goals for the watershed management process will determine which watershed processes need to be assessed and thus the scale should depend on the goals of the analysis. Reevaluation of the scale should take place once all stakeholders have defined specific goals.

Oregon’s Watershed Assessment Manual (WPN 1999) suggests a scale of 150-520 sq km (60-200 sq mi) is appropriate to the framework, while Washington’s Watershed Assessment Manual (WFPB 1997) suggests 40- 200 sq km (15-80 sq mi) is appropriate. The Federal Guide for Watershed Analysis (RIEC 1995) and the EPA Watershed Approach Framework (EPA 1996a) do not suggest a particular scale. At a very broad scale, 1300 sq km (500 sq mi) or greater, watershed management provides insight for the creation of policies and laws and facilitates the ranking of risks and priority issues, e.g. habitat limiting factors for salmon (WSCC 2000a). Mid-scale analyses, 300-1300 sq km (100-500 sq mi), provide descriptions and understanding of processes, while small scale analyses, 30-300 sq km (~10-100 sq mi) can address project or site level questions and issues (RIEC 1995).

At this stage in the framework, the relationship of the assessment and management plan relative to past and ongoing assessment and management plans being conducted at larger and smaller scales should be considered (Loeb et al. 1998). Although the boundaries of the watershed assessment are being drawn based on a given set of ecological and sociopolitical needs, the ecosystem and policy problems in the watershed are meshed in a larger ecological and human societal framework such that policy decisions and human or natural disturbances will have effects outside the watershed of concern (Lackey 1998). The nesting of watershed management plans of different scales within one another could help to expand the analysis for a particular watershed to include significant factors at larger and smaller scales (Loeb et al. 1998; Slocombe 1998).

The type of organization sponsoring the watershed management process should be appropriate for the scale (EPA 1996a). Depending on the scale, different groups are appropriate for different roles. At a large scale, federal agencies, state agencies, or tribes may lead the process, while for mid-scale analyses state agencies, county governments, or conservation districts may sponsor the process (EPA 1996a).

The type and extent of stakeholder involvement should also be appropriate to the scale. At small scales, 30-300 sq km (~10-100 sq mi), involvement of the general public in decision-making and active research is possible and desirable, while at large scales the sheer number of stakeholders makes a direct participatory approach more difficult, necessitating group representation (Johnson and Campbell 1999; WPN 1999). At larger scales stakeholders may be more appropriately represented by larger entities such as community groups, industry, wildlife management agencies, and environmental organizations, though it is important that concerned individuals are given a voice (Johnson and Campbell 1999).

At a larger scale, facilitators could find consensus building more difficult because individuals may have less of a sense of community and place at the scale of the larger watershed. This is because of the existence of multiple municipalities and counties and a greater diversity of interests, thus making the process of building consensus and understanding more difficult. Special interests have a strong incentive to get involved at a large scale, as decisions will have more sweeping effects on an industry's objectives or an organization's goals, such as timber harvest or wildlife habitat conservation (EPA 1996a). At a larger scale special interests are more highly organized and powerful and can take over a stakeholder process, creating a sense of inequality and disproportionate representation. The number of government bodies with jurisdiction in a larger watershed further complicates the stakeholder process. Thus it is the responsibility of the sponsor to ensure full and equal representation of all stakeholders (EPA 1996a). However, it is also possible that at larger scales it will be easier to reach agreement because difficult specific local tradeoffs will not be as dominant, and a large scale may be necessary to capture all important ecological processes.

Overall, defining the scale of analysis will start the process of scoping for human, technical, and financial resources and attempting to create a sense of community, understanding, and a common sense of purpose.

3.4.1.3 Coordination of Involvement and Participation of Stakeholders Who Will Conduct Tasks Other Than Scientific Research or Management

If the outcome of a watershed management plan has the potential to affect an entity, that entity is a stakeholder (Johnson and Campbell 1999; Landis and McLaughlin 2000). Stakeholders can include public agencies, tribes, private companies, environmental and social groups, landowners, and private citizens. Stakeholders in a watershed process are usually a diverse group of people often with conflicting fundamental public and private values and concerns (Lackey 1998). The form that stakeholder involvement should take depends on the scale of the assessment, the pre-existing sense of community, and the ability of the sponsor and facilitator to engage the community in a meaningful way (Pinkerton 1991; WPN 1999). Coordinating stakeholders is a fundamentally important and iterative step in the process.

The sponsor should seek out stakeholders, recruiting representatives from each sector or interest group to create a sense of fairness and equality (EPA 1996a; Pinkerton 1991; WPN 1999). Representatives on a stakeholder committee must be composed of a balance of interests in the watershed (EPA 1996a; Pinkerton 1991; WPN 1999). Powerful interests, that could attempt to break down the process from outside, need to have representation; however, including too many powerful interests could cause the process to become unbalanced (Pinkerton 1991). The facilitator should take the polarized issues and, if possible, help build consensus among stakeholders (Pinkerton 1991; Slocombe 1998). Gaps in local knowledge can be filled by searching out individuals who may have insight and local information (e.g. effective soil conservation techniques or cost-effective drainage course maintenance) (Johnson et al. 2002). Indigenous and local people's traditional ecological knowledge (TEK), "[a] cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationships of living beings (including humans) with one another and with their environment" (Berkes 1999:8), is another source of non-scientific information about the watershed.

Use of public workshops and census data can help determine the most significant stakeholders or interests in the watershed, and local stakeholder willingness and capacity for involvement (Pinkerton 1991). Early and frequent public workshops will engage the greater community and begin building a sense of trust. Further development of community support can occur through stakeholder participation in local volunteer projects associated with the process (Pinkerton 1991).

The desired conditions of the watershed are determined by local stakeholder values and relevant laws. These desired conditions then can be formalized into goals for the watershed (Lackey 1998; Landis and McLaughlin 2000; Szaro et al. 1998). The biophysical feasibility of these goals and desired conditions will be determined during the Watershed Characterization and Watershed Condition Evaluation phases. Goals may need to be adjusted due to biophysical constraints. Stakeholder contributions to goal development will bring local and traditional knowledge into the process and help build community support for the process by creating a greater sense of understanding between stakeholders as each learns what the other has at stake (Pinkerton 1991).

The sponsor is responsible for ensuring that stakeholders are educated throughout the process as more information about watershed components and processes is gathered, analyzed, and synthesized. Interpreting and presenting information in several ways will appeal to the greatest number of stakeholders (Pinkerton 1991). This information should include inevitable trade-offs and side effects of possible management decisions, which will help stakeholders to re-evaluate their goals later in the process (Montgomery et al. 1995).

3.4.1.4 Definition of Broad Goals and Identification of Major Issues

The first thing to be defined should be the overall purpose of the process (WPN 1999). A watershed management process can serve a variety of purposes such as to plan and prioritize resource issues or projects at a regional or site level, to establish a watershed group for long term stewardship, or to manage a particular resource (or resources) of concern (e.g. an endangered species) (WPN 1999).

The sponsor and stakeholders should establish their own definitions for “issue”, “goal”, and “objective”. These definitions may differ from other watershed management processes, but as long as they are clearly defined it will alleviate confusion for those involved in the process and outsiders. As defined in the American Heritage Dictionary, an issue is a point of discussion, debate, or dispute (can be of wide public concern), a goal is the purpose toward which an endeavor is directed, and an objective is the purpose, aim, or goal of a course of action (Morris 1981). When working on multiple scales of analysis within a watershed management process (stream, tributary, reach, and project site) it may be helpful to group the issues, goals, and objectives by scale. This can help as objectives at a broad scale may seem more like goals to someone who has been focusing at a project site scale.

Instead of initially focusing on issues, it is best to focus on possible solutions and desired states, that is, goals for the watershed (Rutherford 2002). Discussing broad goals such as clean water or faster permit review rather than particular polluters or permit agents will help to avoid conflict and direct the discussion towards common purposes (Pinkerton 1991). Existing laws are expressions of broad public values that help to guide goal creation. Defining broad goals helps identify problems and issues, and determine which issues are relevant to the process and important to stakeholders (Rutherford 2002). Issues should be kept broad until greater understanding is reached between stakeholders (Rutherford 2002). The facilitator must elicit concerns from the stakeholders while simultaneously creating a sense of understanding and empathy among them (Pinkerton 1991). Issues often arise from attempts at a local level to deal with federal and state regulations (WPN 1999). Once the broad goals and a list of issues are established there should be an initial prioritization to help focus resources that may be limiting (EPA 1996a). All goals need to be realistic in terms of the human, physical, and biological constraints in the watershed.

If a government agency is the sponsor, then their mission, internal policies and de facto way of doing things may influence the goals of the process and the public's sense of trust for that sponsor (Ostrom 1992). If a watershed council sponsors the process, they will have their own particular bias based on their formation, past experiences, and personal make-up, again influencing goals and the public's trust of the process (WPN 1999). Choosing a sponsor that the public trusts will facilitate stakeholder involvement and acceptance of the process.

When broad goals are defined, the sponsor and stakeholders should re-evaluate the physical scale and scope of the investigation (Pinkerton 1991, 2002). This will involve determining what components of the watershed to focus on considering available resources and at what dimension stakeholders have the power to manage and effect change to the human and natural watershed components. To know this, stakeholders must begin to get an understanding of the larger dynamics of the watershed (Pinkerton 1991, 2002).

3.4.1.5 Creation of More Specific Goals

The Watershed Management Plan should be driven by specific goals. Specific goals should be defined after major issues and broad goals are documented and prioritized in order to focus the process and filter out irrelevant goals (Pinkerton 1991; Rutherford 2002). Goals and objectives are a product of current social, political, environmental, and economic conditions and reflect a stage in the evolution of social values (Lackey 1998). These goals will change over time and should not be considered static or permanent (Lackey 1998).

Goal definition is an iterative process that must consider stakeholder desires for the watershed and existing constraints (Lackey 1998; Szaro et al. 1998). Local stakeholders create goals and objectives by directly communicating their values and priorities to the sponsor and project manager. Definition of specific goals will further identify issues for the technical team so they can begin forming hypotheses about the processes and structures in the watershed that are out of line with stakeholder desires (EPA 1996a).

Before the stakeholders adopt a stated desire as a goal, they must determine if that goal is achievable given current human and natural constraints (Lackey 1998). Specific goals must be consistent with the current level of knowledge about the human and natural processes and structures in the watershed in order to determine if addressing those goals is feasible given existing constraints. Scarcity of information about the watershed may limit stakeholder ability to form specific goals and objectives (WPN 1999). For example, stakeholder desires for specific flood management goals and objectives cannot be addressed until sufficient knowledge of hydrology is attained. These stated desires and their associated data gaps will determine what watershed components need to be characterized and what level of analysis is necessary to address them (WFPB 1997; WPN 1999).

The Watershed Characterization and Condition Evaluation phases (Sections 3.4.2 and 3.4.3) characterize the elements and processes in the watershed and then synthesize that information to determine both what aspects are out of line with stakeholder goals and to help educate stakeholders about the condition of the watershed to help them form goals (RIEC 1995; WDOE 1999; WFPB 1997; WPN 1999). In addition, the Watershed Characterization and Watershed Condition Evaluation phases characterize the system's capacity to achieve each goal, and the trade-offs associated with each goal in terms of ecological functions or economic gains (WDOE 1999). As information is gathered during the Watershed Characterization and Condition Evaluation phases and released to stakeholders, additional goal and objective formation, review, and revision, should take place (Lackey 1998; Montgomery et al. 1995).

3.4.2 Watershed Characterization

The Watershed Characterization marks the beginning of the second phase of the watershed management framework. In this phase, historical and current data are compiled and new data are collected to address the goals and objectives set forth in the Start-Up phase.

3.4.2.1 Identification of Data Gaps and Statement of Assumptions

Data used in watershed management can be qualitative and quantitative, objective and subjective, and anecdotally and scientifically collected. Each of these types of data can be useful for various purposes in the overall process depending on the level of detail and rigor necessary to address the goals of the assessment. Sponsor and stakeholders must agree on what types of data are to be used for each step. Based on this agreement, data quality objectives should be established and these should be used to evaluate data throughout the watershed management process (Brooks et al. 1997).

Data gaps that have been identified should be evaluated and prioritized so that they can help guide data gathering in the watershed, including scientific research and monitoring (RIEC 1995; Rutherford 2002; WPN 1999). The research team should identify data gaps and assumptions before, during, and after the Watershed Characterization and Condition Evaluation phases (RIEC 1999). At each phase, stakeholders need to decide whether the data adequately address the goals of the watershed management process and whether they should continue through the process to development of recommendations or loop back to characterization or evaluation for further research and analysis (RIEC 1999).

Characterization of a new watershed component may be desirable. This will depend on available resources and time balanced with acceptable levels of uncertainty[2]. The implications of missing or poor quality data as well as the assumptions used in the absence of the data should be determined and documented to guide decision-making (RIEC 1999). This will establish credibility for the process in the eyes of the scientific community and will help to build trust with the public (RIEC 1995; WFPB 1997; WNP 1999). Knowing all the implications of missing data is not possible. When it is time to rank or evaluate proposed actions in the watershed, stakeholders need to weigh the tradeoffs between uncertainty of benefits and costs (time, money, potential negative impacts) in order to reach agreement on the level of uncertainty that is acceptable, a necessary step for moving forward with decisions (RIEC 1995).

3.4.2.2 Historical Characterization of the Watershed

Collection of historical information will determine the condition of the watershed in the past, revealing past human management actions and significant human and natural disturbances in the basin ((RIEC 1995; Szaro et al. 1998; WPN 1999). The search for information should focus on characteristics relevant to the issues of concern. This is crucial to avoid the trap of collecting too much data. Examples of issues to explore are settlement patterns, changes in stream channels or riparian vegetation, fire and landslide history, and past resource use (WPN 1999). This information paints a picture of the natural events that have altered the physical appearance of the landscape and the human actions that have interrupted the functioning of natural processes (Szaro et al. 1998; WPN 1999). This will help during the characterization and evaluation phases in creating hypotheses about cause and effect. Human activities have subtle, incremental, and

[2] Uncertainty is a combination of data gaps and assumptions.

pervasive effects and the impacts of future disturbances are contingent on the legacy of past disturbances (Frissell and Bayles 1996). However, studying the historical responses of a particular species or element to certain changes within a particular watershed in the past may not reliably reflect future responses, because the large-scale ecosystem context is also changing (Frissell and Bayles 1996).

3.4.2.3 Identification and Characterization of Current Dominant Physical, Biological, and Human Processes and Features of the Watershed

The purpose of gathering existing and new information to characterize current human, ecological, and physical conditions, processes, and interactions within the watershed is to improve understanding of the systems at work in the watershed, begin forming hypotheses about cause and effect for problems in the basin, and predict outcomes of future land use actions (RIEC 1995).

The watershed components characterized and the depth of characterization should be determined from issues, goals, and desired states identified, as well as the scale of the assessment and available resources. Examples of components are the local human society, hydrology, riparian areas and wetlands, water quality, and fish habitat and abundance (Slocombe 1998; WPN 1999). Using a question and answer approach can help to identify which watershed components should be characterized and what aspects of those components should be described. For example, what effects are current land uses having on peak and low flows (WPN 1999)? Augmenting the characterizations with new information as it becomes available either through field work or research of existing data will help to fill in data gaps over time. As goals are more clearly defined, addition of a new watershed component to be characterized may be necessary (WPN 1999).

In order to come up with a synthesis of information that is meaningful and useful to managers and decision makers, human society needs to be characterized (Ludwig et al. 1993; Machlis et al. 1997). The characterization of humans and their institutions in the watershed could include looking at things like resources people depend on, types of jobs and interests they have, their level of education, their faith, and their earnings (Force and Machlis 1997; Ludwig et al. 1993; Pinkerton 2002; Rutherford 2002). This information can be obtained by using census data, occupational data, and population trends, or by conducting a survey (e.g., of values) of the community within the watershed (Force and Machlis 1997; Machlis et al. 1997). A characterization of the human society will help determine what means of implementation will be effective (prioritize implementation measures and timing of those actions), the relationships between manager's actions and human variables (income, land ownership etc), and sectors or components of that society at risk (health) (Force and Machlis 1997; Ludwig et al. 1993). As with biological or physical data, the social data you need is not always available, it can be inconsistently measured, and only long term data can explain why certain conditions are changing or what structural factors affect the amount of change (Force and Machlis 1997).

Watershed component characterizations should be ecosystem-based and should include humans as part of the analysis (Slocombe 1998). Watershed characterization is not a series of ecological studies, but instead is an analysis of watershed components from an ecosystem perspective (Montgomery et al. 1995). An ecosystem approach looks at elements, processes, and interactions at different scales and attempts to determine potential feedback loops from past and on-going continuous or acute actions in the watershed (Lackey 1998; Slocombe 1998). Analyses should be oriented around people, resources, and ecosystem components and not on specific projects (Montgomery et al. 1995). Determination of what feedback loops to investigate within each component will depend on the goals, which signify the resource, land use, and quality of life concerns (Szaro et al. 1998).

3.4.3 Watershed Condition Evaluation

3.4.3.1 Synthesis and Interpretation of Information from Watershed Characterization

The purpose of this step is to use maps, GIS, and/or simulation modeling to combine data from the characterization of watershed components to determine the current and future projected trends (process and structure changes) that differ from stakeholder goals, as well as trends that are moving toward stakeholder goals (Slocombe 1998). This integration will explain the spatial and temporal interactions of the biological, physical, and social elements and processes in the watershed (RIEC 1995). Examples of linkages between components are the effect of current and future predicted land uses (human physical geography) on peak and low flows (hydrology) and the effect of current and future predicted peak and low flows (hydrology) on fish habitat (fish ecology) (WPN 1999). Once the linkages and elements are better understood, the outcome of a particular human intervention, intentional or not, will also be better understood. This will help guide management of the watershed in terms of how to change some of those links or elements and how to not change others. When resources are limiting and the skills of the team do not permit modeling or complex GIS investigation, simple overlapping of Mylar maps can reveal a great deal about interactions between components over space and time (WPN 1999). At this stage identifying and documenting constraints, impacts, risks, and uncertainties in the analysis and the watershed are essential for informed decision-making during recommendation and action plan creation (RIEC 1995; WFPB 1997).

3.4.4 Watershed Management Plan

This phase involves the creation and selection of actions or projects to address stakeholder goals, the definition of steps required and responsible parties for implementation of those actions, and the creation of a monitoring plan. This phase lasts the longest as it directs the process through implementation and monitoring of recommended actions while being subject to revision as new information becomes available.

3.4.4.1 Development of Specific Management Options, Recommendations, and Scenarios. Establishment of Decision-Making Process and Evaluative Criteria. Prioritization and Selection of Best Option.

Once the evaluation has been completed to the satisfaction of stakeholders, the sponsor and stakeholders should develop a set of management options, using techniques such as visioning and scenario development (Slocombe 1998). Management options should be realistic in terms of physical, biological and human constraints, and the technical team can help stakeholders by explaining these constraints. The specific management options should explore a broad range of watershed management tools, including physical, technical/structural, economic, legal, political, and social means (Pinkerton 1991; Szaro et al. 1998). Examples of physical or technical means are dams, dikes, best management practices (BMPs) and bioengineering. Economic means can come in the form of pricing or tax changes. Political and legal means may include changes in regulation, property rights, policy and permitting procedures. Watch-dogging, landowner education, and involvement in volunteer projects are social means. Management options should address root causes of problems in the watershed when possible or if not, control unwanted symptoms of current and projected processes in the watershed (WDOE 1999).

After creation of management options, stakeholders should develop evaluative criteria and determine their decision-making process for choosing between options. Criteria should help determine the degree to which each management option moves the watershed toward desired conditions (Lackey 1998). Examples of broad criteria are relative ecological impacts, economic efficiency (e.g. cost-benefit analysis), financial efficiency (difference between market-priced returns and costs) (Brooks et al. 1997), feasibility, and social impacts such as equity. Using these criteria, stakeholders should prioritize the options or scenarios to guide future implementation and then recommend the best set of options (WPN 1999). Proposed projects should be evaluated in groups or scenarios so that their cumulative effects can be considered (Pinkerton 1991; Slocombe 1998).
The facilitator should help in building consensus and understanding between members with diverse and polarized values and priorities (Lackey 1998; Pinkerton 1991).

3.4.4.2 Creation of an Action Plan

The sponsor should create an action plan that documents the recommended actions or scenarios and all the necessary steps to move forward with each action (EPA 1996a; WDOE 1999; WFPB 1997; WPN 1999; Pinkerton 1991; Slocombe 1998; Szaro et al. 1998). For restoration or construction projects, required steps such as acquisition of mitigation credits, permits, or landowner approval should be discussed and documented. For policy or legal changes, steps for government agencies or legislating bodies and the public should be outlined (USACE 2000b; WDOE 1999).

3.4.4.3. Creation of an Implementation Plan

The Implementation Plan takes the Action Plan a step further by assigning responsibility for each action and each step to facilitate an action. This will involve identifying sources of the required human, material, and financial resources. It should set up timelines, prioritize actions in case of funding shortfalls, and integrate and coordinate the planning, permitting, and mitigation requirements between local, regional, and state governments (EPA 1996a; WDOE 1999). In watersheds with strained relations between jurisdictions, development, endorsement, and adoption of inter-local agreements may be necessary (Clark 2001). The sponsor's authority to implement the plan will be tested at this phase. Support garnered for the process from agency heads and senior levels of government will pay off during this step (Pinkerton 1991). Local stakeholders can assist at this stage by helping to gain the support of local landowners and businesses who have not yet backed the process. Implementation of projects or actions that will provide immediate and tangible benefits, such as on-the-ground drainage or habitat projects or improvements to processes like permit simplification, will help to gain support for the process (Slocombe 1998).

3.4.4.4 Creation of a Monitoring Plan

The stakeholders should create a monitoring plan that outlines baseline and on-going activities that will document changes in watershed parameters relative to established goals (EPA 1996a; WDOE 1999; WFPB 1997; WPN 1999; Pinkerton 1991; Slocombe 1998; Szaro et al. 1998). The monitoring plan should incorporate the evaluative criteria discussed in Section 3.4.4.1 (WFPB 1997). The evaluative criteria measure the potential for each action or project to achieve each goal and hence in the monitoring plan these criteria should determine which parameters will be measured (WFPB 1997). The goals combined with the evaluative criteria should help determine the desired state or levels of those parameters. The change (or lack of change) in these parameters over time will determine the degree of project success (WDOE 1999; WFPB 1997). If budgets allow, monitoring of variables other than those directly related to stakeholder goals will help to detect unanticipated impacts of management actions.

Baseline monitoring is necessary to determine conditions before implementation of recommended actions, which will help determine outcomes of those actions (Slocombe 1998). The information collected during the Watershed Charcterization will serve as a starting point to determine how much additional baseline monitoring is necessary. On-going monitoring is necessary to measure or observe changes in the environment that occur after project or action implementation.

As new information is collected and interpreted, it can be used to modify the Watershed Management Plan (WDOE 1999; WFPB 1997). Monitoring data should determine if goals are being met, and provide hypotheses as to why/how (WFPB 1997). This information should be used to revisit recommended actions. Thus, the monitoring plan should have a structure setup within it for periodic review and revision and subsequent adaptation to change (Slocombe 1998). However, change to the monitoring plan should be done with caution because changes in chosen protocols affect data consistency, quality, and usefulness. Therefore, revision of chosen protocols should take place early, if possible, to ensure consistency of data through time. Addition of new parameters or protocols will not affect data consistency and thus can take place at any time.

The sponsor should have a strategy to fund monitoring for a period commensurate with the management plan (EPA 1996a). In the United States, a major challenge for monitoring is on-going funding. For example, grant cycles of grants from the USFWS and National Oceanic and Atmospheric Administration (NOAA) as well as private grants from the National Fish and Wildlife Foundation (NFWF) last one to two years, while monitoring should continue for at least 10 years post-implementation (NFWF 2003; USFWS 2001a). In most cases, a government body that has relatively secure and predictable funding sources could more reliably coordinate monitoring. Independence from special interests, who have perverse incentives to skew data for their own purposes, is important and can sometimes be accomplished through government monitoring. Use of volunteers and students for data collection and entry reduces cost, and educates and involves local people. However, the reliability and consistency of volunteer data is often questioned. Government approved protocols and certification and training programs may increase the perceived and real quality of volunteer data (Ely 1992; EPA 1996c).

3.4.4.5. Creation of a Planning and Management Framework

The plans for action, monitoring, and implementation are integral parts of the management framework.

The watershed management framework should outline anticipatory and flexible processes, practices, and programs which can be sustained and respond to changing conditions, new information, and evolving public priorities over time (Slocombe 1998; WDOE 1999). Ideally the sponsor or other implementing entities should have an institutional structure designed for adapting to change (Rutherford 2002). The framework needs a system of internal and external performance review to occur at regular intervals to foster adaptation of both the process and recommended actions (Slocombe 1998; Szaro et al. 1998). The framework should have a process for resolving future disagreements over competing uses in the watershed (WDOE 1999). One option is for the stakeholder group to continue to meet to resolve future disagreements and to report on implementation.

If possible the management framework should be kept simple using existing organizations, shallow hierarchies, and clear chains of responsibility and decision-making (Slocombe 1998). A focus on management processes such as information flow planning and target setting will make it easier to simplify the structure (Slocombe 1998). As stated in Section 3.4.1.2, the nesting of watershed management plans of different scales within one another could help to expand the analysis for a particular watershed to include significant factors at larger and smaller scales (Loeb et al. 1998; Reid 1994; Slocombe 1998; WDOE 1999). The sponsor should continue to solicit or encourage support from senior levels of government throughout the process (Pinkerton 1991).

Watershed management is limited by the ability of people and their institutions to create planning and management frameworks that effectively integrate physical and biological science with social, political, and economic environments (human ecology) (Force and Machlis 1997). A technical team made up of both natural and social scientists is a good start at integrating the two arms of science. However, a formal process for integrating natural and social science for the Watershed Condition Evaluation and Planning and Management Framework phases will encourage integration further and set up a system of accountability if it does not happen.

3.5 Conclusion

The evaluative framework's key elements were built from the common steps of four successful watershed management frameworks at the state and federal levels. The four frameworks vary in terms of their specialization or general applicability. The most specialized is the Washington Watershed Analysis process, where a single resource, timber, is analyzed in terms of the effect of forest management practices on aquatic resources and water quality. The most generalized approach would be the federal watershed analysis process, where the manual is kept general due to the broad scope of issues and uses on federal land. All of the four frameworks define management regions hydrologically in order to determine the cumulative impacts of land use, water use, and resource extraction on aquatic resources, water quality, and all other existing or potential downstream uses of land and water. This evaluative framework should be useful for any scale of watershed management in the United States.

Our efforts to manage watersheds based on the cumulative impacts of multiple activities, are limited by our ability to integrate and synthesize scientific information using a multi-disciplinary approach. Scientific models which relate physical changes to biological responses often rely on many assumptions and limited data. Agreement on scientific facts can reduce uncertainty and false impressions but human ideals, values, and political perspectives are still of paramount importance in resource management. Scientific analyses can reveal great uncertainties due to data gaps and ecological complexities, which can then stimulate conflicts based on political or economic self-interest (Frissell and Bayles 1996). For this reason managers often feel more comfortable when they can portray the ecological assumptions underlying their programs as proven facts instead of scientific hypothesis or theories (Frissell and Bayles 1996).

The key elements of this evaluative framework address these limitations and help to create a flexible and anticipatory planning and management framework based in science and integrated into the ever changing biological, physical, social, political and legal landscape. All stakeholders are involved in the creation of an honest, open, and fair method of managing uncertainty and assumptions. The focus on fostering understanding between stakeholders while increasing stakeholder understanding of the watershed is the key to this framework.

4 Overview of the Mullen Slough Basin CIP Process

Chapter 4 describes the watershed studies and planning that led to the creation of the Mullen Slough Capital Improvement Project Study and Action Plan (Draft) document (King County 2001). The process is broken down into the four phases of the model evaluative framework that I constructed, Start-Up, Watershed Characterization, Watershed Condition Evaluation, and Watershed Management Plan.

The Mullen Slough Capital Improvement Project Study and Action Plan (Draft CIP) is a draft report that analyzes watershed component conditions at a site level and recommends actions to improve the physical condition and functional values associated with the basin's waterways (King County 2001). King County, the sponsor and author of the Draft CIP, carried out a synthesis of existing documentation and conducted additional studies and simulations for the Mullen Slough sub-basin. The report recommends actions to assist in achieving King County goals for flood control, agriculture, salmonid recovery, sensitive areas protection and surface water management. Recommendations consider monetary limitations, land use, and existing regulations and embody two decades of technical planning, scientific analysis, and public participation (King County 2001). The Draft CIP is an attempt to bring the portions of the Mill Creek SAMP (Section 2.5), associated with Mullen Slough, to culmination at a site level (Knauer 2002). The Draft CIP has been published internal to King County in draft form (King County 2001).

4.1 Start-Up

4.1.1 Identification and Designation of Those Stakeholders Who Will Conduct the Research and Manage the Process

In 1999, King County personnel from the Water and Land Resources Division (WLRD) initiated the CIP process (King County 2001). WLRD contracted with the Capital Improvement Project Division of King County to conduct the research and write the document. The CIP Project Team consisted of eleven King County Wastewater Treatment Division, Surface Water Engineering and Environmental Services (SWEES) personnel, two consulting firms, and seven contributing Water and Land Resources Division personnel. SWEES[3] designed and managed the CIP studies. Two consulting firms conducted specialist engineering and environmental services. Other King County staff who helped were the Rivers Section staff, the Farmland Preservation Program (FPP) coordinator, Agricultural Drainage Assistance Program (ADAP) staff and the Drainage Services Section (DSS) engineers (King County 2001).

4.1.2 Definition of Management Region and Boundaries

The boundaries of the watershed analysis were determined from the parent project, the Mill Creek basin SAMP. The Mullen Slough sub-basin was chosen as the management region because of its severe chronic flooding problems, its possession of the best intact wildlife habitat in the Mill Creek Basin, and because it had not received the same level of analysis in the SAMP as the rest of the Mill Creek basin (Clark 2001). A tributary of Mill Creek that contributes runoff during high flows was included as part of the Mullen Slough sub-basin. Local stakeholder input concerning scale and scope of analysis took the form of complaints and one-on-one conversations with landowners. The level of study and analysis conducted for the CIP[4] was site-scale (evaluating an entire tributary), as opposed to project scale (300m (~1000 ft) of a given stream) (Bethel 2002; Knauer 2001). For this reason some studies that will be necessary at a project scale did not occur, such as investigations into large wood placement.

4.1.3 Coordination of Involvement and Participation of Stakeholders Who Will Conduct Tasks Other Than Scientific Research or Management

A stakeholder is an entity that will potentially be affected by the outcome of the watershed management plan. This includes public agencies, Native American tribes, private companies, environmental and social groups, landowners, and private citizens. The CIP process had limited input and participation from outside stakeholders including

[3] SWEES is used in this report to refer to the CIP Project Team
[4] "the CIP" refers to the process and the document

the general public (King County 2001). Pubic involvement took the form of citizen complaint review, casual questioning of landowners while conducting field research, and review of document drafts by the Green River Flood Control Zone District Technical Committee (Althauser 2002). Communication with and education of the community occurred on a one to one basis with land owners during field work (Bethel 2002; Clark 2002). King County field projects such as assistance for drainage watercourse dredging and water quality studies on farms in the Mullen Slough sub-basin served as a platform for public input, as King County personnel talked to landowners and heard their concerns and comments. Additional public input will occur in the future through the State Environmental Policy Act (SEPA) public review process for CIP projects requiring permits; however, no CIP projects have been submitted for SEPA review yet (King County 2001). King County's reasons for not creating a more formal stakeholder involvement process were a limited budget and timeline and the fact that the SAMP public involvement process had already helped to determine local issues, goals, and priorities (Bethel 2002). The SAMP public involvement process was discussed in Section 2.5.2.

Local municipalities had limited involvement in the CIP process. King County had invited the City of Auburn to participate in the process; however, they had other funding priorities and chose not to participate (Clark 2002). The City of Kent has completed a fish study for the Mullen Slough sub-basin (Bethel 2002; Clark 2002). Some of the recommendations made in the Draft CIP involve storm water control projects within Federal Way's potential annexation area. A potential annexation area is the area targeted for annexation (incorporation) by a municipality contingent upon approval through the Growth Management Act (RCW 36.70A) process (see Appendix 1.2.2). The City of Federal Way was not invited to participate in the CIP. The reasons for this are unclear. The City of Federal Way declined an invitation to be involved in the SAMP process (Smith 2002). Federal Way incorporated after the initiation of the SAMP, so perhaps their resources were limiting during the SAMP (Burhans 2002). The City of Federal Way has jurisdiction over one sixth of the area of the Mullen Slough sub-basin. It has targeted another third of the sub-basin as part of its potential annexation area (Burhans 2002).

4.1.4 Definition of Broad Goals and Identification of Major Issues

In early 2001 when the CIP process was starting up, King County WLRD and SWEES did not clearly define the extent of the CIP process. SWEES staff thought of the Mullen Slough CIP as a document that would present study findings and propose actions (Bethel 2002). Other King County staff thought that the document would present study findings, propose, recommend, and prioritize actions, outline responsibilities for implementation, and pave the way for the signing of an inter-local agreement between local municipalities (Clark 2002). This misunderstanding continued throughout the process until revision of the draft document in December of 2002 (Knauer 2002).

Issues in the basin were defined by SWEES and WLRD. The issues and seven goals were derived from 47 citizen complaints, field reconnaissance studies, field surveys, consultations with impacted property owners, past studies and past public input in the Mill Creek Basin (King County 2000a, 1999a, 1993; Shapiro and Associates Inc. 1990; USACE 2000a, 2000b). There was no attempt to define broad goals and issues first, as SWEES used more of a brainstorming approach, defining issues, goals, and objectives all at once (Althauser 2002). Not having the public involved made it possible to move quickly between contentious issues and specific objectives in one session.

Existing laws were used to define all of the seven major goals (King County 2001). Some of these laws and regulations are in direct opposition to each other, such as the Sensitive Areas Ordinance and the covenants of the Farmland Preservation Program (Appendix 1.2.3.1, 1.2.2.2, and 1.3.3). Six major issues and seven major goals were defined and are shown in Table 4.1.

SWEES's main goal was "to develop concepts to improve drainage of the Mullen Slough valley floor so as to allow productive use of the valley floor agricultural lands" (King County 2001: 45). King County personnel were aware of local flooding complaints from their involvement in the SAMP process, their review of permits for dredging drainage watercourses, and their interactions with landowners during field work (Clark 2001). During the SAMP process the most common complaints heard at public meetings from those living or working in the valley floor were of drainage problems (Scuderi 2002).

SWEES scoped the scale of the investigation early and did not consider changing scale. They began defining what watershed components they would focus on, taking into consideration their limited budget and the issues over which they had the power to affect change. They assumed that existing policies, regulations, and covenants would stay the same.

4.1.5 Creation of More Specific Goals

The Draft CIP has seven goals and eleven objectives which are shown in Table 4.1. Some of the seven goals are broad, while others are more specific. For example, the goal "improve water quality" is very broad while "reclaim and maintain tillable land in the valley floor" is more specific. The more specific goals are those derived directly from citizen complaints (Bethel 2002; King County 2001). The objectives were formed by drawing from the Mill Creek Flood Management Plan (King County 1999a), input from King County Rivers Section and Agricultural Program personnel, and other supporting studies (King County 2000a, 1993; Shapiro and Associates Inc. 1990; USACE 2000a, 2000b) followed by discussion between team members with input from Rivers Section and Agricultural Program personnel (Althauser 2002; Bethel 2002).

The CIP technical team determined that use of a multiple objective approach would be necessary to ensure that actions aimed at one goal did not interfere with another (Bethel 2002). For example, will addressing flooding concerns by increasing the hydraulic capacity of a channel have negative effects on aquatic habitat?

With the issues, goals, and objectives defined, SWEES began assessing existing information, identifying data gaps and determining what watershed components needed to be characterized to better understand the existing conditions of the watershed. They decided to characterize nine watershed components (see Section 4.2). Scarcity of information about the watershed limited their ability to judge the feasibility of their objectives. For example, the lack of information about the cause of the low oxygen problem in Mullen Slough, made it impossible to know whether restoration of that habitat for year-round use by salmonids would ever be possible (Knauer 2002). The team would have to wait for the Watershed Characterization and Condition Evaluation to understand the system's capacity to achieve each goal as well as the trade-offs associated with each goal.

Table 4.1 Issues, Goals and Objectives in the Mullen Slough Sub-basin
(King County 2001)

ISSUES	GOALS*	OBJECTIVES**
Conveyance and storage problems in managing storm water from upland and hillside buildings and roads	o **Reduce the hazard and improve the predictability of flooding in the valley** o **Accommodate projected growth and current land use**	o **Reduce storm water runoff from the upland developments to alleviate flooding and soil saturation problems** o **Increase upland storage capacity, through improvements to existing facilities**
Hillside erosion (ravines)	o **Protect and enhance aquatic and wildlife habitats**	o Reduce storm water runoff from the upland developments to alleviate flooding and soil saturation problems o **Stabilize the major sources of sediment to reduce sediment inputs to the system**
Sediment deposition	o **Improve water quality**	o Stabilize the major sources of sediment to reduce sediment inputs to the system
Conveyance capacity	o **Address concerns of property owners (mostly flooding issues)**	o **Improve drainage for the valley's agricultural lands** o **Increase channel capacity and habitat diversity by removing sediments and placing large woody debris.** o **Create a set of best management practices for agricultural waterways**
Flooding of roads and private property	o **Reclaim and maintain tillable land in the valley floor** o Address concerns of property owners (mostly flooding issues)	o Reduce storm water runoff from the upland developments to alleviate flooding and soil saturation problems o Increase channel capacity and habitat diversity by removing sediments and placing large woody debris.
Impacts to natural resources (public goods) and fisheries	o **Protect valuable and functional wetlands** o Protect and enhance aquatic and wildlife habitats o Improve water quality	o **Maintain emergent wetland functions for wildlife benefits (manage and mitigate wetland impacts)** o **Create stream and wetland buffers to improve and protect water quality and to provide other riparian zone functions (e.g. LWD recruitment, wildlife and macroinvertebrate habitat, soil binding).** o **Create a net increase in salmonid rearing and refuge habitat in the Lower Green River** o **Enhance aquatic habitat conditions throughout the system** o Increase channel capacity and habitat diversity by removing sediments and placing large woody debris. o **Participate in a water quality research project to determine the cause of extreme and chronic low dissolved oxygen levels in valley floor waterways**

*The seven goals are shown in bold. When repeated they are shown in normal font.
** The eleven objectives are shown in bold. When repeated they are shown in normal font.

4.2 Watershed Characterization

4.2.1 Identification of Data Gaps and Statement of Assumptions

The data used in the CIP were a combination of qualitative and quantitative, objective and subjective, and anecdotally and scientifically collected. SWEES did not formally decide which types of data were acceptable for each watershed component (Bethel 2002). There was no formal process of identifying data gaps and stating assumptions and there was no discussion of acceptable levels of uncertainty (Bethel 2002).

Some of the CIP recommendations suggest returning to the Watershed Characterization phase. A study of the low oxygen problem in Mullen Slough is necessary before moving forward with plans for fish habitat restoration. In addition, a thalweg profile and cross-section survey of Mullen Slough in the valley floor is needed, both to more accurately model flows in the system and to establish base-line data for restoration project design and on-going monitoring (King County 2001).

Within each watershed component some assumptions and missing data were stated. The implications of assumptions, missing data, or depth of analysis were not discussed. Watershed components were not analyzed exhaustively and the implications of this were not fully discussed. The need to conduct hydrologic and hydraulic modeling was identified early in the CIP process, before the field work began (Bethel 2002). Assumptions and data gaps were stated for these models; however, it was not stated whether the data gaps would be filled (NHC 2002). The implications of these missing data were not discussed (King County 2001).

The major assumption for the CIP stated that existing land use and agricultural covenants will remain in effect and existing laws and policies will be applied (King County 2001).

4.2.2 Historical Characterization of the Watershed

King County used USGS maps from 1900, aerial photographs from 1936, and hydrologic modeling to determine land use / land cover and historical flow patterns in the sub-basin. Extrapolating from 1936 aerial photographs, a land use analysis estimated land use/ land cover prior to significant settlement, from about 1900. From the maps and photographs it was concluded that prior to construction of dikes on the Green River, 1900-1936, the valley floor was probably a large wetland complex recharged by floods and sharing a drainage system with Mill Creek. Aerial photographs from 1936 show a stream and drainage watercourse system exactly as it looks today. This information was not mentioned again in the Draft CIP, and it was not stated what the information would or could be used for (King County 2001).

4.2.3 Identification and Characterization of Dominant Physical, Biological, and Human Processes and Features of the Watershed

King County SWEES staff studied nine watershed components including: Land Use; Flooding; Geology and Geomorphology; Hydrology and Hydraulics; Fish Species, Abundance and Habitat; Surface Runoff Infiltration; Wetlands, Waterfowl and Wildlife; Water Quality; and Buffers. There were teams for each component, but with the limited staff resources each staff member sat on several teams. Land use was the only human component characterized.

King County characterized each component, stated major findings, and in some cases came up with hypotheses about cause and effect for problems in the basin. Most of the characterizations were qualitative, involving direct field observation (walking the streams) or map and aerial photograph interpretation (King County 2001).

4.2.3.1 Land Use

Land use determinations circa 1900, prior to significant settlement, were made based on the assumption that the hillsides were fully forested and the valley floor pasture (King County 2001).

King County used 1999 aerial photographs to determine current land use in the sub-basin. Land use categories included transportation, commercial, multi-family residential, high-density residential, medium density residential, low density residential, pasture, grass (parks, ball fields etc), and forest (King County 2001).

Future land use was determined based on assumed in-fill of existing development to zoned densities and redevelopment of certain land uses to higher zoned densities. Assumptions for forecasting were stated. Zoning was determined from comprehensive land use plans from King County and the cities of Auburn, Kent, and Federal Way (King County 2001).

This information was summarized using GIS, tables, and pie charts. The information was used for hydrologic modeling of future flows in the sub-basin, as well as for qualitative evaluations of current and future impacts of land use on hydrology and fish and wildlife habitat (King County 2001).

4.2.3.2 Flooding

A major objective of the CIP process has been to determine the extent and duration of flooding in the Mullen Slough sub-basin valley from locally generated storm water runoff. Without drainage improvements the land cannot drain adequately for crop production and the flooding can last months after Green River flows return to normal. Control of backwater flooding was investigated at length in the Mill Creek Flood Management Plan (King County 1999a) and was not pursued further in the CIP (King County 2001).

As stated in Section 4.1.4, the main goal of the CIP process is “to develop concepts to improve drainage of the Mullen Slough valley floor so as to allow productive use of the valley floor agricultural lands” (King County 2001: 45). At first, SWEES used local information, existing aerial photographs, and past hydrologic modeling to estimate the extent of the flooding in the Mullen Slough sub-basin (King County 2001). Local information was useful but not comprehensive. Past aerial photographs had not documented the entire extent of chronic flooding. The models characterized extreme, 100 year, floods well; however, the models had not been adequately verified for chronic shallow flooding. The models characterized chronic flooding poorly because of a lack of hydrologic data for model calibration, lack of current channel geometry data, and seasonally varying channel capacities due to dense growths of reed canary grass in-channel. Because of these factors, King County contracted with a consultant to conduct a study of the chronic flooding using a more qualitative approach (NHC 2002). The Mullen Slough study consisted of field survey work including streamflow measurements and water surface profiles and an aerial reconnaissance. The purpose of this field work was to discern the water surface profiles and shallow flooding in the basin representative of chronic flood conditions. Observed water level and streamflow data were compared with available longer records of recorded and simulated data (NHC 2002).

The results of these studies added to the general level of understanding of chronic flooding in the sub-basin by delineating the extent of flooding. This guided and bounded future studies in the valley floor addressing flooding. This information did not directly improve SWEES's ability to create recommendations to address this flooding as further studies are needed before the utility of specific project actions can be established. For example, a stream profile, an oxygen study, and sedimentation rate studies will be necessary before the certainty of success of any maintenance (dredging) or restoration activities on Mullen Slough can be established (Bethel 2002; Knauer 2002). The studies cannot determine whether dredging Mullen Slough will alleviate chronic flooding problems (Smith 2002).

4.2.3.3 Geology and Geomorphology

County geologists used geologic maps, aerial and regular photographs, observational field surveys, and a few geotechnical samples to characterize the geology of the sub-basin (King County 2001). All the tributaries were walked to observe major geomorphological forces and factors and qualitatively evaluate areas susceptible to erosion, sediment transport, and sediment deposition. The characterization identified and located soil and rock types in the basin, especially around streams and drainage watercourses. The locations of deep channel incision, bank erosion, and major sedimentation were noted, all being factors that could contribute to valley-floor flooding (King County 2001).

Information concerning the geology of the sub-basin was useful in identifying areas susceptible to future erosion and deposition. Information on locations of existing problem areas was synthesized with the other characterizations to create recommendations for actions or projects (King County 2001).

4.2.3.4 Hydrology and Hydraulics

King County ecologists and technicians qualitatively assessed the condition of all the tributaries making note of important aquatic resource and drainage problems (King County 2001). They looked at changes in flow, indicated by increased development and increased erosion, and at changes in stream character such as channelization or incision (down-cutting). They also looked at storm water detention capacity, conveyance capacity, floodplain and wetland storage, and channel obstructions such as culverts and natural or anthropogenic debris. Land use was noted in the headwaters and along the channel length (King County 2001).

Information concerning the hydrology and hydraulics of the sub-basin was useful in identifying areas susceptible to future erosion and deposition. Information on locations of existing problem areas was synthesized with the other characterizations to create recommendations for actions or projects (King County 2001).

4.2.3.5 Fish Species, Abundance, and Habitat

The City of Kent completed fish abundance and habitat studies in 1998 and 2000 in Mullen Slough (Clark 2002; MacTutis 2002). Because Kent offered to conduct these studies, no fisheries ecologist was assigned to work with SWEES (there was a wetland plant ecologist who advised the group) (Althauser 2002; Bethel 2002). Due to this lack of fish and wildlife expertise, a limited time frame, and a breakdown in support from WLRD (see Section 5.1.1.2), SWEES did very little in terms of characterizing fish abundance and habitat.

Using aerial photographs and field observations King County technicians conducted a qualitative evaluation of the aquatic habitat and potential drainage problems on the tributaries and main stem of Mullen Slough (King County 2001). Observations were made on type of headwaters, land use throughout, incision, erosion, sedimentation, conveyance capacity, culvert status, and riparian vegetation. From this evaluation King County personnel were able to create hypotheses about causes of erosion, sources of sediment, locations of deposition, explanations for low conveyance, and causes of high temperatures and low oxygen concentrations. From these hypotheses SWEES staff began developing proposals for actions, such as bioengineered bank stabilization projects and large woody debris placement, to remedy these problems to address stakeholder goals (King County 2001).

SWEES staff observed spawning habitat in fair condition in the upper tributaries and rearing habitat in poor condition in the valley floor (King County 2001). They concluded that rearing habitat is limited by lack of cover, low oxygen, high temperatures, low water levels, and potentially low food (macroinvertebrates) concentrations (King County 2001).

Historically, chinook salmon were observed using the mouth of Mullen Slough as refuge from high flows in the Green River and coho juveniles were observed in the middle sections of Mullen Slough (Malcolm 2002). These surveys indicate the potential for this system to serve as rearing habitat.

King County technicians conducted fish use surveys in 1999 and 2000 between June and February (King County 2001). They observed one species of salmon and five other fish species; amphibians were also observed. Hypotheses regarding limiting factors on salmonid distribution in Mullen Slough were formulated (King County 2001). The City of Kent studies found two species of trout and three other fish species (MacTutis 2002).

4.2.3.6 Storm Water Management and Surface Runoff Infiltration

Geologists and engineers qualitatively investigated surface water runoff in the field by walking the streams and documenting areas of high storm water input (King County 2001). They hypothesized that upland developments were increasing surface runoff and as a result causing erosion, sedimentation, and flooding problems. They also hypothesized that development was decreasing groundwater infiltration, reducing groundwater storage and creating low flow problems in streams and wetlands in the summer. By way of desktop investigation they calculated current storm water retention and explored improvement and expansion of existing storm water facilities, to increase water storage and reduce runoff. They also investigated the use of storm water control methods that recharged groundwater, through percolation or direct aquifer recharge. They researched some of the types of aquifer recharge and the federal and state regulations governing their applicability (King County 2001).

Information on existing storm water retention was used for hydrologic modeling (King County 2001). Three recommendations were made for future groundwater recharge studies and actions. However, these were not included in the eleven recommended actions. This information combined with the hydrologic modeling was used to create some of the eleven recommended actions (King County 2001).

4.2.3.7 Wetlands, Waterfowl, and Wildlife

King County personnel consulted past studies of the Mill Creek Basin to determine wildlife use of the sub-basin (described in Section 2.2.2) (King County 2000a; Shapiro and Associates Inc. 1990; USACE 2000a). The only wildlife considered was bird life. No attention was given to mammals or amphibians, except for some sampling of frogs and salamanders while conducting a fish survey in Mullen Slough.

All wetlands in the Mill Creek basin had been evaluated for wildlife and water storage, function and value during the SAMP process (USACE 2000b). No further work was done to investigate wetland functions and values via the CIP process (King County 2001).

The wetlands identified in the SAMP and their habitat value for waterfowl and shorebirds were briefly discussed in the Draft CIP (King County 2001).

Information concerning wildlife was used to create recommendations for salmonid habitat restoration. No mammal, bird, or amphibian habitat was targeted for preservation or enhancement. Valuable and functional wetland preservation was addressed in the SAMP and was not addressed further through the Draft CIP recommendations (King County 2001).

4.2.3.8 Water Quality

Water quality conditions of the valley floor were obtained from the Mill Creek Aquatic Resources Restoration Plan (USACE 2000a). Mill Creek basin water quality problems are discussed in Section 2.4.3. In May of 2002, King County contracted with a University of Washington graduate student to conduct a study of the extreme low oxygen concentrations in Mullen Slough (Knauer 2002). The student is collecting data on dissolved oxygen concentrations, temperature, and biological oxygen demand of the sediments (Travers 2002). It is hoped that this study will help determine some possible causes of the extreme low oxygen problem. Low oxygen levels are thought to exclude fish use of the system in late summer and early fall (King County 2001; Malcolm 2002).

Information on water quality was used to form recommendations for stream restoration and water quantity control (King County 2001). Proposed projects were not touted as tests of hypotheses, but as proposed solutions.

4.2.3.9 Buffers

It was recommended both in the SAMP and Draft CIP that a riparian corridor be planted along as much as possible of Mullen Slough (King County 2001; USACE 2000b). King County staff from the Rivers Section and the Farmland Preservation Program (FPP) reviewed the Tri-County DRAFT Framework of Proposed Salmon Recovery Plan, to establish what the required buffer sizes would potentially be in King County under the new 4(d) Rule (Tri-County ESA Response Team 2000). They also consulted with King

County DDES staff, who make determinations on buffer size for mitigation associated with in-stream work such as dredging of agricultural drainage watercourses. The 4(d) rule will outline buffer sizes on different types and sizes of stream, that are adequate to protect endangered chinook salmon. If a landowner does not follow the 4(d) rule, then technically they can be sued for potentially or actually harming or killing endangered fish (Tri-County ESA Response Team 2000).

Because of existing policy conflicts between the Sensitive Areas Ordinance (SAO) and Farmland Preservation Program (FPP) and the fact that no new buffer regulations have been adopted yet under the Tri-County Framework, the Draft CIP makes no recommendations on buffer size. The Draft CIP does outline three potential buffer sizes based on scientific literature, proposed buffer sizes under the new 4(d) rule, and local, state, and federal laws (King County 2001).

4.3 Watershed Condition Evaluation

In this phase SWEES attempted to determine trends in the watershed that are moving away from stakeholder goals and began looking at what humans could do to influence those trends to move towards stakeholder goals, within the physical, biological, social and economic constraints.

4.3.1. Synthesis and Interpretation of Information From Watershed Characterization.

4.3.1.1 Synthesis of Geologic, Hydrologic, Biological, and Social Information

Data and information from the nine watershed components studied (Section 4.2) were integrated and synthesized using GIS. GIS was used to create maps of land use, zoning and jurisdictions, hydrology (streams, lakes, wetlands, and drainage watercourses), sensitive areas (erosion hazards, landslide hazards, floodplains and wetlands), drainage complaints, storm water detention standards, water quality and fish sampling stations, geology, well locations, and areas susceptible to groundwater contamination (King County 2001).

SWEES had a series of meetings to discuss the major findings from each component, to integrate the observed drainage and aquatic resource problems and to begin creating a list of possible projects to address the problems (Bethel 2002). Their specific recommendations for moving towards stakeholder goals are discussed in Section 4.4.1.1. The process of synthesis was an informal discussion among the team members followed by each member writing a section of the report. The process of synthesis and feedback was not completed due to time and financial constraints (Bethel 2002). Staff considered how problems discovered in one component could affect aspects of another. Models and matrices were not used. There was no input from the public or local municipalities (Bethel 2002).

4.3.1.2 Hydrologic Modeling

Based on models developed for the Mill Creek Flood Management Plan, a consultant conducted hydrologic modeling for the Mullen Slough sub-basin (King County 2001). The simulations illustrated 2 current and 3 future scenarios for storm water control. They modeled four return periods including the 2, 10, 25, and, 100 year floods for 3 scenarios. They modeled flows and detention requirements using land use scenarios from 1900, current, and future built out to zoning (King County 2001).

This modeling, combined with qualitative observations in the field, illustrated that current storm water management requirements were not adequate for retaining enough storm water to prevent erosion in the ravines and sedimentation in the alluvial fans (King County 2001). The model calculated how much detention would be required to contain all storm water generated from new impervious surfaces. In addition, the model illustrated that in the future, the loss of infiltration from increased impervious surfaces would reduce groundwater recharge and further reduce summer water levels in streams and wetlands. No economic factors were considered in the model. The model estimated flows and retention needs but did not estimate increases in erosion, sediment loads, or pollutants from increased urbanization (King County 2001).

This information will be one of the tools that King County and municipalities use in decision-making for future urban planning. Results were used to create proposed policy changes and projects for storm water control (King County 2001).

4.3.1.3 Hydraulic Modeling

A USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) hydraulic model for Mullen Slough and two tributaries was constructed to simulate channel hydraulics and to size a modified channel to contain the existing 2-year flood events (King County 2001). Potential channel improvements were also modeled. The model was developed from existing King County HEC-2 and Full Equations (FEQ) models of Mullen Slough, and a topographic map. There were very limited data on cross-sections and elevations of the channel. Despite the uncertainty in this model project, proposals for dredging and expansion of Mullen Slough were put forward (King County 2001). These identified data gaps have led to the initiation of topographic and stream surveys in Mullen Slough by King County (Knauer 2002).

4.4 Watershed Management Plan

4.4.1 Development of Specific Management Options, Recommendations, and Scenarios. Establishment of Decision-Making Process and Evaluative Criteria. Prioritization and Selection of Best Option.

4.4.1.1 Options, recommendations, and scenarios

Recommendations were considered for three geological areas, the upland plateau, the middle ravines, and the valley floor to address flood control, water quality improvement, aquatic resource restoration, and development in the Mill Creek basin (King County 2001). The Mill Creek tributary, which overflows into Mullen Slough valley floor tributaries, is addressed as part of the valley floor but is in its own section (King County 2001).

Recommendations fall into two categories, immediate actions, which can be implemented within five years, and long term actions that will require a longer-term implementation timeframe (King County 2001). Implementation timeframes were estimated based upon available funding and regulatory factors (King County 2001).

Twelve recommendations were made (Table 4.2). The list of recommendations was developed internally by SWESS. A team member would come up with an idea for a project to address a specific problem in relative isolation from the rest of the problems in the basin. Projects were site specific rather than in sets of integrated projects designed to act together. After proposing a specific project, team members would work together to address that project's connection to other problems in the basin. This was done through discussion, and did not include modeling or matrices (Bethel 2002).

4.4.1.2 Decision-making process and evaluative criteria

Initially, SWEES planned to establish a consensus-based decision making process; however, time and financial constraints would not permit this (Bethel 2002).

Actions and projects were recommended by SWEES based on the interconnected nature of the resource management issues (Bethel 2002). The recommendations were loosely and qualitatively evaluated by SWEES based on the potential impacts, both positive and negative, of each proposal and its ability to achieve each goal. Feasibility within existing financial, regulatory, and physical constraints, was also used to evaluate each recommendation (Bethel 2002). WLRD and SWEES put a high priority on the restoration of rearing habitat in the valley floor because it is a habitat limiting factor in the Green River watershed (WSCC 2000a). The process of creating and evaluating projects occurred simultaneously, so that project proposals were molded to fit the criteria by the time it came for final evaluation.

4.4.1.3 Prioritization and selection of best option(s)

This was a loose process that was not completed (Bethel 2002). The prioritization process occurred through informal discussion within SWEES as well as by weighing the options based on the above criteria (Bethel 2002). It was decided to include the existing list of 12 recommendations in the Draft CIP document. Projects were not formally accepted or adopted as the team felt they had not been adequately evaluated or prioritized (Althauser 2002; Bethel 2002). Recommended projects were prioritized as high, medium, or low using the above criteria. Most of the high priority projects were ones that improved conveyance (King County 2001). Projects may be significantly modified or removed as the Draft CIP is used as a reference for writing the Mill Creek Basin Plan (Bethel 2002; Knauer 2002). A small team within WLRD is writing the Mill Creek Basin Plan (Knauer 2002).

After internal publication of the Draft CIP (King County 2001), SWEES hired a Senior Ecologist to conduct some synthesis work, interconnecting the different watershed components of the Mullen Slough sub-basin (Althauser 2002). She created figures and developed some matrices; however, the recommended actions were still not evaluated or prioritized formally (Althauser 2002; Knauer 2002).

Table 4.2 Recommended Improvements for Mullen Slough Sub-basin
P = Priority: H = High M= Medium L = Low (+ number of goals addressed out of 7) (King County 2001)

P	#	Improvement	Description
Upland Plateau Area			
M 6	1	Detention Pond Retrofits	Expand capacity of four existing storm water detention ponds at the lower ends of tributaries 0045, 0047, 0048, and 0049. These are all currently under King County jurisdiction. Lake Fenwick tributary 0046 will require additional storm water detention to accommodate growth. City of Kent would need to adopt stricter storm water control standards and build regional detention facilities.
L 5	2	Lake Outlet Retrofits	Retrofit outlet structures of Bingaman Pond, Star Lake, and Lake Fenwick to increase active storage capacity.
H 6	3	Increased flow control standards (policy)	Apply the King County "level 3" (or "level 2 forested") flow control standard (regional detention) in the Lake Fenwick and Bingaman Creek tributary drainages. Apply the King County "level 2" flow control standard (on-site detention) as a minimum in all other upland tributary drainages (King County 1998).
L 6	4	New Detention Facilities	Construct new detention facilities near &/or in Lake Fenwick (0046) and Bingaman Pond (0049). Detention facilities could be constructed within adjacent King County parks (Lake Fenwick Park and Bingaman Pond Park).
M 6	5	Surface Runoff Infiltration and Aquifer Recharge	Infiltrate storm water into groundwater or use it to recharge deep aquifers. Convert the existing storm water ponds into recharge or infiltration sites. Geology in upland areas is suitable for both of these options, but site selection for deep recharge will require additional investigation. Future policy revisions: encourage on-site infiltration & roadside bioswales.
H 2	6	Conveyance improvements	Replace culverts downstream of Bingaman Pond and Star Lake. Remove built up sediment in adjacent channels.
Middle Ravine Area			
M 2	7	Bioengineer banks in the ravines	Use large woody debris, coir fabric, boulders, bank wattles (woven live stakes), and other plant material to stabilize eroded banks and reduce sediment transport in the five middle tributary ravines (except Tributary 0046a).
M 2	8	Surface Tightline System (tributary 0045)	Tightline is a term referring to solid drainage pipe as opposed to perforated pipe. This on-the-ground 1200 foot pipeline would divert high flows around sites subject to erosion in tributary 0045.
Mill Creek Tributary 0053			
H 4	9	Channel Improvements (tributary 0053)	1000 feet of improvements at four sites in tributary 0053 would eliminate overflow into Mullen Slough sub-basin. 1) Reconstruct 700 feet of channel at upper section to improve conveyance 2) Replace culvert under West Valley Highway 3) Install a high flow diversion structure 4) Create a new channel to connect the high flow diversion to Mill Creek
L 1	10	Surface Tightline System (trib 0053)	200 foot tightline to redirect flow away from scarp at 65thAve. S. 100 foot tightline to protect small scarp near S. 296th St.

Table 4.2 (continued)

Valley Floor Area (flood waters from 3 sources: Green River, Mullen uplands, Mill Creek trib 0053)			
H 7	11	Restore Main Stem Mullen Slough	Remove accumulated sediments and in-channel vegetation. Plant a riparian buffer (min. 25 feet). Place large woody debris. Create new meandering channel from the old oxbow upstream to S. 277^{th} St. to make up for lost channel length in 3-forks area from combining of 0045 and 0047 (see below #12). Old channel would be filled in.
H 7	12	Restore "Three-Forks" Channels	3-forks channels include tributaries 0045, 0047 and 0048. Restore 0048 along its current alignment. Restore 0045 and 0047, 800 feet north from S. 287^{th} St., from that point on the two tributaries would be combined into a single channel. The new channel would have a meander pattern and LWD. All channels would have 25-foot minimum riparian buffers.

4.4.2 Creation of an Action Plan

An action plan documents the recommended actions or scenarios and all the necessary steps to move forward with each action (Slocombe 1998; Szaro et al. 1998). An action plan was not part of the Draft CIP (King County 2001). The recommendations did not describe specific steps that would be required to implement each project or action (King County 2001). As stated in Section 4.1.4, SWEES thought of the Mullen Slough CIP document as one that would present study findings and propose actions (Bethel 2002), while WLRD thought that the document would present study findings, propose, recommend, and prioritize actions, and outline responsibilities for implementation (Clark 2002).

4.4.3 Creation of an Implementation Plan

The Draft CIP did not outline an action plan and hence could not assign responsibility for each action and each step to facilitate an action (King County 2001). Recommendations varied from broad policy alternatives to specific project-level actions, and yet none of the recommendations had associated required steps, cost breakdowns, time lines, specific players, or funding plans (King County 2001).

4.4.4 Creation of a Monitoring Plan

There are on-going monitoring activities in the Mullen Slough sub-basin such as water quality stations and gauge stations (Knauer 2002). However, the CIP process did not create a monitoring plan for the sub-basin.

4.4.5 Creation of a Planning and Management Framework

With no action, implementation, or monitoring plans the CIP process did not include creation of a planning and management framework for the Mullen Slough Sub-basin.

4.5 Conclusion

The Mullen Slough Capital Improvement Project Study and Action Plan (Draft) was published in draft form internal to King County in April of 2001 (King County 2001). King County was the sponsor of the process. The process created seven major goals, studied nine watershed components, and created eleven recommendations for action.

The final version of the report, which has been submitted for review to King County (Knauer 2002) has some additional figures and matrices; however, the recommended actions are still not evaluated or prioritized formally (Althauser 2002; Knauer 2002). The Draft CIP will serve as a reference document for the writing of the Mill Creek Basin Plan, a compilation of past studies and management plans, that will include an implementation and management plan (Clark 2002; Knauer 2002).

5 Evaluation of the CIP Planning and Management Process

In this chapter I evaluate the King County Draft CIP document and process, using all four phases and all fourteen key elements of the evaluative framework. The CIP is currently in draft form. Its final version, to be released sometime in 2003, may be significantly different from the draft. There are no action or implementation plans and none of the recommended CIP projects or actions have been implemented yet, and therefore evaluation of the effectiveness of the Watershed Management Plan through the implementation phase is not possible in this report. Section 5.1 is the evaluation of the Start-Up phase. Section 5.2 is the evaluation of the Watershed Characterization phase. The Watershed Condition Evaluation phase is evaluated in Section 5.3 and the Watershed Management Plan phase is evaluated in Section 5.4. Table 5.1 outlines an evaluation of the characterization of the nine watershed components. Table 5.2 outlines summary points of the evaluation of the CIP.

5.1 Start-Up

5.1.1 Identification and Designation of Those Stakeholders Who Will Conduct the Research and Manage the Process

5.1.1.1 Sponsor

King County, a large government body with diverse human and technical resources, was the sponsor of the project. There were no co-sponsors. King County was a natural candidate to sponsor the CIP due to its jurisdiction and regulatory authority over 2/3 of the area of the Mullen Slough sub-basin. King County WLRD and SWEES have large and skilled staffs including biologists, ecologists, engineers, hydrologists, GIS specialists, planners, lawyers, real estate specialists, and financial specialists. WLRD is involved in prioritizing salmonid recovery projects in the Green River watershed through the State Lead Entity Process (see Appendix 1.3.2). King County also has on-going activities in the sub-basin such as water quality monitoring, fish surveys, a salmon habitat restoration project, and management of the King County Agricultural Production District under the Farmland Preservation Program. King County was the primary contributor to the Limiting Factors Analysis (WSCC 2000a) and Near Term Action Agenda (King County 2002a) for salmon recovery in the Green River Watershed, thus making it easier to nest the management plan for Mullen Slough into the plans for the Green River Watershed. The disadvantage of having King County as the sponsor is a history of bad relations with private landowners due to the County's regulatory nature and their tendency to make decisions behind closed doors (Koester 2001). This meant that local citizens mistrusted the CIP process from the start (Bethel 2002; Koester 2001). In addition, SWEES, (the CIP team) was inexperienced at planning, and was more skilled at implementing projects (Bethel 2002).

King County chose itself as the sponsor by initiating the watershed management process; however, local municipalities had communicated the need for the process to King County (Clark 2002). King County conducted the CIP process internally, without stakeholder participation, so the process was weak in that the County not only provided and coordinated funding, oversight, and technical support for the process, but they ran the entire process by themselves. From the perspective of the stakeholders the process was very inflexible (Bethel 2002; Koester 2001).

King County has regulatory authority over some aspects of the proposed projects; however, they will have to attain USACE permits for much of the work necessitating consultation with NMFS in order to comply with the ESA. In addition many of the areas with proposed projects lie within potential annexation areas of local municipalities, necessitating approval by these municipalities. King County has not created an implementation plan, but has plans to do so in the future (Clark 2001).

The level of support for the process from agency heads and senior levels of government is mixed. Certain King County Council-members pushed to get the SAMP implemented in the late 1990's, and this may have created support for the CIP process, as it was initially envisioned as a plan that would lead to implementation. In the 1990s there was a political back-lash against basin planning when constituents complained that too much planning was going on and not enough implementation (Bethel 2002). As a result the Basin Planning Program was dissolved. This was a short-sighted political decision as the implementation phase is part of basin planning, thus, by dissolving the program the chances of implementation occurring were even less (Bethel 2002). This had a profound effect on the CIP process, as the Capital Improvement Project Division of SWEES, the team that worked on the Draft CIP, is traditionally responsible for managing the building of capital projects, not planning them, and therefore the process was conducted by a team of people that were accustomed to implementing projects and not to conducting basin planning (Bethel 2002).

5.1.1.2 Project Manager

The Project Manager was a civil engineer with SWEES. He was chosen for the position because of his past involvement in large capital projects being implemented at a regional scale and his skill at bringing people together (Althauser 2002). He does not have a multi-disciplinary background (Bethel 2002). Other team members or contributing staff complained that some of their views were not incorporated into the document (Althauser 2002). In response, the lead engineer, Director of the Capital Improvement Program and supervisor of the Project Manager, adapted the normal process and advised SWEES to submit important input in writing to the Project Manager. There were also problems with communication due to the Project Manager's limitations with English (Althauser 2002). As the process was conducted within King County with a small project team, facilitation skills were less necessary than if the public had been involved. However, better facilitation within the technical team would apparently have been beneficial.

WLRD assigned a manager to act as liaison between WLRD and the SWEES. She wrote a work plan for the CIP process. At first the WLRD and SWEES managers followed the work plan. However, when the WLRD manager left King County, and she was not replaced for several months, the process strayed from the work plan (Althauser 2002). The major change in effort from that specified in the work plan was a significant lack of high quality investigation into environmental factors such as fish and wildlife habitat and wetlands. This straying occurred due to gaps in the skills of SWEES and the lack of feedback and review resulting from an absent manager at WLRD. WLRD did not fulfill their side of the work plan as a number of scheduled internal and external reviews did not occur (Althauser 2002; Knauer 2002).

5.1.1.3 Technical Team

SWEES studied nine watershed components (see Section 4.2.3) (King County 2001). There were teams for each component, but with the limited staff resources each staff member sat on several teams. SWEES (the CIP Project Team) consisted of three civil engineers, one geomorphologist, two engineering technicians, one graphics specialist, one GIS specialist, and one technical editor (King County 2001). There were no land use specialists, ecologists, or social scientists on the team. City of Kent offered to do a fish abundance and habitat study in Mullen Slough (Althauser 2002; Knauer 2002). Because of this fact, and difficulty in acquiring ecologist assistance from other departments, SWEES did not bring on a fisheries or an ecology specialist. The absence of land use specialists was due to lack of resources (Althauser 2002). Social scientists were not considered (Althauser 2002). Other King County staff from WLRD assisted in the studies; however, they did not fill the gaps in ecology, land use, or social science.

The technical team's ability to integrate information from many sources was quite high due to their experience in working together to get projects implemented; however, due to a limited budget and time frame, and a lack of social or biological scientists, the integration did not occur to everyone's satisfaction (Bethel 2002). Team members did not educate the stakeholders and general public as there was no public involvement process (Althauser 2002; Bethel 2002).

5.1.2 Definition of Management Region and Boundaries

The management region boundaries for the CIP process were appropriate to the goals and objectives of the watershed management process. In addition the Draft CIP was nested within other plans at larger scales.

The scale of analysis and watershed boundaries were determined early in the process by WLRD and SWEES expediting establishment of the spatial extent for information gathering (King County 2001). SWEES's main goal was "to develop concepts to improve drainage of the Mullen Slough valley floor so as to allow productive use of the valley floor agricultural lands" (King County 2001: 45). In order to recommend actions to alleviate chronic flooding SWEES would have to analyze the Mullen Slough sub-basin's hydrology and geomorphology to an equal or greater extent than the rest of the Mill Creek basin (King County 2001). Factors affecting chronic flooding could be adequately assessed at this scale, because basin-wide flooding had already been assessed (King County 1999a, 1999b) and larger watershed-wide processes were not relevant to chronic flooding in the sub-basin (King County 2001). Once specific goals were determined the scale did not change (King County 2001). Other goals were addressed within the scale determined by the primary goal.

The scale of the Mullen Slough CIP is 15.5 km^2 (6 $mi.^2$), smaller than most standardized watershed management processes which vary from 40-520 km^2 (~15-200 $mi.^2$) (WFPB 1997; WPN 1999). Choosing this scale was logical because the investigators needed to look at site-level processes such as local storm water effects on channel formation and sediment transport, in order to design projects to alleviate flooding problems (King County 2001; RIEC 1995). The scale allowed reliable modeling of future hydraulics and hydrology with greater accuracy and detail than was accomplished in the SAMP (King County 2001).

The Mullen Slough sub-basin has its own set of ecological and sociopolitical needs; however, SWEES was well aware that the ecosystem and policy problems in the watershed are meshed in a larger ecological and human societal framework (Clark 2002; Knauer 2002). The Draft CIP is nested within other plans such as the SAMP, Limiting Factors Analysis, and Near Term Action Agenda for the Green River (Clark 2002; King County 2002a; Knauer 2002; USACE 2000b; WSCC 2000a). The fact that these larger analyses were considered in the CIP process helped to bring many significant factors into the analysis. For example, a Mill Creek tributary was included in the hydraulic and hydrologic models because the SAMP had revealed that it contributed run-off at high flows (King County 1999a). Off-channel salmonid rearing habitat within the Mullen Slough sub-basin was given high priority for preservation and restoration because it has been identified as a habitat limiting factor in the Green River Watershed (WSCC 2000a) and slated for preservation in the SAMP (USACE 2000b). After its completion the CIP will be used as a reference document for the Mill Creek Basin Plan, a compilation of all the work completed to date in that basin (Clark 2002).

5.1.3 Coordination of Involvement and Participation of Stakeholders Who Will Conduct Tasks Other Than Scientific Research or Management

The CIP process did not involve outside stakeholders in goal formation or decision-making (King County 2001). However, some stakeholder involvement was implicit in the process because it followed from the SAMP which had good agreement with this key element of the framework.

King County conducted the CIP process internally with little new input from stakeholders (see Section 4.1.3). Stakeholder involvement that did occur was very limited because all the communication was one-way and did not allow direct decision-making by local stakeholders. Existing laws and regulations were used to help determine desired conditions of the watershed. For example, water quality goals were set at Washington State standards (King County 2001). SWEES is not accustomed to engaging the community because its primary mission is to implement Capital Improvement Projects, once all stakeholder input has occurred (Althauser 2002; Bethel 2002). The SAMP public involvement process had equitable representation of stakeholders and a good educational component (Section 2.5.2). It involved a citizen advisory council made up of representatives from each sector in the Mill Creek basin and educational materials for informing stakeholders about study results and basin issues that were used at public workshops and meetings (Scuderi 2002).

The lack of stakeholder input into the Mullen Slough CIP process was somewhat beneficial in that it sped up the process of watershed assessment and action plan creation.

However, poor stakeholder involvement has already resulted in municipality and landowner distrust of King County's management decisions in the basin (Burhans 2002; Koester 2001). For example, King County and Muckleshoot Tribal personnel have suggested that as the process moves into implementation, resistance by local municipalities, tribes, environmental and social groups, businesses, and private landowners has the potential to impede implementation of recommendations (Althauser 2002; Bethel 2002; Walters 2002). The level of public support for the plan currently is unknown (Althauser 2002). An additional repercussion is that the educational component has not been furthered beyond the SAMP. Thus conflicting goals revealed through the CIP process have not been communicated and resolved among stakeholders.

5.1.4 Definition of Broad Goals and Identification of Major Issues

The CIP had partial agreement with this key element. The extent of the CIP process was defined poorly, stakeholders were not involved, and issues were not prioritized. King County did a good job of synthesizing major issues from limited current public input, and past studies and constraints were considered.

King County's failure to clearly define the extent of the CIP process has led to a situation where WLRD is dissatisfied with the SWEES product (Althauser 2002; Knauer 2002). There are many reasons why the overall goal was not clearly understood, one of which is that the work plan was not followed (Althauser 2002). The final CIP document will serve as a reference for sections of the Mill Creek Basin Plan rather than making up a chapter of it, due to WLRD's dissatisfaction with the document and process (Knauer 2002).

Direct stakeholder involvement in the creation of goals took place during the SAMP process from 1988-1996, thus the goals derived from the SAMP are not current (Smith 2002). In addition, the goals created during the SAMP are relevant to the entire Mill Creek basin, not specific to Mullen Slough. Because of King County's decision not to involve stakeholders, all the decisions were made by King County. Outside stakeholder support and willingness for implementing the plan is unknown (Althauser 2002; Bethel 2002). During the implementation phase of the CIP process, outside stakeholders may not agree with the major issues defined or the recommended actions. For example, storm water management in the upland plateau was an issue identified in the Draft CIP, and yet the Cities of Federal Way and Kent have not identified storm water detention in the Mullen Slough sub-basin as a problem at this time (Burhans 2002; MacTutis 2002). Involvement of local municipalities and citizens early in the CIP process might have helped to create support for the process and build a greater sense of constituency willing to work towards implementation (Pinkerton 1991).

King County did a good job of synthesizing major issues from limited current public input and past studies (King County 2000a, 1999a, 1993; Shapiro and Associates Inc. 1990; USACE 2000a, 2000b). As such, the perspectives of the agricultural, development, residential, and fisheries communities were represented. The environmental community was only partially represented. The only wildlife issue defined was loss of over-wintering habitat for waterfowl (King County 2001). Loss of forest habitat and its effect on birds, mammals, amphibians, and humans was not discussed (Knauer 2002).

SWEES did not prioritize goals beyond stating their main goal, flood management (King County 2001; Knauer 2002). This may have made it more difficult to prioritize recommended actions thus affecting project implementation.

In terms of recommended actions, SWEES had a predisposition towards engineering and public works projects (Althauser 2002). Their mission, internal policies, and de facto standard practices influenced the issues that they pursued resulting in a focus on engineered solutions for flooding and not on environmental and wildlife concerns (Althauser 2002).

SWEES did a good job of defining issues at a scope and physical scale that was realistic in terms of resources and what stakeholders had the power to change. For example, flooding was chosen as a major issue; however, control of backwater flooding from the Green River was not considered as a goal due to the expense and environmental repercussions (King County 2001). It was stated in the Draft CIP that the goals were realistic in terms of human, physical, and biological constraints in the watershed (King County 2001); however, without outside stakeholder input, WLRD and SWEES may not have been aware of all the constraints and opportunities when forming goals.

5.1.5 Creation of More Specific Goals

The CIP had partial agreement with this key element. Specific goals were created after broad goals and major issues were defined. Goal definition was iterative and based on existing laws, limited public input, and past studies. Only specific goals associated with flooding drove the Watershed Management Plan. Goals were used to determine necessary watershed components to assess. Goals appear to be achievable, based on the team's knowledge of the system.

By creating broad goals first, SWEES formed a structure which produced a constant focus, thus buffering the process from goals and issues irrelevant to stakeholders.

SWEES defined specific goals using the broad goals, WLRD work plan, existing laws, and past studies (King County 2000a, 1999a, 1993; Shapiro and Associates Inc. 1990; USACE 2000a, 2000b). The CIP process was driven by the major goal, flood management rather than all seven goals and eleven objectives (Althauser 2002). The result of this was that characterization of processes and structures affecting flooding was done thoroughly while components not related to flooding were poorly assessed. Additionally, the eleven recommended improvements were primarily focused on flooding.

SWEES decided to characterize nine watershed components (Section 4.2.3), which from a broad perspective comprehensively cover the chosen goals. How effectively and completely these components were characterized is evaluated in Section 5.2.3.

The team did review and revise the goals and objectives as information from the Watershed Characterization and Condition Evaluation became available. For example, the decision to conduct the low oxygen study was made after more data was collected on that problem in Mullen Slough (Bethel 2002; Knauer 2002). Two conflicting goals, drain farmland versus preserve wetlands, were not resolved fully from information gathered and synthesized during the Watershed Characterization and Condition Evaluation phases (King County 2001). The hope is that the Mill Creek Basin Plan, which will include implementation plans, will lay out steps to address this conflict through project level planning (Bethel 2002; Knauer 2002).

5.2 Watershed Characterization

5.2.1 Identification of Data Gaps and Statement of Assumptions

Acceptable types of data and data quality objectives were not defined in the Draft CIP, thus data were not systematically evaluated. There was no formal process for identifying, prioritizing, or addressing data gaps. Data gap identification that did take place was, however, iterative although in a casual format.

With no formal agreement on acceptable types of data, SWEES did not establish data quality objectives or evaluate data formally throughout the Watershed Characterization. SWEES established the necessary rigor for each study within each watershed component as they went along (Bethel 2002). Without agreement data quality consistency may have been a problem.

There was no formal process of identifying data gaps and stating assumptions and there was no discussion of acceptable levels of uncertainty (Bethel 2002). Some informally identified data gaps led to the creation of new studies, such as the low oxygen study initiated during Watershed Characterization (Knauer 2002; Travers 2002). A formal data gap identification process would have encouraged more rigorous identification of important data gaps, assessment of the implications of those missing data, prioritization of the data gaps, and decisions as to which data gaps to fill and in what order. By not deciding on acceptable levels of uncertainty and not determining how to deal with it during the Watershed Characterization and Condition Evaluation phases, SWEES indirectly chose not to deal with uncertainty. Each recommended alternative has a particular level of uncertainty associated with its outcome. Because uncertainty was not considered, recommended improvements may not have the level of success anticipated.

It would have been useful to discuss (or state) for each recommendation what data would be required to move to a project level analysis, and what the implications of past assumptions will be. By stating the major assumption for the CIP process, that existing land use and agricultural covenants will remain in effect and existing laws and policies will be applied, SWEES limited the scope for the process and accepted some major constraints.

5.2.2 Historical Characterization of the Watershed

Land use and drainage patterns were characterized historically in the Draft CIP; however, no other components of the watershed, such as wildlife, resource use, or wetlands were characterized. Once the characterization was complete the information was not used to inform the CIP process.

As there is no comprehensive topographic, hydraulic, or hydrologic study for the Mullen Slough sub-basin, historic drainage patterns could be estimated using old USGS topographic maps and old aerial photographs which would, to a certain extent, reflect current topography and drainage. This historical information, combined with the patchwork of surveys completed in the sub-basin, could help construct a preliminary drainage map of the sub-basin and create options for improved drainage systems.

Hydrologic modeling for pre-settlement conditions was conducted; however, the current channel conveyance system was used for the simulation, even though it is known that flow patterns in the basin are highly altered by humans. For example, the valley floor drainage system is entirely man-made and some of the lake levels are controlled by small dams. It is unknown how well drained the land was naturally, before construction of drainage channels.

5.2.3 Identification and Characterization of Dominant Physical, Biological, and Human Processes and Features of the Watershed

This section is an evaluation of the choice of watershed components, how effectively and completely each watershed component was characterized, and how well the specific processes characterized describe existing conditions of the watershed to help address stakeholder goals.

King County characterized nine watershed components. Each component addressed at least one goal and often more than one. The nine watershed components were similar to the six components recommended in the Oregon Watershed Assessment Manual (WNP 1999). Significant components left out were characterizations of the human system such as economic, social, legal, and political factors at work in the sub-basin and region.

5.2.3.1 Characterization of the Local or Regional Community

The only human layer characterized was land use. Human factors were addressed in a piecemeal fashion within some of the nine components but not in a comprehensive way. For example, regulatory constraints were addressed for many proposed actions; however, economic factors were not considered (King County 2001). These components of the human layer of any sub-basin have an equal or greater effect on the feasibility and effectiveness of the proposed actions and should be given equal weight as criteria for evaluating recommended actions (Force and Machlis 1997). A characterization of the local or regional community will help determine what means of implementation will be effective, the relationships between manager's actions and human variables, and what sectors or components of that society are at risk (Force and Machlis 1997). In order to come up with a synthesis of information that is meaningful and useful to managers and decision makers, the local or regional community needs to be characterized (Machlis et al. 1997).

The staff of SWEES were not skilled or knowledgeable in social sciences. The challenge of integrating natural and social sciences in watershed management is a common problem (Machlis et al. 1997). For most watershed management frameworks, a structure for integrating ecosystem management into land-use decision making does not exist (Montgomery et al. 1995). Ecosystem management also does not provide a clear vehicle or protocol to link the technical analysis with policies and decisions (Frissell and Bayles 1996). However, if the human layers were characterized well in terms of economic, political, legal, and social factors, then linking the technical analyses with policies and decision making would be easier as the decision makers would see that their concerns had been addressed.

5.2.3.2 Evaluation of the Watershed Characterization in General

The CIP had partial agreement with this aspect of the Watershed Characterization key element. The CIP process characterized watershed components associated with flooding well, but characterized fish and wildlife poorly (Knauer 2002). None of the characterizations were comprehensive, and none established quantitative baseline conditions. Even though some of the CIP goals were clear and specific, the characterizations may have been limited by financial, temporal, or human resources. The CIP's scale was determined early; however, the scope was not clear. Some thought the process was for characterizing and recommending actions while others thought the process should result in specific action and implementation plans (Althauser 2002; Bethel 2002; Knauer 2002). SWEES saw the process at a site level rather than a project level. SWEES's level of characterization of each component reflects their view, which is that the document was a starting point for recommending actions (Bethel 2002).

The CIP characterizations focused on investigations for particular projects (Bethel 2002) rather than being oriented around people, resources, and ecosystem components (Montgomery et al. 1995). The CIP's characterizations centered on the stream channels and lakes. This makes logical sense and is similar to other watershed models (WPN 1999); however, a focus on stream channels should not be at the expense of investigating the effects of particular land uses. Land use effects that were investigated focused on existing and current impervious surfaces from mostly residential development (King County 2001). Agriculture makes up 21% of Mullen Slough and yet no analyses of farming practices or their effects on water quality or wildlife habitat were discussed

(King County 2001). Consequently, there were no recommended improvements to farming practices. Feedback loops were investigated incompletely or not at all, and thus, the relationships between the processes governing the desired states were not well characterized. For example, the relationship between increases in impervious surfaces and stream flow / runoff was investigated via the hydrologic model; however, changes in water quality were not assessed (King County 2001). Table 5.1 outlines an evaluation of the characterization of the nine watershed components. This evaluation is discussed in more detail in the following sections.

5.2.3.3 Land Use

Past, present and future projected land use was characterized completely for the sub-basin. This was the only human society component characterized. This characterization was most effective at assessing and addressing flooding-related watershed components. Effects on fish and wildlife other than water quantity issues were not addressed. No regional scale political, economic, or legal factors were considered for accommodating projected growth other than looking at current comprehensive plans. The CIP process assumed the upland plateau would be developed residentially; however, it did little to accommodate this growth.

5.2.3.4 Flooding

The extent of flooding was characterized well; however, the mechanisms of this flooding were not investigated. Recommended actions are thus to be based on hypotheses with high degrees of uncertainty.

5.2.3.5 Geology and Geomorphology

Qualitative information from the characterization was used to identify areas for action. Quantitative information would have made it easier to prioritize projects to address erosion and deposition in the sub-basin. Determining sources of sediments would increase the likelihood that recommended actions would address the source of the problem. Information on sedimentation rates in the valley floor would provide useful information about required future rates of drainage watercourse maintenance (dredging).

Table 5.1 Evaluation of Characterization of Current Processes and Features of the Watershed

Watershed Component	Goal(s) Component Could Potentially Address	Goals Addressed (Benefits)	Goals not Addressed (Poorly Completed or Missing Element)
Land Use	All goals associated with flooding and wetland preservation "Accommodate projected growth and current land use"	A past, present, and future land use characterization useful for: Hydrologic modeling of future flows in the sub-basin Qualitative evaluations of current and future impacts of land use on hydrology Assessing and addressing flooding-related watershed components	Not used to assess effects of development on fish or wildlife Did little to accommodate projected growth: No regional scale political, economic, or legal factors were considered other than looking at current comprehensive plans
Flooding	Reduce the hazard and improve the predictability of flooding in the valley Address concerns of property owners Reclaim and maintain tillable land in the valley floor	Chronic flooding causes the most problems for farmers and landowners, thus it was a priority Extent and location of chronic flooding was characterized well	Causes (mechanisms) of flooding were not investigated scientifically Other watershed components used qualitative means to attempt to form hypotheses about causes of flooding (no attempt to determine the relative contribution of each hypothesized factor).
Geology and Geomorphology	Reduce the hazard and improve the predictability of flooding in the valley Protect and enhance aquatic and wildlife habitats Improve water quality Address concerns of property owners	Qualitative evaluations determined sites of major erosion and deposition Qualitative evaluations of underlying geology determined sites more susceptible to erosion	Did not use quantitative scientific methods No attempt was made to quantify current or future sedimentation rates. Quantitative information would have made it easier to prioritize projects to address erosion and deposition in the sub-basin
Hydrology and Hydraulics	Reduce hazard and improve predictability of flooding in valley Address concerns of property owners Reclaim and maintain tillable land in valley floor	Qualitative studies were a good start at identifying problems to begin addressing stakeholder goals Projects have potential to reduce the hazard of flooding	Qualitative (observational) studies did not improve the predictability of flooding Quantitative studies would have helped determine the degree of importance of each identified problem and may have found problems that were not identified by a few stream walks

Table 5.1 (continued)

Watershed Component	Goal(s) Component Could Potentially Address	Goals Addressed Benefits	Goals not Addressed Poorly Completed or Missing Element
Fish Species, Abundance and Habitat	Protect and enhance aquatic and wildlife habitats	One objective "create a net increase in salmonid rearing and refuge habitat in the Lower Green River" identifies a set of target species.	Looked only at fish and birds No specific species were targeted for identifying or quantifying their habitat Did a poor job of defining specific goals for aquatic and wildlife habitat Few studies on fish abundance and habitat.
Storm Water Management and Surface Runoff Infiltration	All seven goals	Qualitative studies good at identifying past runoff problems Information facilitates prioritization of recommended projects, as far as the qualitative observations were able to discern relative magnitudes of impact. SWEES recommended that groundwater studies be conducted and recharge locations be investigated.	Qualitative studies may miss any new problems (physical manifestation of erosion immediate) Future problems would also not be predicted by qualitative means No efforts were made to study groundwater (groundwater recharge research was cursory) and mostly an exploration of existing information to create recommendations for future study.
Wetlands, Waterfowl and Wildlife	Protect and enhance aquatic and wildlife habitats Protect valuable and functional wetlands	Noted conflict of reducing water levels VS changing wetland function and reducing habitat for waterfowl (and other species); however, mechanisms of chronic flooding were not characterized and investigations into managing for both functions were not undertaken.	No additional information about wetlands, waterfowl, or wildlife was gathered No additional synthesis of old data was conducted. The only wildlife mentioned were birds, namely, shorebirds, waterfowl, and raptors.
Water Quality	Improve water quality Protect and enhance aquatic and wildlife habitats Protect valuable and functional wetlands	SWEES summarized past water quality studies in the basin WLRD prioritized low oxygen as major water quality problem in Mullen Slough: hired graduate student to discern the causes	SWEES did not present water quality information in a useful format for identifying data gaps or prioritizing water quality problems Understanding of mechanisms not clarified by the characterization

Table 5.1 (continued)

Watershed Component	Goal(s) Component Could Potentially Address	Goals Addressed Benefits	Goals not Addressed Poorly Completed or Missing Element
Buffers	Protect and enhance aquatic and wildlife habitats Improve water quality Protect valuable and functional wetlands	Investigated local, state, and federal regulatory framework concerning buffers, to create buffer width recommendations.	Did not characterize existing buffers in Mullen Slough No investigation into appropriate species composition or physical structure of the proposed buffers was made.

5.2.3.6 Hydrology and Hydraulics

Qualitative studies were a good start at identifying problems to begin addressing stakeholder goals; however, they did not improve the predictability of flooding. Quantitative studies throughout the system such as stream profiles, cross-sections, and stream gauging, would have established quantitative baseline conditions, served as data for modeling flows and project design, and helped prioritize actions by determining the degree of importance of each identified problem.

5.2.3.7 Fish Species, Abundance and Habitat

The aquatic and terrestrial habitat for all species present in Mullen Slough should have been considered for characterization, protection, and enhancement. Fish are an important resource on the Pacific Coast of North America, especially salmon (Groot and Margolis 1991). It is understandable that salmonids, a commercially valuable group of fish, would be considered first. However, as society relies less directly on resource extraction, and people become more affluent, natural environments are valued not only for their extractable resources but for other values they provide such as clean water, wildlife viewing and quality of life (Lackey 1998; Pinkerton 1991). Too often in the Pacific Northwest, broad goals of aquatic habitat preservation and restoration turn into goals for salmonid habitat preservation and restoration.

SWEES did a poor job of defining their specific goals for aquatic and wildlife habitat. They qualitatively evaluated streams and documented obvious degraded areas due to erosion, incision, or sediment deposition; however, only salmonid habitat was targeted for identification and assessment. Quantitative studies of wildlife habitat (including fish) would have established baseline data, helped prioritize actions by determining the degree to which a habitat type was limiting, and documented the presence of other species and their habitat. Fish surveys by King County and City of Kent were effective at identifying species present, on a spatial and temporal basis. This will help in selecting target species and sites for restoration activities. SWEES did a minimum of fish abundance and habitat studies due to the fact that they had no fish and wildlife expertise, a limited time frame, a breakdown in support from WLRD, and an agreement with City of Kent for a fish study.

Hypotheses generated as to the causes of declines in quality and quantity of fish habitat, were not tested. Projects were proposed as solutions, even though the causes were not certain.

5.2.3.8 Storm Water Management and Surface Runoff Infiltration

Storm water management has profound effects on the hydrology of a watershed, thus influencing aquatic and riparian habitat-forming processes, water quantity and quality, wetlands, and flooding (Brooks et al. 1997). The qualitative information from this investigation was used, in concert with the hydrologic and hydraulic modeling (Sections 5.3.1.2 and 5.3.1.3), to create recommendations for stream restoration and storm water control. The qualitative information from the stream walks and the research into recharge facilitated prioritization of recommended projects only as far as the qualitative observations were able to discern relative magnitudes of impact.

5.2.3.9 Wetlands, Waterfowl and Wildlife

No additional information about wetlands, waterfowl, or wildlife was gathered (see Table 5.1).

5.2.3.10 Water Quality

In both the SAMP and Draft CIP it was hypothesized that water quality problems have arisen from two main problems, increased runoff and a lack of stream and wetland buffers. SWEES came up with recommendations that addressed these causes; however, the understanding of the mechanisms of those causes was not clarified by the characterization.

5.2.3.11 Buffers

It is recommended both in the SAMP and Draft CIP that a riparian corridor be established along as much as possible of Mullen Slough (King County 2001; USACE 2000b). SWEES did not characterize existing buffers in Mullen Slough. This would have been a useful study as it would determine existing stream and wetland protection and establish baseline conditions for monitoring. Feasibility and cost estimates could be generated from this baseline information.

What buffer size will be recommended and ultimately implemented is dependent on what determination is made under the ESA 4(d) Rule. Knowledge of existing soil types, water levels, and shade regimes, as well as a determination of target species will be required before appropriate species composition or physical structure of the proposed buffers can be determined.

5.3 Watershed Condition Evaluation

5.3.1 Synthesis and Interpretation of Information from Watershed Characterization.

5.3.1.1 Synthesis of Geologic, Hydrologic, Biological, and Social Information

King County has excellent GIS resources and they used them well throughout the CIP process. The maps were created separately without overlapping of data layers; however, the maps were useful for locating resource problems spatially and noting the proximity of potential causes or sources of those problems (Bethel 2002).

The process of synthesis by meeting and discussion was less successful. The team was time limited and there were some communication problems (Althauser 2002). The fact that qualitative and quantitative data from the characterizations had not been presented well, for example in comparative tables or matrices, made the process of synthesizing that information difficult (Bethel 2002).

Because the characterizations were qualitative, and there were no standard forms for observations, there was a lot of overlap between the characterizations. For example, if the streams were walked to document geology, erosion and incision were observed from the perspective of soil type and underlying geology, while if they were being walked to document storm water management and runoff, erosion and incision were observed from the perspective of water quantity and force. A framework or structure to integrate these observations would improve synthesis both during and after data collection.

As stated earlier, the human component of the sub-basin was characterized poorly, especially the social, economic, and political factors. Regulatory factors were assessed and integrated in an unstructured way. With no social characterization there was no integration of elements and processes of the social layer with the biological and physical layers. With no economic characterization, the financial feasibility of the recommendations could not be assessed, and responsibilities for each action could not be assigned with costs unknown.

5.3.1.2 Hydrologic Modeling

The hydrologic modeling was the most sophisticated investigation in the CIP. It is hoped that this information will be one of the tools that King County and municipalities use in decision-making for future urban planning (Althauser 2002; Bethel 2002).

The model estimated flows and retention needs but did not estimate increases in erosion, sediment loads, or pollutants from increased urbanization. These are serious problems that will affect water quality, aquatic habitat, and sedimentation rates. These problems should be considered in future land use decision-making process. No economic factors were considered in the model and no cost-benefit analyses were conducted.

5.3.1.3 Hydraulic Modeling

The model combined past models and existing topographic maps and elevation surveys to determine cumulative reach length, 2-year flood discharge, channel bottom width, channel depth, and flow velocity. The data for the model, such as complete and current elevations and cross sections, were limiting. Currently, elevation and cross-section surveys are being conducted on half of main stem Mullen Slough as part of a project being conducted by the Agricultural Drainage Assistance Program (Knauer 2002). This information will serve as baseline data for monitoring, assist in the design of the new dredged-channel form, and assist in the design of any restoration projects in addition to dredging.

The hydraulic model had a project level assessment phase, namely the sizing of new channels. This information will be very useful for project design during the implementation phase.

5.4 Watershed Management Plan

5.4.1 Development of Specific Management Options, Recommendations, and Scenarios. Establishment of Decision-Making Processes and Evaluative Criteria. Prioritization and Selection of Best Option.

5.4.1.1 Options, recommendations, and scenarios

All the proposed projects, except for one policy proposal, are physical or technical means of addressing sub-basin problems (King County 2001). The policy proposal is like a physical proposal as it recommends increasing storm water control standards for on-site and regional detention in particular locations of the Mullen Slough sub-basin. It is unlike a physical proposal in that it results in increased costs for developers rather than direct costs to a project implementer. No other economic, legal, political, or social means for addressing sub-basin problems were proposed. The main assumption of the Draft CIP is that no policy or regulatory changes will occur, so it is no surprise that there are few policy recommendations (King County 2001). Using a broad scope of means would give the watershed plan a better chance of success, due to the diversity of preferences for options that stakeholders would have (Pinkerton 1991; Szaro et al. 1998; WDOE 1999). This will be the case as long as the means are chosen wisely and targeted at certain stakeholders or stakeholder groups.

Projects should address sources and causes of problems in the sub-basin where possible (WDOE 1999). The proposed projects that reduce storm water runoff, increase groundwater recharge, and create riparian or wetland buffers address direct sources of problems. The proposed projects that tightline or bioengineer a stream bank, place large woody debris, or remove sediments address symptoms of a problem (King County 2001).

If projects are proposed as scenarios it is easier to assess how they will act in concert (Pinkerton 1991; Slocombe 1998). The CIP's process for proposing projects was to address a specific problem in relative isolation from the rest of the problems in the basin (King County 2001). Projects were site specific rather than in sets of integrated projects designed to act together. Some synthesis of recommended actions occurred through GIS. The lack of other integration may cause problems in the future as effects of one project interact with another project's effects in a negative way.

All the projects were not proposed as tests of the hypotheses generated from the investigations, but instead were proposed to solve the flooding and natural resource problems in the basin. The high degree of uncertainty concerning the causes of the problems that these projects were proposed to address, suggests that the certainty of success of these projects is very low.

5.4.1.2 Decision-making process and evaluative criteria

King County did not develop a formal decision-making process.

The process of evaluation was informal, qualitative, and rushed, resulting in recommendation of all proposed projects (Bethel 2002; Knauer 2002). The team looked at potential impacts, both positive and negative, of each proposal and their ability to achieve each goal, thus determining the degree to which each management option could move the watershed toward desired conditions (Lackey 1998). Feasibility within existing constraints was considered for some projects, but was not considered systematically (King County 2001). For example, in making recommendations for additional storm water control, social, economic, and political factors were not considered.

5.4.1.3 Prioritization and selection of best option(s)

Projects were ranked as high, medium, or low priority, thus providing some guidance for project implementation. Most of the high priority projects were ones that improved conveyance of water (King County 2001). Expensive, long-term, or legally complicated projects were given lower priority due to perceived feasibility problems (Bethel 2002).

5.4.2 Creation of an Action Plan

An action plan was not included as part of the Draft CIP (King County 2001). The project proposals did not describe specific steps that would be required to implement each project or action. The final CIP will serve as a reference for sections of the Mill Creek Basin Plan which will include an action plan (Knauer 2002).

5.4.3 Creation of an Implementation Plan.

The CIP process did not include the creation of an implementation plan (Bethel 2002; King County 2001). The fact that the CIP process was conducted internally at King County and input from local stakeholders was not part of the process has created a situation where extensive stakeholder outreach, coordination, and trust-building will need to take place before an implementation plan, that involves local jurisdictions and other stakeholders, can be created.

Even though an implementation plan has not been created, some project planning is already underway for dredging sections of Mullen Slough (Weldin 2002). This project will have immediate and tangible benefits and will assist landowners technically and financially with the permit simplification process (Weldin 2002).

Once the final draft of the CIP is published, it will serve as a reference for sections of the Mill Creek Basin Plan which will include an implementation plan (Clark 2002; Knauer 2002).

5.4.4 Creation of a Monitoring Plan

There are on-going monitoring activities in the Mullen Slough sub-basin such as water quality stations and gauge stations; however, the CIP process did not create a monitoring plan for the sub-basin (King County 2001). Without a monitoring plan, monitoring may occur in isolated pockets for each project rather than in an integrated way throughout the basin. A plan would outline long-term funding strategies, contingency plans for funding shortfalls or project failure, and structured evaluations for the effectiveness of the monitoring protocols or program. A well structured and implemented monitoring plan makes a program accountable, fosters community support, and documents project results. Physical, biological, and human responses of each project should be measured and documented in order to deal with uncertainty and change, and to facilitate adaptation of the management plan. All of these factors increase the quality of a watershed plan especially in the eyes of stakeholders, and permitting and funding entities. It is uncertain whether the Mill Creek Basin Plan will have a monitoring plan (Knauer 2002).

5.4.5 Creation of a Planning and Management Framework

There was no planning and management framework in the Draft CIP. The main reasons for this were poorly defined overall goals of the process and lack of money, time, skills, and resources (Bethel 2002). SWEES thought of the Mullen Slough CIP as a document that would present study findings and propose actions (Bethel 2002). Other King County staff thought that the document would present study findings, propose, recommend, and prioritize actions, outline responsibilities for implementation, and pave the way for the signing of an agreement between local municipalities (Clark 2002). SWEES is accustomed to following plans, written by others, to implement Capital Improvement Projects, not creating their own planning and management frameworks.

WLRD staff assert that when the final CIP is used as a reference to complete the Mill Creek Basin Plan, action and implementation plans will be created for all sections including the Mullen Slough sub-basin (Knauer 2002). In addition, existing and new information will be used to reevaluate the recommended improvements (Knauer 2002). If a planning and management framework is not created, there will be no structure set up to carry the actions and projects through implementation, monitoring, evaluation, and revision. A document that recommends actions and projects without assigning responsibility and creating strategies for action has a high chance of not resulting in action, and has a very low chance of being adaptive. The complexities associated with implementing actions at a sub-basin or watershed scale, in a coordinated, timely, and logical manner require a structure to coordinate the actions of many jurisdictions and stakeholders over time.

Table 5.2 Summary of the Evaluation of the Mullen Slough CIP

Start-Up	Agree with the Framework	Disagree with the Framework
Identification and designation of those stakeholders who will conduct the research and manage the process	**Sponsor** • WLRD experienced at watershed planning (small and large scales) • Regulatory authority in some areas • Mixed level of support from agency heads and senior levels of government **Project Manager** • Past involvement in large capital projects **Technical Team** • Good integrative skills • Engineers and geomorphologists well represented	**Sponsor** • SWEES not experienced at planning • SWEES not used to engaging the community • History of making decisions on their own **Project Manager** • No multi-disciplinary or facilitation skills • Team members felt their views were ignored • Communication problems (English language) **Technical Team** • Lacked social scientists, planners, and ecologists
Definition of	• Appropriate to the goals and objectives of the watershed	

management region and boundaries	management process • Draft CIP nested within other plans at larger scales	
Involvement and participation of other stakeholders	• Some stakeholder involvement was implicit in the process because it followed from the SAMP	• No outside stakeholders (public) involved in goal formation or decision-making • Public not educated about sub-basin & process • Level of public support unknown
Definition of broad goals and identification of major issues	• Good job of synthesizing major issues from limited current public input • Past studies and constraints were considered	• Goals of the process were defined poorly • Stakeholders were not involved • Issues were not prioritized
Creation of more specific goals	• Goal definition was iterative • Goals based on existing laws and past studies • Goals were used to determine necessary watershed components to assess • Goals appear to be achievable, based on the team's knowledge of the system	• Goals formed with very limited public input • Only specific goals associated with flooding drove the Watershed Management Plan

Table 5.2 (continued)

Watershed Characterization	Agree with the Framework	Disagree with the Framework
Identification of data gaps and statement of assumptions	• Data gap identification that did take place was iterative, although in a casual format	• Acceptable types of data and data quality objectives were not defined thus data were not systematically evaluated • There was no formal process for identifying, prioritizing, or addressing data gaps
Historical characterization of the watershed	• Land use and drainage patterns were characterized historically	• No other components of the watershed were characterized historically • Information not used to inform the CIP
Identification and characterization of dominant physical, biological, and human processes and features of watershed	• Characterized watershed components associated with flooding well	• Little characterization of the human system • Characterized fish and wildlife poorly • None of the characterizations were comprehensive, and none established

		quantitative baseline conditions

Watershed Condition Evaluation	Agree with the Framework	Disagree with the Framework
Synthesis and interpretation of information from Watershed Characterization. Determination of those trends moving away from stakeholder goals	• Integrated all components using GIS • Hydrologic modeling integrated land use, topography, hydraulics, and hydrology (data was limiting) • Hydraulic model combined hydrology, hydraulics, and topography (data was limiting)	• No human characterization to integrate with biological and physical layers. • No economic characterization so financial feasibility was not assessed • Synthesis by meeting and discussion was less successful (lack of comparative tables or matrices made the process difficult) • Hydrologic modeling did not integrate geomorphology, water quality, or aquatic habitat with other components

Table 5.2 (continued)

Watershed Management Plan	Agree with the Framework	Disagree with the Framework
Development of specific management options, recommendations, and scenarios. Establishment of decision-making process and evaluative criteria. Prioritization and selection of best option	**Recommendations** • Proposed projects that reduce storm water runoff, increase groundwater recharge, and create riparian or wetland buffers address direct sources of problems **Decision-making / evaluative criteria** • Looked at positive and negative potential impacts of each proposal and their ability to achieve each goal • Feasibility within existing constraints was considered for some projects **Prioritization / selection of best option**	**Recommendations** • All the proposed projects, except for one policy proposal, rely on physical or technical means (did not use a variety of means) • Proposed projects that tightline or bioengineer a stream bank, place large woody debris, or remove sediments address symptoms of a problem rather than causes • Projects were proposed in isolation rather than integrated **Decision-making / evaluative criteria** • Did not develop a formal decision-making process • Feasibility was not considered systematically **Prioritization / selection of best option**

	• Projects were ranked as high, medium, or low priority	• High, medium, and low rankings only provide some guidance for project implementation
Creation of action plan	• Final CIP will serve as a reference for sections of the Mill Creek Basin Plan which will include an action plan	• No action plan
Creation of implementation plan	• Final CIP will serve as a reference for sections of the Mill Creek Basin Plan which will include an implementation plan	• No implementation plan
Creation of monitoring plan	• Existing monitoring activities include water quality stations and gauge stations	• No monitoring plan
Creation of a planning and management framework		• No planning and management framework • Main reasons: poorly defined overall goals of the process and lack of money, time, skills, and resources

5.5 Conclusion

The CIP process successfully assessed chronic flooding issues in the Mullen Slough sub-basin to a level equal or greater in depth than the SAMP and Mill Creek Flood Plan (King County 1999a, 1999b; USACE 2000b). Whether the CIP process has achieved the goal of “develop concepts to improve drainage of the Mullen Slough valley floor so as to allow productive use of the valley floor agricultural lands” (King County 2001: 45) will be determined if and or when the recommended actions and projects are implemented. Because flooding mechanisms were investigated poorly, it is impossible to predict if the recommended actions will indeed reduce chronic flooding. In addition, a recommended action is only effective if there are stakeholders willing to implement it.

In terms of its success as a watershed management process, the CIP was a failure. Overall, King County was a good choice of sponsor, as discussed in Section 5.1.1.1; however, SWEES was not an appropriate section of King County, because their expertise was limited to implementing projects. Definition of issues and goals was comprehensive in terms of synthesizing issues from past basin plans; however, lack of stakeholder involvement meant the goals were potentially not current or complete.

Failure to define and evaluate data type and quality, resulted in a process that could easily make use of inconsistent and inaccurate data. In addition, data comparisons were difficult as information was not presented in terms of its reliability or its qualitative or quantitative nature. Data gap identification did take place in an iterative and casual format. Failure to address uncertainty in a consistent way resulted in a series of studies and recommendations with questionable accuracy and likelihood of success.

The lack of stakeholder involvement throughout the process has created a situation where King County has made all of the decisions about goals, studies, and recommended actions in the Mullen Slough sub-basin. The minimal public input that went into the creation of the Draft CIP meant that all stakeholder goals were not considered; and important information about resources, the physical environment, and human society was not gathered (including constraints). Therefore recommended actions did not include all stakeholder goals and knowledge. A management plan is only as good as the public's willingness to implement it (Pinkerton 1991). The level of public support for the Mullen Slough CIP process is unknown (Bethel 2002). Potential repercussions of lack of public input include lack of support for project implementation and project failure due to a deficiency of local information.

The Watershed Characterization's nine components had the potential to address defined goals; however, only the characterizations concerning flooding were in-depth enough to improve understanding to facilitate recommendation formation. Even flooding was not characterized well enough to understand mechanisms. There was a distinct lack of watershed components that characterized human society (the local or regional human community). Social, economic, and political factors in the basin were only addressed incidentally.

The only real synthesis of information was that relevant to flooding. The information was not presented in a format that facilitated prioritization or comparison.

All but one recommended action are physical or technical means of addressing sub-basin problems. No economic, legal, political, or social means for addressing sub-basin problems were proposed. Some of the recommended actions address sources of the problems. The recommendations were made as isolated individual projects rather than as integrated scenarios of projects acting together. Recommendations were evaluated loosely and not prioritized.

There were no action, implementation, or monitoring plans and no planning and management framework. As stated above, the complexities associated with implementing actions at a sub-basin or watershed scale, in a coordinated, timely, and logical manner require a structure to coordinate the actions of many jurisdictions and stakeholders over time. This structure should assign responsibility for funding and implementation of projects and monitoring activities, and outline an adaptive management plan for review and revision of the plan.

5.6 Recommendations for Future Action

Actions taken by King County in the near future to complete the Mill Creek Basin Plan may address some of the flaws of the CIP process.

The following are some recommendations for actions to address these flaws. Public workshops to involve and educate the community could begin the process of creating trust and support. The Watershed Characterization of the Mullen Slough sub-basin could be improved, especially those components dealing with aquatic and wildlife habitat, human society (or human ecology) and land use effects of agriculture and urban development. Synthesis of information from all the watershed components could be improved through the use of matrices, additional GIS, and/or modeling. Action implementation, and monitoring plans could be created that outline responsible parties, timelines, priorities, contingency plans, and adaptive management processes. This work should be done by WLRD, if possible, as they have a greater diversity of human resources.

King County is not considering a formal public involvement process to be part of the creation of the Mill Creek Basin Plan other than State Environmental Policy Act (SEPA) permit public review (see Appendix 1.2.2.2) when it is time to implement projects (Knauer 2002). It would be to King County's advantage to consider at least holding workshops to begin informing local stakeholders.

Watershed Characterization currently continues in the Mullen Slough sub-basin in the form of scientific studies of water quality (Knauer 2002; Travers 2002) and effects of ditch dredging on fish (Weldin 2002) that may help characterize the mechanisms and causes of poor water quality and will help determine potential outcomes of some recommended projects. In addition, King County and Mid Sound Fisheries Enhancement Group, a non-profit organization that conducts stream restoration in King County, are conducting stream surveys (hydraulic analyses) in main stem Mullen Slough (Weldin 2002). This data will create quantitative baseline data for monitoring as well as assist with design of drainage and habitat improvement projects.

The local human community was not characterized beyond land use. It would be beneficial to gain more information about human values, employment, resource dependencies, income, and risk factors. This information would be invaluable for judging whether a recommended action will be accepted and be effective in that community. The effect of farm practices on water quality and aquatic life was not characterized. The King Conservation District could be brought into the process to evaluate farming practices and suggest alternative pasture, field, and manure management practices. This would help address land use effects for 21% of the Mullen Slough sub-basin. In addition, effects of future residential developments on water quality should be addressed and storm water treatment options recommended if necessary. Of particular concern are the increased rates of sedimentation from residential construction activities in the headwaters. GIS could be combined with sedimentation studies to link construction management practices with water quality deterioration. Construction's contribution to sedimentation rates should be determined. If it is determined to be a significant source, control and inherent system improvements such as creation of buffer zones could be explored (Schreier and Brown 2002).

It is unclear what additional synthesis will take place before publication of the Mill Creek Basin Plan. WLRD is aware that projects were recommended in an isolated manner and thus their joint functions or dysfunctions are unknown. It is possible that not all recommended projects will make it into the Mill Creek Basin Plan (Knauer 2002). Synthesis of existing and all additional information should occur through the use of matrices, additional GIS, and/or modeling. Given that King County is on a limited budget, simply displaying the information in matrices and on maps with multiple GIS layers will improve the synthesis considerably.

King County plans to create action and implementation plans for the Mill Creek Basin Plan (Knauer 2002). At this point it is unclear what those plans will consist of and whom they will involve (Knauer 2002). A monitoring plan should be created; however, it is unclear if there are plans to draft one (Knauer 2002). Desirable characteristics of these plans and of a planning and management framework are discussed in Sections 3.4.4.2-3.4.4.5.

6 Evaluation of the Evaluative Framework

In order for new watershed management processes to benefit from the positive and negative experiences of their predecessors, research is needed to evaluate the causes of those experiences (Kerr and Brown 2002). I created a watershed management framework from the key elements of the watershed management approaches from Oregon State, Washington State and the United States federal government (EPA 1996a, 1996b; RIEC 1995; WFPB 1997; WPN 1999). Each recommended key element was further supported using the planning, resource management, and scientific literature, as well as government agency reports and reviews. Watershed approaches vary in terms of specific goals, objectives, priorities, factors, timing, and resources; however, the above watershed approaches and corresponding supporting literature indicate that there are some common principles and practices used by watershed managers and recommended by academics that have been shown to increase the likelihood of success (Pinkerton 1991). Hence, the key elements of the evaluative framework are strongly supported by the resource management community.

Evaluation of watershed management processes is difficult due to their social and technical complexity, especially if watershed process evaluators aim to learn lessons from a single watershed management process about how a similar process would perform in other settings (Kerr and Brown 2002). By creating an evaluative framework, I was able to combine the lessons from a number of watershed approaches, and then use the framework to evaluate the success (or potential for success) of a watershed management process.

6.1 Advantages and Disadvantages of Using an Evaluative Framework

When applying a framework to a watershed management process, there may be a pre-existing sense of success or failure of the process either in the community or within the sponsoring organization. Application of a framework can validate or falsify the "opinion" of stakeholders as to whether the process was a failure or success. A framework provides a structure with which to pick apart a process in a formal and organized manner. Common sense suggests that by breaking a process up into distinct components, even if those components occur iteratively, one can start to look at the execution of each component in isolation and then analyze the interaction of the actions and outcomes of that component with those of others. An effective framework will elucidate elements of the process that lead to success or failure.

A framework is standardized, ensuring that each watershed management process will be subject to the same evaluative process. Standardization can be considered a disadvantage as a process may not conform with a framework due to local constraints, and creative solutions applied to these constraints may not be acknowledged while using a standard format of evaluation.

This highlights the need for users of the framework to be knowledgeable about its limitations when applying it (see Section 6.2.4). In addition, users need to be sensitive to the specific context of the watershed management process, being aware of unique constraints and opportunities. This implies a need for flexibility when applying the framework, and a need to be conscious of adjustments made by stakeholders to compensate for constraints and opportunities.

6.2 Evaluation of the Evaluative Framework

6.2.1 Use of the Evaluative Framework for the CIP

Because the CIP process is in draft form and none of its recommendations have been implemented, outcomes of the process are unknown. For this reason potential outcomes were discussed in this report. By applying the evaluative framework to the CIP process, missing key elements were identified and hypotheses were formed as to the connections between those missing factors and certain outcomes (Chapter 5 and Table 5.2). Framework key elements that were included in the CIP process were also identified and hypotheses were formed as to the connections between those factors and certain outcomes. Those hypotheses were based on support from the literature as to potential results of including or not including certain elements in a watershed management process. Some of the outcomes were direct and concrete. For example, the lack of a social scientist and planner within SWEES resulted in human society not being characterized. However, outcomes from the lack of other key elements, such as public involvement, were speculative, even though they have a great deal of support from the literature, as public support for the process is unknown and only a few stakeholders have expressed their opinion about this issue (Clark 2002; Walters 2002). The final step was to make recommendations for future actions to help correct some of the apparent flaws in the process. The user of a framework as an evaluative tool acts like a doctor: by observing what factors have strayed from the "healthy" template, they diagnose what is "wrong." More important, however, is the determination of how to remedy the situation.

Table 5.2 shows that 26 components of the 14 key elements were included in the CIP process while 36 components were not. The components do not have equal weight in terms of importance or impact but these numbers indicate that a significant number of components that improve the chance of success of a watershed management process were missing. What the framework elucidated most effectively was the sponsor's lack of adequate human and financial resources, minimal involvement of stakeholders other than the sponsor, and the complete lack of action, implementation, or monitoring plans and thus lack of a planning and management framework.

6.2.2 Use of the Framework as a Management Checklist

The evaluative framework could potentially function as a management checklist in the early stages of planning a watershed management process, thus acting like a consolidated and simplified version of the four management frameworks used to create it (EPA 1996a; RIEC 1995; WFPB 1997; WPN 1999). The evaluative framework is more flexible than the frameworks used to create it, as it does not have specific steps to follow or data sheets to fill in. It also incorporates elements of other models for watershed assessment.

Situations will arise in any watershed management process where constraints on time, or human or financial resources make it impossible to fulfill every element of the evaluative framework. By acknowledging that a certain aspect of the framework is not being satisfied, the sponsor, project manager, members of the technical team, and other stakeholders can make adjustments to compensate for a missing element either by attempting to fill a position with someone less qualified or by at least acknowledging that the resource or data gap exists as the process continues.

6.2.3 Using the Evaluative Framework for Other Watershed Management Processes

The evaluative framework could be used to evaluate any watershed management process. As stated in Section 6.1, the person applying the framework needs to be flexible and conscious of the specific context, always mindful of stakeholder efforts to compensate for constraints.

6.2.4 Limitations of the Evaluative Framework

The framework is a qualitative tool. Key elements and phases are not weighted equally so that a purely quantitative presentation of number of key elements or phases satisfied would be misleading in terms of the quality and effectiveness of the process. Qualitative researchers place an emphasis on context and on understanding the subtle manifestations and determinants of project success, usually by tapping the diverse perspectives of multiple stakeholders (Kerr and Chung 2002). If a quantitative evaluation was combined with this framework it would undoubtedly make it stronger. Quantitative studies, however, also have limitations. Experimental project sites are not likely to be replicated exactly in other sites and an experimental program is likely to be carried out differently than the program in the management plan (Kerr and Chung 2002).

The framework does not give credit for efforts that are outside of the scope of the key elements, whether they are successful or not. The evaluator applying the framework must be aware of sponsor and stakeholder attempts to implement or achieve each key element. In cases of failure, it is important to make note of intent and suggest how to improve upon certain actions.

The framework does not suggest all possible alternatives for satisfying a key element, and thus the evaluator must judge the effectiveness of the action based on stakeholder response, usefulness of information gathered in addressing stakeholder goals, or improvement in understanding through synthesis. For example, if stakeholders synthesize information in a very low-tech fashion it does not necessarily make it less effective in that context.

Finally, the framework does not come with a complete how-to manual, thus application of the framework will not be standardized. The framework is a subjective tool which makes use of the weight of evidence from the resource management community.

7 Final Remarks

This evaluation of the Mullen Slough CIP process has demonstrated the usefulness of a watershed management framework developed from other leading watershed approaches. The evaluation revealed that many key elements of watershed management that were thought to be essential in other settings were either inadequately addressed in, or missing from the CIP process. My evaluation and recommendations should help King County to learn from this experience and improve its future watershed management efforts.

There are also at least two important broader lessons for watershed management that may be drawn from this study. As this is a single case study, additional research will be required before these lessons can be generalized, but they are sufficiently important to call for further analysis in other settings.

First, a fundamental principle in the evaluative framework and in the literature on watershed management is that the social and natural science watershed components should be synthesized; however, because there are no key elements or principles in the framework outlining how this integration should occur, the framework is inadequate for evaluating or guiding the integration of the natural and social sciences. Other authors have criticized the ability of other watershed management frameworks to guide integration of social and natural sciences information (Montgomery et al. 1995; Frissell and Bayles 1996).

One major problem in existing frameworks is that social information is viewed as being useful only after characterization and synthesis of the biophysical components of a watershed (Montgomery et al. 1995; Frissell and Bayles 1996). This stems from the inherent difficulty of combining physical data with social information. This is illustrated in the Draft CIP in that land use and other physical human elements were included in the Watershed Characterization and Watershed Condition Evaluation because these are physical elements, but human values, economics, and politics that influence these physical elements will not be incorporated until the planning phases, if at all.

There is a need in watershed management for some common principles to guide the collection and integration of natural and social science information and the use of this integrated information to inform management decisions (such as creation and selection of recommended actions). There are many existing types of decision-making tools for watershed management, such as decision trees, matrices, and complex models that could be adapted for the above purposes. If watershed managers are to begin using social information at each step in the process, then principles for its use must be incorporated into the existing watershed management frameworks.

The second broad lesson from this case study concerns the choice of sponsor. King County was a good choice for a sponsor due to their experience in Watershed Planning in the Green River watershed, their jurisdiction over much of the Green River Watershed, and their large and multi-disciplined staff. However, the major disadvantage of having King County as sponsor is their reputation in the region. Many citizens in King County do not trust King County staff to run an open and honest process (Koester 2001). King County has a reputation of not involving the public in management processes and of making decisions behind closed doors. Mullen Slough sub-basin citizens are not surprised that there was no stakeholder process, and they are dissatisfied with the process generally (Bethel 2002). In addition King County has a reputation for doing a lot of planning but little implementation. For example, complaints about blocked culverts that have not been fixed for years are common (Koester 2001). Also, the public reputation of King County as a whole is often based on experiences with one of its Departments, the Department of Development and Environmental Services (DDES), which is the regulatory and permitting arm of King County. Farmers in the Mullen Slough sub-basin are unhappy about not being able to acquire permits to dredge their ditches to remove the built up sediments (Bethel 2002; Koester 2001), and this has shaped their impressions of King County.

The example of King County illustrates that any sponsor will come with its own way of doing things as an institution, and often with its own history in the community. If a sponsor is aware of its reputation with stakeholders, it can attempt to improve some of the negative aspects of its "way of being" or it can explain to the public why in the past, certain things have happened which displeased the stakeholders. The first step for the sponsor then, is to acknowledge negative aspects of its reputation. Early and ongoing public involvement and input, if it is fair and open, can begin the process of creating a sense of trust between the sponsor and stakeholders. By simply being present and part of the community, the sponsor is more likely to notice dissatisfaction as it arises and can address it early before it worsens. If the original sponsor's reputation is so bad that many stakeholders will not participate, and if another sponsor is available, then the original sponsor should consider stepping down to facilitate a more stakeholder-driven process. Alternatively, the original sponsor could take on a funding and oversight role, while a more trusted body takes on the actual planning and management.

1 Appendix 1: Relevant Institutions, Laws, and Non-Regulatory Programs in the United States and Washington State

The main natural resource management issues in the Mill Creek basin and Mullen Slough sub-basin, as identified in the SAMP and Draft CIP, are flooding, wetland preservation vs. development, and degradation of salmonid habitat and water quality. Because watershed management involves managing the uses of both water and land it is difficult to find a law that is not relevant to watershed management in some way. This appendix introduces the laws, practices, policies, and institutions that deal with and are particularly relevant to the management of flooding, wetlands, salmonids, and water quality in the Mill Creek basin, King County, Washington.

1.1 Relevant Institutions and Agencies

1.1.1 Federal

The mission of the United States Environmental Protection Agency (EPA) is to protect human health and to safeguard the natural environment with comprehensive regulatory authority over air, water, and land (EPA 2002). The EPA is charged with regulating point and non-point sources of pollution through administration of the federal *Clean Water Act* (CWA) (33 U.S.C. s/s 1251 et seq. 1977). EPA leads the nation's environmental science, research, education and assessment efforts. They work closely with other federal agencies, state and local governments, and Indian tribes to develop and enforce environmental regulations. EPA is responsible for researching and setting national standards for a variety of environmental programs and can then delegate to states and tribes the responsibility for issuing permits, and monitoring and enforcing compliance (EPA 2002).

The U.S. Department of Agriculture (USDA) is responsible for supporting and regulating agriculture. The Farm Service Agency (FSA) and the Natural Resources Conservation

Service (NRCS) are agencies within the U.S. Department of Agriculture. The FSA provides farm loans, conservation programs, and emergency assistance for farmers (FSA 2001). The NRCS works in assisting private landowners with conserving their soil, water, and other natural resources. They provide technical assistance, cost shares, and financial incentives for their voluntary programs through partnerships with local entities such as conservation districts (NRCS 2002).

The Department of Commerce's National Marine Fisheries Services (NMFS) is concerned with rebuilding and maintaining sustainable fisheries through recovery of protected species and protection and maintenance of the health of coastal marine habitats (NMFS 2000).

The Department of Interior has a broad range of goals for the public lands and people it manages and the scientific studies it conducts. The United States Geological Survey (USGS), the United States Fish and Wildlife Service (USFWS), and the Bureau of Indian Affairs (BIA) are agencies within the Department of Interior. USGS is the science arm of the Department of Interior. It is non-regulatory and provides both policy relevant and policy neutral science to help resolve complex natural resource problems (USGS 2002). The USFWS works with others to conserve, protect and enhance fish, wildlife and plants and their habitats (USFWS 2001b). It manages the National Wildlife Refuge System and operates National Fish Hatcheries. It enforces federal wildlife laws, administers the *Endangered Species Act* for listed inland species, manages migratory birds, restores nationally significant fisheries, and conserves and restores wildlife habitat such as wetlands (USFWS 2001b). The BIA serves as an advisory agency to Indian tribes in the United States. Historically, the BIA distributed food and other supplies to tribes and acted as tribal government by operating schools, dispensing justice, distributing supplies, administering allotments, and leasing contracts. Currently, tribes are progressing towards self-determination and self-governance (Henson 1996). The Muckleshoot Indian Tribe (MIT) resides in the Green River Watershed. They have fishing rights and partial authority over salmon habitat protection in this watershed under the Boldt Decision (U.S. v. Washington, 384 F. Supp. 312. 1974). In Washington State tribes are entitled to fifty percent of the salmon catch within their "usual and accustomed area" or the area historically fished by them. This makes salmon habitat protection of paramount importance for them. Local, state and federal agencies are required to submit copies of permit applications that have the potential to affect salmon habitat to their local tribe for review. Tribes have the ability to contest permit authorization.

The United States Army Corps of Engineers (USACE), within the Department of the Army, has regulatory authority over navigable rivers and wetlands under Section 404(d) of the Clean Water Act. They review permits for the altering of wetlands or placement of "fill" in United States waters (USACE 2002b). They manage the associated mitigation for cumulative impacts to the environment. Some major principles of the USACE are environmental sustainability, stakeholder input (defined in Section 4.1.3), a balance and synergy among human development activities and natural systems, and development and use of an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and human impacts (USACE 2002b).

1.1.2 State

The Washington Department of Ecology (WDOE) is Washington's principal environmental management agency with a mission to protect, preserve and enhance the environment, and promote the wise management of air, land and water (WDOE 2002). Their goals are to prevent pollution, clean up pollution, and support sustainable communities and natural resources. WDOE administers the Washington State *Dairy Nutrient Management Act* (Chapter 90.64 RCW) and through its partial authority to administer the federal *Clean Water Act* (CWA) (33 U.S.C. s/s 1251 et seq. 1977), sets and enforces state water quality standards (WDOE 2001). In addition, WDOE provides ongoing oversight of watershed action plans and audits each watershed action plan every two years to ensure consistent and adequate implementation (WAC 400-12-635).

The Washington Department of Fish and Wildlife (WDFW) is the primary manager of fish and wildlife in the state (WDFW 2001). They conduct research for fisheries and wildlife science. They manage fisheries harvest, hatcheries, and habitat as well as wildlife and hunting reserves. They are a regulatory body, in charge of reviewing and issuing Hydraulic Permit Approvals (HPA) for any work in state waters, such as lakes, rivers, and streams (WDFW 2001).

The Washington State Conservation Commission (WSCC) assists and guides local conservation districts which protect soil and water quality in agricultural areas. The Commission is made up of landowners, farmers, state agency directors and a University Dean (WSCC 2002a).

The Salmon Recovery Funding Board (SRFB) was formed to restore endangered and threatened salmon stocks in Washington State, under the Pacific Salmon Recovery Act of 1999 HR2798 (Salmon Information Center 1999). Their mission is "to support salmon recovery by funding habitat protection and restoration projects, and related programs and activities that produce sustainable and measurable benefit for the fish and their habitat." They manage the distribution of millions of federal and state dollars allocated for salmon recovery each year. The board is made up of five citizen members appointed by the Governor and five state agency representatives from WDFW, WDOE, WSCC, the Washington Department of Natural Resources (WSDNR), and the Washington State Department of Transportation (WSDOT) (Salmon Information Center 1999).

1.1.3 Local

King County has jurisdiction over the entire Green River watershed. King County has nine departments, two of which are relevant to the Mill Creek basin. The Department of Natural Resources and Parks (DNRP) manages fish, wildlife, and open space in the county (King County 2002b). DNRP is also concerned with the preservation of prime agricultural soils, the promotion of environmentally friendly agricultural practices, and the enhancement and promotion of commercial agriculture in King County. They protect the county's water, land and natural habitats, supporting sustainable communities and the safe disposal of and reuse of wastewater and solid wastes. DNRP conducts extensive scientific research related to local fish and wildlife and is active in salmon recovery (King County 2002b). The Department of Development and Environmental Services (DDES) issues building and land use permits for properties in unincorporated King County. They enforce county land use and building codes, with regulatory authority over water, flood zones, and sensitive areas (King County 2002c).

Conservation districts are non-regulatory bodies that provide technical and financial resources to local landowners and farmers (WSCC 2002b). They are funded through a five dollar tax on every land parcel in King County. The Washington State Conservation Commission, described in Appendix 1.1.2, provides leadership, partnership and resources to support locally governed conservation districts. There are forty-eight conservation districts in Washington State with service areas that generally correspond with county boundaries. Their primary function is to help landowners conduct on the ground restoration and conservation, and implement best management practices on their land. They are responsible for helping farmers to design and implement farm plans under the Clean Water Act (WSCC 2002b).

1.2 Relevant Laws

1.2.1 Federal

1.2.1.1 Endangered Species Act (ESA) Title 16 Chapter 35 Sec 1531-1544

The Endangered Species Act (ESA) was passed in 1973. The U.S. Congress found that "..various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern and conservation. Other species of fish, wildlife, and plants have been so depleted that they are in danger of or threatened with extinction. These species of fish, wildlife, and plants are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people…" (ESA Sec. 2(a)).

The Act casts a very broad net as its purpose is to conserve and recover threatened and endangered species and preserve the habitat or ecosystems that they depend on (Northwestern School of Law 1998). It also protects any part, product, egg or offspring and the dead body or parts of an endangered species. It is an ambitious and sophisticated statute as it ties the animals to their habitat. This can be a problem when the species have broad habitats, which is the case for pacific coast salmon. Other statutes that deal with animals and habitats allow for multiple uses but under ESA the objective is to protect the animals and their habitats and for the most part there are no economic considerations. The ESA is a safety net before extinction, an indication that local and state governments have done a poor job of managing wildlife and their habitats. The act contains a citizen provision, meaning that citizens can petition to have a species listed and can sue an individual that they suspect is harming an endangered species (Northwestern School of Law 1998).

The United States Fish and Wildlife Service (USFWS), in the Department of the Interior, and the National Marine Fisheries Service (NMFS), in the Department of Commerce, share responsibility for administration of the ESA. NMFS is responsible for marine or anadromous species while USFWS is responsible for inland species (NMFS 2000; USFWS 2001b).

In Washington State, wild salmonids including salmon, trout, and char are a valuable natural resource that are suffering rapid population declines from over fishing, habitat destruction, and competition with hatchery stocks. Because salmonids are anadromous, spawning in rivers and maturing at sea, they occupy and therefore rely on diverse environments to complete their life cycle. In March 1999, NMFS listed the Puget Sound chinook salmon as a threatened species under the ESA (WSCC 2000a). Puget Sound chinook salmon use the streams, sloughs and wetlands of the Mill Creek basin.

1.2.1.2 Clean Water Act (1972)

The Clean Water Act (CWA) (33 U.S.C. s/s 1251 et seq. 1977) is an amendment to the Federal Water Pollution Control Act of 1972, which created the framework for regulating point source discharges of pollutants into the waters of the United States. The CWA consists of two major parts, a financial assistance program for municipal sewage treatment plant construction and regulatory requirements to protect water quality. The regulatory part of the CWA is relevant to this report. Section 301 of the CWA makes it illegal to discharge any pollutant into US navigable waters, except as allowed by National Pollutant Discharge Elimination System (NPDES) permits issued under Sections 402 and 404. Authorized by Section 404 the USACE, subject to and using the EPA's environmental guidance, administers the permit program for disposal of dredge or fill material in the nation's waters, including wetlands. Exempt activities include certain farming, ranching, and forestry practices which do not alter the use or character of the land. When issuing Section 404 permits, the Corps is required to coordinate with the implementation of other statutes and executive orders. This can be one of the more lengthy steps in permit review. The USACE must follow guidelines for thorough consideration of less environmentally damaging practicable alternatives (CWA Sec. 404(b) (1)).

The CWA allows EPA to delegate permitting, administrative, and enforcement aspects of the law to state governments. In Washington State the EPA has given partial authority to the Department of Ecology (DOE), to manage the inspection, permitting and enforcement of the Clean Water Act. If EPA does delegate they retain oversight responsibilities. The Act requires each state to establish water quality standards for all bodies of water in the state. Non-point sources of pollution, such as pesticide and fertilizer residues in runoff from farm fields, are not subject to CWA regulations. They are covered by state runoff management programs under Section 319. Individuals may bring a citizen suit in U.S. district court against persons who violate an effluent standard or against the EPA Administrator or equivalent state official for failure to carry out a nondiscretionary duty under the Act.

1.2.2 State

1.2.2.1 Watershed Management Act (RCW 90.82)

In 1998, the Washington State Legislature passed the Watershed Management Act (ESHB 2514) to provide a framework for local citizens, interest groups and government organizations to collaboratively identify and solve water-related issues in each Water Resource Inventory Area (WRIA).

“The purpose of (the Act) is to develop a more thorough and cooperative method of determining what the current water resource situation is in each WRIA of the state and to provide local citizens with the maximum possible input concerning their goals and objectives for water resource management and development” (RCW 90.82.005).

Under the law, citizens, local governments, tribes, and other members of a planning unit have flexibility to design the planning process, focus on issues and particular elements of importance to local citizens, assess water resources and needs, and recommend management strategies. The law requires that grant money be used to address water quantity issues and recommends the option of assessing water quality, fish habitat, and instream flows. The initiating governments include county, city, water supply utility, and tribal representatives. The initiating governments are also responsible for forming a planning unit to include broad representation of water-resource interests in the watershed. Once the planning unit has been formed, they conduct the initial organization, watershed assessment and produce the final watershed plan.

1.2.2.2 State Environmental Policy Act (SEPA) Chapter 43.21C RCW

The Washington State Environmental Policy Act provides a method for determining possible environmental impacts that may result from governmental decisions. These decisions may be related to issuing permits for projects in the private sector, construction of public facilities, or adoption of policies, regulations, or plans. The WDOE is the agency with SEPA authority. Sometimes they delegate this authority to a local government agency. The applicant fills out a checklist, which is a long list of questions about potential environmental, social and economic effects on water, air, and land. The agency with SEPA authority must make a determination of effect or no-effect within ninety days after the application and supporting documentation are complete (RCW 43.21C.033 (1)). Once a determination has been made the agency with SEPA authority must, at a minimum, post a public notice at the project site and post the review period in a major local newspaper. The public then has 14 days to comment on or appeal the determination.

1.2.2.3 Growth Management Act (GMA) Chapter 36.70A RCW

The Growth Management Act (RCW 36.70A) was adopted because the Washington State Legislature found that uncoordinated and unplanned growth posed a threat to the environment, sustainable economic development, and the quality of life in Washington (RCW 36.70A.010). The GMA requires state and local governments to manage Washington's growth by identifying and protecting critical areas and natural resource lands (RCW 36.70A.060), designating urban growth areas (RCW 36.70A.110), preparing comprehensive plans (RCW 36.70A.040) and implementing them through capital investments and development regulations (RCW 36.70A.070).

1.2.3 Local

1.2.3.1 King County Agricultural and Open Space Lands Ordinance (KCC Title 26-04)

In 1979, King County Ordinance 4341 was passed to create a program for preserving agricultural and open space land in King County (RCW 26.04). The program allows King County to set up a bond in order to purchase development rights, conservation easements, or outright fee simple ownership of lands deemed worthy of preservation for public benefit. The Farmland Preservation Program (FPP), was one outcome of this ordinance (King County 2000b). See Appendix 1.3.3 for information about the Farmland Preservation Program.

1.2.3.2 King County Sensitive Areas Ordinance (KCC Title 21A-24)

The King County Sensitive Areas Ordinance (SAO) was enacted to implement the goals and policies of the Washington State Environmental Policy Act (RCW 43.21C), and the King County Comprehensive Plan which call for protection of the natural environment, public health, and safety (King County Code 21A-24). The ordinance attempts to prevent cumulative adverse environmental impacts and protect wildlife and wildlife habitat. In addition it seeks to protect members of the public from injury or loss due to landslides, seismic events, flooding, and steep slope failure. The ordinance outlines development standards, permitted alterations, and requirements for mitigation, maintenance, and monitoring of sensitive areas. Sensitive areas include wetlands, streams, shorelines, and their buffers as well as landslide and steep slope hazard areas. The ordinance is administered by the King County Department of Development and Environmental Services (DDES).

1.3 Relevant Processes, Programs, and Practices

1.3.1 Tri-County Initiative to Recover the Puget Sound Chinook

In Washington State, King, Pierce, and Snohomish counties are developing comprehensive habitat conservation/restoration plans in order to take a coordinated adaptive-management approach to conservation (Tri-County ESA Response Team 2000). The framework they create will act as a 4(d) Rule Proposal, and the National Marine Fisheries Service (NMFS) will determine if the actions are adequate to protect salmon listed under ESA and their habitat. If NMFS accepts the proposal, then the cities and counties that agree to abide by the provisions of the 4(d) Rule can act without fear of violating the ESA (Kattelmann 1999). The plan proposes to improve storm water management, enhance regulation of grading actions, and restrict further development or destruction of sensitive areas (wetlands and steep slopes). The 4(d) Rule Proposal does not address harvest, forest practices, or hatchery management which are addressed by NMFS in its proposed West Coast 4(d) rule (Tri-County ESA Response Team 2000).

1.3.2 The Lead Entity Process for Salmon Recovery

In response to the listings of salmonids under ESA, the Washington State Legislature passed three laws, house bills 2514 and 2496 and senate bill 5595, to direct watershed planning in a sustainable manner that would not imperil salmonids. The laws contain directives about geographic areas, organizational structures, and funding mechanisms for planning at a watershed level. Watershed planning units are called Water Resource Inventory Areas (WRIAs) (WSCC 2000a). The appointed lead entity of a WRIA, can be a county government, an independent council, or a nonprofit organization. King County has WRIA 8 (Cedar River/Lake Washington) and WRIA 9 (Green River) within its boundaries. The county serves as the lead entity for both WRIAs 8 & 9. A lead entity's role is to identify steering and technical committees who prioritize funding for salmon conservation, solicit project applications, develop a strategy for addressing habitat limiting factors to salmonid recovery within their boundaries, and create a list of projects for the Salmon Recovery Funding Board (see Appendix 1.1.2).

1.3.3 King County Farmland Preservation Program

The Farmland Preservation Program (FPP), was one outcome of the King County Agricultural and Open Space Lands Ordinance (King County 2000b), described in Appendix 1.2.3.1 above. Under the FPP, King County purchases the development rights of property in agricultural use. The property owner receives a one time payment for the development rights of the property and also receives a reduction in annual property taxes. The land is then bound by and permanently subject to a set of restrictive covenants, terms, and conditions. If the grantor (landowner) decides to break the contract they must pay back seven years of reduced taxes (King County 2000b).

2 Appendix 2: Watershed Management Evaluative Framework with Support from Literature

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Start-up	Identification and designation of those stakeholders who will conduct the research and mange the process: • sponsor • project manager • research team members	Identify assessment team **(WPN 1999).** Identify and form the assessment and field manager teams **(WFPB 1997).**	Sponsor (who the sponsor is can make a difference as to the goals, outcomes, and process used) 1) Local lead agency must have a clear sense of purpose and the authority to assure implementation of plan recommendations. (Sometimes this can be done through signed agreements, rather than having a regulatory body be the sponsor) 2) Agency overseeing the planning grant should be willing to intervene in a project which is not proceeding successfully, but should avoid creating rigidities. Senior levels of government need to take on oversight and supportive stances, during and after the process **(Pinkerton 1991).** Sponsors need to take an active management orientation **(Slocombe 1998).** Technical Advisors/Leads for each characterization step For each step in the watershed assessment process, the manual outlines the skills necessary to conduct each task, to help build a good assessment team and to identify training needs **(WPN 1999).** The watershed process does not need to be funded and managed by the same body. Having one organization or agency sponsor the process and another manage or conduct scientific studies can be a good model for minimizing any attempts of a managing body top forward its agenda **(Pinkerton 2002).** Project Manager/Facilitator/Coordinator Coordinator of the planning process must be highly experienced in interest-based planning. Skills: Providing private caucuses, establishing a sense of fairness, building consensus, and knowing how not to “ talk down” **(Pinkerton 1991).** Project Manager should have good organizational and communication skills. Meeting facilitation skills will help focus community meetings and build support for the assessment process **(WPN 1999).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Start-Up	Definition of management region and boundaries	Define management or assessment region **(WPN 1999).** **Geographic Focus** Activities are directed within specific geographic areas. Defined by surface or ground water **(EPA 1996a).** Define the scale of analysis (River basin, subbasin, watershed, subwatershed, drainage or site) **(RIEC 1995).**	Place-based. Boundaries of the place of concern must be clearly and formally defined **(Lakey 1998).** Define the ecosystem naturally (bioregionally instead of arbitrarily) **(Slocombe 1998).** Ensure that there is an operational or administrative body (**Slocombe 1998:33).** Define the area of concern / interest **(Szaro 1998).** Plan must address entire watershed (WRIA or group of WRIAs) **(WDOE 1999).** Local stakeholders may be interested in helping to define the management region, so this should be re-visited after their recruitment into the process **(Rutherford 2002).**
	Coordination of involvement and participation of stakeholders who will conduct tasks other than scientific research or management	Coordinate stakeholder input, involvement, and education **(WPN 1999).** **Partnerships** Stakeholders: Those people most affected by management decisions are involved throughout and shape key decisions. People who depend upon the natural resources within the watersheds need to be well informed of and participate in planning and implementation activities **(EPA 1996a).**	Team, Project Manager and Advisors meet with Watershed Council to start ID issues and to discuss ways to involve all stakeholders in the watershed. Hold informal meetings with local community groups **(WPN 1999).** 1) Selection of watershed committee members must include a balance of representatives from all the affected local interests. Especially including group(s) with power and influence to damage community support. No sector should have a majority. Screening process OK. Less qualified committee, increases need for a qualified coordinator. 2) Community support for the plan will be strongest where a local constituency is built through community education and participation in volunteer projects. volunteer projects, teachers, WSU-type education for community time programs**. (Pinkerton 1991).** (reference continued below)

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Start-Up	Coordination of involvement and participation of stakeholders who will conduct tasks other than scientific research or management **(continued)**	Early, open, and frequent participation in the process by public stakeholders is encouraged **(RIEC 1995).** Notify landowners, local governments, tribes, DNR, other state agencies, and the public **(WFPB 1997).**	3) Technical and educational resources must be available to the coordinator and must be used judiciously by the coordinator. Experienced coordinators spent a great deal of time in first 2-3 months, educating the public/committee. A technical committee can meet separately and help develop educational materials for the watershed committee. Government agencies can help provide educational materials. Use one meeting to educate committee on group process. Guest speakers are helpful. Watershed committee members must become active participants in the education process **(Pinkerton 1991).** Guidance for clarifying the "public interest" for the purposes of water rights decisions in the watershed. The planning process must be broadly inclusive and include public input **(WDOE 1999).** 1) Develop an initial synthesis as a springboard for the future. 2) Use local and traditional knowledge. When you have information, use it: analyze, map, simulate, discuss. 3) Disseminate information and research**:** Make information available within and outside the ecosystem. Interpret and present information in several different ways. 4) Be practical; when resources are limited focus on understanding that will make a difference **(Slocombe 1998).** Facilitated, representative, scoping workshops and ongoing consultation **(Slocombe 1998).** Stakeholders need to be involved in: 1) Developing a shared vision of the ecosystem's desired future condition 2) Establishing ecosystem goals and objectives 3) Developing and implementing an action plan based on selected alternatives for achieving the goals **(Szaro 1998).** Society determines the desired conditions of the "assessment space" (watershed) as determined by cultural values and laws. A location outside of the assessment space is a departure from desired social benefits **(Landis & McLaughlin 2000).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Start-Up	Definition of broad goals and identification of major issues	Identify and define the management issues / concerns (BROADLY) **(WPN 1999).** Team defines the problems in the watershed by answering a series of questions **(WFPB 1997).** Identification of Major Problems: prioritize them **(EPA 1996a).** Once a list of issues is compiled, teams should make a preliminary assessment of priorities **(RIEC 1995).** Iterative process Begin gathering existing data **(WPN 1999).** Collect required information and materials **(WFPB 1997).**	Critical watershed issues should be identified early in the process to help focus the watershed assessment. Use regulatory listings and land use categories to organize potential watershed issues. Not ALL stakeholder concerns will be addressed **(WPN 1999).** Facilitated, representative, scoping workshops and ongoing consultation **(Slocombe 1998).** ID key water resource problems and issues in the watershed **(WDOE 1999)** Define broad goals first to focus on desired outcomes. Identifying issues can start the process off in a negative mindset **(Rutherford 2002).** First step is to use public outreach to identify issues **(Reid et al. 1994).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Start-Up	Creation of more specific goals	Begin creating goals **(WPN 1999).** Goal Setting: and identification of environmental objectives based on the condition or vulnerability of resources and the needs of the aquatic ecosystem and the people within the community **(EPA 1996a).**	Clear goals and objectives need to be stated early. Consensus goal definition and related planning for their achievement **(Slocombe 1998)** Terms such as sustainability, ecosystem health, biological integrity, and biological diversity if used at all should be clearly defined – specifically the time frame of concern, the benefits and costs of concern, and the relative priority of the benefits and costs **(Lakey 1998).** 1) Coordinator must provide guidance to the watershed committee in how to set and reach long-term goals. Coordinator must present educational materials WHILE eliciting the concerns of the different community interests. Thereby "the problem of how the community was (or soon would be) in violation of (some) standards was set in the context of increased understanding and respect for the needs of different interest groups. Solution VS blame approach. 2) Coordinator must help build consensus among committee members. Process starts with polarized issues (or potentially polarized). Types of pollution rather than sources (blame again). Explore issues in smaller groups: sub-committee approach, OR encourage people to stop by office outside of meetings, Helps quieter ones express concern (coordinator can help them articulate the problem more clearly.. and less confrontationally). This also helps people express "needs" instead of "positions" **(Pinkerton 1991).** If the local stakeholders have goals for themselves as a community, determine what their goals are for working together as a community. If people in the community have not worked together before it will be a large step to get everyone to work together **(Pinkerton 2002).** 1) Establish ecosystem goals and objectives with all stakeholders 2) develop a shared vision of the ecosystem's desired future condition with all stakeholders **(Szaro 1998).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Start-Up	Creation of more specific goals **(continued)**		1) Maintain ecosystems in the appropriate condition to achieve desired social benefits. Desired social benefits are defined by society not scientists. 2) Current social values and priorities reflect a stage in their continuing evolution. It is neither a beginning nor an end. 3) Science is one element in a decision-making process that is fundamentally one of public or private choice. 4) Biological diversity is not always a desired social benefit. 5) Fundamental public and private values and priorities are in dispute, resulting in partially or wholly mutually exclusive decision alternatives. 6) Public and private stakes are high, with substantial costs and risks of adverse effects (some irreversibly ecologically) to some groups regardless of which option is selected **(Lakey 1998).** Setting priorities for action allows public and private managers from all levels to allocate limited financial and human resources to address the most critical needs **(EPA 1996A).**
Watershed Characterization	Identification of data gaps and statement of assumptions	Review data and identify gaps (including missing stakeholders and gaps in local knowledge) **(WPN 1999)** Identify and document data gaps. State implications, recommendations for prioritizing data collection and assumptions used in the absence of data **(RIEC 1995)**.	List issues that will require additional assessment or data gathering. Determine if additional issues have come to light (iterative process of issue identification and definition).

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Watershed Characterization	Historical Characterization	Research , summarize, and map historical conditions **(WPN 1999).** Describe the known or inferred history of the landscape **(RIEC 1995).**	Compile history of the area. Land use, hydrology, stream channel alterations, logging, fishing, dams and dikes, land cover, fish and wildlife species and abundance, water quality etc. **(WPN 1999).** Characterize the historical ecosystem **(Szaro 1998).**
	Identification and characterization of dominant physical, biological, and human processes and features of watershed	Conduct comprehensive scientific studies of watershed components: summarize and map **(WPN 1999).** Inventory of watershed processes and resources (Implement the inventory modules) **(WFPB 1997).** Resource Assessment and Characterization Assessment and characterization of the natural resources and the communities that depend upon them **(EPA 1996a).**	Assess Watershed Components: e.g. Hydrology and Water Use, Riparian/Wetlands, Sediment Sources, Channel Modification, Water Quality, and Fish and Fish Habitat **(WPN 1999).** 1) Analyze key water resource problems and issues in the watershed. 2) (If desired by stakeholders), Conduct an assessment of the information related to water quality issues, habitat issues, and minimum flows **(WDOE).** Conduct comprehensive studies using theory and detailed knowledge. Multidisciplinary studies **(Slocombe 1998).** If there is not enough data, use weight of evidence to form hypotheses about cause and effect. The assessment may not produce a scientifically defensible understanding of the watershed's actors and systems but there will be greater understanding than before the assessment **(Rutherford 2002).** 1) Conceptually based on ecosystem approaches. 2) Describes parts, systems, environments, and their interactions. 3) Describes system dynamics (e.g. through examples of stability and feedback) at different levels/scales. 4) Holistic, comprehensive, and trans-disciplinary. 5) Use local and traditional knowledge. 6) Be practical; when resources are limited focus on understanding that will make a difference **(Slocombe 1998).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Watershed Characterization	Identification and characterization of dominant physical, biological, and human processes and features of watershed **(continued)**	Characterize basic ecological conditions, processes and interactions/elements. Core topics include: erosion processes, hydrology, vegetation, stream channel, water quality, species and habitats, and human uses **(RIEC 1995).**	1) Characterize present economic, environmental and social conditions and TRENDS for the ecosystem. 2) Shift from a fragmented to an integrated multi-disciplinary approach **(Szaro 1998).** Can take advantage of the ability of ecosystems to respond to a variety of stressors, natural and man-made, but there is a limit in the ability of all ecosystems to accommodate stressors and maintain a desired state **(Lakey 1998).** Characterize humans and their institutions e.g. characterize the nature of the community, resources people depend on, what jobs, interests etc, by using census data, occupational data, population trends or by conducting a survey (valuation) of the community within the watershed **(WDOE 1999).** (1) Includes people and their activities in the ecosystem (land management practices such as number of trees planted, waste management practices such as amount and types of effluent dumped in waterways). 2) Incorporate Actor-System dynamics (e.g effect of poor culvert maintenance by the County on attitudes of private landowners towards maintenance of their own) 3) Analysis should include institutional factors and constraints (e.g. management record for the sponsor, type of decision-making, sponsor's regulatory authority and jurisdiction, level of internal and external support) **(Slocombe 1998).** Include human motivation and responses as part of the system to be studied and managed (e.g. willingness to pay, elasticity, responses to policy, local values, historical responses to policies and management) **(Ludwig et al 1993).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Watershed Condition Evaluation	Synthesis and interpretation of information from Watershed Characterization	Integrate and synthesize information from each component **(WPN 1999).** Team locates and maps sensitive areas, evaluates impacts of delivery, and assesses the potential or existing impacts on resources (the Ghost of Impacts Past) **(WFPB 1997).** Inventories and interpretations provide a basis for area-specific problem statements and rule calls which link forest practices, watershed processes, and resource effects **(WFPB 1997).** Synthesize and interpret information from the characterization. Explain the spatial and temporal interactions of biological, physical, and social processes at work **(RIEC 1995).** Collectively, watershed stakeholders employ sound scientific data, tools, and techniques in an iterative decision making process **(EPA 1996a).**	The synthesis should determine: hat historical, current, and future projected trends (process and structure changes) differ from stakeholder goals? (i.e. What is wrong?). What can humans do to influence those trends to move towards stakeholder goals within the physical, biological, social, and economic constraints? **(Rutherford 2002).** Comprehensive and multidisciplinary studies with integrative simulation and GIS methods. **(Slocombe 1998).** (1)Can use single-species research and small-scale research but need to integrate the results of various studies and programs to understand the larger-scale interactions, structure and function. (2) Can use models to generate hypotheses. 3) In order to understand an ecosystem, one needs to have knowledge of ecological processes at all levels (individual to system), including interactions among systems. Managing ecosystems entails sustaining these ecological processes. Pacific-salmon and spotted owls are examples of single-species focused research that has created a wealth of knowledge and understanding about Pacific Northwest ecosystems, especially forests. This is because logging (silvaculture practices) has been the land use of concern among some stakeholders in the past 40 years **(Loeb 1998).** Analyze key water resource problems and issues in the watershed **(WDOE 1999).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Watershed Management Plan	Development of specific management options, recommendations, and scenarios. Establishment of decision-making process and evaluative criteria. Prioritization and selection of best option.	Create recommendations. Establish decision-making process and evaluative criteria (For each type of resource, action, or project) **(WPN 1999).** Based on findings of assessment determine the required and voluntary forest practices for EACH identified area of resource management **(WFPB 1997).** Recommendations: Develop specific management options **(EPA 1996a).** Bring results of Evaluation to conclusion by creating recommendations for types of activities that will help meet management objectives. Potentially harmful management actions, based on watershed's risk areas, should be stated. Recommendations should be commensurate with the scale of analysis **(RIEC 1995).**	**Create Recommendations** Plan developed by the committee must include a strategy for reaching their goals, expressed in a series of recommendations which lead to an action plan. Outline: Education, Technical assistance (farm BMPs, habitat restoration), Peer pressure, Volunteer compliance / monitoring , Regulations (enforcement) (septic tank inspection, grading and filling) **(Pinkerton 1991).** Use visioning and scenario development exercises **(Slocombe 1998).** Develop and implement an action plan based on selected alternatives for achieving the goals in cooperation with all stakeholders **(Szaro 1998).** **Establish Decision-making criteria and select** Coordinator must help build consensus among committee members. Process starts with polarized issues (odr potentially polarized). Types of pollution rather than sources (blame again). Explore issues in smaller groups: sub-committee approach, OR encourage people to stop by office outside of meetings, Helps quieter ones express concern (coordinator can help them articulate the problem more clearly.. and less confrontationally). This also helps people express "needs" instead of "positions" **(Pinkerton 1991).** 1) Innovative approaches to evaluation, definition of criteria. 2) Use visioning and scenario development exercises **(Slocombe 1998).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Watershed Management Plan	Development of specific management options, recommendations, and scenarios. Establishment of decision-making process and evaluative criteria. Prioritization and selection of best option. **(continued)**	This is the stage at which risk, uncertainty, and impacts of each scenario are considered (used as criteria). A scenario that lowers all three is desirable. The full range of watershed management tools are: Physical/technical, economic, legal, political, and social means. Examples of these are structural work projects (dams), pricing or taxing changes, policy or legislation for preservation or permit streamlining, and watch-dogging **(WPN 1999).**	1) There may be substantial and intense political pressure to make rapid and significant changes in public policy. 2) "Ecosystem" and "policy problems" are meshed in a large framework such that policy decisions will have effects outside the watershed of concern 3) Fundamental public and private values and priorities are in dispute, resulting in partially or wholly mutually exclusive decision alternatives. 4) Public and private stakes are high, with substantial costs and risks of adverse effects (some irreversibly ecologically) to some groups regardless of which option is selected **(Lakey 1998).** Public or private agency making decisions.. or the public at large? What factors go into making the decisions: resource characteristics, economic efficiency, environmental impacts, and social factors. Use economic social factors for evaluating alternatives, Economic Efficiency / Social Implications & Constraints. ID and analyze alternative solutions using the full range of watershed management tools. Create strategies and mitigation options for addressing key water resource problems and issues in the watershed **(WDOE 1999).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Watershed Management Plan	Creation of action plans	Create action plans **(WPN 1999)**. Development action plans from evaluation of specific management options **(EPA 1996a).** Based on findings of assessment a “field managers” team, made up of managers and analysts, determines the required and voluntary forest practices for EACH identified area of resource management**.** The managers and resource specialists will visit the sensitive areas and ID one or more practices or strategies for EACH that are likely to prevent, avoid, or minimize problems **(WFPB 1997).**	Plan developed by the committee must include a strategy for reaching their goals, expressed in a series of recommendations which lead to an action plan. Outline: Education, Technical assistance (farm BMPs, habitat restoration), Peer pressure, Volunteer compliance / monitoring , Regulations (enforcement) (septic tank inspection, grading and filling) **(Pinkerton 1991).** Develop and implement an action plan based on selected alternatives for achieving the goals in cooperation with all stakeholders **(Szaro 1998).** Use visioning and scenario development exercises **(Slocombe 1998)**. Create strategies and mitigation options for addressing key water resource problems and issues in the watershed **(WDOE 1999).**
	Creation of implementation plan	Create an implementation plan **(WPN 1999).** Create an implementation plan **(EPA 1996A).**	Local lead agency must have a clear sense of purpose and the authority to assure ***implementation*** of plan recommendations. Senior levels of government need to take on oversight and supportive stances, during and after the process **(Pinkerton 1991).** Implement close to the ground and ensure there are some immediate, visible benefits and products. Practical incentives (not financial) (1) better access to information that is clear, understandable and useful, (2) simpler processes, (3) clearer regulations, and (4) new professional opportunities **(Slocombe 1998).** Develop water resources management program that can be sustained over time and can respond to changing conditions, new information, and evolving public priorities. The program may include a process for coordinated decision-making among the organizations designated for plan implementation **(WDOE 1999).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Watershed Management Plan	Creation of monitoring plan	Create monitoring plan **(WPN 1999).** W.A. team develops a plan to measure the effectiveness of the prescriptions **(WFPB 1997).** Identify appropriate monitoring variables and protocols to test the effectiveness of the plan using the information gathered in the assessments as a basis **(WFPB 1997).** Evaluation of effectiveness and revision of plans, as needed **(EPA 1996a).** Identify monitoring activities that address issues while focusing on watershed processes, trends, and data gaps **(RIEC 1995).**	Monitor and evaluate outcomes (successes and failures) **(Szaro 1998).** Conduct baseline and on-going monitoring of characteristics **(Slocombe 1998).** Monitoring of baseline conditions, outcomes, and stakeholder compliance needs to be part of the ACTION PLAN **(Pinkerton 1991).** Develop a long-term system for acquiring new information on key issues and trends in key water resource parameters. As new information is collected it can be used to modify the management program **(WDOE 1999).** Establishing environmental indicators helps guide activities toward solving those high priority problems and measuring success in making real world improvements rather than simply fulfilling programmatic requirements **(EPA 1996a).**

Phase	Key Element	Framework Reference	Support and Recommendations from Literature
Watershed Management Plan	Creation of a planning and management framework	Sequence for addressing watersheds that balances workloads from year to year and a specified length of time planned for each major management activity (assessment, management option development, and implementation) **(EPA 1996A).** Action Plan and Monitoring Plan is the framework **(WPN 1999).** Watershed analysis report outline recommendations and methods of implementing TYPES of activities **(RIEC).**	Keep it simple: try not to layer new levels and organizations onto existing ones; shallow hierarchies; clear chains of responsibility and decision-making; specific goals and objectives providing criteria for decision-making. Focus on management processes: information flow planning, target setting. Structure a review process to foster adaptation. Use an anticipatory, flexible, research and planning process. Sponsors need to take an active management orientation **(Slocombe 1998).** Current social values and priorities reflect a stage in their continuing evolution. It is neither a beginning nor an end (so be flexible) **(Lakey 1998).** Adapt management according to new information **(Szaro 1998).** 1) Develop a water resources management program that can be sustained over time and can respond to changing conditions, new information, and evolving public priorities. As new information is collected it can be used to modify the management program. 2) Create a long-term process for resolving disagreements over competing or conflicting uses… in the watershed. This must occur while still addressing the public interest and respecting the framework of existing laws and obligations **(WDOE 1999).**

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