# Redmond-Bear Creek Valley Ground Water Management Plan

**Draft**
November 4, 1994

**Prepared by:**
Seattle-King County Health Department, Environmental Health Division, Ground Water Section

Redmond-Bear Creek Valley Ground Water Advisory Committee

**Funded by:**
Washington State Department of Ecology

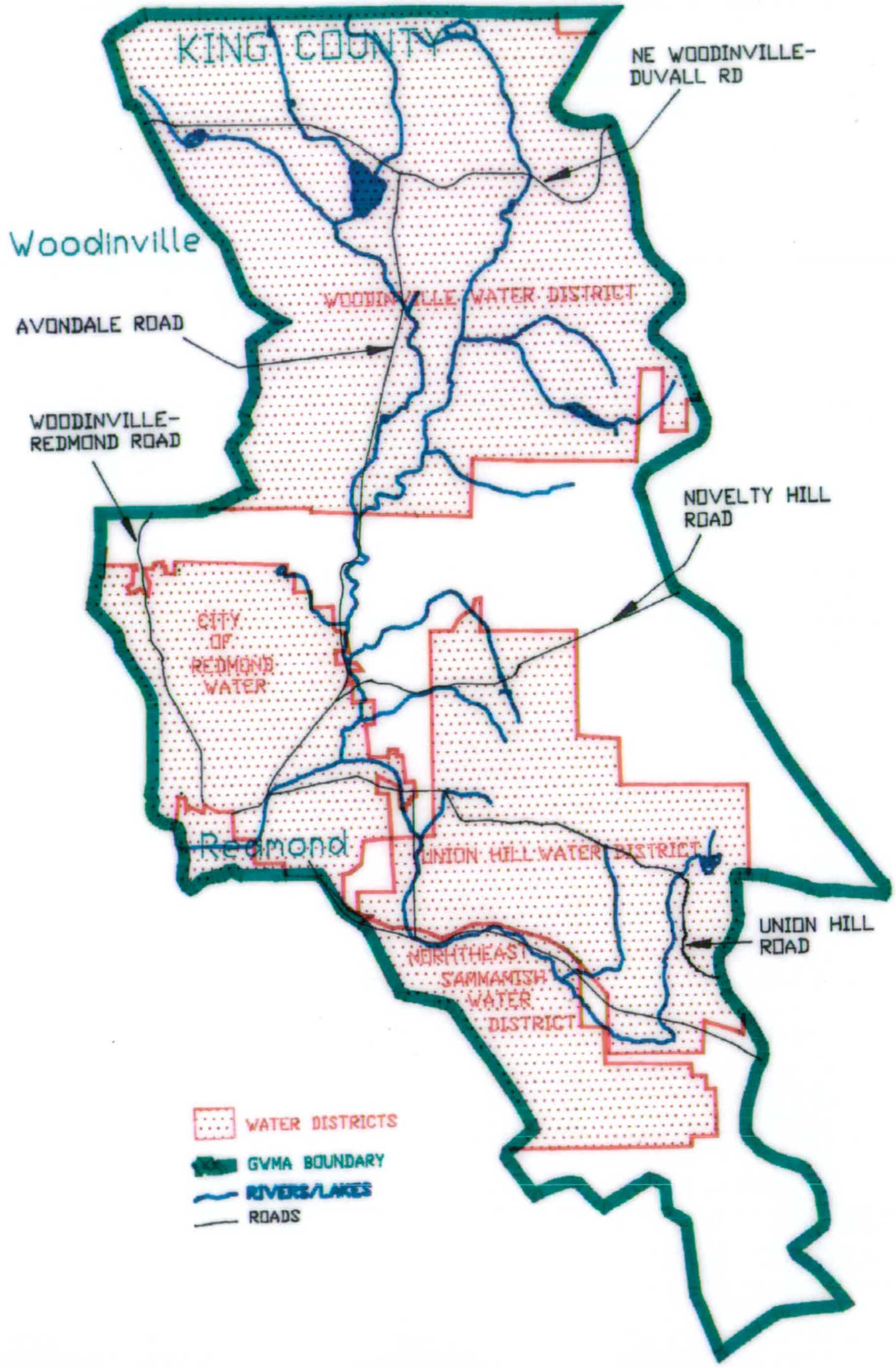
King County

City of Redmond

Northeast Sammamish Water and Sewer District

Union Hill Water Association

Woodinville Water District




WASHINGTON STATE DEPARTMENT OF ECOLOGY

CITY OF SEATTLE

KING COUNTY

95100338



Table of Contents

# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF FIGURES (continued)

## APPENDICES

| | |
|---|---|
| APPENDIX A | EAST SAMMAMISH COMMUNITY PLAN<br>BEAR CREEK COMMUNITY PLAN POLICIES<br>CITY OF REDMOND COMMUNITY DEVELOPMENT GUIDE |
| APPENDIX B | WELL LOGS FOR GEOLOGIC CROSS SECTIONS (Available upon request) |
| APPENDIX C | ELECTRICAL RESISTIVITY SURVEY (Available upon request) |
| APPENDIX D | NEW WELL CONSTRUCTION REPORT (Available upon request) |
| APPENDIX E | PUMP TESTING DATA (Available upon request) |
| APPENDIX F | DAILY PRECIPITATION DATA (Available upon request) |
| APPENDIX G | STREAM FLOW MEASUREMENT DATA (Available upon request) |
| APPENDIX H | WELL LOGS FOR WATER LEVEL MONITORING SITES (Available upon request) |
| APPENDIX I | WATER LEVEL MEASUREMENT DATA (Available upon request) |
| APPENDIX J | LABORATORY WATER QUALITY TESTING DATA (Available upon request) |
| APPENDIX K | ENVIRONMENTAL CHECKLIST |
| APPENDIX L | DECLARATION OF NON-SIGNIFICANCE |
| APPENDIX M | PUBLIC COMMENT AND LEAD AGENCY RESPONSE (Included after Concurrence) |
| APPENDIX N | LETTERS OF CONCURRENCE BY AFFECTED JURISDICTIONS (Included after Concurrence) |
| APPENDIX O | GUIDELINES FOR THE DEVELOPMENT OF GROUND WATER MANAGEMENT AREAS AND PROGRAMS (Chapter 173-100 WAC) |
| APPENDIX P | LIST OF RELATED DOCUMENTS (Available upon request)<br>●Data Collection and Analysis Plan<br>●Data Management Plan<br>●Quality Assurance Project Plan<br>●Public Involvement Plan<br>●Area Characterization Report<br>●Data Analysis Report |

Acknowledgments

## SEATTLE-KING COUNTY HEALTH DEPARTMENT

CITY OF SEATTLE KING COUNTY

HEALTH OFFICER
Sharon Stewart-Johnson, Acting Health Officer

ENVIRONMENTAL HEALTH DIVISION
Carl Osaki, Chief

GROUND WATER SECTION
William J. Lasby, Supervisor
Trudy C. Rolla, Senior Environmental Health Specialist
Carolyn Boatsman, Senior Environmental Health Specialist
Paul Shallow, Senior Environmental Health Specialist
Steve Fischnaller, Environmental Health Specialist
Bruce McLean, Environmental Health Specialist
Lisa Burden, Administrative Specialist
Sean Groom, Research Assistant
Tom Gearhart, Research Assistant

## CITY OF REDMOND

THE CITY OF REDMOND · WASHINGTON ·

MAYOR
Rosmarie M. Ives

CITY COUNCIL
Richard Cole
Mark Denton
Sharon Dorning
Richard Grubb
Nancy McCormick
Greg Misenar
Jim Robinson

DEPARTMENT OF PUBLIC WORKS
Mark Cassell
Phil Cohen

## NORTHEAST SAMMAMISH SEWER AND WATER DISTRICT

BOARD OF COMMISSIONERS
- James L. Brazil
- Joseph M. Faulstich
- Lavern E. Lewis

DISTRICT MANAGER/ENGINEER
- Harold Mathews, Manager
- RH2 Engineering, Inc.
  - Ron Heinke
  - Geoff Clayton

## UNION HILL WATER ASSOCIATION

BOARD OF COMMISSIONERS
- Richard Hardesty
- Don Kono
- Steven Palmer
- John McDaniel
- Carol Fratt

DISTRICT MANAGER/ENGINEER
- John Phillips and Associates

## WOODINVILLE WATER DISTRICT

BOARD OF COMMISSIONERS
- Ed Cebron
- Gail Harrell
- Gwenn Maxfield

DISTRICT MANAGER
- Bob Bandarra

# REDMOND CREEK VALLEY
# GROUND WATER ADVISORY COMMITTEE

| CURRENT MEMBERSHIP | REPRESENTING |
|---|---|
| BOB BANDARRA | Woodinville Water District, Formerly with City of Redmond |
| CATHY BEAM | City of Redmond |
| MARK CASSEL | City of Redmond |
| STEVE CLARK | Formerly with Woodinville Water District |
| GEOFF CLAYTON | RH2 Engineering, for Northeast Sammamish Water District |
| PHIL COHEN | City of Redmond |
| JACK DAVIS, CHAIR | King Conservation District |
| STEVE DEEM | State Department of Health |
| BERTHA EADES | Citizen |
| KAREN FATTA | Citizen |
| LYLE FITCH | King Conservation District |
| RON HEINKE | RH2 Engineering, for Northeast Sammamish Water District |
| MAX L. POPE | Formerly with Woodinville Water District |
| T. L. CANNON | B & J Drilling |
| BILL LASBY, VICE CHAIR | Seattle-King County Health Department |
| HAROLD MATTHEWS, MANAGER | Northeast Sammamish Sewer and Water District |
| JOHN PHILLIPS | J. Phillips & Associates, for Union Hill Water Association |
| TRUDY ROLLA* | Seattle-King County Health Department |
| DOUG RUSHTON | Washington State Department of Ecology |
| PAUL SHALLOW* | Seattle-King County Health Department |
| TAMI THOMAS | Water Tenders |
| STEPHANIE WARDEN | King County Council Staff |

**THE FOLLOWING INDIVIDUALS HAVE CONTRIBUTED TO THE GWMP DEVELOPMENT AS FORMER MEMBERS, ALTERNATES OR IN SOME OTHER CAPACITY**

| | |
|---|---|
| INGRID ANDERSON* | Formerly with King County DDES SEPA Section |
| BOB ASHWORTH | Formerly with City of Redmond Council |
| MOE BATRA | Formerly with Washington State Department of Health |
| PAUL BEESON | Citizen |
| CAROLYN BOATSMAN | Formerly with Seattle-King County Health Department |
| BOB BRUCE | Formerly King County Council Staff |
| ANN DAIGLE* | Domestic Well Owner |
| NANCY DARLING | Washington State Department of Ecology |
| JOAN EDWARDS | Sierra Club |
| STEVE FISCHNALLER | Seattle-King County Department of Public Health |
| LARRY FRANKS | Northeast Sammamish Sewer and Water District |
| DAVE GARLAND | Citizen |
| HERB GOSHORN | Campton Water System |
| SHARL HELLER | Domestic Well Owner |
| JOE HENRY | Soil Conservation Service |
| DAVE HOLMBLAD | Sundstrand |
| DOUG HOLSTEN | Citizen |
| DUANE ISAACKSON* | Grange |
| HOLLY KEAN | Formerly King County Council Staff |
| VALERIE LYNN | Washington State Department of Ecology |
| BECKY MAGUIRE* | METRO |
| DAVID MASTERS | Formerly with King County Parks, Planning and Resources |
| JOHN MCDANIEL | Concerned Citizens of Union Hill |
| BRUCE MCLEAN | Seattle-King County Health Department |
| HAROLD O. MEYER | H. O. Meyer Drilling |

| | |
|---|---|
| JON PACE | Washington State Department of Ecology |
| FRANK PACHARD | United States Geological Survey |
| DAVE PEELER | Washington State Department of Ecology |
| ELIZABETH PHINNEY | Citizen, formerly Ecology GWMP Project Manager |
| DAVE PIERCE | Washington State Department of Natural Resources |
| ELLOUISE PRITCHETT | Water Tenders |
| PAUL QUERNA | Formerly with Johnson Screens |
| KLAUS RICHTER | King County Resource Planning |
| VICKY RIDGE-COONEY | METRO |
| MONICA ROPPO | Formerly with Seattle-King County Health Department |
| VERNON S. MILLS | Grange |
| KAY SHOUDY | Formerly with the City of Redmond |
| JOHN SHUBA | Rockcor (Chamber of Commerce) |
| NANCY STAFFORD* | Water Tenders |
| GINNY STERN | Washington State Department of Ecology |
| ERIK STOCKDALE | King County Resource Planning |
| BARBARA SULLIVAN | City of Redmond |
| DAN SULLIVAN | Sundstrand |
| PAUL TAYLOR | Cadman Gravel |
| TIFFANY YELTON | Washington State Department of Ecology |
| MARGARET ZIMMERMAN | Citizen |

***Denotes Alternate**

# ACKNOWLEDGEMENTS

The development of the Ground Water Management Plan was extensive and complex. This Ground Water Management Plan has been produced jointly by the Redmond-Bear Creek Valley Ground Water Advisory Committee (RBC-GWAC), the Seattle-King County Department of Public Health (SKCHD), the Department of Ecology (Ecology), the City of Redmond, the Northeast Sammamish Sewer and Water District, and the Union Hill Water Association. The Woodinville Water District assisted in test well drilling. In addition, the following agencies contributed information or staff: King County Planning, King County Surface Water Management, King County Department of Development and Environmental Services, King County Council Staff, and the King Conservation District.

The RBC-GWAC was formed in 1988 and met regularly throughout the planning process. The RBC-GWAC's role was to develop the plan according to the state regulations, and to provide their represented agency's perspective during the development. The input provided by the RBC-GWAC was the foundation for the plan.

The various King County departments and Ecology provided staff to the GWAC and also staff for the Technical Review Committee to review technical documents.

The RBC-GWAC and the SKCHD staff would like to thank the numerous other organizations and citizens who contributed during the course of the development of this plan.

The plan was prepared with the assistance of the consulting team of EMCON Northwest, Inc., with Adolfson Associates Inc., CWR-HDR Inc., Russell Resources, and Geo-Recon.

Preface

# PREFACE

In response to growing concern about Washington state's ground water resources, the Washington state legislature adopted Substitute House Bill 232, an addition to Chapter 90.44 RCW, in 1985, to help local governments manage ground water. As part of this process, the Washington State Department of Ecology established procedures for designating ground water management areas and developing comprehensive ground water management programs for these areas, under Chapter 173-100 WAC.

King County and the City of Redmond requested the Department of Ecology to designate the Redmond-Bear Creek Valley as a ground water management area to seize the opportunity provided by the state legislature and Ecology to protect ground water in this area. Ecology, after a public hearing, designated the area on October 7, 1986.

This Ground Water Management Plan was written for the specific needs of the Redmond-Bear Creek Valley Ground Water Management Area (RBC-GWMA). The goal of the plan is to protect the quality and quantity of ground water by providing effective and coordinated management of the ground water resource.

The Redmond-Bear Creek Valley Ground Water Management Area Ground Water Advisory Committee (RBC-GWAC) developed the plan. The RBC-GWAC consists of many different groups that manage, develop, or rely on ground water in the area. The RBC-GWAC has representatives from cities, water purveyors, environmental community, business, and state and local government. The RBC-GWAC, through extensive discussion, produced a plan that will provide for the diverse needs and goals for ground water of the people who live in this area.

This document contains 7 sections: **Preface, Introduction, Area Characterization, Recommended Ground Water Management Plan, Recommended Implementation Process for the Ground Water Management Plan, References, and Appendices.**

The **Area Characterization** describes the ground water management area and how its boundaries were chosen. It lists the governments and agencies that manage land and water use and describes their responsibilities. It addresses historical land use activities that impact ground water quality and quantity. This section also describes the area's hydrogeology and characterizes past and present ground water quality. It includes estimates of historical and current rates of ground water use and projections of future ground water supply needs.

The **Recommended Ground Water Management Plan** contains summaries of the threats to ground water quality and quantity. It consists of three sections: threats to both ground water quantity and quality and ways to address these threats; threats to ground water quality and ways to address these threats; and threats to ground water quantity and ways to address these threats. The recommended management strategies, which are the ways to address the perceived threats, are prefaced by a summary statement of the issues explored by the Redmond-Bear Creek Valley Ground Water Management Committee. The Redmond-Bear Creek Valley Ground Water

Management Committee goal and recommended management strategies are then listed. This section also contains a detailed work plan for each management strategy, including identifying the responsible agencies, estimated costs and funding source. The complete issue papers with unabridged background information are listed in the Appendix.

The **Recommended Implementation Process for the Ground Water Management Plan** describes the preferred methods for funding and implementation oversight for the plan. It also contains tables showing the management strategies. The management strategies are listed in order, based on the Redmond-Bear Creek Valley Ground Water Management Committee priorities for funding and implementation. Another table lists the management strategy by responsible agency, in implementation order, with costs and funding source.

# CHAPTER 1

## 1.1. INTRODUCTION

An aquifer is a saturated underground soil or rock formation that yields water in sufficient quantity to be economically useful. Aquifers provide water for many uses in the Redmond-Bear Creek Valley Ground Water Management Area (RBC-GWMA), including drinking water, irrigation for farms and landscaping. Ground water provides most of the water used in the RBC-GWMA for private, municipal, industrial, and agricultural needs. Also, ground water provides base flow to surface water bodies during low rainfall, and sustains fish, wildlife, and recreation.

Aquifer recharge, or replenishment, occurs when rain, stormwater runoff, surface water or other sources reaches an aquifer. The rate of infiltration and the quantity of water that reaches an aquifer are influenced by natural and constructed elements. Natural elements include the amount of rainfall, soil characteristics, vegetation, and topography. Constructed elements include impermeable surfaces (such as roads, parking lots, buildings), vegetation removal, soil compaction, and other changes to the environment.

It is essential that the ground water resource be protected from sources of contamination. Once a ground water source is contaminated, it may be lost forever. The cost of protecting ground water from contamination is considerably less than the cost of remedial action. Ensuring ground water availability is also crucial. The natural hydrologic system can be interrupted by development and over use of the aquifer.

The citizens and officials of King County are the stewards of the ground water resource, both for present and future generations. This Plan is intended to inform and guide ground water protection efforts of the citizens and officials. This Ground Water Management Plan for the RBC-GWMA has been developed because (1) ground water is a limited resource, vital to the future of the County, the well being of its residents, and the vitality of our living natural resources; (2) ground water is not a separate body of water nor is it a separate environmental resource; therefore, ground water needs to be protected and managed as a part of the entire hydrologic system, ecosystem, and economic system.

## 1.2. GROUND WATER MANAGEMENT PLAN PURPOSE AND SCOPE

The purpose of the Washington State Department of Ecology Ground Water Management Plan is to foster the development and implementation of local Ground Water Management Plans. These Plans represent a community consensus on the most practical ground water protection measures to safeguard quality and ensure continued availability of this vital resource. The Ground Water Management Plan directs local and state agencies in developing regulations and programs to protect ground water.

## 1.3. GROUND WATER MANAGEMENT PLAN HISTORY

In response to growing concern in Washington State about ground water resources, the state legislature passed Substitute House Bill 232 in 1985, codified as Chapter 90.44.400 RCW *Regulation of Public Ground Waters*. This legislation directed the Washington Department of Ecology (Ecology) to:

- Identify specific locations in need of ground water management programs;
- Establish a program to provide financial assistance to these locations; and
- Develop guidelines for the implementation of local ground water management strategies.

Ecology responded by adopting Chapter 173-100 WAC *Ground Water Management Areas and Programs*. These regulations define a ground water management area as a specific geographic area that encloses one or more aquifers, and which exhibits a justifiable concern for the quality and/or quantity of the ground water.

Ecology's ground water program (WAC 173-100) establishes how a local ground water management plan must be developed. A ground water management plan is designed to protect ground water quality and assure ground water quantity for current and future uses. Chapter 173-100 WAC establishes a well defined process that allows for ground water issues, concerns and opportunities from all interested groups and agencies to be incorporated into the planning process in an effective and efficient manner. The process is designed so that a ground water management plan can be initiated and developed on the local level while being supported by state legislation and regulations. The ground water management program process also provides local government with a method to achieve comprehensive ground water protection goals.

On April 17, 1986, King County petitioned Ecology to designate the RBC-GWMA as a ground water management area. The petition document outlined a number of ground water protection problems facing the area:

- potential contamination sources threaten ground water quality, or ground water is susceptible to contamination;
- major aquifers have the potential for over use based on projected future demands; and
- aquifers where an approved coordinated water system plan has identified a need for a Ground Water Management Plan.

Ecology designated the RBC-GWMA on October 7, 1986. According to guidelines in WAC 173-100, Ecology approved the membership of the Redmond-Bear Creek Valley Ground Water Management Area Ground Water Advisory Committee (RBC-GWAC), consisting of a broad cross section of interests with representatives from many groups. Ecology selected the

Seattle-King County Department of Public Health (SKCHD) to be the lead agency because it has jurisdiction throughout the Ground Water Management Area and has a regulatory role in water systems, on-site sewage systems, and other environmental health concerns.

## 1.4. GROUND WATER MANAGEMENT PLAN GOALS AND OBJECTIVES

After Ecology designates the area, and the Ground Water Advisory Committee membership and lead agency are established, the first step in developing a Ground Water Management Plan is to establish goals and objectives. The SKCHD and the RBC-GWAC developed the following goal and objectives:

**Goal**: To preserve the purity and assure the quantity and quality of existing and future ground water supplies within the management area.

**Objectives**: Designate the RBC-GWMA as a Ground Water Management Area, making it eligible for state grants designated for the development of ground water management programs and plans. The Ground Water Management Plan must:

- Be consistent with federal regulations, state ground water management laws and local ordinances;
- Include the public and local agencies participation in drafting, reviewing and modifying the plan; and
- Include elements as described in WAC 173-100 *Ground Water Management Areas and Programs*. These include:

  A public involvement plan to educate and inform the public about ground water and the Ground Water Management Plan (GWMP) process. The public will be informed of the need to protect the ground water resource from contamination and overuse and will provide support to the public and private actions required to protect the resource.

  An area characterization section that includes mapping jurisdictional boundaries showing land and water use management authorities boundaries and goals; a description of the locale; the hydrogeology; the ground water quality; and the current ground water use and future needs.

  Identification and description of threats to ground water; stating goals and objectives related to these threats; and recommending strategies that solve or reduce these threats. Technical understanding of the ground water resource will be developed to assist decision makers in formulating public policy.

An implementation process for the plan, which includes:
- a work plan for each affected agency and jurisdiction;
- an effectiveness monitoring system; and
- a process for periodic review and revision.

- Obtain local approval and state certification of the plan, which will ensure implementation of the recommended ground water protection measures. Public agencies will work cooperatively to fulfill their responsibilities to protect the ground water resource. Local, state and regional land use and water use plans, policies and regulations will be effective in protecting the ground water resource.

## 1.5. PLAN TEAM AND RESPONSIBILITIES

The following agencies and committees are responsible for developing the ground water management plan:

- Washington State Department of Ecology
- Seattle-King County Health Department
- Ground Water Advisory Committee
- Interlocal Participants:
  - City of Redmond
  - Northeast Sammamish Sewer and Water District
  - Union Hill Water Association
  - Woodinville Water District

### 1.5.1. Department of Ecology (Ecology)

Ecology appoints the Ground Water Advisory Committee in cooperation with local governments. Ecology is also a participant on the advisory committee. Ecology reviews and approves interim plan products, such as the Public Involvement Plan, the Data Collection and Analysis Plan, the Quality Assurance/Quality Control Plan, and the Data Management Plan. Ecology certifies the final Ground Water Management Plan, after all affected agencies have concurred.

### 1.5.2. Seattle-King County Health Department (SKCHD)

As lead agency, SKCHD is responsible for coordinating the activities necessary for development of the Ground Water Management Plan. This includes preparation of a work plan, coordinating data collection and scheduling advisory committee meetings. The Ground Water Advisory Committee aided the SKCHD in rainfall data collection. SKCHD developed the issue papers. A consultant prepared elements for Chapter 2 Area Characterization, and the SEPA checklist.

1.5.3. Ground Water Advisory Committee

The Ground Water Advisory Committee plays a critical role in developing a sound ground water management plan. The Ground Water Advisory Committee consists of a broad cross section of ground water interest groups, including local, state and federal government agencies, large and small businesses, environmental organizations and citizens. The Ground Water Advisory Committee is responsible for assuring that the Ground Water Management Plan is both technically and functionally sound. The committee will give final approval to the plan before it is submitted to Ecology for certification. The committee's specific duties include:

- Oversee the development of the Ground Water Management Plan;
- Review the work plan, schedule, and budget developed by the lead agency;
- Assure that the plan is functional, and will not cause environmental or economic adversity;
- Verify that the plan is consistent with the state's regulations on ground water protection; and
- Formulate and implement a public involvement plan.

1.5.4 Interlocal Participants

Interlocal agreements and a King County resolution have been executed to support development of the management plan.

**City of Redmond**

Responsible for the following, as agreed to in the interlocal contract with King County:

- Provide appropriate staff support and guidance in the development and implementation of the Ground Water Management Plan;
- Provide three staff members to serve on the Ground Water Advisory Committee;
- Assist in consultant selection;
- Prepare sub-area designation request to Ecology;

- Develop detailed Scope of Work and budget;
- Prepare draft grant application for submittal;
- Assist King County in obtaining approval of grant application;
- Hold a joint hearing with Ecology on the draft Ground Water Management Plan; and
- Finance its portion of the local matching share for the Ground Water Management Area: $81,810 in-kind match plus $56,405 cash = $138,215.

**Northeast Sammamish Sewer and Water District**

Responsible for the following, as agreed to in the interlocal contract with King County:

- To reimburse King County for services: $30,000 cash and $15,000 for in-kind match, $45,000 total.

**Union Hill Water Association**

Responsible for the following, as agreed to in the interlocal contract with King County:

- To provide a site for a test well; and
- To provide water quality testing, precipitation and water balance monitoring;
- To reimburse King County for services: $10,000 cash and $23,400 in-kind match, $33,400 total.

**Woodinville Water and Sewer District**

Responsible for the following, as agreed to in the interlocal contract with King County:

- To provide $17,412.70 for test well drilling.

## 1.6. PUBLIC REVIEW, ADOPTION, AND IMPLEMENTATION

Discussed below are the processes for public review, adoption, and implementation of the Ground Water Management Plan.

### 1.6.1. Public Review

Upon completion, the Draft Ground Water Management Plan shall be subject to public review after Ecology holds a local public hearing for comment and review of the plan.

### 1.6.2. Adoption

Following the hearing, each affected agency and government will have 90 days to evaluate the plan and either concur or disagree with the plan. The Ground Water Advisory Committee will negotiate with nonconcurring agencies and governments to reach agreement. After concurrence, and when the plan is found to be consistent with the intent of Chapter 173-100 WAC, Ecology will certify the plan.

### 1.6.3. Implementation

Affected agencies and jurisdictions are responsible for implementing the plan following certification. The implementation process and schedule is described in Chapter 4. The Ground Water Advisory Committee has provided a mechanism for modifying the plan to adapt to changing conditions under the supervision of the Redmond-Bear Creek Valley Ground Water Management Area Management Committee. This committee will advise and oversee ground water management activities that take place under this plan. The committee also will review new issues and programs that have emerged during and after Plan preparation. The Management Committee will develop methods to incorporate the new issues and programs into the implementation of the plan.

Chapter 2. Area Characterization

# CHAPTER 2 - AREA CHARACTERIZATION

## 2.1. INTRODUCTION

This report provides an updated characterization of the Redmond-Bear Creek Valley Ground Water Management Area (RBC-GWMA). The report also summarizes the results of ground water data collection and analysis activities between 1989 and 1992 conducted as part of the Redmond-Bear Creek Valley Ground Water Management Plan (RBC-GWMP).

The updated area characterization is a compilation of the information presented as a result of previous water investigations conducted in the RBC-GWMA as well as a presentation of information regarding the physical characteristics of, regulatory agencies over, and regulations concerning the RBC-GWMA.

Section 2.2 presents a detailed description of the boundaries of the RBC-GWMA. Section 2.3 identifies and describes the various federal, state, and local agencies which have political jurisdiction over the RBC-GWMA.

Section 2.4 discusses climate, topography, and drainage. The plans and policies affecting the ground water resource, present and future land and water use impacts, and conclusions regarding ground water quality and quantity are discussed in Section 2.5. Section 2.6. discusses geology, hydrogeology, new wells drilled, data collection, ground water quality and conclusions. Section 2.7. discusses the water balance and Section 2.8. discusses recommendations for protecting the ground water resources.

The data collection and analysis task involved data collected for ground water quality and quantity, rainfall, and stream flow. Data was collected by personnel from the City of Redmond, Union Hill, the N.E. Sammamish Sewer and Water District, Seattle-King County Health Department (SKCHD), the Redmond-Bear Creek Valley Ground Water Advisory Committee (RBC-GWAC), and the environmental firms of EMCON Northwest, Inc., and Adolfson Associates, Inc.

The data collection effort was based on recommendations by the project consultants EMCON Northwest, Inc., and Adolfson Associates, Inc., as defined in the Data Collection and Analysis Plan (June 1989, March 1990, and October 1990). This plan was reviewed and approved by the Department of Ecology (Ecology), Seattle-King County Health Department, the City of Redmond, N.E. Sammamish Sewer and Water District, Union Hill Water Association and the RBC-GWAC. This report specified the types of data to be collected, the frequency of collection, the location of monitoring sites, and the reasons for the rationale for collection of specific data. Additionally, all data that was collected was handled and maintained per the June 1989 and August 1989 Data Management Plan approved by Ecology and the RBC-GWAC.

The following updated characterization of the RBC-GWMA summarizes the results of the data collection task and combines this information with the previous historical reports.

The objective of the data collection and analysis task in the Redmond-Bear Creek Ground Water Management Plan development was and is to further the understanding of the RBC-GWMA water resources (quantity and quality) and to identify data gaps to facilitate protection of the RBC-GWMA's ground water. The methodology by which this goal was attained was through the generation and interpretation of the data is described below.

2.1.1. Historical Record

The Background Land and Water Use Report (July 1991) and the Background Hydrogeologic Characterization Report (November 1992) examined existing information on water and land uses, geology, hydrogeology, data collection activities, new wells drilled, and ground water quality. This report updates the 1991 and 1992 reports.

2.1.2. Rainfall

Rainfall data was collected from seven stations by personnel from the City of Redmond, Woodinville Water District, Union Hill Water Association, King County Surface Water Management, and volunteers who reside in the area.

2.1.3. Stream Gauges

These data were collected from six sites by personnel from United States Geological Survey, King County Surface Water Management Division, EMCON Northwest, Inc., and the SKCHD.

2.1.4. Ground Water Levels and Water Quality

Ground water levels were collected from eighty-one well sites, and water quality samples were collected from thirty-four wells, by personnel from the City of Redmond, Union Hill Water Association, N.E. Sammamish Sewer and Water District, EMCON Northwest, Inc., and the SKCHD.

2.1.5. Monitoring Wells

In 1990 five wells were drilled in areas where subsurface data were absent to evaluate current or future ground water supply. These wells were drilled in the northwest, southwest, south central, and Evans Creek Valley portions of the RBC-GWMA.

## 2.2. REDMOND-BEAR CREEK VALLEY GROUND WATER MANAGEMENT BOUNDARIES

The RBC-GWMA is located in north central King County approximately 20 miles northeast of Seattle, Washington. The RBC-GWMA covers approximately 50 square miles. It is bounded on the west by the Sammamish River and on the north by the Snohomish-King County line. The eastern boundary follows the topographic divide between the Bear Creek and Snoqualamie River valleys. The area is bounded on the south by Lake Sammamish and by the topographic divide between the Evans Creek Drainage and the Sahalee Plateau (Figure 2.2.1.). The Bear Creek Valley bisects the study area north to south, and the Evans Creek Valley bisects the southern tip east to west.

## 2.3. JURISDICTIONS IN THE REDMOND-BEAR CREEK VALLEY GROUND WATER MANAGEMENT AREA (RBC-GWMA)

This section discusses the role of jurisdictional public agencies within the RBC-GWMA. The ground water related policies and activities of the agencies in the RBC-GWMA are delineated and discussed by federal, state, county, and local agencies, respectively.

### 2.3.1. Federal Agencies

The following federal agencies influence ground water management in various ways, both through their role as regulatory bodies, and in their capacities as policy makers.

**Environmental Protection Agency**

The Environmental Protection Agency administers numerous programs that influence ground water management in the RBC-GWMA. The Environmental Protection Agency also provides technical assistance to state and municipal officials on a variety of ground water-related issues, and acts as a regulatory agency. As a lead agency, the Environmental Protection Agency regulates water pollution, underground storage tanks, pesticide and herbicide use, hazardous waste management (including Comprehensive Environmental Response, Compensation, and Liability Act, and the Superfund Amendments and Reauthorization Act of 1986 sites and generators), and drinking water management. As a support agency, the Environmental Protection Agency is involved with regulation of lagoons and holding ponds, sewage waste disposal, sludge application, spill control and prevention, solid waste handling, storm-water runoff, ground water, surface water, wetlands, and wells and water rights. The Environmental Protection Agency administers the Sole Source Aquifer Program, the Pesticides in Ground Water Study, and the Agricultural Chemicals in Ground Water Strategy.

**Department of Agriculture**

The U.S. Department of Agriculture provides technical assistance to landowners and communities concerning municipal sludge application, livestock, irrigation design, wildlife, and animal-waste ponds. The Department of Agriculture is a lead agency for pesticide and herbicide programs, and administers programs such as fish and wildlife conservation programs and watershed projects.

**The Soil Conservation Service**

As part of the Department of Agriculture, the Soil Conservation Service provides technical assistance in soil erosion control and pesticide and herbicide use. It also plays a support role in agriculture, diking, drainage, forestry, lagoons, surface water, and wetlands issues.

2.3.2. Washington State Agencies

The following agencies operate at the state level, but influence ground water affairs at the local level as well.

**Washington State Department of Ecology (Ecology)**

Ecology is responsible for protecting the waters of the state, therefore, the activities of Ecology both directly and indirectly affect ground water management decisions in the RBC-GWMA. Funding for the development of the Redmond-Bear Creek Valley Ground Water Management Plan was provided through the Centennial Clean Water fund, a grant program administered by Ecology. Ecology issues NPDES and state waste discharge permits, performs compliance monitoring, enforces discharge regulations, and responds to contaminant release incidents. Ecology is a lead agency in over 20 environmental categories, including aquifer depletion, seawater intrusion, water resources, well construction and abandonment, and water rights. As a regulatory agency, Ecology is responsible for the cleanup of leaks and spills of hazardous materials (except in navigable waters), oversight of Resource Conservation and Recovery Act facilities and state hazardous waste cleanup sites, and the regulation of underground storage tanks.

**Washington Department of Health, Office of Environmental Health Programs**

The Washington Department of Health is involved in a variety of programs that influence ground water management. The Northwest Drinking Water Operations Program of the Washington Department of Health is responsible for plan approval for Group A public water supplies, including well site inspections and final system completion certification.

The Washington Department of Health's On-Site Sewage Program is responsible for enforcing the rules and regulations of the State Board of Health per on-site sewage disposal, Chapter 346-272 WAC. These regulations are currently under revision to increase effectiveness in protecting public health and water quality. The Washington Department of Health is also responsible for guideline development and performance review of alternative wastewater disposal systems.

**Washington State Department of Natural Resources**

The proprietary responsibility of the Department of Natural Resources includes management of state lands for timber production; Christmas trees; evergreen brush such as salal, huckleberry, and other special forest products; and coal, sand, and gravel; as well as other mineral deposits.

**Washington State Department of Community Development**

The Department of Community Development provides guidelines for implementing the Growth Management Act.

2.3.3. <u>King County Agencies</u>

The following King County agencies have jurisdiction in the preparation of Comprehensive Land Use Plans within the RBC-GWMA. Each of these agencies conduct activities that either directly or indirectly affect ground water management in the area.

**The Metropolitan King County Council**

The Metropolitan King County Council has legislative authority to enact ordinances and regulations governing protection of ground water resources, including land use provisions. In the past, the Metropolitan King County Council has administered water resource, land use, and wetlands programs, in addition to assisting in community plan reviews. The Metropolitan King County Council has adopted the King County Comprehensive Plan and the Community Plans for Bear Creek, East Sammamish, and Northshore. It has also adopted the City of Redmond's Community Development Guide.

**King County Department of Parks, Planning, and Resources**

Divisions of Parks, Planning and Resources, as discussed below, are involved in the implementation of the King County Comprehensive Plan, as well as the Community Plans for Bear Creek, East Sammamish, and Northshore. They are also responsible for conducting environmental reviews of proposed land use developments.

<u>Planning and Community Development Division</u>. The Planning and Community Development Division is primarily involved in implementing the King County Comprehensive Plan and in developing zoning and land use policies. Additionally, this division is involved in coordinating King County's review of all water and sewer system comprehensive plans operating in unincorporated King County.

**Department of Development and Environmental Services**

The Department of Development and Environmental Services is responsible for the regulation and enforcement of land development and zoning within unincorporated King County, including the RBC-GWMA. Its specific duties include development control, commercial and residential permitting, sensitive area monitoring, and SEPA review. The Department of Development and Environmental Services also implements the Community Plans for Bear Creek, East Sammamish, and Northshore by regulating issuance of building permits and by administering rezones and plats in those areas.

Resource Planning Section, Environmental Division. Resource Planning is the lead agency for the compilation of the natural environmental chapter of the King County Comprehensive Plan. Resource Planning also studies the interaction of wetlands and surface runoff, and is involved in drainage basin planning.

**Seattle-King County Health Department (SKCHD), Environmental Health Division**

The SKCHD is an advisory and regulatory body involved in a wide variety of topics, including regulation of Group B public water systems. The SKCHD served as lead agency for the RBC-GWMP. In that capacity, SKCHD coordinated the activities necessary for the development of the ground water management plan. Those activities included collecting ground water quality and quantity data, managing the ground water database, drafting technical issue papers, and preparing and monitoring the budget for development of the RBC-GWMP.

The SKCHD is responsible for evaluating site suitability for, and the permitting of, on-site wastewater disposal systems. SKCHD responds to complaints about, and regulates the repair of, failing systems; reviews all subdivision proposals for which on-site sewage disposal is proposed; and educates homeowners in the proper maintenance of their systems.

The Solid Waste Program of SKCHD is responsible for permitting landfills, overseeing and permitting sludge application sites and sampling ground water in areas around the landfills. The Local Hazardous Waste Management Program of the Environmental Health Division of the SKCHD helps businesses in identifying hazardous wastes and assists them in managing these wastes properly.

**King County Department of Public Works**

The King County Department of Public Works consists of several divisions that perform specific functions in the RBC-GWMA. These functions are described below in the RBC-GWMA.

Solid Waste Division. The Solid Waste Division is currently conducting a detailed hydrogeologic investigation of the closed Duvall Custodial Landfill. There are no active landfills in the RBC-GWMA.

Surface Water Management Division. The King County Surface Water Management Division is responsible for administering a variety of programs that address surface water quality and quantity in the RBC-GWMA. These programs include: basin planning (Bear Creek Basin Plan); non-point pollution control; wetlands; public education and involvement; and the construction and maintenance of drainage and water quality facilities. Given the interrelationship between surface water and ground water in much of King County, the management of surface water has a direct influence on the quantity and quality of water infiltrating to ground water.

Roads and Engineering Division. In addition to construction and maintenance of roads and associated drainage, the Roads Division is responsible for vegetation control. Although the

Division employs an Integrated Vegetation Management Plan, herbicides are applied along area roadsides.

**Department of Metropolitan Services (formerly Metro)**

Metro oversees regional sewage collection and treatment and is the designated regional water quality planning agency under the *1972 Clean Water Act*. Metro provides sewage treatment services to the City of Redmond, the N.E. Lake Sammamish Sewer District, the Woodinville Sewer and Water District, and the Lake Washington School District 414. Wastewater from these facilities are pumped to Metro's wastewater treatment plant in Renton.

2.3.4. Local Agencies

The following agencies operate at the local level to influence ground water management in the RBC-GWMA.

**City of Redmond**

The City of Redmond Planning Department's responsibilities include review and approval of proposed developments; review of the framework for future growth within the city limits, and assessment of patterns of growth for conformity with city, local, and state regulations.

The City of Redmond Public Works Department's responsibilities include: water and sewer system planning and administration; road maintenance; roadside vegetation control; stormwater facility maintenance and enhancement; and local water quality monitoring and protection.

**N.E. Sammamish Sewer and Water District, Woodinville Water District, Union Hill Water Association**

The jurisdiction of these Districts and Association is limited to households and commercial services. Unlike the City of Redmond and King County, they do not have regulatory authority, nor do they have the police power necessary to enforce programs. Their role is to provide water and/or sewer service within a specific area, as well as to advise on matters relating to ground water quality and quantity.

2.3.5. Other Agencies

Discussed below are other local agencies that influence ground water management in the RBC-GWMA.

**King Conservation District**

The King Conservation District works with the urban and agricultural community to implement animal management and land use practices that increase productivity while minimizing soil erosion and water pollution. The district is, neither a branch of county government nor an enforcement agency, but rather, a political subdivision of state government authorized by Chapter RCW 89.08. The Conservation District is dedicated to the conservation and best use of the natural resources of King County.

## 2.4. PHYSICAL GEOGRAPHY

### 2.4.1. Geographic Setting

The RBC-GWMA contains a number of lakes and streams. The primary streams include Cottage Creek, Daniels Creek, Seidel Creek, Bear Creek, and Evans Creek. The four largest lakes inside the RBC-GWMA boundary are Lake Leota, Cottage Lake, Welcome Lake, and Peterson Park.

### 2.4.2. Topography

Elevations in the RBC-GWMA range from approximately 30 feet above mean sea level in downtown Redmond to just over 600 feet near the Redmond watershed. Surface elevations rise steadily in a northerly direction from the City of Redmond up the Bear Creek Valley gaining approximately 450 feet of elevation.

### 2.4.3. Climate

Maritime air masses from the Pacific Ocean influence the climate of the RBC-GWMA and result in moderate temperatures. During the fall and winter months, prevailing winds are from the southwest bringing moist air about the same temperature as the ocean's surface. Precipitation is typically of light to moderate intensity and long duration. About 75 percent of the annual precipitation occurs during the period October through March. In the spring and summer prevailing winds are from the northwest. The summer can be described as the dry season, as less than 5 percent of the annual rainfall occurs between July and September.
The Redmond-Bear Creek watershed receives an average of 42 inches of rainfall annually. The precipitation varies seasonally with approximately 75 percent of the annual precipitation falling between October and March with January having the greatest amount of precipitation. Precipitation decreases sharply in summer with the least precipitation occurring in September. Rainfall was usually greatest at the higher elevations along the western boundary of the RBC-GWMA and lowest in the lower Bear Creek Valley around the cities of Redmond and Woodinville.

## 2.5. LAND USE IMPACTS ON GROUND WATER

Land use activities can have a significant impact on ground water quality and use. As area population grows, consumptive use of ground water will increase, particularly if alternative sources are not sufficient to meet demands. In addition, as development increases, the risk of contamination of ground water resources is likely to increase. Ground water reserves can also be depleted by development sealing recharge areas.

Based on population and employment growth forecasts prepared by the Puget Sound Regional Council, the RBC-GWMA will experience a significant (100-200 percent) increase in population during the next 30 years. Along with the increased population, employment opportunities in the RBC-GWMA will expand significantly as well. These two factors will have a major impact on land uses in the area. These impacts will include an increase in residential housing densities, expansion and enlargement of vehicular transportation corridors and growth of commercial and industrial activities.

The RBC-GWMA boundaries do not correspond with the Forecast Analysis Zones for the Puget Sound Regional Council population forecasts.

The King County Planning and Community Development Division, Annual Growth Databook 1993 has three community planning areas within or partly within the RBC-GWMA. The Bear Creek Community Planning Area is within the RBC-GWMA. The remaining two areas, East Sammamish and Northshore are partly within the RBC-GWMA. The City of Redmond also has a community development guide available.

Because the East Sammamish and Northshore Community Planning areas are only partly within the RBC-GWMA, and the Puget Sound Regional Council's forecast analysis zones don't correspond to the RBC-GWMA, it is difficult to give accurate estimates of population growth and forecasts for the whole RBC-GWMA.

In 1992 the City of Redmond had 17,747 housing units consisting of 7,860 single-family, 9,512 multi-family and 375 mobile homes. (Table 2.5.1.).

In the Bear Creek Community Planning Area the population increased in the unincorporated area from 12,250 people in 1980 to 22,600 people in 1992, an increase of 84.5 percent (Table 2.5.2.). Table 2.5.3. indicates a projected population increase in the unincorporated area from 12,250 in 1980 to 37,600 in the year 2010 an increase of 206.9 percent.

In the Puget Sound Regional Council's forecast analysis zone (1992) for the North Bear Creek area, the population was 4,033 in 1980 and 7,276 in 1990, an increase of 80.4 percent. The projected population in the year 2000 is 11,642 (Table 2.5.4.).

These areas all show dramatic increases in population growth to 1992 and for future projections. This also means a greater demand for potable ground water.

### 2.5.1. Community Plans, Policies, and Regulations

This section discusses plans and policies relating specifically to ground water management for each agency and the impacts to ground water from various land use activities.

The RBC-GWMA is contained in all, or portions of, four community planning areas. These community planning areas include King County's Bear Creek, East Sammamish, and Northshore, and the City of Redmond's community development guide. Specific land uses and accompanying area-wide zoning, consistent with the King County Comprehensive Plan's policies, are established in the community plans. The portions of the RBC-GWMA covered by each of the four community plans are shown on Figure 2.5.1. Based on information in the four local community plans, existing and proposed future land uses in the RBC-GWMA were compiled and mapped (January 1991). Figure 2.5.2. shows the existing (1989) land uses and Figure 2.5.3. shows the anticipated future land uses. Since all of the community plans are currently in the process of being revised or updated, future land use patterns may be different from those shown on Figure 2.5.3. A summary of policies, plans and regulations relevant to ground water management in the RBC-GWMA are provided in Appendix A.

As ground water management alternatives are developed for the ground water management plan, existing policies and regulations will be reviewed and incorporated if appropriate. In areas where deficiencies exist, these will be noted and recommendations developed to revise or prepare new policies or regulations.

**King County Comprehensive Plan**

King County's Comprehensive Plan establishes county-wide policies and goals as well as a framework for policy making at the local level. The Comprehensive Plan is concerned with land use in the County and directs decisions affecting growth and land development.

The King County Comprehensive Plan was recently revised to comply with the State of Washington Growth Management Act and the King County County-wide Planning Policies. The land use goals of the 1985 King County Comprehensive Plan were revised as part of the growth management update.

The King County Comprehensive Plan establishes policy priorities for ground water management for all of King County, including the RBC-GWMA. The Comprehensive Plan calls for the implementation of these policies through land use plans and development reviews. Ground water policies should also be used to guide the County's review of the plans of water and sewer purveyors and other government projects.

The proposed policies in the Executive Proposed King County Comprehensive Plan public review draft, dated June 1994, state the following key protection strategies for ground water:

**NE-332** In unincorporated King County, areas with high susceptibility for ground water contamination are designated as Critical Aquifer Recharge Areas as shown on the map, entitled Areas Highly Susceptible to Ground Water Contamination. The map should be continually refined as new information becomes available, from ground water studies.

**NE-333** King County should protect the quality and quantity of ground water county wide by:

a. Placing a priority on implementation of Ground Water Management Plans;
b. Developing a process by which King County will review, and implement, as appropriate, Wellhead Protection Programs in conjunction with cities and ground water purveyors; and
c. Developing, with affected jurisdictions, best management practices for new development recommended in Ground Water Management Plans and Wellhead Protection Programs as appropriate. The goals of these practices should be to promote aquifer recharge quality and quantity.
d. Refining regulations as appropriate to protect critical aquifer recharge areas when new information is supplied by Ground Water Management Plans and Wellhead Protection Programs.

**NE-334** King County should protect ground water recharge quantity in the Urban Growth Area by promoting methods that infiltrate runoff where site conditions permit, except where potential ground water contamination cannot be prevented by pollution source controls and stormwater pretreatment.

**NE-335** In making future zoning decisions, King County shall evaluate and monitor ground water policies, their implementation costs, impacts upon the quantity and quality of ground water and the need for new water supplies.

**NE-336** King County should protect ground water in the Rural Area by:
a. Preferring land uses that retain a high ratio of permeable to impermeable surface area and that maintain or augment the infiltration capacity of the natural soils; and
b. Requiring standards for maximum vegetation clearing limits, impervious surface limit, and, where appropriate, infiltration of surface water.

**Community Plans**

Community Plans represent another legally binding policy document with jurisdiction in the RBC-GWMA. King County is divided into community planning areas allowing citizens and planning officials to develop local area goals, plans, and policies. Once adopted by the Metropolitan King County Council, a community plan becomes an official document affecting development and municipal expenditures in the community.

King County Community Planning Areas in the RBC-GWMA are Bear Creek, N.E. Sammamish, Northshore, and the City of Redmond Community Development guide. Policies are developed for each community and if adopted by the Metropolitan King County Council, they become law and are included in the community plan.

**Bear Creek Community Plan**

The Bear Creek Community Plan covers approximately two-thirds of the RBC-GWMA. Although, the King County Comprehensive Plan designated the Bear Creek planning area as a

Transitional Area, the adoption of the 1989 Bear Creek Community Plan redesignated the area for urban and rural uses. Subsequently, in November 1993, Interim Urban Growth Areas were designated in King County to meet the requirements of the State of Washington Growth Management Act. All properties currently zoned S-E, S-C and GR-5 (except for the Novelty Hill Master Plan Development Area) are now considered Rural under the Interim Urban Growth Areas as adopted by Ordinance 11110. The ordinance also prohibits subdivision of lots smaller than five acres in size until December 31, 1994.

Significant goals of the Bear Creek Community Plan are:

- Meet the need for land for housing and population growth and, at the same time, protect existing rural character, natural resources and environmentally sensitive features.
- Direct most commercial and industrial development to locate in existing urban activity centers.
- Designate the eastern plateau of the planning area Urban/Master Plan Development.
- Use on-site disposal systems as the long-term approach to sewage disposal in the low density residential and rural areas.
- Allow existing water purveyors to continue to serve the study area. Expansion of systems in rural areas would require county approval subject to specific policies and criteria.

**East Sammamish Community Plan**

The RBC-GWMA includes a portion of the East Sammamish Community Planning Area. An updated East Sammamish Community Plan was adopted on May 25, 1993.

In the East Sammamish Community Planning Area, the southern most portion of the RBC-GWMA is urban. The area immediately south of State Route 202 is predominately rural. A small amount of manufacturing is located at the intersection of State Route 202 and 228th Avenue NE.

Significant features of the East Sammamish Community Plans include:

**NE-6.** Public sewers are the preferred method for wastewater treatment in Urban Areas, including Urban Reserve Areas. Within Rural Areas, and Urban Areas where sewers are not yet available, proper siting and maintenance of septic systems should continue to receive special attention for new and existing land development to preserve the valuable ecological functions and beneficial public uses of water resource.

**NE-8.** Upon adoption, the recommendations of the Redmond Bear Creek Ground Water Management Plan should be implemented through zoning and other mechanisms to protect ground water resources.

**NE-11.** All golf course proposals shall be carefully evaluated for their impact on surface and ground water quality and quantity, sensitive areas and fish and wildlife resources and habitat.

**NE-12.** Water used for irrigating golf courses should come from non-potable water sources wherever possible. Use of natural surface water sources, such as streams should be avoided due to impacts on fish and other wildlife habitat. A water conservation plan shall be submitted with golf course applications which should address measures such as the use of drought tolerant plant species.

**GM-4.** Lands within the Urban Reserve Area should be reclassified to their potential zones, either through an amendment to the area zoning or an individual reclassification application, only when it can be demonstrated to King County and determined that area wide service deficiencies in water, roads, electrical service and parks are remedied or do not apply to a particular property or subarea. County approval of the reclassification should occur only when King County finds that by the time a development is ready to be occupied the following criteria will be met not withstanding the foregoing, the underlying potential zone shall be effective on June 30, 1996:

- Domestic water supplies are adequate to support planned growth, either by virtue of an intertie between the Plateau and the regional water supply in cooperation with Seattle, the development of new ground water resources, conservation measures sufficient to guarantee capacity, or the property is located in or can be served by the Northeast Sammamish Sewer and Water District.

- The East Lake Sammamish and Non-point plans are adopted, and those projects that are identified by the Council during adoption of these plans as necessary to accommodate future growth are operational.

The draft East Sammamish Community Plan is listed in Appendix A.

**Northshore Community Plan**

The Northshore Community Plan (adopted Feb. 1993) affects only the northwestern edge of the RBC-GWMA.

Primary goals for the Northshore Community Plan are:

- Population growth should fill in already partially developed suburban areas with low and medium density residential use.

- Development should occur along existing patterns set by commercial/industrial centers and major street and highways.

- As development occurs, agricultural uses, open space and the area's many natural amenities should be preserved as much as possible.

The Plan should also provide greater detail about land use designations within the planning area. Areas adjacent to the City of Redmond are planned for high density single-family residential growth, while Hollywood Hill is designated as rural residential. Portions of the RBC-GWMA within the City of Woodinville will ultimately be developed at urban densities.

**Bear Creek Basin Plan**

The Bear Creek Basin Plan focuses on drainage and flooding, water pollution, and programs with fish and wildlife habitat in the 51 square mile Bear Creek basin. The plan recommends a set of regulatory, programmatic, and capital improvement actions to address these problems. While the plan focuses on surface water issues, the maintenance of ground water quality and recharge was considered in the development of the recommendations. The plan was adopted by the King County Council in August 1992. The City of Redmond has adopted portions of the plan.

**Redmond Community Development Guide**

The Redmond Community Development Guide addresses development within the Redmond city limits and areas outside the city limits that are being considered for future annexation. The most important goals/policies of the Redmond Community Development Guide are:

- Preserve Redmond's natural environmental by minimizing the alteration of natural land features by methods including strict regulations of grading, filling, and clearing.

- Directing intense development away from sensitive environmental resources.

- Provide for multi-family densities in or near major commercial and employment centers, when consistent with the open space and agricultural land goals and policies.

- Require buffering to minimize the impacts between development with conflicting land use classifications.

- Conserve ground water resources and maintain high quality water resources.

### 2.5.2. <u>Residential and Commercial Land Use</u>

**Existing Development**

As can be seen from the existing land use map (see Figure 2.5.2.), the dominant land uses in the RBC-GWMA are low (≤1 home/acre) to moderate (2 to 3 homes/acre) density residential and undeveloped land. About 50 percent of the unincorporated RBC-GWMA is zoned a for minimum lot size of five acres. Most of the area east of Avondale Road and north of Union Hill Road is currently undeveloped or in rural development with minimum lot sizes of five to ten acres per dwelling. Most higher density residential development is located west of Avondale Road and south of State Route 202 (Redmond-Fall City Road) within the City of Redmond. In areas where local sewer service is available, (within the City of Redmond, at the southern end of the RBC-GWMA and the north side of Northeast 128th), residential development is generally denser than in the rest of the RBC-GWMA (see Figure 2.5.2).

Approximately 40 percent of the City of Redmond north of Northeast 88th Street and South of Northeast 116th Street, is zoned to accommodate single family residences with four to six dwellings per acre. Most of the remaining northern portion is zoned to accommodate one to three dwelling units per acre.

Multiple family development in the RBC-GWMA is limited to areas within the City of Redmond (see Figure 2.5.2.). These areas are located immediately north of the commercial district along Avondale Road and the Redmond-Woodinville Road, along the Sammamish River, and on the east edge of the city along the Redmond-Fall City Road.

**Future Development**

In the rural area, with an absence of public sewers, the density of new housing development will be limited to a maximum density of one house per 2.5 to 5 acres. Areas serviced by sewer will provide for higher density residential development. The intersection of Avondale Road and NE 116th Street has been zoned to provide for multifamily residential development and the area southeast of the City of Redmond will allow for higher density residential development of up to six dwelling units per acre. The majority of high density and multifamily residential development will be located within the City of Redmond and the Novelty Hill Master Planned Developments; (if the Master Plan Developments are approved).

Multifamily residential development within the City of Redmond will be confined to the center, southern boundary, and near the northwestern boundary of the city limits. High density single family residential development will remain concentrated in the northern section of the City of Redmond.

The Novelty Hill Master Plan Developments include two large contiguous landholdings: the 1,500-acre Redmond Block site and the 1,000-acre Port Blakely Tree Farm site. This Master Plan Development area is planned to have moderate density single-family (3 to 6-dwelling units/acre) and multifamily (18-dwelling units/acre) units on sewers.

**Commercial/Industrial Development**

Existing Development. Most commercial development in the RBC-GWMA is within the City of

Redmond. Neighborhood commercial development is restricted to scattered locations in the Evans and Bear Creek valleys, along the major arterials including Avondale Road, Woodinville-Duvall Road, and State Route 202 (Redmond-Fall City Road).

Significant light industrial areas are located in the lower Sammamish Valley immediately east of Marymoor Park and east of the intersection of State Route 520 and State Route 202. Research and development and high technology manufacturing occurs in these areas, as well as in Overlake and on the hills west of the Sammamish Valley.

Future Development. Major new commercial and industrial development is planned to occur within the City of Redmond. A regional shopping mall is proposed for the north side of State Route 520 on the former Redmond golf course. Another shopping district will be built in 1994-1995 at the intersection of State Route 520 and Avondale Road, near the City of Redmond's Well No. 5. Light industrial and high technology manufacturing, research, and development will continue to be developed in south east Redmond, east of the State Route 520 and State Route 202 intersection. The proposed Novelty Hill Master Plan Development area will provide a major employment center based on retail and business/office park uses. Three neighborhood-scale centers at Avondale Road/NE 116th, Avondale Road/Woodinville-Duvall Highway, and along Redmond-Fall City Road will provide for future local retail and service uses.

### 2.5.3. Ground Water Quantity

The amount of ground water available and what can be recharged into the ground is affected by land use, population growth and water use.

Ground water recharge is impacted by the amount of vegetation, soil conditions and the topography of the potential recharge area. Vegetation decreases the velocity of stormwater runoff as water is diverted around plant stems and roots. This is a benefit to recharge because slowing the runoff increases the time available for infiltration and thereby increases infiltration. By clear cutting the land and removing vegetation, recharge of ground water can be diminished.

Soils composed of coarse-grained material such as sand and gravel are generally more porous and better for recharge than those composed of fine-grained particles such as clay. Sealing over these recharge areas with parking lots, residential and commercial building will reduce the amount of ground water recharge.

The slope of the surface upon which precipitation falls affects the amount of precipitation that recharges into the ground. More rain tends to run off a steep slope than off a level plain.

With population growth there is an increase in the number of residential and commercial buildings, roads, and parking lots sealing over ground water recharge areas, and an increased demand for water. Ground water withdrawals from the aquifer combined with reduced recharge areas can lead to a diminished ground water supply for drinking water purposes. Because ground water and surface water are interconnected, surface water features such as lake levels and the base flow of creeks are impacted by diminished ground water levels.

With the demands for more ground water, agencies and purveyors must plan for methods to protect this valuable finite resource. In new developments, certain areas must either be left in their natural state or provided with vegetation that induces recharge. Stormwater facilities must be constructed to promote recharge of ground water provided that the stormwater is first adequately treated so as not to contaminate ground water. Ecology is also currently investigating ways to treat and reuse wastewater.

To conserve water, low use water fixtures need to be installed in residential and commercial buildings and the public needs to be educated in water saving habits.

### 2.5.4. Water Use

The primary beneficial uses of ground water in the RBC-GWMA are for domestic and public water supply, fire suppression, and recharge to streams and lakes.

Information on water purveyors and water rights within the RBC-GWMA was obtained through a review of SKCHD, Department of Health, and Ecology records. Approximately 57 approved public water systems operate within the RBC-GWMA, including four Group A systems. Under WAC 246-290, the Rules and Regulations of the State Board of Health Regarding Public Water Supplies, Group A systems within the RBC-GWMA include the City of Redmond, Union Hill Water Association, Northeast Sammamish Sewer and Water District, and Woodinville Water District.

The 53 Group B public water systems in the RBC-GWMA serve two to nine service connections each.

The Washington Department of Health has two classes of public water systems, the larger systems are known as Group A systems and the smaller systems are known as Group B systems. Group A systems generally serve 15 or more service connections. Group B systems are those with fewer than 15 permanent service connections. The SKCHD presently regulates Group B systems serving 2 to 9 service connections.

Water rights were found for only three of the four Group A systems in the RBC-GWMA. Based on Water utility estimates from Union Hill and Woodinville Water Districts (Coordinated Water System Plan, 1989), actual consumption of ground water by Group A water utilities in the RBC-GWMA averages about 8 million gallons per day (MGD). The exact quantity of water rights held by smaller systems within the RBC-GWMA is not known but is probably between 0.2 and 0.5 MGD.

According to the Bear Creek Community Plan (August 1987), most of the Bear Creek Planning area is within the approved service and planning areas of Group A water systems. The Bear Creek Community Plan recognizes these King County approved service and planning areas and encourages any new development to be served by these systems. Portions of the Bear Creek planning areas outside the boundary of Group A water service systems must rely on Group B systems or individual wells.

**Coordinated Water System Plan (CWSP)**

A preliminary assessment of problems related to water supply and reliability of service was performed for all of King County in 1985. Based on the results of this evaluation, East King County was declared a Critical Water Supply Service Area in 1986 (under the authority of the 1977 Public Water System Coordinated Water system Plan was prepared (October 1989) to address service needs and supply problems. The RBC-GWMA is located within the Critical Water Supply Service Area and was included in the 1989 Plan. A primary reason the eastern portion of King County was cited as a Critical Water Supply Service Area was concern over coordination of regional ground water service provision. Other important issues included water quality, ground water protection, existing and future source needs, land development and ability to provide adequate water supply for fire services to residents of the eastern part of the county.

The establishment of existing and future service areas provides a partial basis for water system planning. The Coordinated Water System Plan identified both existing and future service areas for water purveyors in East King County. These service areas are on record with the King County Parks, Planning and Resources Division, King County Planning, and the SKCHD. Service boundaries for Group A purveyors in the RBC-GWMA have been identified from the service area information provided in the Coordinated Water System Plan and are shown in Figure 2.5.4. A listing of Group A purveyors is provided in Table 2.5.5.

The Coordinated Water System Plan also provided a check list of topics that all water systems in the East King County area must address in their future comprehensive plan updates. These items include establishment of future service areas, development of water system design standards, implementation of water utility service review procedures, implementation of minor and major regional supply projects, management and operation of small water systems, and water conservation programs.

**Growth Projections**

Future growth and development within the RBC-GWMA will result in increased demand on existing sources. Preparing for this growth requires planning, identification, and development of new sources. For East King County, an evaluation of future water supply needs was made as part of the development of the Coordinated Water System Plan. The future demand for water was calculated in 1989 based on growth projections provided by the Puget Sound Council of Governments (now the Puget Sound Regional Council) and King County. From review of projected growth data, the need for new or expanded regional supply and distribution facilities was identified by comparing anticipated demand with existing source capacities.

For East King County, a water supply deficit was projected beyond 1997. Since information specific to the RBC-GWMA was not provided, if a deficiency will actually exist in the later 1990s within this area has not been fully evaluated. Future study is required to quantify the exact need and time frame for development of new sources to serve the expanding population projected to live within the RBC-GWMA.

**Potential Ground Water Sources**

East King County currently receives 75 percent of its drinking water supply from the Seattle Water Department (via the Tolt pipeline from the Tolt River watershed), with the remaining portion supplied by local purveyors who utilize ground water as a primary source. The Coordinated Water Supply Plan reviewed potential new sources of drinking water to service burgeoning population growth within this area of the county because of the projected deficit for east King County in the later 1990s. Of the potential water supply options identified in the Coordinated Water Supply Plan, several are located within the RBC-GWMA. These include the following ground water (aquifer) systems:

- Redmond Aquifer
- Evans Creek Aquifer
- Sammamish Plateau Aquifer

The Redmond and Evans Creek Aquifers are located in relatively shallow (<200 feet) fluvial deposits (material deposited by a stream or river) in Evans Creek and lower Bear Creek valleys. The Sammamish Plateau Aquifer, as the name implies, occurs beneath the Sammamish Plateau in relatively deep (<400 feet) glacial outwash deposits (sand and gravel deposited by an advancing glacier). The Coordinated Water Supply Plan concluded that the water supply potential of these aquifers was not significant enough for meeting future regional supply demands. Specific information regarding these aquifers is currently being developed as part of this study and will be part of a detailed hydrogeologic characterization report for the RBC-GWMA (refer to page 2-40 in this chapter).

**Current Domestic Ground Water Usage**

Ground water use for individual water supply wells is not currently managed. A drillers report must be filed with Ecology at the time of construction of each domestic supply well; however, under RCW 90.44.050, water rights (permits to appropriate) are not required for wells that supply under 5,000 gallons of water per day. No official estimate has been made of water consumption by individual wells in the RBC-GWMA. The Coordinated Water Supply Plan did not address water usage by individual wells. Using purveyor water use data in addition to Ecology and SKCHD well records, a total of 0.28 MGD of water consumption by individual wells has been estimated.

**Existing and Future Water Supply Needs**

As previously indicated, nearly all of the ground water rights that have been issued in the RBC-

GWMA are for public water supply purposes. On an average day, Group A water right holders are currently withdrawing an estimated average quantity of 8 million gallons per day. Based on population projections developed by Puget South Council of Governments, the Coordinated Water Supply Plan estimates that the current average consumption of 65 to 67 million gallons per day of water within East King County will increase to 77 to 84 million gallons per day by the year 2000 and 134 to 185 million gallons per day by 2040 (Table 2.5.6.). Estimated consumption volumes have not been developed specifically for the RBC-GWMA but usage can be expected to increase at about the same percentage as that for the rest of east King County.

The volume of ground water that is estimated to be withdrawn by individual wells currently exempt from water rights requirements is not expected to significantly increase in the future. Since the use of individual wells for new residential development within the RBC-GWMA is now primarily restricted to large-lot, rural applications, most of the additional growth in the RBC-GWMA, which is expected to be primarily urban and suburban residential, will be served by existing public water systems.

2.5.5. Ground Water Quality

## Ground Water Quality Conditions

Ground water supplies in the RBC-GWMA are drawn from several different aquifers (water-bearing zones). The primary producing aquifers are located in valley alluvial deposits along Bear Creek and Evans Creek, at relatively shallow depths (< 150 feet). Specific information regarding the hydrologic conditions and distribution of these aquifers will be provided in Section 2.6 (Hydrogeology). Existing and historical water quality data for all aquifers in the study area are primarily limited to Group A public water systems and resource protection wells around the closed Woodinville-Duvall landfill and new data collected during this study in 1989 and 1990. Additional limited ground water quality data are available from private domestic wells through SKCHD, Washington Department of Health, and Ecology. Historical data are discussed briefly here. The results of the data collected in 1989 and 1990 will be discussed in detail in Section 2.6.

The ground water quality, on the basis of existing (and historical) data generally meets all the primary and secondary state and federal drinking water standards. The primary problems identified from the historical data are as follows:

- Elevated levels of iron and manganese are common, particularly in deeper wells. This condition is common throughout glacial deposit aquifers of western Washington and is usually due to natural mineralization of the ground water system.

- Problems with bad tasting or odorous water occur sporadically. Hydrogen sulfide, a by-product of natural organic material decay, is often the cause of the bad taste and odor.

- As a result of a sewer line break in 1987, coliform contamination was detected in one of Redmond's municipal wells (No.5). The well was pumped at a high rate of discharge for several months and the coliform contamination was eventually eliminated.

This last incident underscores the vulnerability of the shallow Redmond Aquifer in particular, and shallow aquifers throughout the study area in general.

Widespread contamination from surface sources or as the result of specific incidents (e.g., accidental spills or accidents) has not been recorded to date.

**Water Quality Monitoring**

Successful management of a ground water resource is at least partially dependent upon the maintenance of an effective ground water monitoring program. Ongoing or long-term collection and analysis of ground water data are necessary to detect significant changes in the quality and quantity of water or in water levels. Early detection of problems allows them to be mitigated at an early stage of their development, when they are generally easier and less costly to correct.

The best available source of ground water quality data is the monitoring conducted by the Group A water purveyors within the RBC-GWMA. Pursuant to the requirements of WAC 246-290, the Rules and Regulations of the State Board of Health Regarding Public Water Systems, systems must be monitored on a regular basis for bacteria, inorganic chemicals, corrosivity, pesticides, radionuclides, trihalomethanes, and priority pollutants.

If conducted on each individual well in a public water system, such monitoring would provide critical information concerning the condition of ground water within the RBC-GWMA. Unfortunately, systems served by multiple wells are often tested at random locations within the distribution system. Water from such random locations is often a composite or mixture of water from several different wells. Monitoring data obtained from composite samples offer little information regarding the quality of ground water coming from any specific well in the system and provides essentially no basis for comparison with future sampling results. Monitoring data must be tied to specific wells to track water quality trends over time. Monitoring of Group B Public water systems can also provide important water quality information.

**Potential Impacts to Ground Water**

The vulnerability of ground water to contamination is related to the hydrogelogic environment and contaminant characteristics as well as the type of land use activity. The hydrogeologic characteristics of the RBC-GWMA are discussed in Section 2.6, Hydrogeology. A comparison of various land use activities and their potential impacts to the ground water system are summarized in Table 2.5.4. Some specific vulnerability factors include:

- Physical characteristics of contaminants (e.g. solubility, viscosity, density, biodegradation potential, volatility);

- Source, type, and quantity of contaminants;
- Hydrogeologic factors such as soil permeability, geologic material, and depth to water;
- Aquifer characteristics such as gradient, ground water flow velocities, hydraulic head, and hydraulic conductivity; and
- Existing and future beneficial use of ground water resources and intensity of these uses.

The following land use activities potentially affect ground water quality and quantity. It is important to evaluate all potential threats to ground water quality and quantity to effectively manage the ground water resource.

### 2.5.6. Sewerage Service

**Existing Conditions**

The King County Comprehensive Plan (1985) concludes that sanitary sewers are the best means of treating wastewater in densely developed urban areas. However, it needs to be recognized that this management technique may pose localized threats to ground water under unusual circumstances. The protection and development of aquifer resources needs to consider sewage service in its overall strategy.

The City of Redmond sewer system is the principal sewer utility operating within the RBC-GWMA. In addition to the City of Redmond sewer system, there are several other local sewer service areas within the RBC-GWMA including the Northeast Lake Sammamish Sewer District, the Woodinville Sewer and Water District, and a small private district operated by the Lake Washington School District 414. In the future, the City of Redmond sewer service may be extended to an area on Novelty Hill proposed for a Master Plan Development. Discharges from all of the facilities are pumped to Metro's Renton Sewage Treatment Plant. The current and future areas served by sewer systems are indicated in Figure 2.5.5.

**Future Data Collection Needs**

Additional information relating to sanitary sewer systems will be required to more adequately manage the potential risk to ground water. Specific items that need to be addressed include:

- Mapping of existing and proposed sewer alignments; and
- Historic information on sewer line leaks or breaks.

### 2.5.7. On-Site Sewage Disposal

**Existing Conditions**

Outside of the portion of the RBC-GWMA served by the identified sewer systems, disposal of sewage is accomplished through the use of on-site systems, primarily septic tanks and gravity drainfields (subsurface absorption systems). The SKCHD estimates that over 3,000 individual on-site sewage systems are in operation within the RBC-GWMA. These systems typically serve single family residences on suburban or rural parcels. The population within the unsewered areas is estimated to be over 7,000 people.

When properly sited, designed, and constructed, on-site sewage systems can represent a satisfactory long-term form of wastewater disposal. However, when improperly located, constructed, or misused, such systems can adversely affect both surface and ground water quality as well as public health. Contaminants typically present in domestic septic tank effluent include bacteria, viruses, nitrates, and phosphates. Effluent can also contain solvents or other home use chemicals. Nitrate is generally considered the most significant contaminant found in domestic wastewater because of its resistance to removal by treatment mechanisms normally present in the soil profile. Abnormal levels of nitrate in ground water are a good indicator of non-point pollution from on-site sewage systems.

The effect of septic tank effluent on ground water will have the most significant impact where sewage from a number of residences is collected and disposed of in a single community on-site system. Community systems are also used to serve shopping centers, institutions, or recreational areas. While individual residential on-site systems are diffused throughout an area, community systems concentrate effluent in a relatively small disposal area increasing the likelihood of local adverse impacts on ground water.

In addition to the aforementioned contaminants, effluent from on-site systems serving commercial and industrial facilities can also be a significant source of organic chemicals particularly those used in solvents, degreasers, and paint products. The typical chemical characteristics of various types of wastewater are summarized in Table 2.5.8.

The performance of an on-site sewage system must be evaluated based on two criteria, the effectiveness of effluent disposal and the efficiency of effluent treatment. Traditionally, the viability of an on-site system has been considered only in terms of its effluent disposal capability, that is, the ability of soils around a drainfield to absorb or accept effluent. Traditionally on-site system failure is considered to occur when the amount of effluent entering a drainfield exceeds the absorptive capacity of surrounding soil causing effluent to either back up into a building sewer or overflow onto the ground surface.

An on-site sewage system can also fail to function properly from the standpoint of its treatment efficiency. Failure of this type is more insidious than a disposal capacity failure (surfacing effluent) since there are no physical indications of the malfunction. It is generally accepted that filtration through 20 to 36 inches of fine-to-medium textured, unsaturated soil is necessary for removal of contaminants from septic tank effluent (Tyler et al., 1979). Soils that are limited by depth, or that are made up of large particles, such as coarse sand and gravel, may not provide adequate treatment.

Unlike a disposal capacity failure, which can generally affect only surface water quality, a treatment efficiency failure may affect either surface or ground water quality, depending on local conditions. In shallow soils that are underlain by a relatively impervious substratum, such as a hardpan (glacial till) or clay, there is a high potential for horizontal migration of poorly treated effluent. The potential for horizontal effluent migration is greatest in areas where a perched water table develops as a result of intense precipitation during the winter months. Contaminants carried in the perched water table can be released to the surface water system through road cuts, springs, or exposed banks.

A qualitative approach to evaluating the potential threat to ground water from septic tank drainfields in the RBC-GWMA was accomplished by compiling and mapping the locations of repair permits on file with the SKCHD. Since a septic system repair permit is required for any modification or expansion of an on-site sewage system it does not necessarily indicate a failed system. Figure 2.5.6. shows the distribution of repair permits issued in 1987. The highest concentration of repair permits were issued for systems in the northwest portion of the study area just south and west of Cottage Lake. The relative aquifer vulnerability in this area will be discussed in Section 2.6. (Hydrogeology).

**Soils and Effluent Treatment**

Ground water contamination from on-site sewage systems is generally associated with their use in coarse textured soils, such as large grained sands and gravel that overlie an unconfined, permanent aquifer. Effluent travel time through a coarse textured soil is often too rapid for treatment mechanisms to effectively remove or attenuate contaminants prior to their reaching ground water.

The most dominant soil in the unsewered portion of the RBC-GWMA is a gravelly sandy loam referred to by the Soil Conservation Service as the Alderwood series (Figure 2.5.7.). The detailed distribution of Alderwood soil as well as other soil series that are present within the RBC-GWMA are outlined in maps presented in the Soil Survey of the King County Area published by the Soil Conservation Service in 1973.

The Alderwood series is a moderately well drained soil that is formed in glacial till. Glacial till, commonly known as hardpan, is an unsorted, unstratified, compacted glacial drift consisting of a mixture of gravel, sand, silt, and clay. The typical profile of the Alderwood series consists of approximately 27 inches of gravelly sandy loam overlying weakly to strongly consolidated glacial till that extends to a depth of 60 inches or more.

The glacial till substratum of the Alderwood series generally restricts the vertical or downward movement of septic tank effluent and precipitation. Depth to maximum seasonal water table can range from about 24 to 42 inches below the ground surface. The limited depth of the

Alderwood soil above the saturated zone may not provide adequate treatment of effluent prior to reaching the water table. Further, the consolidated glacial till is typically less than 4 feet below ground surface and hydraulic conductivity of the till is very low (less than 0.6 inches per hour). The poorly treated effluent can move laterally with the perched water table and be released to surface water drainage courses or directly to surface water bodies such as a lake or nearby stream. On-site sewage systems installed in Alderwood soils must be carefully designed to maximize the separation between the drainfield trench bottom and the seasonal water table. When adequate separation is not available, alternate engineering design will be required or development may be prohibited.

The Everett series is another soil found sporadically within the RBC-GWMA. The Everett series is made up of somewhat excessively drained soils that are underlain by very gravelly sand at a depth of 18 to 36 inches. The Everett series substratum is black to brown, gravelly to very gravelly sandy loam about 32 inches thick. The substratum extends to 60 inches or more. The depth to water table exceeds 6 feet below ground surface in these well-drained soils. Although soils having a rapid or very rapid percolation rate do not impede downward movement of effluent from the subsurface absorption system (e.g., drainfield), they may permit the effluent to contaminate nearby water supplies. In many parts of the King County area, soils that have a rapid percolation rate to a depth of 4 to 5 feet meet the minimum requirements established by health codes (King County Board of Health, Rules and Regulations No. 3, April 1, 1987) for on-site treatment systems. These soils include Everett series. Everett soils may be expected to be suitable from a capacity standpoint, but high septic system densities may lead to shallow aquifer contamination. Existing regulations address this concern for new systems by requiring enhanced treatment of effluent to protect ground water quality.

Instances of ground water contamination associated with the operation of on-site sewage disposal systems have not been documented in the RBC-GWMA. This may be more a function of limited monitoring and evaluation rather than trouble-free sewage disposal systems.

**Future Data Collection Needs**

Future data collection needs relating to on-site sewage system should focus on special data needs which will include:

- Updating the information on the number and location of septic system repair permits;
- Developing a mechanism to identify repair permits issued for failed septic systems;
- Identification of older (> 15 years) septic systems located in critical aquifer recharge areas; and
- Increased ground water monitoring and sampling using existing or new wells in areas of highest density of on-site systems.

2.5.8. Solid Waste Disposal

**Existing Conditions**

Landfills are potential sources of ground water contamination, especially those constructed prior to implementation of new standards for construction of these solid waste facilities. In the RBC-GWMA, an old King County landfill (Duvall Custodial Landfill) is located on the northeastern border of the RBC-GWMA, just off of the old Woodinville-Duvall Road. This landfill is not currently active and was closed in 1981 under WAC 173.301. The landfill was capped with a clay layer during closure to minimize leachate production. A leachate collection system surrounds the landfill to collect leachate generated from the landfill. Leachate is routed to a tank that is pumped occasionally and disposed outside the RBC-GWMA. The King County Department of Public Works, Solid Waste Division has conducted quarterly ground water sampling in the vicinity of the old landfill. No detectable levels of dangerous/hazardous constituents have been found to date.

The King County Solid Waste Division is currently conducting a detailed hydrogeologic investigation at the landfill. A test pit survey locating near-surface saturated areas and defining the depth of an upper water-bearing zone has been conducted (Holmes, 1994).

Another closed landfill site was located between 155 Place N.E., 152 Place N.E., and N.E. 172 Street east of Woodinville. This site, the H.H. Oleson site, operated for seven years and accepted demolition waste consisting of inert materials and wood. There has been no methane found and no leachate detected from limited sampling (one time) of the site by the SKCHD (Bishop, 1994).

No other former or current landfills are known to be located within the RBC-GWMA.

**Future Data Collection Needs**

A more detailed understanding of ground water flow and ground water quality conditions needs to be developed at the Duvall Custodial landfill site. The Solid Waste Division is installing six dual-completion wells at the Duvall Custodial landfill in 1994 to define lower water bearing zones. The data collected from this investigation will be used to characterize the hydrogeology, the effects the landfill may have on surface or ground water, and any potential contaminant transport pathways (Holmes, 1994).

The data collected by the Solid Waste Division from the Duvall Custodial landfill site needs to be shared with SKCHD and the RBC-GWAC.

2.5.9. Hazardous Waste

Hazardous waste, as defined in the Washington State Administrative Code (WAC 173-303-070 to 120), is a material that is ignitable, corrosive, reactive, or toxic. Hazardous wastes can be introduced to the environment, including ground water, in a number of ways. For Resource Conservation and Recovery Act-regulated generators and potential small waste generators in the RBC-GWMA not served by a pubic sewer system, hazardous wastes may be discharged illegally to septic systems through sinks, toilets, or floor drains. Inadvertent or intentional discharges to stormwater disposal systems represent another release mechanism. Small quantities of hazardous wastes that are discarded along with normal solid waste refuse can be placed in landfills and contribute to leachate contamination of underlying ground water. Finally, hazardous wastes that are deposited on exposed ground surfaces from traffic accidents, spills, or from improper storage can percolate into the soil and may migrate via recharging precipitation into the ground water environment.

**Hazardous Waste Disposal**

No sites listed on the Superfund National Priorities List or Comprehensive Environmental Response Compensation and Liability Information System are located within the RBC-GWMA. Additionally, no listed Washington State confirmed hazardous substances sites, potential hazardous substances sites, or sites undergoing long-term monitoring are located within the RBC-GWMA. There is little or no likelihood that the RBC-GWMA will ever be considered for potential siting of a hazardous waste disposal site.

**Hazardous Waste Generators**

To be regulated under the federal Resource Conservation and Recovery Act, a commercial or industrial facility must generate at least 220 pounds per month of hazardous waste; transport dangerous/hazardous waste; treat, store, or dispose of dangerous/hazardous waste; or burn or blend dangerous waste fuels. Several commercial and industrial facilities located within the RBC-GWMA generate quantities of hazardous or extremely hazardous waste regulated under the Resource Conservation and Recovery Act. A "windshield" survey of the major arterials in the RBC-GWMA was conducted and several other businesses were observed that are not regulated under the Resource Conservation and Recovery Act but may produce hazardous wastes in quantities below regulated amounts (i.e., small quantity generators). Small quantity generators produce less than 220 lbs. of hazardous waste each year. The SKCHD and Metro assess how small quantity generators store, use, and dispose of hazardous waste. Hazardous waste spillage at small quantity generators is SKCHD Local Hazardous Waste Management Program's highest priority. Businesses where hazardous waste spillage is observed are reinspected in approximately one month to determine if the site has been satisfactorily cleaned up. These businesses must still handle their waste properly according to WAC 173-303 and Title 10 of the King County Board of Health Regulations. To date SKCHD and the Metro have been inspecting automotive repair and silk screening businesses (Coville, personal communication, 1993).

Ecology maintains a record of businesses that generate, store, treat, or transport hazardous waste in the state. This list (notifier's list) was reviewed to identify businesses that may handle hazardous waste in the RBC-GWMA. The Resource Conservation and Recovery Act regulated and other potential generators of hazardous waste in the RBC-GWMA are listed in Table 2.5.9.

Table 2.5.9. also shows the number of businesses that are either regulated under the Resource Conservation and Recovery Act or not regulated under the Resource Conservation and Recovery Act but are potential hazardous waste generators. At least one type of hazardous material is associated with the normal operations of each type of Resource Conservation and Recovery Act regulated and potential small waste generator listed in Table 2.5.9. For example, automotive repair shops typically handle large quantities of volatile solvents and oil-based products containing organic compounds such as benzene, chlorinated ethylenes, toluene, and methylene chloride. Dry cleaners use solvents and cleaning solutions containing chlorinated ethanes and ethenes, especially trichloroethane and tetrachloroethane. Paint supply stores may deal with products containing heavy metals, phenols, and toluene. When these materials are discarded because their usefulness has diminished due to age or over-use (e.g., spent solvents), they will probably be classified as hazardous wastes.

Table 2.5.10. lists businesses in the RBC-GWMA where Ecology is investigating or monitoring the clean-up of toxic material spills. In most instances, ground water contamination is either suspected or confirmed.

### 2.5.10. Underground and Above-ground Storage Tanks

**Existing Conditions**

Underground Storage. Underground petroleum and chemical storage tanks represent one of the most significant potential threats to ground water in the RBC-GWMA. Releases may be readily detected from all types of underground storage tank systems. Releases go undetected when operators ignore their responsibility to monitor the systems on a regular basis. Releases from underground storage tank systems occur above ground, as associated with sloppy surface handling practices (i.e. during bulk deliveries or dispensing episodes), and from below ground causes, as from failed piping or tank components. Underground storage tank system components may fail from corrosion, however, failure from careless workmanship during installation and assembly is more common (Knowlton, 1994).

The purpose of federal and state Underground Storage Tank Regulations are simply to preserve the quantity and protect the quality of our country's ground water resources (Knowlton, 1994).

Underground Storage Tank Regulations began when the President signed the 1984 Hazardous and Solid Waste Amendment (Public Law 98-616) to the Resource Conservation and Recovery Act. Under the new authority of Resource Conservation and Recovery Act Subtitle I, the Environmental Protection Agency wrote and published the first set of requirements for underground storage tank owners and operators. These federal regulations were revised and finally codified as 40 CFR Parts 280 and 281 which became effective December 22, 1988. The title of this regulation is "Underground Storage Tanks; Technical Requirements and State Program Approval; Final Rules."

40 CFR Part 280 outlines the Environmental Protection Agency's objectives and promulgates requirements for the following activities: notification (e.g. providing the Environmental Protection Agency's details about the underground storage tank owner, operator, and protection for tanks and piping, spill protection, overfill prevention, release reporting, and financial responsibility (i.e. liability insurance for the property owner) (Knowlton, 1994).

In 1989, the Washington State Legislature passed House Bill 1086 which was signed by the governor as State Law 90.76 RCW. It became effective July 1, 1990 and expires July 1, 1999. This new law directed Ecology to write and implement underground storage tank regulations at least as stringent as the Environmental Protection Agency's. Ecology's regulations (Chapter 173-360 WAC) are similar but not identical (more stringent) to the Environmental Protection Agency's.

In addition, petroleum products are considered hazardous substances in Washington. They are taxed, transported, stored, and consumed as such, but wastes derived from petroleum products are not always considered hazardous. The recovery and cleanup of spills (a surface phenomenon) and releases ( the subsurface version) of petroleum products that contact soil, surface water, or ground water are regulated by the Model Toxics Control Act and Cleanup Regulation (Chapter 173-340 WAC). Response and reporting requirements associated with releases from underground storage tanks are described under Chapter 173-340-450 WAC. According to Ecology's underground storage tank records, 73 underground storage tanks ranging in size from 111 gallons to 20,000 gallons are in operation at 23 sites within the RBC-GWMA (Table 2.5.11.). The Ecology list contained within the 1991 Background Land and Water Use Report showed 193 underground storage tanks in operation at 57 sites. This is consistent with a state wide trend of fewer underground storage tanks in operation. This list is not all inclusive, it only reflects those systems reported to Ecology. This list does represent the majority of regulated underground storage tank systems in the area. This number does not include home heating oil tanks. The 73 reported tanks hold a variety of petroleum products including leaded and unleaded gasoline, diesel fuel, lubricating oil, fuel oil, kerosene, and waste oil. The total number of underground storage tanks in the RBC-GWMA is much greater than Ecology records indicate because: some owners have yet to notify Ecology about the systems they use; systems that are not regulated by Ecology are not tracked (i.e. heating oil tanks or tanks less than 110 gallons); and many systems were emptied and taken out of service prior to the Environmental Protection Agency's notification requirement but still remain in place (Knowlton, 1994). The approximate location of some of these underground storage tanks is shown on Figure 2.5.8.

Many different types of facilities in the RBC-GWMA own and operate regulated underground storage tanks. The most common examples are gasoline stations and vehicle repair shops. Other, less common examples include hospitals, fire and police stations, bakeries, dry cleaners, telecommunication utilities, schools, city parks, and equipment rental shops. Most establishments that one would expect to own or operate regulated underground storage tanks have notified Ecology and are on the enclosed lists.

The changes in tank design, or manufacturing standards, are a direct result of the Environmental

Protection Agency's "Interim Prohibition". Interim Prohibition describes the period of time between the authorization of the Resource Conservation and Recovery Act Subtitle I (November 1984) and the final publication of 40 CFR Part 280 (September 1988). The Resource Conservation and Recovery Act Subtitle I created federal Underground Storage Tank Law; 40 CFR Part 280 are the final set of the Environmental Protection Agency regulations that implement that Law. Interim Prohibition was nothing more than an Environmental Protection Agency milestone in the 40 CFR Part 280 development process. Its purpose was to establish minimum standards for underground storage tank design and installation that would help reduce the incidence of releases from old or poorly engineered systems (i.e., prevent the re-installation of old, bare steel tanks and the continued manufacture of unprotected steel tanks). Interim prohibition went into effect May 1985. In summary, Interim Prohibition required that no underground storage tank could be installed unless: 1) it was engineered to prevent releases from structural failure for its operational life; 2) it would prevent releases from corrosion for its operational life; and 3) it was compatible with the product stored. Interim Prohibition has been replaced by "New Tank Performance Standards" under 40 CFR Part 280. Chapter 173-360 WAC parallels the Environmental Protection Agency's regulation in this regard (Knowlton, 1994).

Table 2.5.12. lists the age of the 73 underground storage tanks in operation in the RBC-GWMA. There are 27 underground storage tanks between 11 and 15 years old, 12 underground storage tanks between 21 and 30 years old, and one underground storage tank older than 30 years.

Table 2.5.13. lists the substances contained is the 73 underground storage tanks in operation. There are 28 underground storage tanks containing unleaded gasoline and 17 underground storage tanks containing diesel fuel. Table 2.5.14. lists the size of underground storage tanks in operation. There are 27 underground storage tanks in operation with a size between 10,000 and 19,999 gallons.

Twelve leaking underground storage tanks sites have been confirmed in the RBC-GWMA to date (Table 2.5.15.). Of these twelve sites, four sites where clean up is in progress/ongoing have ground water contamination. As older underground storage tank systems are removed or replaced with newer systems one would expect this number to increase (Knowlton, 1994).

Above-Ground Storage. No above-ground chemical storage tanks other than home heating oil tanks were identified during the windshield survey in the RBC-GWMA. Bulk fuel storage tank farms identified in the RBC-GWMA are underground facilities.

**Future Data Collection Needs**

Underground storage tanks represent a threat to ground water in the RBC-GWMA since leaks may go either unreported or undetected. The location of potentially hazardous underground storage tanks is difficult to determine due to their hidden nature and the lack of reliable records.

A priority of future data collection efforts should be the identification of underground storage tanks located in sensitive aquifer recharge areas. Additional research should also try to locate small private underground storage tanks, especially residential heating oil tanks. An effort should be made to obtain access to underground storage tank sites where ground water

monitoring networks have been installed so that long-term cleanup or impacts can be monitored.

2.5.11. Stormwater

**Existing Conditions**

Stormwater can enter ground water by several means. In undeveloped areas, stormwater infiltrates into the soils and is carried downward via gravity to underlying aquifers. In developed areas, stormwater can be routed into drainage swales and/or retention/detention systems used to reduce peak flows from these areas. The stormwater then infiltrates into the ground water, or is released to a surface water body. Another common practice used to manage stormwater is the construction of dry wells in rapidly percolating unsaturated soils. In these situations, stormwater is discharged directly into the substratum. Infiltration of stormwater into ground water through dry wells is the most direct subsurface disposal method. Subsurface disposal methods bypass the vegetative land surface and relatively fine textured topsoils that are effective in removing some contaminants, especially particulates, from stormwater. Infiltration of stormwater may provide direct contamination of the ground water with oils, greases, nitrates, and heavy metals often found in urban stormwater runoff.

Quantities of stormwater runoff generated within a given areas will vary with the nature of local land-use. Forested open spaces may absorb nearly all precipitation and generate very little runoff. Conversely, a shopping center consisting largely of impervious surfaces such as rooftops, asphalt parking lots, and sidewalks, will absorb almost no precipitation. Therefore, precipitation must either evaporate or enter a stormwater collection and disposal system. Typically, runoff from forest areas may be as little as 10 to 25 percent of total precipitation while runoff from highly impervious developments may rise to 60 to 80 percent of precipitation.

In general, stormwater from developed areas may contain heavy metals, organic pollutants, coliform bacteria, nutrients, and suspended solids. The quality of stormwater varies depending on the land-use. Typically, runoff from industrial areas can contain metals, soluble solvents, and other hydrocarbons including benzene, chloroform, TCE, oil and grease, phthalates, less volatile solvents, or chemicals associated with a specific manufacturing process. Commercial land uses, particularly those involving extensive parking lots, generate runoff carrying particulates laden with heavy metals. The most prevalent heavy metals are typically copper, lead, and zinc associated with automobile operation (National Urban Runoff Program, 1983). Runoff from residential areas also have detectable levels of heavy metals present but more typically contain nitrates, pesticides, and coliform bacteria. Ranges of values for different constituents are presented in Table 2.5.16.

Certain areas of the RBC-GWMA contain rapidly percolating soils, swales, retention ponds, and dry well systems which are used to manage stormwater runoff. Within the City of Redmond alone, some 122 retention systems are installed. These systems discharge untreated stormwater directly into the underlying aquifer system. According to the King County Department of Public Works no drywells operate in the unincorporated portions of the county. However, retention ponds are used widely throughout the rural county areas for control of drainage along rights-of-way. Contaminant loading to the ground water from surface water runoff is therefore of concern for the RBC-GWMA particularly in areas where retention is employed because of the potential degradation of ground water quality.

Another significant risk to ground water associated with stormwater disposal in the RBC-GWMA is infiltration of hazardous materials released to open roadside ditches or retention ponds as the result of transportation spills.

**Future Data Collection Needs**

Additional information needs relating to potential storm runoff impacts in the RBC-GWMA include:

- The number and location of stormwater retention basins in the RBC-GWMA.
- The monitoring of stormwater quality in retention ponds located in critical aquifer recharge areas.

2.5.12. Transportation Spills

**Existing Conditions**

Ecology does not maintain records on the number of transportation related hazardous waste spills in the RBC-GWMA. Ecology's Spill Response Section indicated that numerous transportation related hazardous waste accidents have occurred in the past in the RBC-GWMA (Personal Communication, April 1990). These accidents have occurred mainly on State Route 202, State Route 520, and Avondale Road.

The Washington State Department of Transportation records do not contain specific files of the number of transportation related hazardous waste spills for the RBC-GWMA. Statewide information suggests that approximately 1 in 10,000 reported motor vehicle collisions involve vehicles where hazardous waste is transported. Actual accident rates will vary from roadway to roadway depending on speed limit, traffic load, and highway conditions. In general, accident rates of 1.0 to 15 per million vehicle miles have been encountered in similar areas (Gig Harbor GWMA (data developed by Sweet Edwards/EMCON), and Thurston County Public Works, McAllister/Easton Creek Stormwater Management Plan and Ground Water Risk Assessment (draft report May 1990)). Hazardous waste spills do not necessarily occur at every accident involving a hazardous waste vehicle.

According to Ecology's Spill Response Section, the potential for transportation related hazardous waste accidents in the RBC-GWMA is high due to the relatively frequent number of trips by trucks carrying hazardous materials (Personal communication, April, 1990). Traffic counts and accident information were obtained from the City of Redmond Public Works Department for the major arterials within the RBC-GWMA. Table 2.5.17. shows the rounded-off average daily traffic counts, for the reaches within the RBC-GWMA, and the total traffic accidents reported for those reaches of the major arterials within the RBC-GWMA in 1993.

The Washington Utilities and Transportation Commission provided statistical information of truck accidents occurring in the City of Redmond between 1989 and 1991 (Table 2.5.18.). In 1991, there were 33 truck accidents, none of which involved hazardous materials. In 1990, there were 45 truck accidents with one involving hazardous materials. Similarly in 1989 one truck accident involving hazard materials also occurred. Statistics were unavailable prior to 1989.

Traffic volumes on all roadways within the RBC-GWMA are expected to increase significantly in the future. The King County Public Works Department indicated that the expected increase in traffic on Avondale Road is expected to be around 12 percent per year to the year 2000. The City of Redmond Pubic Works traffic projections indicate that traffic at Union Hill Road and Avondale Road is expected to increase by 10 to 12 percent per year. Based on past Washington State Department of Transportation traffic increases, travel on State Route 202 in the RBC-GWMA is also expected to increase by approximately 10 percent per year.

With an estimated average annual increase in the traffic on the major arterials within the RBC-GWMA of between 10 and 12 percent, traffic in the RBC-GWMA may almost double by the year 2005. The increased volumes will result in significantly higher numbers of accidents. In all likelihood, the greatly increased traffic congestion will also result in higher transportation related hazardous waste accident rates.

**Future Data Collection Needs**

A better understanding of traffic patterns and volumes in the RBC-GWMA will be necessary before there can be a significant effort to evaluate the potential risks to ground water from transportation related spills. Specific data that needs to be collected include:

- Accurate traffic volume estimates for all the major transportation routes in the RBC-GWMA, including the proportional volume for each significant section of a transportation corridor.

- Statistics on the number of truck accidents occurring on the major transportation routes.

- Intersection/highway stretches were accidents occur most frequently.

- Location of hazardous waste generators in the RBC-GWMA which use, dispose, or transport hazardous waste via trucks or railroad which enter the study area.

2.5.13. Well Construction and Abandonment

**Existing Conditions**

Although not actually a source of contamination, the methods used to construct a well can have a significant impact on water quality. For instance, unless a well is sealed properly, the casing can act as a conduit for pollutants originating at the ground surface to travel to an underlying aquifer. Additionally, if a well penetrates more than one aquifer unit, water from the various aquifer units can mix. If the water of one aquifer unit is contaminated, it can, under certain hydrologic conditions, introduce contaminants to other aquifer units. Adequate well design and construction standards must be enforced to prevent water quality problems of this nature.

There are 53 Group B small public water systems in the RBC-GWMA. There is also an unknown number of private wells (Cox, 1994). Also, an unknown number of wells may no longer be in use or may be abandoned in the near future due to growth of centralized public water systems in the RBC-GWMA. Many of these wells were drilled prior to the introduction of well construction standards and are not equipped with adequate sanitary seals. Thus, they will continue to provide an opportunity for land surface contaminants to migrate to ground water. After their use has been discontinued, wells, including test wells, must be properly abandoned to prevent them from deliberately or unintentionally becoming an avenue for contamination to reach ground water.

The Minimum Standards for Construction and Maintenance of Water Wells (WAC 173-160) requires that well drillers submit a report on the construction of every new water well to Ecology. Such reports should include the information necessary to describe the well's location, surface elevation, and the type of well construction. In addition, the report should provide pertinent data concerning the geologic conditions encountered during construction and the characteristics of the aquifer.

Well reports serve as an important database for the evaluation and management of ground water resources within the RBC-GWMA. Meeting future demands for drinking water in the RBC-GWMA may be dependent on ground water; thus, the accuracy and completeness of well reports is necessary to develop future water planning for the area.

**Future Data Collection Needs**

Future data collection efforts should attempt to identify improperly abandoned wells or wells that were improperly constructed and should be abandoned in the RBC-GWMA. A data sort showing locations of wells which predate subsequent service by a water system can be used to define areas of higher probability for the existence of unused wells. An additional task should be the identification of shallow, particularly dug wells, located in critical aquifer recharge areas.

2.5.14. Fertilizer Use

**Existing Conditions**

Since commercial agriculture is virtually absent in the RBC-GWMA, fertilizer use is largely restricted to turf applications at public golf courses, residential lawns, and institutional lawns. Turf fertilizers are a source of two potential contaminants, nitrate and phosphate. Of the two, nitrate represents the greatest risk to ground water contamination because of its high water solubility and high mobility in the soil column.

Phosphates in turf fertilizers generally do not pose a significant threat to ground water for a number of reasons. First, the water solubility of phosphate is low and much of the available phosphorus will be utilized within the root zone. The pH of the turf and underlying soil is conducive to the rapid binding of phosphate with aluminum ions found in abundance in western Washington soils (Braun, 1989). The use of phosphate on turf is essentially self-limiting. Only a relatively small amount of phosphate is used by grasses and little of that is actually bound up in plant tissue. Excessive application of phosphate will result in undesirable seed head growth, diminishing the aesthetic quality of the turf.

Two golf courses are located within RBC-GWMA. The 200-acre Sahalee Golf Course is situated in the southern portion of the RBC-GWMA. The 182-acre Redmond-Bear Creek Golf Course is located in the east central portion of the study area. Fertilizing practices are essentially the same for most golf courses in western Washington. Nitrogen is applied to the fairways at relatively low rates, about 2 to 2.5 pounds per 1,000 square feet. The 2 to 2.5 pounds is split into two annual applications. The greens receive nitrogen at a much higher rate, about 6 pounds per 1,000 square feet, split into 10 to 12 annual applications. These application practices are generally consistent with those recommended by the Washington State University Cooperative Extension Service (Personal communication). The Cooperative Extension Service suggests that nitrate contamination of both ground and surface water associated with turf fertilizers can be avoided through frequent, low-level applications of no more than 4 to 6 pounds of nitrogen per 1,000 square feet per year in 0.5 pound increments. Over-watering the turf after fertilizer application should be avoided to reduce the opportunity for nitrate wash-through. Use of urea should be avoided since it converts rapidly to nitrate. Ammonia sulfate is the recommended form of nitrogen because it is assimilated quickly, becomes tied up in the organic matter of the turf, and converts slowly to nitrate.

The nature of turf fertilizer use for residential and institutional lawns in the RBC-GWMA is not documented. Presumably, the amount applied and the frequency of application varies widely. However, an informal telephone survey conducted by HDR (subconsultant on the RBC-GWMA project) of fertilizer suppliers in the vicinity of the RBC-GWMA indicated that most are currently recommending application practices that are consistent with those of the Cooperative Extension Service. Specifically, they recommended 3 to 4 pounds of nitrogen per 1,000 $ft^2$/year in the form of ammonia sulfate and 1 pound of phosphate per 1,000 $ft^2$/year, divided into several low-level applications.

**Future Data Collection Needs**

Fertilizer use does not appear to pose a significant threat to ground water in the RBC-GWMA. Future data collection efforts should focus on obtaining information on the types and quantities of agricultural fertilizers used at the few commercial businesses that use fertilizers, such as golf courses and nurseries.

2.5.15. <u>Pesticide Use</u>

**Existing Conditions**

Currently, no significant pesticide use has been documented within the RBC-GWMA. The King County Department of Public Works Roads Division maintains the unincorporated portions of the RBC-GWMA. Roads Division staff apply herbicides to control noxious weeds on the right of way, and weed and grass growth on gravel shoulders and around guard rails. Either Escort or Garlon are used for broad leaf control. Oust or Roundup are used for the non-selective control on the shoulders. The use of the chemicals Simazine and Atrazine were discontinued in 1989. All herbicides including those not on a "restricted use" are applied by certified pesticide applicators (Matsuno, 1994). Herbicide use at golf courses is limited to occasional applications of small quantities of Roundup.

Puget Sound Power and Light has an integrated vegetation management plan for its entire service area. The vegetation management plan is on a five year rotation cycle in most cases. Herbicide use is a tool of the integrated vegetation management program. The Union Hill Transmission line right-of-way, as well as other transmission and distribution lines in the Bear Creek area, are subject to selective herbicide use, along with mechanical and hand cutting methods in prescribed areas (Dennison, 1994). All herbicides are used selectively and no broadcast spraying is done. Garlon 3A, Garlon 4, and Rodeo are herbicides most frequently used on a selective basis. Selective treatment is low volume basal, low volume foliar, and stump treatment prescribed for each specific site (Dennison, 1994).

The nature of residential pesticide use in the RBC-GWMA is not documented.

**Future Data Collection Needs**

Pesticide use does not appear to pose a significant threat to ground water in the RBC-GWMA. Future data collection efforts should focus on the types and quantities of pesticides used by King County, Puget Power, and commercial businesses, with particular attention focused on activities in sensitive aquifer recharge areas.

### 2.5.16. Mining Operations

**Existing Conditions**

Gravel mining operations can impact ground water quality because they often leave portions of an aquifer directly exposed to surface water and contaminants from adjacent land use activities. Historic undocumented fills used in reclamation of gravel mine sites may have contaminated ground water. These areas may also be a significant source of ground water recharge for an aquifer.

Several active gravel mining operations are located in the RBC-GWMA. Active mining operations are sites which have a Department of Natural Resources permit to mine. Permits have no completion date. A mine is still designated as active by the Department of Natural Resources even if the site is not physically in operation. A mining site becomes inactive when reclamation is completed to the Department of Natural Resource's requirements (Pierce, 1994).

There are a number of active gravel mining operations in the RBC-GWMA. The majority of these are located south of the Union Hill Road (Pierce, 1994), some contain off-site fill.

**Future Data Collection Needs**

Because of the potential vulnerability to ground water quality posed by gravel mining operations, future data collection efforts should include development of ground water monitoring networks to enable evaluation of any existing or future impacts to aquifers.

### 2.5.17. Sludge (Biosolids) Disposal

**Existing Conditions**

No sewage treatment plant sludge (biosolids) land application sites exist in the RBC-GWMA and is unlikely to occur given existing regulations and land use plans.

### 2.5.18. Conclusions

In each description of land use activities in the RBC-GWMA, the effects of existing and potential land use activities on ground water is still uncertain. The purpose of this report is to present information relevant to the Redmond-Bear Creek Valley Ground Water Management Plan and to point to areas where additional information will provide decision makers with a complete picture of ground water management issues in the study area.

Future research priorities should focus on the following:

**Ground Water Recharge Zones**

The location of surface areas where aquifers are most heavily recharged is important to every land use activity previously described. These are areas where surface contamination is most likely to lead to ground water contamination. Also, ground water loss can occur if these areas are covered by parking lots and buildings.

These sensitive aquifer recharge areas (susceptibility of ground water to contamination and recharge) are identified in Figure 2.6.19. Efforts to minimize the possibility of contaminants reaching these areas and the paving over of these areas should be undertaken. Land and water use activities are relevant to ground water management only in as much as they affect ground water quality and quantity. Surface activities described in this report will have the greatest impact on ground water when they take place in ground water recharge zones. Figure 2.6.19. should be further refined as more information becomes available from studies such as wellhead protection and SEPA reviews.

**Future Development**

A detailed analysis of existing land use activities in the RBC-GWMA together with projected residential, commercial, and industrial development trends is needed to assess the land use activities that account for ground water contamination, and to determine the future increased demand for ground water.

**Septic Systems**

The overloading, inadequate treatment of sewage, and the threat to ground water quality from septic tanks and drainage fields should be of particular concern as development becomes more concentrated in areas where sewer service is not available. The location of all septic tanks, especially those with a history of failure and those older than 15 years located in potential ground water recharge zones, should be evaluated for their impacts on ground water quality. On-site systems located in the highest density residential areas should be monitored for their impacts on ground water by sampling existing and new wells in those areas.

**Sewers**

Additional information is needed on sewer line leaks or breaks concerning impacts to ground water quality and quantity. Existing and proposed sewer alignments need to be mapped.

**Underground Storage Tanks**

Without proper prevention or detection systems in place, there is a high risk of ground water contamination due to an underground storage tank leak or accident. Additional information on appropriate commercial and residential underground storage tank locations, especially in sensitive aquifer recharge areas is necessary to determine the extent and type of ground water contamination. Underground storage tank sites which have ongoing long-term cleanup programs should be monitored.

**Stormwater**

The number and location of stormwater basins in the RBC-GWMA should be identified. The water quality of stormwater outlets should be monitored during storm events, especially where these outlets discharge to ground water and creeks in sensitive aquifer recharge areas.

**Landfills**

Evaluating the extent of ground water contamination from landfills is a complex process. The water quality data collected by the Solid Waste Division at the Duvall Custodial landfill site should be monitored.

**Hazardous Waste**

Monitor and evaluate the impacts on ground water quality from data collected small and large quantity from hazardous waste generator facilities.

**Hazardous Material Spills**

Hazardous material spills, particularly transportation spills and their impacts on ground water, should be monitored. Hazardous waste generation in the RBC-GWMA which use, dispose, or transport hazardous waste via trucks or railroads which enter the study area should be located. Accurate traffic volume data for all major transportation routes in the RBC-GWMA, including the proportional volume for each significant section of transportation corridor, should be collated. Statistics on the number of truck accidents occurring on the major transportation routes and where these accidents most frequently occur should also be collated.

**Plant Control**

Pesticides, herbicides, and fertilizers all represent a potential threat to ground water quality in the RBC-GWMA. These chemicals are applied in a broad range of activities including: agriculture, the maintenance of powerline corridors, roadside spraying, and park and landscape maintenance. Additional information is needed as to the types and quantities of fertilizer applications at commercial businesses (golf courses, nurseries) and their impacts on ground water quality, as well as the types and quantities of pesticides used in the RBC-GWMA by government agencies and businesses particularly in sensitive aquifer recharge areas.

**Mines**

Additional information is needed on how existing operations affect ground water quality. At this time, little is known about the impacts of industrial contaminants that seep into exposed aquifers at mines, and of the potential for hazardous material spills at a mining operation.

**Non-Point Contaminants**

Non-point pollutants from urban runoff (oils, greases, and other materials washed from impervious surfaces) and agricultural practices may contribute to ground water contamination in the RBC-GWMA. Although very few studies of non-point contaminants have been conducted in the RBC-GWMA, studies in other areas have indicated that non-point sources can contribute to ground water contamination.

## 2.6. HYDROGEOLOGY

This section summarizes existing and new geologic, hydrogelogic, and ground water quantity and quality information for the RBC-GWMA. The purpose of this section is to provide a framework for understanding the geologic and hydrogeologic conditions in the RBC-GWMA and to provide information necessary for short- and long-term water resource planning and protection. Information contained in this section was obtained from existing sources and through new data collection activities. The data used in this section was collected by personnel of EMCON Northwest, Inc., SKCHD, the City of Redmond, Union Hill, and Northwest Lake Sammamish Water Districts, and members of the RBC-GWAC.

The scope of work performed to prepare this section included the following tasks:

- Existing data collection and analysis;
- An electrical resistivity survey;
- Design and implementation of a ground water monitoring network;
- Water level monitoring;
- Well installation and testing;
- Water quality sampling and analysis;
- Stream flow gauging;
- Precipitation monitoring;
- Evaluation of data; and
- Preparation of this report documenting findings and conclusions.

### 2.6.1. <u>Geology</u>

**General Description**

The Redmond-Bear Creek study area contains three basic rock types: tertiary or older sedimentary and crystaline bedrock, semi-consolidated to unconsolidated fluvial, glacial, and marine Pleistocene sediments, and recent alluvium (Figure 2.6.1.).

The depth to bedrock in the study area ranges from 0 feet to greater than 1,500 feet below ground surface. Bedrock may occur at the surface only in a small outcrop near Peterson Pond in the southeast corner of the RBC-GWMA.

In most of the study area, bedrock exists beneath 400 to 1,200 feet of Pleistocene sediments (Hall & Otherberg, 1974). These sediments appear to be thickest near the City of Redmond at the north end of Lake Sammamish.

Glacial deposits typically include outwash deposits, glacial till, and interglacial lacustrine deposits. Outwash deposits are composed of sands and gravel deposited as the glacial ice advanced (advance outwash) or receded (recessional outwash). Glacial till, a compact mixture of gravel, sand, silt, and clay, is formed by glaciers overriding, grinding, and compacting outwash material. Lacustrine (lake) sediments typically include finer-grained materials such as clay, silt, and fine sand, and often contain organic debris.

Individual geologic units in the RBC-GWMA are difficult to distinguish based only on the descriptions provided on driller's well logs. Using data derived from a combination of sources including well logs, field investigations, and geophysical surveys, seven geologic units have been identified beneath the RBC-GWMA. The units, from youngest to oldest, are as follows:

- Alluvium
- Vashon Recessional Outwash
- Vashon Glacial Till
- Vashon Advance Outwash
- Transitional Beds
- Olympia Gravel
- Older Undifferentiated Deposits

A stratigraphic column indicating the estimated age relationships of these units is shown on Figure 2.6.2.

**Geology History**

The Puget Sound basin has been in existence since Tertiary times when sedimentary and volcanic basement rocks were folded downward between the Olympic and Cascade ranges. The resulting basin provided an avenue for several episodes of piedmont or ice sheet-type glacial flow from southwestern Canada, with concurrent sedimentary deposition during the Pleistocene. Recent post-glacial topographic modifications by erosion and deposition have been minor, occurring primarily along river floodplains.

Two and perhaps four glacial episodes occurred during the Pleistocene age. A maximum of 1,000 feet of glacial, river, lake, and marine sediments were deposited (Thorsen, 1983). The final episode of glaciation, termed the Vashon stade, was the most significant geologic influence on the development of ground water in the study area. Approximately 20,000 years ago, the ice sheet was in the vicinity of Vancouver, British Columbia. Approximately 18,000 years ago, the ice sheet had reached the Port Townsend area and effectively isolated the Puget Sound Basin from the Strait of Juan de Fuca.

A large lake developed in front of the ice front, and thick sequences of fine-grained sediments were deposited in the basin. As the ice advanced and reached the maximum southern limits 14,000 years ago, lateral streams from the Olympic and Cascade ranges were blocked by ice, diverting flow through temporary channels. Thick sequences of coarse sands and gravel flowed from the ice front, spreading over the basin and mixing with river sediments. The ice front overrode the coarse sediments and deposited a veneer of till (a mixture of clay, silt, and fine gravel). The ice reached a maximum thickness of 3,000 feet and an elevation of approximately 5,000 feet above mean sea level in King County. The weight of the ice compressed the till and depressed the basin. Soon after the glacial maximum, the ice front began to recede as the rate of accumulation of snow and ice became lower than the rate of melting. By 12,500 years ago, the ice had retreated from the study area. Isolated lenses of sand and gravel were deposited from the ice margins as the glacier retreated. After the ice had retreated beyond the lateral streams and into the strait, rivers returned to former channels and marine deposition continued (Thorsen, 1983).

The geologic history throughout King County includes the following chronology (listed from youngest to oldest):

- Non-glacial recent deposits
- Frasier Glaciation
- Olympia Interglaciation
- Possession Glaciation
- Pre-Possession Interglaciation
- Double Bluff Glaciation
- Pre-Double Bluff fluvial and lacustrine deposition
- Compaction of sediments into layers of shale, sandstone, and peat
- Deposition of volcanic debris and sedimentary material into a subsiding basin which covered most of western Washington during the Tertiary Period

The surficial and subsurficial geologic deposits form distinct layers exposed at the surface and in deep borings in the study area. These deposits are presented in five geologic cross-sections shown in Figures 2.6.3. to 2.6.7. Well logs used to prepare these cross-sections are presented in Appendix B. Well logs are grouped according to the corresponding cross section on which they were used.

**Geologic Units**

Alluvium. Post-glacial depositional and erosional processes have modified the glacial land forms and former stream and river valleys. Today, alluvial sediments are found primarily in the Evans Creek and Bear Creek valleys and in the downtown portion of the City of Redmond, north of Lake Sammamish. The alluvial deposits are composed of organic-rich fine sand, silt, and clay. Their maximum thickness is approximately 40 feet.

Vashon Recessional Outwash. The Vashon Recessional Outwash consists primarily of well-drained stratified sand and gravel with some silt and clay deposited from meltwater flowing from the receding glacier. In the study area, Recessional Outwash deposits range up to 90 feet in thickness. The Recessional Outwash deposits are generally discontinuous and occur as isolated surface deposits in the upper Bear Creek Valley, around Cottage Lake, on the western edge of Union Hill, and in the Evans Creek Valley.

Vashon Till. Commonly known as "hardpan" due to its compacted nature, the Vashon Till consists of non-sorted clay, silt, sand, gravel, and boulders deposited directly by glacial ice and compacted by the weight of the overriding glacier. The Vashon Till is present at the surface over much of the RBC-GWMA, including Education Hill, Hollywood Hill, Novelty Hill, and Union Hill. The till is typically only slowly permeable and causes water percolating down from the surface to pond or perch on the top of the unit, forming a perched water table and swampy areas. The till ranges up to 100 feet thick in the study area and appears to be thickest in the northern portion of the RBC-GWMA.

Vashon Advance Outwash. Vashon Advance Outwash deposits underlie the Vashon Till and consist of stratified clean sand and gravel with some thin clay beds. The thickness of this unit ranges up to 90 feet in King County and comprises one of the thickest and most extensive aquifers in the area.

Deposits of Advance Outwash are exposed on the upper portions of the steep slopes bordering the Snoqualmie River, Evans Creek, Bear Creek, and Cottage Lake Creek. In the study area, Advance Outwash generally underlies the Vashon Till except where it has been eroded away by creeks.

**Pre-Vashon Deposits**

Transitional Beds. The Transitional Beds are made up of glacial and non-glacial lacustrine deposits which consist mainly of laminated or thin-bedded to thick-bedded blocky jointed clay, silt, and fine sand. This unit was formed mainly from sediments deposited in a large lake which 14,000 years ago, covered much of the Puget Sound region between the Olympia Interglacial period and the early Frasier Glaciation. The Transitional Beds range up to 180 feet thick in King County, with the thickest exposures visible along the west bank of the Snoqualmie River. The Transitional Beds are also visible at the surface on the slopes along Evans Creek and in a small area of the Hollywood Hills.

Olympia Gravel. The Olympia Gravel consists of stratified fine to very coarse sand and gravel with minor thin silt and clay beds deposited by streams. This unit ranges up to 135 feet in thickness and is visible in the RBC-GWMA on the lower slopes bordering Lake Sammamish and the Evans Creek Valley. Elsewhere, the Olympia Gravel underlies the transitional beds at elevations ranging from 200 feet above mean sea level to 200 feet below mean sea level.

Older Undifferentiated Deposits. Older undifferentiated deposits include both glacial and non-glacial sediments deposited by glacial events older than the Vashon Glaciation 18,000 years ago. The materials consist of stratified and unstratified silt, sand, gravel, and clay deposited as glacial drift and interglacial lacustrine clay and silt. These deposits are generally not visible at the surface in the RBC-GWMA, but underlie most of the region. These deposits have been penetrated by several of the deep wells in the RBC-GWMA, including the Woodinville Water District and Redmond test wells. Where present in the GWMA, the deposits have a minimum thickness of 400 feet.

### 2.6.2. Hydrogeology

This section describes the occurrence, movement, recharge, and discharge of ground water within the RBC-GWMA. The RBC-GWMA is underlain by at least four major water-bearing zones which, for the purpose of this report, have been termed the Alluvial Aquifers, the Sea Level Aquifers, the Local Upland Aquifers, and the Regional Aquifers.

The Alluvial Aquifers consist of a number of different deposits including recent and older alluvium deposited in and along stream channels in the RBC-GWMA. The Sea Level Aquifers consist of the Olympia Gravel and some older undifferentiated deposits found at elevations near mean sea level. The Local Upland Aquifers are made up of discontinuous Advance Outwash deposits and permeable zones within the Vashon Till. The upland aquifers underlie the ridges on the eastern, western, and southern boundaries of the RBC-GWMA. The Regional Aquifers are composed of the older undifferentiated glacial and interglacial deposits which underlie most of the RBC-GWMA (refer to Figures 2.6.3. to 2.6.7.).

**Occurrence of Ground Water**

Geologic materials able to store and transmit ground water are considered to be aquifers. In the RBC-GWMA, the major aquifer systems can be divided into shallow, intermediate, and deep ground water systems. Shallow ground water systems occur as alluvial deposits along the major streams and the shallow portions of the upland aquifers. Intermediate ground water systems occur as Sea Level Aquifers and the deeper portions of the Local Upland Aquifers. Below the intermediate and shallow aquifer systems, the deeper Regional aquifers are contained in older undifferentiated deposits of sand, gravel, and silt deposited during past glacial, interglacial, and Pre-glacial periods.

**Major Hydrostratigraphic Units**

The hydrostratigraphy of the RBC-GWMA includes a number of aquifers and aquitards. The major hydrostratigraphic units, delineated based on field activity findings and discussed in section 2.6.3., include four aquifer zones (Alluvial, Local Upland, Sea Level, and Regional) and at least two major aquitards (Vashon Till and Transitional Beds). Each of the wells used to collect water level and water quality data were delineated based on location and water intake elevation into one of the four aquifer zones. Table 2.6.1. shows which aquifer zone each well was assigned to and the corresponding water intake elevations. The distribution of wells monitored for this study in each aquifer zone is shown on Figure 2.6.8. Each of the major aquifer zones contains more than one water-bearing zone which may or may not be in hydraulic connection with other water bearing zones in the same unit. For example, the local upland aquifers include discontinuous shallow perched water bearing zones which are separated by an aquitard (a geologic material that retards the flow of water) from underlying water bearing zones. Similarly, the regional aquifers include all water bearing zones approximately 100 feet below sea level. In the future, as more data become available, these hydrostratigraphic units may be further subdivided into additional, more distinct units. The remainder of this section provides a brief description of the major hydrostratigraphic units in the study area.

**Alluvial Aquifers**

The Alluvial Aquifers appear restricted to alluvial deposits along Cottage Lake Creek, Bear Creek, and Evans Creek. These deposits consist of sand, gravel, and silt deposited in and along stream channels as alluvium, alluvial fan deposits, and older alluvium. The deposits range up to 40 feet in thickness.

At least 36 wells used in this study are screened in the Alluvial Aquifers. Depth to water ranges from less than 10 feet to about 100 feet below ground surface. Static ground water elevations measured in wells screened in these aquifers range from approximately 140 feet above mean sea level near Evans Creek at the eastern boundary of the RBC-GWMA and 100 feet above mean sea level at the northern boundaries to less than 20 feet above mean sea level at the discharge area near the northern edge of Lake Sammamish. Monthly ground water elevations in the alluvial aquifers appear to vary by up to 6 feet with seasonal changes in precipitation (Figure 2.6.9.), however, seasonal variations are not large.

**Vashon Till**

The Vashon till typically forms a low permeability barrier to downward water percolation on the upland surfaces of the study area. Shallow ground water may occur at the base of the upper 8 feet of weathered till, perching on the upper surface of the unweathered till. The presence of till close to the surface is manifested by swampy areas and poor drainage. Ground water is sometimes found within the unweathered portion of the Vashon till, typically restricted to thin, discontinuous lenses of sand and gravel. These sources of water are occasionally tapped by older private wells yielding up to 25 gpm, but are subject to seasonal fluctuations and may completely dry up during the summer months.

Recharge of rain water to the unweathered Vashon till is slow because of low infiltration capacities, and most water is lost through surface runoff. Increased infiltration occurs in the locally higher permeable zones with the ability to transmit and store ground water. Topographic depressions in the upper surface of the unweathered till will trap ground water that slowly infiltrates into underlying geologic units and aquifers.

### Sea Level Aquifers

The Sea Level Aquifers underlie the entire RBC-GWMA and appear to be relatively independent of topography. These aquifers consist of the Olympia Gravel and may include some of the older undifferentiated deposits. The thickness of these aquifer units is not known, but appears to range from 50 to 135 feet.

At least 13 wells in the RBC-GWMA are screened in the Sea Level Aquifers. Depth to water ranges from less than 50 feet to almost 400 feet, depending on surface topography. Ground water levels are higher in autumn than in spring as shown on Figure 2.6.10. Seasonal variations in the ground water elevation of 10 to 20 feet may result from higher precipitation during the autumn months and lower precipitation in the spring.

### Local Upland Aquifers

The Local Upland Aquifers occur beneath the ridge of the RBC-GWMA and may be discontinuous. Their occurrence appears to be largely controlled by topography. These aquifers are mainly comprised of Vashon Advance Outwash which ranges up to 90 feet thick in the RBC-GWMA. The Local Upland Aquifers may also include the more permeable portions of the Vashon Till.

At least 18 wells in the RBC-GWMA are screened in the Local Upland Aquifers. Depth to water ranges from less than 10 feet in perched water bearing zones to about 350 feet. The Local Upland Aquifers may recharge the Alluvial Aquifers along the valley walls. The typical response of ground water levels to precipitation is shown in Figure 2.6.11. Ground water levels in these aquifers show some seasonal variation, however, it is generally less than 5 feet.

### Transitional Beds

This major hydrostratigraphic unit is an important aquitard separating the Local Upland Aquifers from the Sea Level Aquifers. This unit consists of 50 to hundreds of feet of continuous fine-grained lake-bed deposits that restrict vertical ground water movement between aquifers. Scattered isolated lenses of sand within the transitional beds are locally capable of supplying less than 100 gpm of water. The transitional beds are recharged from above by advance outwash sediments and from below by Olympia gravel and deeper units.

### Regional Aquifers

The Regional Aquifers underlie the entire RBC-GWMA and are independent of topography. They are composed of the older undifferentiated deposits more than 400 feet thick in the RBC-GWMA. In portions of the RBC-GWMA, the Regional Aquifers occur below the Olympia Gravel and Transitional Beds, usually under confined conditions.

Only five wells used in this study are screened in these aquifers. Depth to water in the regional aquifer can range from about 100 feet to over 400 feet. Static ground water elevations range from 31 to 123 feet above mean sea level. Ground water levels in the Regional Aquifers response to changes in precipitation is evident from the graph of ground water elevation and precipitation over time (Figure 2.6.12.), however, the variations are less than 3 feet.

**Ground Water Flow Conditions**

Water level elevation data collected during this study were plotted and contoured for the Alluvial, Local Upland and Sea Level aquifers. Because of the paucity of wells in the Regional Aquifers, there were insufficient data to contour. After review of the water level elevation data, maps were produced from the October 1989 and April 1990 data. These months were selected as being representative of the average potentiometric surfaces during generally low and high annual water table periods.

**Alluvial Aquifers**

Ground water in the Alluvial Aquifers is usually under unconfined or semi-confined conditions. In general, ground water in the Alluvial Aquifers flows toward local discharge points along valley streams, the Sammamish River and in Lake Sammamish. Ground water flow maps (Figures 2.6.13. and 2.6.14.) indicate that ground water flows south along Bear Creek and Cottage Lake Creek and west along Evans Creek. Horizontal gradients range from 0.004 ft/ft from north to south to 0.01 ft/ft from east to west.

**Sea Level Aquifers**

Because the sea level aquifers occur beneath one or more aquitards, ground water in this zone is under confined conditions. Except for the extreme southern part of the RBC-GWMA, ground water in the Sea Level Aquifers generally flows west from high elevations of 160 to 200 feet above mean sea level near the Redmond watershed to low elevations ranging from 60 to 80 feet above mean sea level near the western boundary of the RBC-GWMA (Figures 2.6.15. and 2.6.16.). Horizontal gradients range from 0.002 to 0.01 ft/ft. In the extreme southern part of the RBC-GWMA, ground water in these aquifers flows southwest toward Lake Sammamish.

**Local Upland Aquifers**

Ground water conditions in the Local Upland Aquifers may be unconfined or confined depending on the depth and presence of overlying aquitards. In the Local Upland Aquifers, ground water flows away from the highland area north of the City of Redmond toward the Alluvial Aquifer along the Sammamish River and Bear Creek. At the eastern edge of the RBC-GWMA, ground water in these aquifers flows west toward Bear Creek and southwest toward Evans Creek (Figures 2.6.17. and 2.6.18.). In these aquifers, horizontal gradients range from 0.02 to 0.05 ft/ft.

### Regional Aquifers

Ground water in the Regional Aquifer is under confined conditions. From the limited data available on these aquifers, it appears that ground water generally flows toward the west. In the deeper zones, the discharge area is probably Puget Sound.

### Ground Water Recharge

Ground water systems are replenished (recharged by the addition of water to the zone of saturation (aquifer) through precipitation, overland flow, and infiltration from surface water bodies. For this discussion, a recharge area is an area where water infiltrates the ground, and where there is a downward component of hydraulic head (pressure head) that causes water to flow through the subsurface to an aquifer.

Aquifer recharge areas occur where permeable geologic materials and other physical conditions allow water to percolate down to the water table and into an aquifer system. These areas are said to have "infiltration potential," indicating that not only can precipitation easily reach an underlying aquifer, but contaminants also may reach an aquifer.

The likelihood that water will infiltrate and pass through the surface materials to recharge the underlying aquifer system is called the recharge potential. The recharge potential depends on a number of physical conditions. These include:

- Soil permeability
- Surficial geologic material
- Depth to water, and
- Topography.

For this study, only existing information was used to evaluate the occurrence of these physical conditions in the RBC-GWMA. In addition, only the infiltration potential of the **uppermost aquifer system** was evaluated.

The infiltration potential differs from the recharge potential by excluding hydraulic head as a criteria. This means that in areas where there is an upward component of pressure head (groundwater flows from a higher head to a lower head) water infiltration still has potential to reach the uppermost aquifer, but by definition it is not a ground water recharge area. By using infiltration potential, those areas where surface contaminants may reach the shallow aquifer systems may be evaluated.

Evaluation of recharge to deeper aquifers was not done as part of this study. That type of evaluation requires more information and analysis than could be done under the scope of this study.

**Infiltration Potential Mapping Criteria**

The specific approach used to evaluate the physical conditions is described briefly below for each condition (criterion).

Soils. The recharge potential of the surface material (soils) will be mapped by grouping soil units (defined by the Soil Conservation Service in the *Soil Survey of the King County Area, 1973*) by recharge potential classifications. These classifications are based on the permeabilities of each soil unit, as defined by the Soil Conservation Service. A summary of the soil units and their recharge potential classification is provided in Table 2.6.2.

Geologic Materials. Information on the surficial geologic materials was obtained from United States Geologic Service geologic maps. The relative recharge potential of each major geologic unit in the study area was classified using a conservative approach that assumes internal uniformity of each unit. For example, glacial outwash will have a relatively high recharge potential, even though in some areas the outwash materials are fine-grained and may not permit a significant amount of recharge. The relative recharge potential of geologic materials in the study area is provided in Table 2.6.3.

Depth to Water. Depth to water below ground surface was determined from driller's logs and previous investigations. Perched or seasonal water bearing zones were not used. Water table elevation maps generated during this study were used to derive the depth to water by subtracting the elevation of the water table from the elevation of the land surface. In areas of rapidly changing topography, an average value was used. The relative recharge potential based on the depth to ground water is shown on Table 2.6.4.

Topography. The effect of topography on the recharge potential was determined by evaluating the slope of the land surface. The percent slope of an area was determined both from information in the Soil Conservation Service Soil Survey of King County and from topographic maps. The relative recharge potential based on topographic slope is also shown on Table 2.6.4.

**Infiltration Potential Mapping Rationale**

An overlay map was prepared for each of the physical parameters (criterion). The relative infiltration potential of any one area compared to another area was then determined using a qualitative rating system. Each criterion in a given area was subdivided into a number of potential conditions present in the study area. Each condition was assigned a qualitative rating factor of low, moderate, or high to describe its relative infiltration potential. A combined rating "score" (e.g., high-moderate-low) was assigned to each portion of the mapped area based on the rating factor for each criterion in a given area. Table 2.6.5. shows the possible combined rating scores and associated infiltration potential classifications. After the combined rating scores were determined for each portion of the study area, a composite map was prepared showing the relative surface infiltration potential for the RBC-GWMA. The resulting surficial infiltration potential map for the RBC-GWMA is shown in Figure 2.6.19.

**Infiltration Potential Areas**

Areas of high and medium infiltration potential were determined from the infiltration potential map prepared for the RBC-GWMA. The areas which show the highest potential Aquifer Areas) for infiltration are the Cottage Lake Creek, Bear Creek, and Evans Creek valleys. The remainder of the RBC-GWMA appears to have a medium infiltration potential based on the criteria discussed above.

Although not evident from the map of infiltration potential (Figure 2.6.19), the Redmond watershed area also appears to be a ground water infiltration area in the RBC-GWMA. Vertical potential head gradients between wells in the Sea Level Aquifers (82 and 10) and the Local Upland Aquifers (27, 28, and 30) suggest the possibility of downward flow from the Local Upland Aquifers to the Sea Level Aquifers which may indicate recharging conditions in this area. Along Bear Creek in the center of the RBC-GWMA, the local Upland Aquifers (well 26) appear to recharge the Alluvial Aquifers (well 23). In the western part of the RBC-GWMA, the Local Upland Aquifers (well 15) seem to recharge the Regional Aquifers (well 16).

The entire RBC-GWMA is classified as being either a high or moderate infiltration area. This means that in most areas, significant surface infiltration will probably occur and may eventually reach the uppermost aquifer system. Therefore, at the scale shown on this map, all areas are important to the continued recharge and preservation of the aquifer system. The location of the surface areas where there is potential infiltration is important to know, relative to land use activities, because these are areas where surface contamination is most likely to lead to ground water contamination. Also, ground water loss may occur if these areas are covered over by parking lots, buildings, or other changes are made to the topsoil that reduces the amount of water that infiltrates into the soil.

2.6.3. Data Collection Activities

New data collection activities were accomplished to expand and refine the understanding of geology, hydrogeology, and ground water quality in the RBC-GWMA. The new data collection activities performed for this study consisted of:

- Design of a regional geophysical investigation and collection of electrical resistivity data at thirty-seven locations in the study area;
- Installation of five test wells to evaluate the geology, aquifer conditions, and water quality in areas where data were lacking;
- Pump testing of three test wells to obtain information on aquifer properties;
- Collection and analysis of precipitation data from seven stations in the study area;
- Collection and analysis of stream flow data from six sites in the study area;

- Collection of periodic water level data from eighty-one private and public wells; and
- Sampling and chemical analysis of ground water samples from thirty-five wells.

The specific activities and interpretation of the data are discussed below.

**Geophysical Investigations**

Geophysical resistivity is a tool used to aid in the interpretation of regional stratigraphy. When used in conjunction with a well drilling program, it is useful in providing stratigraphic correlation between known data points (wells) and in investigating deep subsurface geologic conditions where no data are available. The geophysical investigation program consisted of 41 vertical electrical soundings completed from November 7, 1988, to December 18, 1988, and from March 1, 1989, to March 29, 1989. Field work was performed by a three-person field crew from GeoRecon International of Seattle, Washington. Each electrical sounding site is shown on Figure 2.6.20. The soundings were performed within the existing road right-of-way to alleviate any legal access problems. Locations of underground utilities were noted throughout the project area when possible, and sounding locations were adjusted to decrease the impact of utilities on the results. A description of the electrical resistivity data collection methodology and general resistivity theory is presented in Appendix C.

**Discussion of Results**

Five geophysical cross-sections were developed throughout the study area and are shown in Figures 2.6.21. through 2.6.25. The assigned number of each vertical electrical sounding is shown above the interpreted solution on the geo-electrical sections. Each geo-electrical section has a geologic interpretation of the electrical resistivity values. Table 2.6.6. shows typical resistivity values representative of the types of geologic materials found in the study area.

The cross-sections were constructed by using existing well logs, surficial geologic data, and geophysics to identify apparent resistivity patterns and corresponding geologic conditions. These cross-sections were expanded to other areas and depths lacking direct geologic information. The sections show a mixture of fine to coarse-grain soil units ranging from clay to gravel. Generally, these are not discrete units of clay or gravel, but mixtures of each material type with the resistivity indicating the predominant grain-size present. Bedrock was also interpreted to exist at depth in three of the sections (Figures 2.6.21., 2.6.23., and 2.6.25.).

Section 1 (Figure 2.6.21.) is oriented west-east along Northeast 116th Street from the Sammamish River to 209th Avenue Northeast. This section shows a general trend of geologic material dipping to the west. There is an apparent change in the dip near vertical electrical soundings where it appears that the low resistivity marker units (32 -ohm-meters overlying much lower resistivities) may rise toward the surface. The low resistivities found above the interpreted rock surface may indicate interbedded sand, silt, and gravel.

Section 2 (Figure 2.6.22.) is oriented in a west-east direction along the Woodinville-Duvall Road, centered approximately at Avondale Road. Along this section, the upper resistivity values are considerably higher than those encountered along Section 1. The high resistivity values found within 100 to 200 feet of the surface in this section may indicate the presence of relatively coarse-grained units which could be water-bearing.

Section 3 (Figure 2.6.23.) is a west-east section along the Redmond-Fall City Road from Redmond to the roadway adjacent to approximately 236th Avenue Northeast. This section is similar to Sections 1 and 2 in that it is generally underlain by an approximate 30-ohm-meter to 66-ohm-meter unit. Like the two previous sections, this section may exhibit an apparent dip to the west. Additionally, soundings completed in March 1989 indicate there may be considerable variation in the electrical properties of the interpreted bedrock material. This may depend upon grain size, saturation, and depth of burial. Vertical electrical sounding-40 was completed near a bedrock outcrop. The resistivities interpreted for vertical electrical sounding-40 are shown in Table 2.6.7. Field observations indicate the probable occurrence of bedrock, at the sounding location, to be nearly 40 feet in depth. This corresponds to an interpreted electrical layer at 36 feet where the resistivity drops from 539-ohm-meters to 246-ohm-meters.

Vertical electrical sounding-40 was completed at a Northeast Lake Sammamish Water District well site (TW-1), approximately 2,500 feet south of Sections. A section was planned from well TW-1 to soundings north of Section 3, but unusually high influences from utilities and fencing did not permit completion north of Section 3. The data for vertical electrical sounding-37 (well TW-1) are also shown on Table 2.6.7.

Also, of considerable interest are the extremely high resistivity values encountered west of vertical electrical sounding-15. These values indicate very coarse-grained alluvial deposits.

Section 4 (Figure 2.6.24.) is a north-south section along Avondale Road from the Woodinville-Duvall Road to Northeast 85th Place. The southern end of this section correlates well with Section 3 which ends just east of Section 4. The central portion is indicative of interbedded silt/sand/gravel deposits seen elsewhere in the Puget Sound area. From vertical electrical sounding-12 north, it was not possible to establish any direct correlation in the deeper portion of this section. Considerable lateral changes appear to occur in the northern 3,000 feet of this section. Further study will be required to define the nature of these lateral changes.

Section 5 (Figure 2.6.25.) is a north-south section along 208th Avenue Northeast from Northeast 100th Street to the Fall City Road. Based on the previously established premise for identifying bedrock along Section 3, interpretation of the local bedrock projects north along this section. In the vicinity of vertical electrical sounding-27 northward to vertical electrical sounding-9, a thick section of 90- to 100-ohm-meter material may represent an extensive thickness of silty to coarse-grained materials between a depth of 200 to more than 900 feet.

## Monitoring Well Installation and Pump Testing

As part of the RBC-GWMA study five test wells were completed to collect stratigraphic and hydrologic data for characterization of subsurface conditions and evaluation of ground water resource potential. Well location selections, shown on Figure 2.6.26., were based on two primary factors:

- Areas where subsurface data were absent, and
- Current or future potential ground water supply areas.

At each of the selected sites, a 6-inch-diameter borehole was drilled to a depth between 160 and 500 feet. Subsurface materials were collected every 5 feet to evaluate geologic conditions. During drilling, water bearing zones (aquifers) were noted and, if significant in terms of water resource potentials, a 6-inch test well was installed. At two sites, no significant water resource was identified so small diameter (2-inch) monitoring well(s) were installed. In addition to well drilling, aquifer testing was performed in three of the test wells to evaluate certain aquifer parameters such as potential pumping capacity and aquifer transmissivity. The testing consisted of a variable rate and a 24-hour constant rate pump test. A synopsis of drilling, well completion, and aquifer testing details is provided in Table 2.6.8. Copies of the water well reports for each well are included in Appendix D. Copies of the pump testing data are included in Appendix E.

A brief description of the findings and interpretations derived from the drilling and testing at each of the five sites is given below.

### Woodinville Test Well

The Woodinville test well site is located in the extreme northwestern portion of the study area just north of the Woodinville-Duvall Road. Drilling work was accomplished between February 26 and March 2, 1990. The test hole was drilled to a depth of 490 feet below ground surface. The geologic material encountered consisted of unconsolidated glaciofluvial and lacustrian deposits of sand, gravel, silt, and clay.

During drilling, a sandy silt (till) was present to a depth of 10 feet. Between 10 and 85 feet below ground surface, a saturated fine-to-coarse sand and occasional silt layers were encountered. A significant (>200 gallons per minute [gpm]) water bearing zone was identified between 72 and 88 feet. Below a depth of approximately 90 feet, the material was predominantly dense silt and clay deposits with occasional interbeds of sand and gravel. No significant aquifers were found below a depth of 90 feet.

Following drilling, a 6-inch stainless steel well screen was installed between 75 and 85 feet below ground surface to evaluate aquifer conditions. A 24-hour pump test was performed on May 3, 1990. Results of the pump test are presented in Table 2.6.8. In summary, the pump test indicated a moderately permeable aquifer with a extrapolated projected well yield of 700 to

1,200 gpm. Water quality testing showed relatively low (below secondary drinking water standards) levels of iron and manganese and no elevated levels of primary standards.

**Redmond Test Well**

The Redmond test well site is located in the south central portion of the study area on the southwest corner of Union Hill Road and 196 Avenue Northeast. Drilling work was accomplished between February 8 and 14, 1990. The test hole was drilled to a depth of 500 feet below ground surface. The geologic materials encountered were from depositional environments similar to those in the Woodinville well.

From ground surface to a depth of 75 feet, geologic materials consisted of fine to coarse sand and gravel. A significant (>200 gpm) aquifer was present between 20 and 70 feet. Below a depth of 75 feet, the material consisted predominately of silt and clay mixtures with occasional interbeds of sand and gravel. No significant aquifers were found below the upper water bearing zone.

Since the upper water bearing zone is currently being used by the City of Redmond wells, significant aquifer data have already been collected. For this reason, plus limited funds for pump testing, one 2-inch monitoring well was installed at the base of the shallow aquifer. Water quality testing of this well did not indicate any parameters exceeding primary or secondary drinking water standards.

**Lower Evans Creek Test Well**

The site for this test well is the lower Evans Creek Valley on the north side of State Route 202. Drilling work was accomplished between March 8 and March 9, 1990. The test hole was drilled to a depth of 160 feet below ground surface. The geologic materials encountered were predominantly sand and gravel glaciofluvial deposits.

The borehole penetrated predominantly sandy gravel and gravelly sand from ground surface to a depth of 156 feet. The bottom of the boring (156 to 160 feet) encountered a clayey silt. A significant water bearing zone (50 to 100 gpm) was present between 90 and 100 feet, but there was a strong hydrogen sulphide odor. A more productive zone (>200 gpm) was found from 120 to 156 feet. A slight hydrogen sulphide odor was also present in the lower zone.

Six-inch stainless steel well screen was installed between 143 and 153 feet below ground surface. A 24-hour pump test was performed on April 30, 1990. Results of the pumping test are presented in Table 2.6.8. The pump test indicated a moderately permeable aquifer with a potential well yield of 400 to 700 gpm. Water quality testing showed elevated levels of iron and manganese.

**Upper Evans Creek Test Well**

The upper Evans Creek test well site is in the Upper Evans Creek Valley on the south side of State Route 202. Drilling work was accomplished between March 6 and 8, 1990. The test hole was drilled to a depth of 237 feet and encountered geologic materials with depositional histories similar to those at the Lower Evans Creek site.

Drilling at this site encountered a sandy gravel from ground surface to 44 feet overlying a silt/sandy silt zone between 44 and 80 feet. Interbedded layers of fine sand, silt, and silty gravel were found from a depth of 80 feet to about 120 feet.

Potential yields in this interval appeared to be less than 50 gpm. At a depth of 122 feet and continuing to 160 feet, the material became predominantly gravelly sand. Potential yields appeared to increase slightly, but are probably less than 100 gpm. From 160 to 237 feet, the geologic material consisted of fine to medium sand. The water bearing capacity of the lower sand did not appear significant.

Since no significant water bearing zones were encountered, pump testing was not performed at this site. The borehole was completed with two 2-inch diameter monitoring wells installed at different depths (see Table 2.6.8.). In addition to providing information on water quality and water levels, these wells may provide information on hydrologic and geologic conditions within the Evans Creek aquifer(s) if aquifer testing is performed on new or existing production wells in the valley.

**Marymoor Park Test Well**

The well site is located in the southwestern portion of the study area just south of the East Lake Sammamish Parkway. Drilling work was accomplished between August 30 and September 5, 1990. The test hole was drilled to a depth of 180 feet below ground surface. The geologic materials encountered reflect deltaic and lacustrian depositional environments.

The drilling encountered coarse sand and gravel, typical of deltaic deposits from ground surface to a depth of 115 feet. Saturated conditions existed below about 8 feet. Very significant quantities of water appear to exist in this aquifer. From 120 to 140 feet below ground surface, a dense silt and clay unit was penetrated. Below this low permeability unit, a gravelly sand and sand unit was encountered from about 145 to 165 feet. This confined aquifer also appears to have the potential for producing significant quantities of water. From 165 to 180 feet, the material encountered consisted predominantly of fine to medium sand which appeared to be getting finer with depth.

After drilling was completed, a 6-inch diameter well screen was installed from 151 to 161 feet below ground surface. Due to budget constraints a 24-hour pump test could not be performed on this well. Two short-term pump tests (40 and 60 minutes) indicated a potential well yield of at least 100 gpm.

## Precipitation

Precipitation data were compiled from measurements at seven weather stations in the Redmond-Bear Creek watershed during 1989, 1990, and 1991. The location of each precipitation collection station is shown on Figure 2.6.27. Monthly precipitation data are compiled in Table 2.6.9. Daily precipitation data are included in Appendix F.

The Redmond-Bear Creek watershed receives an average of 42 inches of rainfall annually, approximately 8 inches more than the Everett weather station to the north. Total monthly precipitation data for each weather station during the years 1989, 1990, and 1991 are shown in Figures 2.6.28., 2.6.29., and 2.6.30. Precipitation totals for weather stations with no data in a particular month have not been plotted for that month. Incomplete or no data were available for a few months at certain stations including the Union Hill Site from August through November 1990, and the Woodinville Station between September and December 1989.

The monthly precipitation plots illustrate how precipitation varies seasonally in the watershed with approximately 75 percent of the annual precipitation falling during the fall and winter months (October through March). On average over the three-year period, the month of January had the greatest amount of precipitation. The RBC-GWMA-wide averages of precipitation for January ranged from approximately 4.5 to 9.1 inches. The highest recorded monthly rainfall, 10 inches, occurred at the North Ridge Station in January, 1990. Precipitation decreases sharply during the summer with the least precipitation typically occurring during September. Average precipitation over the watershed during the month of September ranged from 0.15 to 0.30 inches during the three years of study.

To evaluate precipitation patterns within the RBC-GWMA, monthly precipitation totals for each station were plotted for both a high and low precipitation month. July and October of 1990 were selected because there are data at all of the precipitation stations for both months. The isohyetal maps, Figures 2.6.31. and 2.6.32., show the distribution of precipitation during July and October of 1990, respectively. The maps show that precipitation generally increases from west to east across the watershed. As expected, rainfall was usually greatest at the higher elevations along the western boundary of the RBC-GWMA and lowest in the lower Bear Creek Valley around the cities of Redmond and Woodinville. As shown graphically on Figure 2.6.33., the Sahalee and north ridge stations consistently recorded the highest monthly precipitation totals.

## Streamflow

The RBC-GWMA is drained by four major streams: Cottage Lake Creek, Daniels Creek, Bear Creek, and Evans Creek. Daniels Creek, located in the northern part of the watershed, flows south into Cottage Lake which is drained by Cottage Lake Creek. Evans Creek originates in a marshland at the southern end of the watershed and flows northwest toward the Sammamish River. Cottage Lake Creek and Bear Creek both flow south until they merge north of Avondale and empty into Evans Creek at Union Hill Road just east of Redmond. Evans Creek eventually discharges to the Sammamish River.

During this study, stream discharge data were collected for six gauging stations in the RBC-GWMA from 1989 through 1991 (Figure 2.6.34.). Station Number 1 was located on Daniels Creek at the Woodinville-Duvall Road, Station Number 2 on Upper Bear Creek along the Woodinville-Duvall Road, Station Number 3 on Cottage Lake Creek at Avondale Road, and Station Number 4 on Lower Bear Creek at Northeast 132nd Street. Two stations (Numbers 5 and 6) were located on Evans Creek at Union Hill Road, approximately 1.5 miles apart. At stations 1 and 2, stream flow data were collected periodically by EMCON personnel. Data from Station Number 3 were collected by the SKCHD, using a continuous recorder. Data from the Lower Bear Creek station Number 4 were collected by the United States Geological Survey with a continuous recorder, and data from Evans Creek stations 5 and 6 were collected by the King County Surface Water Management Division using continuous recorders.

**Gauging Methods**

At each site, an attempt was made to collect measurements from a reach of stream with a smooth shoreline, no brush hanging in the water, no large rocks, and no back-eddies. These optimum conditions were found only in culverts beneath roads, so they were the location of choice for stream gauging. Stream sections exhibiting fair to good conditions were used where culverts were not available.

At the Daniels Creek site, and the upper and lower Bear Creek sites, stream velocity measurements were made with a Swoffer impeller-type current meter (number M-1-01-K). Velocity and water depth were measured at 6 to 24 equally spaced points along a tape stretched perpendicularly across the stream. Each point represents the midpoint of a flow segment whose vertical sides are located midway between neighboring measurement points on the tape. Velocity measurements at each point were made at a depth corresponding to six-tenths of the depth of the stream. At each point, at least three 20-second velocity measurements were collected and averaged.

Discharge for each segment is the product of the average velocity and the area of the segment. Discharges for each segment were summed to determine the total stream discharge at each site. Stream flow measurements collected during the study are presented in Appendix G.

Hydrographs of stream discharge were prepared for the two Evans Creek stations and for the Lower Bear Creek station for the years 1989 through 1991. These streams flow throughout the year. Seasonal variations in stream flow appear to correspond to changes in precipitation and are generally characterized by high flows in the winter and spring and low flows in the summer and fall. Hydrographs for Evans Creek at Union Hill Road (Station 5) are shown in Figures 2.6.35., 2.6.36., and 2.6.37. Hydrographs for Evans Creek at Union Hill Road (Station 6) are shown in Figures 2.6.38., 2.6.39., and 2.6.40 and hydrographs for Lower Bear Creek near Redmond (Station 4) are shown in Figures 2.6.41, 2.6.42., and 2.6.43. Stream discharge data for the Daniels Creek and Upper Bear Creek stations are summarized in Table 2.6.10.

During each year, base flow comprised most of the flow in each creek during the summer months from July through September. This period also corresponds with the months of lowest precipitation. Storm flows typically occur between November and April, with the largest peak flow in each stream recorded in January 1990. Along Evans Creek, baseflow increases greatly between the upstream and downstream gauging stations, indicating ground water discharge to Evans Creek. In 1990, baseflow ranged from approximately 5 cubic feet per second upstream to 25 cubic feet per second downstream. Base flow in Evans Creek was highest in 1991 and lowest in 1990.

The Evans Creek hydrographs (Figure 2.6.35. through 2.6.40.) show that flow varied from about 5 cubic feet per second to 200 cubic feet per second from January 1989 to September 1991 at the upstream Union Hill Road station and from 15 cubic feet per second to 1332 cubic feet per second during the same period at the downstream station near Avondale. At the Bear Creek gauging station near Redmond, streamflow varied from about 5 cubic feet per second to 250 cubic feet per second from April 1989 through September 1991 as shown on the Bear Creek hydrographs (Figures 2.6.41. to 2.6.43.).

**Water Level Monitoring**

Existing ground water data available prior to this study were too limited and too sporadic to use in determining long-term water level trends or ground water flow directions. In the winter of 1989, a water level monitoring network was developed including 81 private and public water supply wells and monitoring wells. Water levels were collected periodically, generally once a month, beginning in February 1989 and continuing through July 1991. Not all wells were monitored the entire period and monitoring of some wells is still ongoing. Table 2.6.11. is a summary of the wells used in the monitoring network. Well locations are shown on Figure 2.6.44.

**Well Selection**

Well driller's logs obtained from Ecology were reviewed. Several wells were selected for possible monitoring and each potential well was field checked. Wells were selected for monitoring based on the following criteria: (1) location of the well within the study area, (2) well construction, (3) aquifer zone, and (4) usefulness of data on the well logs. Each well was identified as producing from a shallow aquifer zone or a lower deep aquifer zone. Representative wells were selected to provide a uniform distribution for aquifers throughout the study area. Finally, each owner's permission was obtained before water levels were measured. Driller's well logs for the wells selected for monitoring are presented in Appendix H.

**Water Level Measurements**

Water level measurements were obtained by personnel from the City of Redmond, SKCHD, EMCON Northwest, Inc., Union Hill, Northeast Lake Sammamish Water Districts, and volunteers from the RBC-GWAC. Water level data forms were used to record depth-to-water measurements. The data were then entered into the SKCHD data base. Copies of water level measurements for each well are provided in Appendix I.

Water levels were measured with either a Slope Indicator (Model 51453) water level indicator or an Actat Olympic Well Probe (by SKCHD). These devices electrically measure the point at which the probe makes contact with water. The distance from the top of the well casing to the probe is then recorded to the nearest 0.01 foot. Before lowering the probe into each well, the first twenty feet of well probe is disinfected with liquid chlorine bleach in a distilled water solution.

The water level elevation for each well was calculated by subtracting the depth to water from the elevation at the top of the well casing. Elevations were obtained from survey data collected by Phillips and Associates, Engineers of Bellevue, Washington. City of Redmond Surface Water Management also supplied elevations for wells in the Redmond area.

### 2.6.4. Ground Water Quality Sampling

The chemical quality of ground water in the RBC-GWMA affects the potential development and use of the area's ground water resources. Ground water chemistry in the RBC-GWMA was evaluated using the results of samples collected from wells throughout the area and analyzed for a variety of constituents. The analyzed constituents were selected to provide information about the quality of ground water in the RBC-GWMA aquifers.

Ground water must meet strict standards before it can be developed or used as a drinking water supply. These standards are defined in the Washington Drinking Water Regulations (WAC 246-290), the Washington Ground Water Quality Standards (WAC 173-200), the National Primary Drinking Water Standards (40 CFR 143). Ground water samples from the RBC-GWMA were collected and analyzed for selected primary and secondary drinking water constituents, and the results were compared with state and national primary and secondary drinking water standards. The significance of each selected primary and secondary drinking water standard analyte is discussed in the Primary Drinking Water Standard Analytes section and the Secondary Drinking Water Standard Analytes section below. The results of the analyses are presented and discussed in the Results and Discussion for Analytical Testing section below.

Potential ground water resource development for applications other than drinking water supply is determined by deciding which constituents affect the proposed application, and evaluating the concentrations of those constituents with respect to the specific resource application. This report does not address applications other than drinking water supply.

The concentrations of major and minor ions were evaluated to determine the general characteristics and type(s) of ground water in the management area aquifer(s) and can sometimes be used to indicate associations and/or connections between aquifers. The significance of the major and minor ions evaluated for this study is discussed in the Ground Water Characteristic Constituents section below and the results of the analyses are presented and discussed in the

Results and Discussion of Analytical Testing section.

Chemical analyses of priority pollutant metals, phenol, cyanide, and other potential contaminants can be used as indicators of ground water contamination. The significance of each of these analytes is discussed in the Additional Potential Contaminants section and the results of these analyses are summarized and discussed in the Results and Discussion of Analytical Testing section.

Ground water samples were collected from each of 35 wells in the RBC-GWMA. Samples were collected in December 1989 and May 1990. For the December 1989 ground water sampling, samples were collected from all wells and analyzed for primary and secondary drinking water standards and characteristic constituents (including major and minor ions). Selected wells were also tested for total organic halogens. For the May 1990 ground water sampling, analysis of ground water from selected wells was expanded to include volatile organic compounds, semivolatile organic compounds, chlorinated pesticides, polychlorinated biphenyls, and the priority pollutant metals which were not already included in drinking water standard constituent testing. During the May 1990 sampling, a reduced number of wells were tested for total organic halogens.

Analytical testing parameters were selected to allow characterization of ground water quality and characteristics in the RBC-GWMA. All wells were tested for primary and secondary drinking water standard constituents to determine whether ground water in the RBC-GWMA generally meets national drinking water standards. Total organic halogens analyses were used to scan for potential ground water contamination. Volatile organic compounds, semivolatile organic compounds, and additional priority pollutant metals testing were used to assess potential ground water contamination. The locations of wells sampled for this study are shown on Figure 2.6.44. Constituents tested at each well are listed in Table 2.6.12.

All ground water samples were collected in accordance with standard procedures described in the Redmond-Bear Creek Ground Water Management Area Quality Assurance Project Plan (Sweet-Edwards/EMCON, March 2, 1990), and the Redmond-Bear Creek Ground Water Management Area Data Collection and Analysis Plan (Sweet-Edwards/EMCON, March 5, 1990). All chemical data were reviewed and were considered valid for the purposes and limitations of this report. Copies of the laboratory testing results for each well are included in Appendix J.

**Significance of Analyzed Constituents**

Inorganic and organic materials occur in ground water as dissolved solids. Some of these materials occur naturally in ground water and some occur only as introduced contaminants. The relative abundance of naturally occurring dissolved solids analyzed for this study are listed in Table 2.6.13. This section describes the analytes examined during this study and discusses the occurrence of each analyte in natural (uncontaminated) ground water and in samples collected from wells within the RBC-GWMA. The analytes were selected by the SKCHD in accordance with Ecology guidelines.

Sources used to develop the discussions presented in this section include Callahan et. al. (1979a, 1979b), Hem (1985), Davis and DeWiest (1966), Driscoll (1986), Salomons and Forstner (1984), Stumm and Morgan (1981), Todd (1980), and Tuerkian and Wedepohl (1961).

**Primary Drinking Water Standard Analytes**

Primary drinking water standard analytes are defined by the National Primary Drinking Water Regulations (40 CFR 141), which have been adopted by the State of Washington in WAC 246-290 and the Ground Water Quality Standards WAC 173-200. These regulations address constituents which potentially affect public health if consumed in drinking water. Ground water must meet all primary drinking water standards to be suitable for development as a drinking water supply. All public water supplies must be regularly tested for all of the primary drinking water analytes. For this study, ground water samples were collected and analyzed for the following selected primary drinking water standard analytes: arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, nitrate, and total and fecal coliform bacteria. Each of the analytes are described below.

Arsenic. Arsenic is considered ubiquitous in rocks and soil, generally occurring at concentrations ranging from 1 to 13 parts per million (ppm). Higher concentrations of naturally occurring arsenic are associated with some types of ore deposits. Concentrations of arsenic in ground water are typically low (less than 0.010 ppm), but greater concentrations can occur either naturally or due to contamination. The primary drinking water standard for total arsenic is 0.05 ppm. In the RBC-GWMA, arsenic was not detected above the primary drinking water standard except for one well (64) completed in the alluvial aquifers, where it was detected at 0.43 ppm.

Barium. Barium is abundant in rocks and soils, ranging in concentration from less than 1 to greater than 2,000 ppm. The most common barium mineral is barite (barium sulfate). Barium concentrations in natural waters are generally about 0.045 ppm, with greater concentrations found under special conditions (such as in oil field brines). The primary drinking water standard for total barium is 1.0 ppm. Barium concentrations in the ground water samples from the RBC-GWMA were below the primary drinking water standard in all but well 64. The sample from well 64 contained 5.4 ppm of barium.

Cadmium. Cadmium is a relatively rare, naturally occurring element concentrated in zinc-bearing ores. As a result, low concentrations of cadmium are found in all zinc products. Cadmium concentrations in natural rocks and soils are generally less than 0.6 ppm. Many cadmium-bearing minerals are soluble. The normal concentration of cadmium in seawater is less than 0.0002 ppm, and the normal concentration of cadmium in surface waters is generally about 0.001 ppm. Little information is available about the normal concentrations of cadmium in ground water. The primary drinking water standard for total cadmium is 0.01 ppm. Cadmium was not detected above the laboratory method reporting limit in any of the ground water samples from the RBC-GWMA.

Chromium. Chromium occurs naturally in soils and rocks. Although chromium concentrations of 1,600 ppm have been reported for some ultrabasic igneous rocks, concentrations are generally lower than 200 ppm. Chromium-bearing minerals generally have low solubilities. Although chromium concentrations in natural waters are usually very low (less than 0.01 ppm), naturally occurring chromium concentrations up to 0.2 ppm have been reported for ground water. The primary drinking water standard for total chromium is 0.05 ppm. Chromium concentrations were below the laboratory method reporting limit in all ground water samples from the RBC-GWMA.

Fluoride. Fluoride is an element that occurs naturally and commonly in soils and rocks. Fluoride is an essential nutrient and component of bones and teeth. Excessive fluoride can, however, cause mottling of tooth enamel and cause teeth and bones to become brittle. Fluoride is a component of many minerals, the most common being fluorite (calcium fluoride). The concentration of fluoride in soils and rocks is generally less than 1,500 ppm. Although fluoride concentrations in natural water are generally less than 1 ppm, concentrations as high as 50 ppm have been reported. Relatively high fluoride concentrations can occur in water with high (greater than 9) pH values, thermal water, and water affected by volcanism. The primary drinking water standard for fluoride is 4.0 ppm. Fluoride was not detected above the primary drinking water standard in any ground water sample from the RBC-GWMA. Fluoride concentrations exceeded the laboratory method reporting limit only in well 16 which is completed in the Regional aquifers.

Lead. Lead occurs naturally in soils and rocks at concentrations up to 80 ppm, but may range to percent levels in some ore deposits. The most common lead-bearing mineral is galena (lead sulfide). Natural lead compounds have low solubilities, so lead concentrations in natural waters are generally low (less than 0.01 ppm). However, synthetic lead compounds (including the organic lead compounds added to leaded gasoline), have much higher solubilities, and lead concentrations in urban rainwater and snow can exceed 0.1 ppm. The primary drinking water standard for total lead is 0.05 ppm. Lead was not detected above the primary drinking water standard in ground water samples from the RBC-GWMA with the exception of one well in the regional aquifer (16), where it was detected at 0.33 and 0.13 ppm, and one well (64) in the Alluvial aquifers where it was detected at 0.31 ppm.

Mercury. Mercury is a trace element which usually occurs in trace (less than 1 ppm) concentrations in rocks and soils, but can be concentrated in ore deposits. Mercury concentrations in water are generally lower than 0.001 ppm, with the typical concentration in seawater of 0.0002 ppm. Mercury concentrations up to 0.01 ppm can occur in water associated with thermal ground water or mercury ore deposits. The primary drinking water standard for total mercury is 0.002 ppm. Mercury concentrations were below the laboratory method reporting limit in all samples from the RBC-GWMA except well 64 where it was detected at 0.0028 ppm.

Selenium. Selenium is a trace element that occurs naturally in soils and rocks, with concentrations in soils and fine-grained sediments generally being 1 ppm or lower, and concentrations in other rocks generally being lower (0.1 ppm or lower). Although metal selenides have low solubilities, other selenium compounds are soluble. Although selenium concentrations in surface and ground water are usually lower than 0.001 ppm, concentrations up to 3 ppm have been reported for irrigation water draining through soils with naturally high selenium concentrations. The primary drinking water standard for total selenium is 0.01 ppm. Reported selenium concentrations in the RBC-GWMA were generally at or below the laboratory method reporting limit. There was no reported concentrations above the primary drinking water standard in any ground water samples from the RBC-GWMA.

Silver. Silver is a trace element which occurs naturally in rocks and soils, normally at concentrations lower than 0.4 ppm. In ore deposits, silver usually occurs as a native metal (often in a mixture with native gold), as argentite (silver sulfide), or associated with the sulfides of lead, copper, or other metals. Although metallic silver and argentite are virtually insoluble in natural waters, some silver compounds are slightly soluble. Silver concentrations in seawater and river water are generally about 0.0003 ppm. Little is known about the normal concentrations of silver in ground water. The primary drinking water standard for total silver is 0.05 ppm. Silver concentrations were all at or below the laboratory method reporting limit in ground water samples from the RBC-GWMA.

Nitrate. Nitrogen occurs naturally in rocks and soils, generally at concentrations of 30 ppm or lower. There are two nitrate minerals; niter (potassium nitrate, or saltpeter), and soda niter (sodium nitrate). These minerals are easily dissolved in water, and are, therefore, only found in arid climates. They are thought to be formed by processes like evaporation or come from the accumulation of materials such as bat guano. Atmospheric nitrogen combines with oxygen to form nitrate through common metabolic processes of several types of bacteria and fungi found in soils. Concentrations of nitrate in natural water are generally lower than 1.0 ppm. The concentration of nitrogen (which normally occurs as nitrate) in seawater is generally lower than 1 ppm. The natural concentration of nitrate in surface and ground water is not well understood, since the nitrate contributions from natural sources (human waste, barnyard waste, and fertilizers) vary widely. The primary drinking water standard for nitrate is 10 ppm. Nitrate concentrations ranged from the laboratory method reporting limit to 3.6 ppm in ground water samples from the RBC-GWMA. In the alluvial aquifers, nitrate concentrations ranged from the method reporting limit to 3.1 ppm. In the Local Upland Aquifers, nitrate concentrations ranged from the method reporting limit to 3.6 ppm. Nitrate concentrations in the Sea Level Aquifers ranged from the method reporting limit to 1 ppm. Nitrate samples from wells in the Regional Aquifers did not exceed the method reporting limit.

Total and Fecal Coliform Bacteria. Large populations of coliform bacteria occur naturally in the intestinal tracts of all warm-blooded animals. Coliform bacteria also occur naturally in both surface and (less commonly) ground water. Coliform bacteria usually are not harmful in and of themselves, but are used as an index of fecal pollution since they are numerous, and the test is easy and inexpensive. Large counts of any fecal coliform bacteria, indicate other pathogenic organisms may be present. The tests for these other pathogenic organisms, which include other bacteria, protozoans, and viruses, are considerably more difficult and expensive to perform. The primary drinking water standard for total coliforms is 1/100 ml. Total and fecal coliform bacteria were detected in ground water samples from all four aquifers. In the Alluvial Aquifers, total coliform bacteria were detected at concentrations ranging from 2 to 110 organisms per 100 ml. In the Local Upland Aquifers, total coliform bacteria were detected in four wells at concentrations from 7 to 17 organisms per 100 ml, respectively. Coliform bacteria were detected at 11 org/100 ml in one well in the Sea Level Aquifers, and at 2 org/100 ml in one well in the Regional Aquifers. Fecal coliform bacteria were not detected in any of the ground water samples submitted for analysis.

**Secondary Drinking Water Standard Analytes**

Secondary drinking water standard analytes are defined by the National Secondary Drinking Water Regulations (40 CFR 143), which have been adopted by the State of Washington in WAC 246-290 and the Ground Water Quality Standards WAC 173-200. The federal regulations are not enforceable and were prepared as guidelines for the states. These regulations address ground water constituents primarily affecting the aesthetic qualities (and, therefore, public acceptance) of drinking water. For this study, ground water samples were collected and analyzed for the following selected secondary drinking water standard analytes: chloride, copper, fluoride, iron, manganese, sulfate, total dissolved solids, and zinc. The primary drinking water standard analyte, fluoride, has been discussed above in the Primary Drinking Water Standards Analytes section. Chloride, copper, iron, manganese, sulfate, total dissolved solids, and zinc are discussed below.

Chloride. Chlorine is a common element which occurs naturally in deep sea sediments and clays at concentrations of approximately 21,000 ppm, and in rocks and soils at concentrations generally less than 600 ppm. More than three-fourths of the chlorine on earth is found in the oceans, with concentration of chlorine in seawater generally being about 19,000 ppm. Chlorine normally occurs in water as the chloride ion ($Cl^-$). Chloride is present in all natural waters and is considered a major component of ground water. Natural chloride concentrations in ground water vary widely and can range from less than 10 ppm in some spring water up to 189,000 ppm in brines. The concentration of chloride in drinking water is not regulated, but the national and state secondary drinking water (aesthetic) standard for chloride is 250 ppm. Chloride concentrations ranged from 1.3 to 15 ppm in ground water samples from the RBC-GWMA, well below the secondary drinking water standard of 250 ppm.

Copper. Copper is an essential nutrient and occurs naturally as a trace metal in rocks and soils. Copper commonly occurs as a native metal as chalcocite (copper sulfide) and in sulfides in conjunction with other metals (e.g., chalcopyrite and bornite are important iron/copper sulfide minerals). Average concentrations of copper in natural rocks and soils range to 1,000 ppm in clays and to 100 ppm in other rocks and soils. Copper concentrations in natural water are normally lower than 0.01 ppm, but can exceed 300 ppm in water affected by acid mine drainage. The concentration of copper in drinking water is not regulated, but the national and state secondary drinking water (aesthetic) standard for total copper is 1.0 ppm. Copper was not detected above the laboratory method reporting limit in any of the ground water samples from the RBC-GWMA with the exception of well 64 where it was detected at 1.5 ppm.

Iron. Iron is an essential nutrient, and is one of the most abundant elements on earth. It occurs naturally at high concentrations (up to 7 percent in rocks and soils with higher concentrations in ore deposits). Iron occurs in most natural water, usually as the ferrous iron ion ($Fe^{+2}$). The concentration of iron in natural water depends upon the concentration of oxygen and oxygen-containing compounds. Where oxygen concentrations are high (for example, in a flowing stream), iron concentrations are typically 0.01 mg/l or less. Iron concentrations in ground water often range from 1 to 10 ppm and can exceed 50 ppm. The concentration of iron in drinking water is not regulated, but the national and state secondary drinking water (aesthetic) standard for total iron is 0.30 ppm. Iron concentrations were detected above the secondary drinking water standard in several wells in each of the four principal aquifer systems in the RBC-GWMA. It was detected in five wells in the Alluvial Aquifers at concentrations ranging from 0.71 to 1,000 ppm, and in six wells in the Local Upland Aquifers at concentrations ranging from 0.31 to 9.1 ppm. Iron concentrations in the Sea Level Aquifers were above the standard in samples from three wells and ranged from 0.31 to 29 ppm. Iron concentrations in the Regional Aquifers were above the standard in three wells and ranged from 0.31 to 11 ppm.

Manganese. Manganese is an essential nutrient and is an abundant element. Manganese concentrations in rocks and soils generally range up to 6,700 ppm. Manganese occurs commonly in silicate minerals and can occur in other forms (for example, oxides and carbonates). Manganese occurs in most natural water, usually as the ion $Mn^{+2}$. Manganese concentrations in seawater are generally about 0.002 ppm and are usually less than 1 ppm in surface and ground water. The concentration of manganese in drinking water is not regulated, but the national and state secondary drinking water (aesthetic) standard for total manganese is 0.05 ppm. Manganese concentrations were detected above the secondary drinking water standard in ground water samples from several wells in the RBC-GWMA. In the Alluvial Aquifers, manganese concentrations were above the standard in seven wells and ranged from 0.055 to 0.111 ppm. In the Local Upland Aquifers, manganese was detected above the standard in five wells at concentrations ranging from 0.055 to 0.161 ppm. Manganese concentrations in the Sea Level Aquifers were above the standard in ground water samples from one well at 0.056 and 0.07 ppm and in four wells in the Regional Aquifers at concentrations ranging from 0.06 to 0.21 ppm.

Sulfate. Sulfur is a common element which occurs in concentrations to 2,400 ppm in rocks and soils. Sulfur often occurs as sulfide minerals, such as pyrite (iron sulfide) and galena (lead sulfide). Many of the most important ore minerals are sulfides. Although some sulfate minerals like calcium sulfate (gypsum) are easily dissolved, some (like barite, which is barium sulfate) are virtually insoluble in water. Sulfate occurs naturally in most water and is almost always present in brackish or saline water. Seawater generally contains about 2,700 ppm of sulfate. The sulfate concentration in ground water is generally expected to be the same as the sulfate concentration in rainwater, about 1 to 3 ppm. Where sulfate is absent from ground water, it has generally been transformed into sulfide by microorganisms. The concentration of sulfate in drinking water is not regulated, but the national and state secondary drinking water (aesthetic) standard for sulfate is 250 ppm. Sulfate concentrations in ground water samples from the RBC-GWMA ranged from the method reporting limit to 75 ppm, well below the secondary drinking water standard.

Total Dissolved Solids. The total dissolved solids present in a sample is determined by filtering the water into a weighed evaporation dish, evaporating the filtered water, and weighing the dish with the dried residue. After correcting for the volume of sample filtered, the total dissolved solids of the sample is calculated as the difference in weight between the empty dish and the dish-plus-residue. The concentration of total dissolved solids in drinking water is not regulated, but the national and state secondary drinking water (aesthetic) standard for total dissolved solids is 500 ppm.

Waters with greater than 500 ppm total dissolved solids concentrations may have an unpleasant flavor and may be difficult to digest for consumers of the water. Since total dissolved solids is a rough measure of the mineralization of the water, samples with high dissolved solids concentrations may be unsuitable for industrial applications. In these cases, the analyses of individual elements of concern (such as calcium and iron) should be reviewed to determine whether further testing is necessary prior to approving the water supply. Total dissolved solids concentrations in ground water samples collected in the RBC-GWMA ranged from 6 to 590 ppm, with the highest concentrations found in the samples from the Regional Aquifers.

Zinc. Zinc is an essential nutrient which occurs naturally and is fairly common in rocks and soils. Zinc concentrations in soils and rocks are generally less than 200 ppm, however, zinc concentrations in ore deposits are generally several percent. The most common zinc mineral is zinc sulfide (sphalerite). Zinc concentrations in ground water are generally low (less than 1 ppm) under most conditions. The concentration of zinc in drinking water is not regulated, but the national and state secondary drinking water (aesthetic) standard for zinc is 5 ppm. Zinc was not detected above the secondary drinking water standard in any ground water samples submitted for analysis. Zinc concentrations ranged from the method reporting limit to 3.2 ppm.

**Ground Water Characteristic Constituents**

For the purposes of this study, ground water characteristic constituents are those dissolved solids which are major and secondary constituents of potable water (see Table 2.6.13.). These materials occur as both natural constituents of and introduced contaminants in ground water. The primary drinking water standard analytes fluoride and nitrate have been discussed in the Primary Drinking Water Standard Analytes section above. The secondary drinking water standard analytes chloride, iron, and sulfate have been discussed in the Secondary Drinking Water Standard Analytes section above. Bicarbonate, carbonate, hydroxide, calcium, magnesium, nitrite, potassium, silica, sodium, and total hardness are discussed below.

Alkalinity. Alkalinity measures the ability of a water sample to neutralize an acid. All ground water typically has measurable alkalinity. Alkalinity is caused by carbon dioxide gas dissolved in the ground water. The main sources of dissolved carbon dioxide gas are carbon dioxide in the atmosphere, gas in the soil, and carbonate minerals in the aquifer.

The total alkalinity of a sample equals the sum of all titratable bases in that sample and, for natural waters, is typically a function of the carbonate, bicarbonate, and/or hydroxide concentrations in the sample. The measurement method assumes that carbonate, bicarbonate, or hydroxide are the only bases which occur in the sample. This is a reasonable assumption as other naturally occurring bases (such as borates, phosphates, and silicates) are generally minor and will not contribute much to the total.

In practice, a laboratory measures alkalinity by titrating a sample using two different pH indicators (i.e., methyl orange and phenolphthalein). The laboratory calculates the relative contribution(s) of the carbonate, bicarbonate, and hydroxide alkalinities using the ratio between the methyl-orange ("total") and phenolphthalein alkalinities. The laboratory reports the total alkalinity and the calculated carbonate, bicarbonate, and hydroxide alkalinities. Alkalinity concentrations in drinking water and ground water are not regulated. The total alkalinity of the ground water samples from the RBC-GWMA ranged from 2 to 300 mg/L as calcium carbonate ($CaCO_3$). Alkalinity was generally less than 100 mg/L in most Local Upland Aquifer samples and approximately 100 mg/L in the Alluvial Aquifer samples. The highest alkalinity was measured in ground water samples from wells in the Regional Aquifer.

Calcium. Calcium is an essential nutrient common in rocks and soils, and occurs in a wide variety of minerals. The general concentrations of calcium in rocks and soils range from about 5,100 ppm in some granites to over 312,000 ppm in some carbonates. Calcium is a major constituent of natural waters, where it occurs only as the ion $Ca^{+2}$. The general concentration of calcium in seawater is about 410 ppm. Calcium concentrations in ground water range from lower than 50 ppm in some limestones, to greater than 93,500 ppm in an oil-field brine. Calcium concentrations in drinking water and ground water are not regulated. Calcium concentrations in ground water samples from the RBC-GWMA ranged from 4.7 to 260 ppm, with the highest concentration occurring in the ground water sample from well 64 in the Alluvial Aquifers.

Magnesium. Magnesium is an essential nutrient common in rocks and soils. Magnesium occurs in a wide variety of minerals, with concentrations in rocks and soils ranging from 1,600 ppm in some granites, to over 200,000 ppm in ultrabasic rocks. Magnesium is a major constituent of natural waters, where normally it occurs only as the ion $Mg^{+2}$. The general concentration of magnesium in seawater is about 1,350 ppm. Magnesium concentrations in ground water range from less than 4 ppm in some limestones, to greater than 12,000 ppm in an oil-field brine. Magnesium concentrations in drinking water and ground water are not regulated. Magnesium concentrations in all but one of the wells sampled ranged from 0.01 ppm up to 19 ppm. Magnesium was detected at 400 ppm in well 64.

Nitrite. Nitrogen has been addressed in the discussion of nitrates (see Primary and Secondary Drinking Water Standards Analytes section above). Unlike nitrate, nitrite does not occur as a mineral. Nitrite ($NO^{2-}$) is formed by removing one oxygen atom from nitrate ($NO^{3-}$). This process is called "nitrate reduction" and generally results from the metabolic processes of some microorganisms which occur naturally in soil and ground water. Although nitrate is common in ground water, nitrite is uncommon. Little is known about the natural concentrations of nitrites in surface or ground water. Nitrite concentrations in drinking water and ground water are regulated as total nitrogen and must meet the primary drinking water standard of 10 mg/L. Nitrite was detected at or below the laboratory method reporting limit of 0.5 ppm in all ground water samples from the RBC-GWMA.

Potassium. Potassium is an essential nutrient common in rocks and soils. Although potassium concentrations are about 40 ppm in ultrabasic rocks, they generally range from 2,700 to 48,000 ppm in most rocks and soils. Potassium occurs in most natural waters and is normally found as the potassium ion ($K^+$). Potassium concentrations in seawater are generally 390 ppm. Concentrations of potassium in ground water generally range from 1 to 20 ppm, but can exceed 120 ppm in an oil-field brine. Potassium concentrations in drinking water and ground water are not regulated. Potassium concentrations in ground water samples from the RBC-GWMA generally ranged from 1 to 12 ppm with the highest concentrations in wells screened in the Regional Aquifers. Potassium levels of 135 ppm were detected in well 64.

Silica. Silicon is the second most abundant element in the earth's crust (oxygen is the most abundant). Although the concentration of silicon in carbonates is usually low (less than 50,000 ppm) the general concentration of silicon in rocks and soils usually exceeds 200,000 ppm. Many minerals contain some silicon. Silicon occurs in most natural waters, usually as a form of dissolved silicic acid $Si(OH)_4$. By convention, dissolved silicon ions are represented as silica (the oxide, $SiO_2$). Concentrations of silica in natural water generally range from 1 to 30 ppm, although concentrations of 100 ppm are typical for some ground water systems. Elevated silica concentrations are usually associated with elevated ground water temperatures and silica-rich aquifer materials. Silica concentrations in drinking water and ground water are not regulated. Silica concentrations generally ranged from 11 to 58 ppm in ground water samples collected in the RBC-GWMA. Silica was detected at 300 ppm in the sample from well 64.

Sodium. Sodium is an essential nutrient common in rocks and soils. Sodium occurs in a wide variety of minerals ranging from silicates, such as feldspars, to evaporites, such as halite (NaCl, or common table salt). Sodium is found in most natural waters and generally occurs as the sodium ion ($Na^+$). Sodium concentrations in seawater are generally about 10,500 ppm. Concentrations of sodium in ground water vary widely, ranging from less than 1 ppm in some limestones to over 10,000 ppm in some brines. Sodium concentrations in drinking water and ground water are not regulated. Sodium concentrations ranged from 0.02 ppm to 130 ppm with the highest concentrations occurring in wells in the Regional Aquifers.

Total Hardness. Total hardness is a measure of the calcium and magnesium cations in water which form an insoluble precipitate with soap. In practice, the calcium and magnesium concentrations are measured, combined, and expressed as the equivalent concentration of calcium carbonate. (Note that this is not the same as simply adding and reporting the combined concentrations of calcium and magnesium). Therefore, the total hardness of a sample is proportional to its relative concentrations of calcium and magnesium. The actual hardness concentrations for the RBC-GWMA samples are meaningful only in relationship to each other. The total hardness of drinking water and ground water are not regulated. Total hardness of the ground water samples in the RBC-GWMA ranged from 31 to 128 mg/L as CaCO3, indicating soft to moderately hard water in most areas. The sample from well 64 had a hardness of 2,300 mg/L as CaCO3 and is considered very hard.

**Additional Potential Contaminants**

All ground water samples collected during the December 1989 sampling round were analyzed for total organic halogen. All ground water samples collected during the May 1990 sampling round were analyzed for total organic halogen except for the Doughty, Paradise Park, Kloepfer, Sharp, Thenos Dairy, King County Shops, and Campton Community wells. The Doughty, Bondo, Kloepfer, Sharp, Thenos Dairy, Olympian Precast, King County Shops, Campton Community wells, and Redmond Well 2 were sampled for cyanide, phenol, volatile organic compounds, semivolatile organic compounds, chlorinated pesticides, polychlorinated biphenyls, and several additional priority pollutant metals (antimony, beryllium, nickel, and thallium) during the May 1990 sampling.

Generally, the organic compounds detected with the total organic halogens, phenol, volatile organic compounds, and semivolatile organic compounds analyses do not occur naturally in ground water. The compounds detected with the cyanide, chlorinated pesticides, and polychlorinated biphenyls analyses do not occur naturally in water. The detection of any of these compounds may be indicative of ground water contamination.

Arsenic, cadmium, chromium, lead, mercury, selenium, and silver are priority pollutant metals which have been discussed in the Primary and Secondary Drinking Water Standards Analytes section above. The priority pollutant metals copper and zinc are secondary drinking water standard analytes which were discussed in the Ground Water Characterization Constituents section above. Antimony, beryllium, nickel, and thallium are discussed below. These metals can occur naturally in ground water and their presence does not necessarily indicate ground water contamination. The concentrations of these metals in ground water are not regulated by either Washington State or the federal government.

Total Organic Halogen. The total organic halogen analysis refers to compounds which contain the halogens chlorine, bromine, or iodine. The total organic halogen analytical method is used to estimate the total quantity of organic halogens in a sample. This analysis returns a total concentration of organic chloride, bromide, and iodide, but does not detect fluorinated organics. Compounds which contribute to the reported total include trihalomethanes, some halogenated organic solvents, chlorinated and brominated pesticides and herbicides, polychlorinated biphenyls, and several other halogenated volatile and semivolatile organic compounds. Since no halogenated organic compounds occur naturally in ground water, this analysis provides a relatively inexpensive screening tool which can be used to determine whether more expensive analyses for specific organic contaminants are warranted. However, if the natural ground water concentrations of inorganic halogens (such as chloroform, which is commonly produced by microorganisms in ground water) are high, then some of the inorganic halogens may be included in the total organic halogen value, giving a "false positive" result, or an overestimated total organic halogen concentration.

Concentrations of total organic halogen in ground water are not regulated as such. If total organic halogen are detected in ground water, then the sample source must be retested to determine which specific organic compounds are present and at what concentrations. Total organic halides were detected above the analytical detection limit in eight samples at concentrations ranging from 7 to 23 ppb.

Antimony. Antimony occurs naturally as a trace (0.2 to 0.5 ppm) constituent of rocks and soils, but also as an ore mineral. Little is known about the normal concentrations of antimony in ground water. Antimony concentrations in drinking water and ground water are not regulated. Antimony was not detected above the laboratory method reporting limit in any of the ground water samples from the RBC-GWMA.

Beryllium. Beryllium is a rare element which occurs naturally in rocks and soils. The most important source of beryllium is the mineral beryl, a silicate compound which occurs in some igneous rocks. The solubility of beryllium is extremely low (in the ppb range), and few data on normal concentrations of beryllium in ground water exist. Beryllium concentrations in drinking water and ground water are not regulated. Beryllium was not detected above the laboratory method reporting limit in any of the ground water samples collected in the RBC-GWMA.

Chlorinated Pesticides. Chlorinated pesticides include a wide variety of compounds with widely varying physical, chemical, and biological properties. These compounds are created by chemical synthesis. Examples of chlorinated pesticides include DDD, DDE, DDT, chlordane, endrin, and toxaphene. Where data are available, chlorinated pesticides are usually considered potential human carcinogens. Although chlorinated pesticides usually have very low solubility in water they tend to bioaccumulate. Because of the potential health concerns, the Washington State water quality standards for chlorinated pesticide concentrations in drinking water and ground water are generally less than 0.001 mg/L. These standards are set on a compound-by-compound basis. No chlorinated pesticides were detected in any of the ground water samples collected during this study.

Cyanide. Cyanides are a group of organic and inorganic compounds which contain the cyanide ion. Although cyanides are produced by many natural metabolic processes in plants and animals (for instance, apple seeds contain low concentrations), they do not normally occur in rocks or soils. The most common and toxic form of cyanide is hydrogen cyanide gas which can dissolve in water. When low concentrations of cyanide are present in water it tends to form insoluble metal compounds and, therefore, be removed from the water. At higher concentrations, however, cyanide forms soluble complexes with many cations (such as sodium, iron, gold, nickel, copper, or zinc). Because cyanide soluble complexes with many cations the "heap-leaching" process (where mined ore is washed with a cyanide solution) is effective at dissolving and recovering gold from ore. Cyanides do not occur naturally in ground water. When present, cyanides generally occur as either hydrogen cyanide gas or as the cyanide ion complexed with some cation (such as sodium or a metal). Cyanide concentrations are not regulated in drinking water and ground water. Cyanide was not detected above the laboratory method reporting limit in any of the ground water samples from the RBC-GWMA.

Nickel. Nickel is a common metal which occurs naturally in rocks and soils. Economically viable nickel deposits are generally associated with igneous ores. Concentrations of nickel in ground water are generally low (less than 50 ppb). Nickel concentrations in drinking water and ground water are not regulated. Nickel was not detected above the laboratory method reporting limit in any of the ground water samples from the RBC-GWMA.

Phenol. Phenol, or carbolic acid, is a benzene ring with one attached hydroxyl ($OH^-$) group which dissolves easily in water. Phenols occur naturally and are found in seawater at low (less than 2 ppb) concentrations. Little is known about the natural concentrations of phenol in ground water. Phenol concentrations are not regulated in drinking water and ground water. Phenol was not detected above the detection limit in any of the ground water samples from the RBC-GWMA submitted for analysis.

Polychlorinated Biphenyls. Polychlorinated biphenyls are a family of compounds with widely varying physical, chemical, and biological properties. These compounds are created by chemical synthesis and do not occur naturally. The name "polychlorinated biphenyls" refers to the basic chemical structure of the family where two phenyl groups are joined by a single bond and have varying numbers of chlorine atoms attached in various positions. About 100 of the possible 209 polychlorinated biphenyl compounds have actually been synthesized. Because of the variety of possible chemical structures, polychlorinated biphenyls have wide uses. Polychlorinated biphenyls are used as heat-transfer liquids in transformers, as insulators for electrical condensers, as additives in very high pressure lubricants, and to synthesize a variety of other compounds (such as epoxies and polyvinyl acetate). Normally, mixtures of polychlorinated biphenyls (called Aroclors) are utilized, rather than the individual polychlorinated biphenyls compounds.

Where data are available, polychlorinated biphenyls are considered potential human carcinogens. Although polychlorinated biphenyls (and, therefore, Aroclors) have very low solubility in water they tend to bioaccumulate. Because of the potential health concerns, the Washington State water quality standards for total polychlorinated biphenyls concentrations in drinking water and ground water are 0.00001 mg/L. Polychlorinated biphenyls were not detected in samples tested for these constituents.

Semivolatile Organic Compounds. Semivolatile organic compounds include a wide variety of compounds with varying physical, chemical, and biological properties. Although many of these compounds are created by chemical synthesis and do not occur naturally, some (such as the coal tar derivatives, including acenapthene, anthracene, fluorene, naphthalene, and other polycyclic aromatic hydrocarbons) occur in natural organic deposits such as coal, tar, and oil. Semivolatile organic compounds are widely used and occur in a wide variety of products including dyes, medications, mothballs, wood preservatives, and petroleum derivatives. Some semivolatile organic compounds are considered potential human carcinogens. Because of the potential health concerns, the Washington State water quality standards for semivolatile organic compounds concentrations in drinking water and ground water are generally less than 0.001 mg/L. These standards are set on a compound by compound basis. No semivolatile compounds were detected above the laboratory method reporting limit in the samples tested.

Thallium. Thallium occurs naturally in the earth's crust at concentrations around 1 ppm. Although thallium is soluble in most aquatic systems, there is little known about natural concentrations of thallium in ground water. Thallium concentrations in drinking water and ground water are not regulated. Thallium was not detected above the laboratory method reporting limit in any of the ground water samples from the RBC-GWMA.

Volatile Organic Compounds. Volatile organic compounds include numerous compounds with widely varying physical, chemical, and biological properties. Although many of these compounds are created by chemical synthesis and do not occur naturally, some (such as benzene) occur in natural organic (petroleum) deposits. Volatile organic compounds are widely used and occur in a wide variety of products including gasoline and other petroleum derivatives, medications, and solvents. Some volatile organic compounds are considered potential human carcinogens. Because of the potential health concerns, the Washington State water quality standards for volatile organic compounds concentrations in drinking water and ground water are generally less than 0.001 mg/L. These standards are set on a compound-by-compound basis. Methylene chloride, carbon tetrachloride, and acetate were detected at very low levels in several samples. The specific significance of this is discussed below.

**Results and Discussion of Analytical Testing**

This section presents the analytical testing results for ground water samples collected from wells in the RBC-GWMA in December 1989 and May 1990. The results of all chemical analyses are presented in Table 2.6.14. The classification of each analyte and its maximum permissible concentration in drinking water (if any) are listed in Table 2.6.15.

**Primary and Secondary Drinking Water Standard Analytes**

Ground water must meet all primary drinking water standards to be suitable for development as a drinking water supply. Ground water which meets primary, but does not meet secondary, drinking water standards can be developed as a drinking water supply, but the supply may be aesthetically unappealing. For example, water with elevated iron concentrations may be safe to drink, but can stain sinks and clothes and have an offensive flavor. The maximum acceptable concentrations for primary and secondary ground water standard constituents are presented in Table 2.6.15.

Ground water need not meet primary and secondary drinking water standards to be suitable for development as an irrigation, stock, or industrial water supply. The suitability of a ground water resource for any purpose other than drinking water supply depends on the nature and concentrations of its constituents and the proposed use of the resource. For example, ground water with elevated fluoride concentrations may be unfit for drinking but usable for industrial cooling purposes. Water which is usable as drinking water but has elevated silica concentrations may be unsuitable as an industrial cooling supply since the silica may foul the cooling system piping.

At least one sample from each of eight wells (Wells 1, 5, 12, 16, 29, 62) failed to meet the primary drinking water total coliform standard, a most probable number (MPN) of 1 total coliform bacterium per 100 milliliters of ground water. Total lead concentrations exceeded the primary drinking water standard, and total iron and manganese exceeded the secondary drinking water standard in well 12. Total arsenic, barium, chromium, mercury, and lead exceeded the primary drinking water standards, and total copper, iron, and manganese exceeded secondary drinking water standards for well 64. Ground water from all other wells sampled met the primary drinking water standards.

One ground water sample from well 14 did not meet the secondary drinking water standards for total dissolved solids, total iron, or total manganese. One or more of the ground water samples collected from wells 1, 3, 6, 10, 12, 14, 16, 20, 21, 27, 33, 35, 38, 40, 43, 51, 62, 64, 69, 73, 74 76, and 79 did not meet the secondary water quality standards for iron and/or manganese.

**Ground Water Characteristic Constituents**

All samples were analyzed for selected ground water characteristic constituents. These constituents include major ions (i.e., ions which are normally found at ppm to percent concentrations), and minor ions (ions which are normally found at concentrations less than a few ppm). Piper diagram plots of major ions were used to type the ground water and to group similar types of ground water. Major ions analyzed include bicarbonate, calcium, carbonate, chloride, hydroxide, magnesium, potassium, sodium, and sulfate. Minor ions are used to confirm and/or subdivide ground water types. Minor ions which were analyzed include nitrite and silica. The major cation and anion concentrations, as well as some common minerals, were also graphed according to distribution and occurrence in each of the four primary aquifer systems. In addition to the major and minor ions, arsenic, copper, lead, nitrate, iron, and manganese were evaluated and graphed.

In the RBC-GWMA, all sampled ground water is characterized as being a bicarbonate type. Samples from wells 4, 5, 34, 61, and 62, have relatively elevated sulfate concentrations (see Figure 2.6.45.). Samples from wells 14 and 16, which are located in the Sammamish River valley, have relatively elevated sodium concentrations (see Figure 2.6.46.). These samples also have relatively high total bicarbonate and total sodium concentrations (see Figure 2.6.45. and 2.6.46.). Typically, concentrations of arsenic, copper, lead, iron, and manganese appear to be relatively uniform in all four aquifer systems (Figures 2.6.47. through 2.6.50). Although elevated levels of iron and manganese occur in well 74 in the Sea Level Aquifers and well 16 in the deep aquifer, other wells in these aquifers do not show significantly higher levels of those minerals. Nitrate concentrations (Figure 2.6.51.) do appear to be higher in the Alluvial and Upland Aquifers; this is expected since these aquifers are generally closer to the surface and at greater risk from land use activities such as septic tank drainfields and agricultural practices.

Of the minor ions reviewed (Figures 2.6.51. and 2.6.52.) no trends in analyte distribution or aquifer association were apparent. Most of the water sampled can be characterized as bicarbonate type waters. Figure 2.6.53., shows a plot of selected water quality data presented in a trilinear diagram developed by Piper (1944). The diagram is a plot of the normalized major ion concentrations, in millequilivents per liter, expressed as percentages of the total ion concentration. Figures 2.6.54. through 2.6.57. are plots of the ground water chemistry data segregated into aquifer groups; Alluvial Aquifers, Local Upland Aquifers, Sea Level Aquifers, and Regional Aquifers, respectively.

Data for the Alluvial Aquifer (Figure 2.6.54.) was plotted in two groups. The smaller group consists of data for wells 51, 61, and 62. This group has anion levels higher in percentage sulfate and lower in percentage alkalinity than the larger group. Anion data for the smaller group plotted in the $HCO_3$-$SO_4$-Cl, mixed anion type field. These anion data are the only data collected for this study to plot outside the bicarbonate type field. The cation data plotted in the Ca-Mg-Na+K, mixed cation type field.

Local Upland Aquifers data was plotted in a single group (Figure 2.6.55.). The waters can be characterized as mixed cation and magnesium type and bicarbonate type.

Sea Level Aquifers data was plotted in two groups (Figure 2.6.56.) The smaller group consists of data for wells 27 and 29. Water from the smaller group can be characterized as sodium-bicarbonate type, whereas waters from the larger group can be characterized as calcium-mixed cation types and bicarbonate type. The difference in the two groups is distinguished by the level of percentage sodium. Waters from the smaller group are higher in percentage sodium and lower in percentage of other major cations.

Water from the Regional Aquifers was plotted in two groups (Figure 2.6.57.). The smaller group is composed of wells 14 and 16. Data from these two wells plotted in the sodium plus potassium apex of the cation triangle. The larger group of wells plotted in the mixed cation-calcium fields.

Figure 2.6.53. is an overlay of all the data on one trilinear diagram. Generally, the anion data overlap the ranges in the bicarbonate field. The exception is the small group from the Alluvial Aquifers. Although the differences between the aquifer groups are small, a general trend can

be seen. The trends starts with the small group of the Alluvial Aquifers in the $Ca+Mg-Cl+SO_4$ field, then progressing to the $Ca+Mg-HCO_3$ field where most of the data plot. The data trend then crosses into the $HCO_3+CO_3$ field and progresses towards the sodium apex. The cause of the trend is unclear, but may represent the geochemical evolution from the Alluvial Aquifers to the Regional Aquifers. The data are plotted as relative percentage, so differences in absolute concentration will be overlooked with this diagram.

**Additional Potential Contaminants**

Total organic halogen was reported at concentrations ranging from 7 to 23 $\mu$g/l for one or more of the ground water samples collected from the Kloepfer, Sharp, Thenos Dairy, Goss, King County Shops, Cedar Lawns, Campton Community wells, and Evans Creek Well 1. Total organic halogen was reported at 8 $\mu$g/l in the December 1989 sample and was not detected at or exceeding 5 $\mu$g/l in the May 1990 sample from Redmond Well 5.

Methylene chloride was reported in several samples. Since the laboratory method blank(s) associated with every sample reported methylene chloride, and the concentrations of methylene chloride reported in the laboratory method blanks are similar to the concentrations reported in the associated samples, all occurrences of methylene chloride in these samples are considered to result from laboratory contamination. Acetone was reported at 0.0207 mg/l in the May 1990 sample, and carbon tetrachloride was reported at 0.0016 mg/l in the duplicate from the King County Shops well. Since each compound was detected in only one of the duplicated samples, the detection of these compounds probably reflects laboratory error or laboratory contamination of the sample rather than ground water contamination. Acetone is not a regulated ground water contaminant. The concentration of carbon tetrachloride reported for the duplicate King County Shops sample is less than the National Drinking Water Standard of 0.005 mg/l, but exceeds the Washington State Drinking Water standard of 0.0003 mg/l. No other volatile organic compounds, pesticides, polychlorinated biphenyls, or semivolatile organic compounds were detected in the analyzed samples.

## 2.6.5. Conclusions

**Precipitation**

The Redmond-Bear Creek watershed receives an average of 42 inches of rainfall annually. The precipitation varies seasonally with approximately 75 percent of the annual precipitation falling between October and March with January having the greatest amount of precipitation. Precipitation decreases sharply in summer with the least precipitation occurring in September.

Rainfall is usually greatest at the higher elevations along the western boundary of the RBC-GWMA and lowest in the lower Bear Creek Valley around the cities of Redmond and Woodinville. However, at some weather stations no data were available for certain months for various reasons. These locations could have automatic rain gauge data loggers installed.

**Stream Gauges**

Seasonal variations in stream flow appear to correspond to changes in precipitation and are generally characterized by high flows in winter and spring and low flows in summer and fall.

Baseflow along Evans Creek, (indicating ground water discharge) ranged from 5 cubic feet per second upstream to 25 cubic feet per second downstream.

Stream flow varied in the creeks from 5 cubic feet per second to 1,332 cubic feet per second.

**Resistivity Study**

Five geophysical cross sections were developed using well logs, surficial geologic data, and geophysics to identify apparent resistivity patterns and corresponding geologic information. The sections show a mixture of fine to coarsed grain soil units, which range from clay to gravel. These are not discrete units of clay or gravel but mixtures of each material type with the resistivity indicating the predominant grain-size present. Bedrock was also interpreted to exist at depth.

**Monitoring Wells**

Five test wells were completed to collect stratigraphic and hydrologic data for characterization of subsurface conditions and evaluation of ground water potential. Of the five wells drilled, two wells had a moderately permeable aquifer; one well had a significantly permeable aquifer; one well had an upper water bearing zone where the City of Redmond's water supply is withdrawn; and the remaining well had no significant water bearing zone.

**Water Level Monitoring**

Water levels were monitored periodically in 81 wells between 1989 and 1991. Although the data was useful to develop ground water flow maps and document seasonal variations, the time period was to short to identify any long-term trends.

**Water Quality**

The ground water samples collected from the RBC-GWMA generally met all primary and secondary state and federal drinking water standards. Several wells did not meet the primary water quality standards for coliform. These wells penetrate different aquifers in different parts of the study area, indicating microbial contamination problems are restricted to individual wells, and there is no general microbial contamination of ground water in the RBC-GWMA. The Sharp well failed to meet the primary state drinking water standards for coliform and lead, and the secondary drinking water standards for iron and manganese. The source of the metals in the Sharp water samples may be the water supply piping system rather than the ground water.

Many wells in the RBC-GWMA do not meet state secondary (aesthetic) drinking water standards for total dissolved solids, iron, and manganese. Although this does not impact consumer health, these water supplies are less desirable and their industrial use may be restricted.

Although total organic halogen were reported for several wells, no specific organic contaminants were confirmed by resampling. It is possible acetone and carbon tetrachloride occur in groundwater samples from the King County Shops well. However, since these compounds were present only in low concentrations and only in one of two duplicated samples, their presence in ground water has not been confirmed. The methylene chloride detected in several samples is likely due to laboratory contamination and does not reflect contamination of the ground water supply. No other organic contaminants were detected in ground water samples, however, the King County Shops well should be resampled to confirm the absence of organic contaminants. Ground water samples collected in the RBC-GWMA is generally free from the organic compounds tested.

## 2.7. WATER BALANCE

The availability of ground water in the unconsolidated deposits (shallow aquifers) of the RBC GWMA was estimated by evaluating the quantity of ground water recharged or introduced into the area and the quantity of water used or discharged from the area. In other words, the change in ground water storage was calculated by estimating the quantities of water lost or gained through natural or human processes.

Ground water recharge occurs from ground water flowing into the area via subsurface flow, surface water leakage, infiltration of precipitation, recycled water following human use (i.e., wastewater discharge), and vertical flow from underlying water bearing units. Water loss from the area occurs through subsurface flow out of the area, discharge to streams or springs, evapotranspiration, stormwater runoff, and human consumption. Many of the parameters in a hydrologic budget can be measured directly: precipitation, stream flow, and transported water. Ground water inflow and outflow are determined from the hydraulic characteristics of the aquifer (conductivity and gradient). The water balance can be expressed in the form of a simple equation:

> Ground Water Recharge = (precipitation + surface water inflow + imported water + ground water inflow) - (evapotranspiration + surface water outflow + exported water + ground water outflow)

The methods used to evaluate the change in storage parameters for the RBC-GWMA are described below.

**TABLE 2.7.1**
**HYDROLOGIC BUDGET FOR RBC-GWMA STUDY AREA**

| Item | Recharge[a] (acre-feet/year) | Ground Water Loss[a] (acre-feet/year) |
|---|---|---|
| Precipitation - Average | 112,000 | -- |
| Ground Water Extraction | -- | -- |
| City of Redmond | -- | 4,000 |
| Rural UAA | -- | 360 |
| Water Loss to Surface Water | -- | 35,000 |
| Evapotranspiration | -- | 64,000 |
| Surface Runoff - Precipitation | -- | 13,300 |
| Wastewater Recycling | -- | -- |
| Rural UAA | 1,465 | -- |
| Flux (ground water under flow) | -- | -- |
| Out of UAA | -- | 1,626 |
| Into UAA | 4,821 | -- |
| TOTAL | 118,286 | 118,286 |

[a] Refer to sections 2.7.2 through 2.7.4 for discussion on value determination

2.7.1. Surface Area

The area investigated in the evaluation of the basin storage calculations is the area of the RBC-GWMA underlain by the shallow uncolidated aquifers. This area is termed the Uppermost Aquifer Areas. The surface area of the Uppermost Aquifer Area is approximately 50 square miles.

2.7.2. Ground Water Discharge

Ground water discharges (losses) from the Uppermost Aquifer Area include ground water extraction for municipal purposes, loss of ground water to streams, ground water transpired from phreatophytes (plants whose roots tap into the saturated zone), and ground water discharged to underlying aquifers. The quantity of water transpired by phreatophytes is unknown and is not factored into the storage calculation. The quantity of ground water discharged to underlying units is incorporated via the ground water flux calculations (refer to the Ground Water Flux section below).

**Ground Water Extraction — City of Redmond**

Ground water consumption rates for the City of Redmond were obtained from the City of Redmond draft water system plan (CH2M Hill, 1990). The entire ground water supply is currently being extracted from the shallow uppermost aquifers. Based on this data, the average daily demand from the unconsolidated aquifers is an estimated 4,000 acre-feet per year (3.61 mgd) and the per capita use is 0.12 acre-feet per year (107 gallons per day).

### Ground Water Extraction — Rural Area Use

The per capita water consumption for the population outside the City of Redmond and within the Uppermost Aquifer Area was estimated based on the per capita use within the city (0.3 acre-feet/capita/year). The population in the Uppermost Aquifer Area was based on population data supplied by the local community plans which estimated 12,000 persons outside the urban centers.

If each person in the rural area of the Uppermost Aquifer Area extracted 0.12 acre-feet/year from the unconsolidated aquifer, then 1,440 acre-feet/year would be used. This value is unrealistic because a portion of the ground water is extracted from aquifers below the Uppermost Aquifers or receive water from outside the study area (City of Seattle). For the purposes of this storage calculation, it was assumed that one-quarter of the population uses ground water from the unconsolidated aquifer (3,000 people); although the actual number is not known. Therefore, it is assumed that a 360 acre-feet/year of ground water is extracted from the unconsolidated aquifer for human use in the rural area.

### Water Loss to Streams

The RBC-GWMA contains a number of large streams that flow year-around. Most of these streams originate in the RBC-GWMA. Eventually, all streams discharge into Evans Creek which discharges into the Sammamish River. For purposes of this water budget, gauging measurements taken at Station 5 on Evans Creek were used to estimate losses to surface water. In 1990, an average flow of 50 cubic feet per second (35,000 acre-feet/year) was estimated for Station 5 on Evans Creek.

### Evapotranspiration

Evapotranspiration is the total loss of water from the soil as a result of evaporation from the soil and transpiration from the growing crop or vegetation. Evaporation due to residential/commercial watering and crop irrigation, based on an estimate by the Soil Conservation Service, 24 inches of actual evapotranspiration annually in the Seattle area. The amount of water transpired by plants depends on such factors as the plant type, moisture supply, heat available, and the temperature of the air surrounding the plant; 24 inches per year is, therefore, a rough estimate of the evapotranspiration. Actual evapotranspiration is defined as the computed amount of water lost under existing conditions of temperature and precipitation. Therefore, 64,000 acre-feet/year is calculated into the storage formula as a ground water loss due to evapotranspiration.

**Surface Runoff**

The amount of surface runoff directly affects the quantity of water recharged to the aquifer. Overland flow occurs when water drains across the land into stream channels. Overland flow may occur during precipitation events and from irrigation when surface soils are saturated or frozen impacting downward movement. For convenience, the quantity of water tallied as runoff in these storage calculations is listed as ground water loss. This number could just as easily be subtracted directly from the values calculated from precipitation and irrigation output.

Mean annual runoff from the precipitation events was calculated using published mean annual runoff data from the Soil Conservation Service (1972). The quantity of water lost to runoff based on the published data of 5 inches of runoff annually over the Uppermost Aquifer Area, is 13,300 acre-feet per year.

2.7.3. Ground Water Recharge

The unconsolidated aquifers are recharged by direct infiltration from precipitation, septic systems and ground water recharge through underlying hydrostratigraphic units. Sources of ground water recharge contributing to the unconsolidated aquifer are discussed below. Ground water recharge from underlying hydrostratigraphic units was not calculated specifically, but is incorporated in the ground water flux calculations.

**Precipitation**

Average annual precipitation data from the National Oceanographic and Atmospheric Administration (NOAA) was used to determine the average precipitation which falls over the RBC-GWMA. Based on an average of 42 inches of precipitation each year, estimated average annual precipitation over the RBC-GWMA is approximately 112,000 acre-feet/year.

**Wastewater Infiltration**

In the rural areas not serviced by the city sewage treatment system, the quantity of effluent generated for each person is based on the daily quantity of effluent generated by each person in the city (approximately 109 gallons per person). It is assumed that all outlying areas are serviced by septic systems, no effluent is lost to evapotranspiration, and all effluent recharges the unconsolidated aquifer system. Using a rural population of 12,000 people (see Ground Water Extraction - Rural Area Use section above) the total recharge from wastewater in the GWMA to the unconsolidated aquifer is 1,465 acre-feet per year.

2.7.4. Ground Water Flux

Ground water flux is an approximation of the transient ground water flow in a region. Ground water flux calculations interpret the quantity of ground water which flows into and out of the region. The flux in a region will change based on the aquifer thickness, hydraulic gradient, and quantity of ground water extracted and recharged from/to the aquifer.

In the RBC-GWMA, difficulties in evaluating the quantity of ground water flowing through the region include an unknown contribution from lower aquifers. To compensate for this difficulty, the flux out of the area was evaluated in the southern portion of the RBC-GWMA and the flux into the area was calculated as the difference of the sum of all recharge and discharge parameters evaluated in the storage calculation. This method of calculation assumes that the ground water budget is equal to zero (input equals output), and accounts for non-calculatable parameters such as discharge and recharge from/to the underlying aquifers.

**Flux Out**

Ground water flow out of the unconsolidated aquifer was evaluated using a cross-section of the southern portion of the RBC-GWMA. The ground water flow through the cross-sectional area was calculated using (1) the area between the water table and the underlying confining unit, (2) the hydraulic gradient in the vicinity of the section, and (3) the hydraulic conductivity.

A hydraulic conductivity of 147 feet per day was used in the calculations. This value is the geometric mean of three hydraulic conductivities determined in pumping tests conducted in three wells in the study area. The use of a single value does not account for variations in occurrence or distribution of facies comprising the glaciofluvial deposits of the study area.

The estimated quantity of ground water which flows out of the area at the south was calculated to be 1,626 acre-feet per year.

**Flux In**

The flux into the RBC-GWMA was calculated as the difference between the recharges and discharges to the aquifer. The sums of the recharges and discharges to/from the aquifer are 113,465 acre-feet/year and 118,286 acre-feet/year, respectively. Based on these values, the flux into the RBC-GWMA is 4,821 acre-feet/year.

2.7.5. Hydrologic Budget

The hydrologic budget for the area was determined assuming that the net change in the basin's ground water storage in the uppermost aquifer is equal to zero. Based on this assumption, the quantity of ground water lost and gained from the aquifer each year is approximately 118,286 acre-feet (refer to Table 2.7.1.).

Based on the calculations presented above, a minimal quantity of ground water is available in the Uppermost Aquifers for additional development. Potentially available quantities of ground water include ground water flowing out of the study area via substance flow and ground water loss to surface water.

Ground water flowing out of the area via subsurface flow accounts for a total of 1,626 acre-feet per year. It should be assumed that it is not safe to extract this total volume of water because some quantity is required to recharge deeper aquifer zones.

All ground water discharged to surface water is not available for use because some portion is required to maintain a minimum base-flow to protect fisheries and wildlife in streams and protect downstream senior surface water rights.

Assuming average rainfall and that only 50 percent of the water flowing out of the study area is available for use, an estimated 813 acre-feet/year (0.725 mgd) of ground water would be available for new development. Based on these figures, and until additional data can be obtained to refine the ground water budget, it may not be prudent to develop significant new water sources in the RBC-GWMA. Since the hydrologic budget for the RBC-GWMA is based predominately on data collected through indirect sources (e.g., census data to estimate ground water consumption rates) or data that represents a snapshot in time (e.g., stream flow measurements), the calculated recharge/discharge values should be viewed as estimates only. It is imperative that future data collection efforts attempt to refine the hydrologic budget with more accurate and refined data. Therefore, until further data are available, the only safe alternatives for acquiring additional water sources are trading existing water sources (such as water rights) or implementing water conservation measures.

## 2.8. RECOMMENDATIONS

The Redmond-Bear Creek study has provided a framework for future protection and management of the ground water resource. This framework consists of new data collected over a 3 year period and an evaluation of existing data. Much of the new data collected for this study represents the first attempt to characterize the complex geologic and hydrologic conditions in the study area. This data, while sufficient to use for initial development of various ground water protection and management strategies, also identified many gaps and questions which require more data in order to be answered. The following recommendations summarize the future data collection activities needed to fill in gaps or help in development of long term ground water protection strategies.

1) Long term water level data needs to be collected throughout the study area in all aquifer zones. Water levels should be collected twice a year (summer and winter) to evaluate fluctuations and trends. New monitoring wells should be surveyed for vertical elevation control.

2) Ground water chemistry data is virtually non-existent except in municipal and water district wells. A representative number of wells sampled for the RBC study should continue to be monitored at least annually. Efforts should focus on the shallow, uppermost aquifer zones if there is insufficient resources to monitor all zones.

3) Hydrostratigraphic information is very limited for parts of the basin, particularly along

Avondale road and Cottage Lake. Additional test wells should be drilled in these areas to evaluate geologic and ground water conditions. Since all of this area is served by septic systems, an understanding of the subsurface conditions is critical to evaluating aquifer vulnerability.

4) In the area north of NE 116 St, depth and configuration of aquifers, aquitards, and aquicludes is largely unknown. Geophysical investigation should be integrated into a test well drilling program.

5) In order to develop an accurate water balance for the RBC-GWMA, additional streams gauging, precipitation, evapotranspiration, and water use data must be collected. Stream gauging needs to be accomplished at 2 locations (upper and lower reaches) of each continuous flowing stream. Gauging should also be done where two streams intersect and where Bear Creek and Daniel Creek enter the north end of the study area. The gauging should be done hourly for at least 10-15 years, or permanently.

6) Precipitation data should continue to be collected in Redmond, Woodinville, Sahalle, and Novelty Hill. An evapotranspiration station should be established, probably in Redmond.

7) The number and distribution of domestic wells should be determined. This would show areas most vulnerable to a reduction in ground water quality and quantity. Much of this work could be accomplished through use of assessor records (location and well existence) and correlation with existing well logs.

8) To better estimate future ground water use potential and to supply input into any numerical computer models, aquifer parameters such as hydraulic conductivity and transmissivity should be estimated for the various aquifer zones. This should be accomplished through pump testing of existing and new test wells. Pumping tests should be done for a minimum of 24 hours and up to 72 hours if possible. Again, priority should be given to the shallow aquifer zones in the valley and upland areas.

9) An aquifer vulnerability assessment that integrates physical susceptibility and land use activities would be useful for long term ground water protection planning. Specific information that would be needed includes land use zoning, septic tank density, underground storage tanks, transportation corridors, beneficial use of ground water, and known contamination sites.

## 2.9. REFERENCES

40 CFR 141, National Primary Drinking Water Regulations.

40 CFR 143, National Secondary Drinking Water Standards.

Allen, B. February, 1994. Washington Utilities and Transportation Commission. Information on heavy truck hazardous waste accidents.

Bardy, L. February, 1994. Department of Ecology. Information on confirmed and suspected contaminated sites.

Bishop, G. February, 1994. Seattle-King County Health Department, Environmental Health Division, Solid Waste Section. Information on landfills.

Booth, D. February, 1994. King County Department of Public Works, Surface Water Management Division. Information on stormwater.

Burke, S. February, 1994. Seattle-King County Health Department, Environmental Health Division. Local Hazardous Waste Management Program. Information on small quantity waste generators.

Callahan, Michael A., Michael W. Slimak, Norman W. Gabel, Ira P. May, Charles F. Fowler, J. Randall Freed, Patricia Jennings, Robert L. Durfee, Frank C. Whitmore, Bruno Maestri, William R. Mabey, Buford R. Holt, and Constance Gould. 1979b. *Water-Related Environmental Fate of 129 Priority Pollutants, Volume II*. EPA-440/4-79-029a.

Cohen, P. February, 1994. City of Redmond. Information on jurisdictional agencies, Redmond Community Development guide, residential and commercial land use, transportation spills and sewerage.

Cox, G. February, 1994. Seattle-King County Health Department, Environmental Health Division. Information on wells.

Davis, E. February, 1994. Seattle-King County Health Department, Environmental Health Division, On-site program. Information on on-site sewage disposal.

Davis, S.N., and R.J.M. DeWiest. 1966. *Hydrogeology*. John Wiley & Sons, Inc.

Dennison, D. February, 1994. Puget Power. Information on fertilizer use.

Devitt, R. February, 1994. Department of Ecology. Information on transportation spills.

Driscoll, F.G. 1986. *Ground Water and Wells, Second Edition*. Johnson Division, St. Paul, Minnesota.

Franson, M.H. 1985. *Standard Methods for the Examination of Water and Wastewater, Sixteenth Edition*. American Public Health Association, Washington, D.C.

Glass, R. February, 1994. Washington State Patrol. Information on transportation spills.

Hem, J.D. 1985. *Study and Interpretation of the Chemical Characteristics of Natural Water, Third Edition*. U.S. Geological Survey Water-Supply Paper 2254.

Holmes, A. February, 1994. King County Department of Public Works, Solid Waste Division. Information on landfills.

Knowlton, D. February, 1994 Department of Ecology. Information on underground storage tanks.

Larson, B. February, 1994. Department of Natural Resources. Information on the Department of Natural Resources role in the Redmond-Bear Creek Valley Ground Water Management Area.

Matsuno, R. February, 1994. King County Department of Public Works, Roads and Engineering Division. Information on pesticide use on county right-of-ways and transportation spills.

Misko, D. February, 1994. Department of Ecology. Information on hazardous waste, hazardous waste disposal and generators.

Pinyuh, G. February, 1994. Washington State University Cooperative Extension. Information on fertilizer use.

Pierce, D. February, 1994. Department of Natural Resources. Information on gravel mining operations.

Reid, J. February, 1994. King County Parks, Planning and Resources Department, Planning and Community Development Division. Information on jurisdictional agencies, community plans, King County Comprehensive Plan, residential, commercial and industrial land use, and sewerage service.

Salomons, W., and U. Forstner. 1984. *Metals in the Hydrocycle*.

Springer-Verlag, New York.

Snyder, Dale E., Philip S. Gale, and Russell F. Pringle, 1973. *Soil Survey of King County Area, Washington.* United States Department of Agriculture, Soil Conservation Service.

Stumm, W., and J.J. Morgan. 1981. *Aquatic Chemistry, Second Edition.* John Wiley & Sons, New York.

Sweet-Edwards/EMCON, Inc. March 2, 1990. *Redmond-Bear Creek Ground Water Management Area Quality Assurance Project Plan.*

Sweet-Edwards/EMCON, Inc. March 5, 1990. *Redmond-Bear Creek Ground Water Management Area Data Collection and Analysis Plan.*

Todd, D.K. 1980. *Ground Water Hydrology, Second Edition.* John Wiley & Sons, New York.

Tuerkian, K.K., and K.H. Wedepohl. 1961. *Distribution of the Elements in Some Major Units of the Earth's Crust.* GSA Bulletin v. 72, p. 175-192.

Washington Administrative Code (WAC) 173-200, Washington Ground Water Quality Standards.

Washington Administrative Code (WAC) 246-290, Washington Drinking Water Regulations.

Tables

**TABLE 2.5.1.**
**NUMBER OF EXISTING HOUSING UNITS FOR**
**THE CITY OF REDMOND, 1992**

| Jurisdiction | Single Family | Multi-Family | Mobile Home | Total Units |
|---|---|---|---|---|
| Redmond | 7,860 | 9,512 | 375 | 17,747 |

Source: King County Department of Assessments, 1992. King County Annual Growth Databook, 1993.

**TABLE 2.5.2.**
**POPULATION AND HOUSING ESTIMATES**
**1980 - 1992 BEAR CREEK COMMUNITY PLANNING AREA**

| Demographic | 1980 | 1990 | 1992 | % Changes 1980-1992 | % Changes 1990-1992 |
|---|---|---|---|---|---|
| Population Unincorporated Area | 12,250 | 20,900 | 22,600 | 84.5% | 8.1% |
| Pop. per square mile | 270 | 470 | 508 | 88.1% | 8.1% |
| Households Total | 3,800 | 6,600 | 7,200 | 89.5% | 9.1% |
| Household size | 3.23 | 3.17 | 3.14 | -2.8% | -0.9% |
| Housing Units Total | 4,000 | 6,800 | 7,400 | 85% | 85% |
| Single Family Households | 3,580 | 6,200 | 6,800 | 89.9% | 9.7% |
| Mobile Homes | 300 | 450 | 450 | 50% | 0.0% |
| Multi-Family Households | 120 | 150 | 150 | 25% | 0.0% |

Source: King County Annual Growth Databook, 1993.

**TABLE 2.5.3.**
**POPULATION ESTIMATES AND FORECASTS 1970-2010**
**BEAR CREEK COMMUNITY PLANNING AREA**

| Demographic | Incorporated | Unincorporated | Total |
|---|---|---|---|
| 1970 | 100 | 6,000 | 6,100 |
| 1980 | 1,000 | 12,250 | 13,250 |
| 1990 | 2700 | 20,900 | 23,600 |
| 2000 | 4,000 | 33,100 | 37,100 |
| 2010 | 4,700 | 37,600 | 42,300 |

Source: King County Annual Growth Databook 1993.

TABLE 2.5.4.
POPULATION AND HOUSING ESTIMATES NORTH BEAR CREEK

| YEAR | 1980 | 1990 | 2000 | 2010 | 2020 |
|---|---|---|---|---|---|
| TOTAL POPULATION | 4,033 | 7,276 | 11,642 | 14,589 | 16,884 |
| Average Household Size | 3.16 | 3.12 | 2.95 | 2.77 | 2.65 |
| TOTAL HOUSEHOLDS | 1,276 | 2,332 | 3,934 | 5,256 | 6,359 |
| Single Family Households | 1,250 | 2,318 | 3,868 | 5,113 | 6,200 |
| Multi-family Households | 26 | 14 | 66 | 143 | 159 |
| Lower-Income Households | 145 | 234 | 421 | 572 | 689 |
| Lower-Mid Income Households | 231 | 386 | 575 | 715 | 816 |
| Upper-Mid Income Households | 414 | 714 | 1,054 | 1,332 | 1,537 |
| Upper Income Households | 486 | 998 | 1,883 | 2,637 | 3,317 |
| TOTAL EMPLOYMENT | 170 | 595 | 1,673 | 2,811 | 3,978 |
| Manufacturing | 32 | 50 | 85 | 128 | 163 |
| Whol/Tran/Comm/Util | 23 | 40 | 68 | 100 | 152 |
| Retail Trade | 22 | 181 | 653 | 1,224 | 1,727 |
| Services | 68 | 252 | 691 | 1,036 | 1,417 |
| Government/Education | 25 | 72 | 176 | 323 | 519 |

Source: Puget Sound Regional Council 1992.

Note: These forecasts were prepared by consultants of the Puget Sound Regional Council and are subject to jurisdictional review. Final adopted forecasts will be published by the Puget Sound Regional Council in 1994.

**TABLE 2.5.5. GROUP A PUBLIC WATER SYSTEMS REDMOND-BEAR CREEK GROUND WATER MANAGEMENT AREA**

| |
|---|
| Union Hill Water Association |
| City of Redmond |
| Northeast Sammamish Sewer and Water District |
| Woodinville Water District |

**TABLE 2.5.6. PROJECTED FUTURE WATER USAGE**

| | | | Projected Increases |
|---|---|---|---|
| | Current Use | 2000 (%) | 2040 (%) |
| East King County | 65-67 MGD | 77-84 MGD (16-27) | 134-185 MGD (103-180) |
| RBC-GWMA | 8 MGD | 9.3-10.1 MGD (16-27) | 16.6-22.4 MGD (103-180) |

## Table 2.5.7
## Potential Impacts to Ground Water Conditions From Land Use Activities

| Residential, Commercial, and Industrial Activities | |
|---|---|
| **Activity** | **Impact** |
| Use of private supply water wells | Increased discharge and translocation of ground water |
| Use of onsite septic tank sewage disposal | Formation of shallow ground water recharge mounds, downslope surface eruptions of effluent |
| Construction of impermeable surface (roof tops, pavement, parking lots, drainage systems) | Increased runoff, decreased infiltration and recharge |
| Building excavations and slope cuts, filling and constructions | Altered percolation of ground water, interconnection of aquifer systems |
| Landscaping and alteration of vegetative cover and maintenance | Altered evapotranspiration, surface drainage, infiltration, and recharge, increased discharge for irrigation |
| Operation and maintenance of cemeteries | Altered percolation of ground water, increased discharge for irrigation |
| Operation and maintenance of commercial and industrial facilities | Water quality degradation due to accidental spills, discharges or leaks |
| **Public and Utilities Services** | |
| **Activity** | **Impact** |
| Excavations for utilities and pipelines | Altered percolation of ground water |
| Grounded bed borings for pipelines and structures | Interconnection of surface drainage and aquifer systems |
| Construction of streets and roads, highway interchanges, parking lots, facilities with impermeable surface and rooftops | Increased runoff, decreased infiltration and recharge, increased ponding and folding with possible erosion downstream from collection points |
| Mechanical and chemical vegetation control in right-of-ways | Increased runoff, decreased infiltration and recharge |
| Construction of storm drainage | Increased runoff, decreased infiltration and recharge, possible localized recharge mounds under storm detention storage and along grassed waterways |
| Construction of public water supply | Translocation of water |
| Construction, operation, and closure of landfills | Altered infiltrations, surface drainages, and ground water percolation, aquifer interconnections, recharge mounding |
| Maintenance of vegetation along utility corridors and transportation right-of-ways | Varied evapotranspiration, runoff, infiltration, and recharge |
| Maintenance of parks, golf courses, and landscaping | Increased discharge of irrigation, translocation of water, varied evapotranspiration, infiltration and recharge |

## Table 2.5.7

## Potential Imapcts to Ground Water Conditions From Land Use Activities (Continued)

| Activity | Impact |
|---|---|
| **Agriculture** | |
| High density animal husbandry | Increased surface runoff, decreased infiltration and recharge |
| Irrigation and stock watering | Translocation of ground and surface water, shallow recharge mounding |
| Field preparation and crop cultivation | Varied evapotranspiration, increased runoff, decreased infiltration and recharge |
| **Sand and Gravel Mining** | |
| Activity | Impact |
| Operations (removal of overburden, sand and gravel, excavation site dewatering) | Decreased physical aquifer capacity, increased discharge of ground water to surface, altered surface drainage, interconnected aquifer systems |
| Abandonment of operations | Varied local ground water recharge or discharge, translocation of aquifer water, altered surface drainage |
| **Land Clearing** | |
| Activity | Impact |
| Tree and vegetation removal | Increased runoff and varied disruption of evapotranspiration processes |
| Access road construction | Increased surface runoff, decreased infiltration and recharge |

## Table 2.5.8
## Wastewater Characteristics[1]

| Land Use | Total Nitrogen[2] (mg/l) | Chloride (mg/l) | Lead (mg/l) | Zinc (mg/l) | Cadmium (mg/l) | Mercury (mg/l) | Total Phenol (ug/l) | Benzene (ug/l) | Toluene (ug/l) | Chloroform (ug/l) | Trichloro-Ethylene (ug/l) | Tetrachloro-Ethylene (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RESIDENTIAL** | | | | | | | | | | | | |
| Range | 20-85a | 0-400b | 0.0063-0.96b | 0.016-0.66b | 0.00016-0.007b | 0.0002-0.0023b | 13-22a | 2.3-2.4c | 4.3-5.4c | 0.7-5.3c | 0-150b | 2.6-100a |
| Mean[3] | 40 | | | | | | | | | | | |
| **INDUSTRIAL - FOOD** | | | | | | | | | | | | |
| Range | Highly Variable | Highly Variable | 0.001-0.31d | 0.270-1.5 | 0.0001-0.0067d | 0.0002-0.002d | 6.0-60d | 1.0-30.d | 1.0-101.0d | 2.0-140.0d | cd | 1.0-6.0d |
| Mean | | | 0.01 | 0.56 | 0.0006 | 0.0001 | 2.4 | 0.637 | 8.8 | 5.45 | 0 | 0.653 |
| **INDUSTRIAL - CHEMICALS** | | | | | | | | | | | | |
| Range | Highly Variable | 2.0-57,00 | 0.001-2.4d | 0.11-39 | 0.0001-1.09d | 0.0001-0.23 | 5.0-1,400,000d | 2.0-1,700.0 | 5.0-117,000 | 1.0-55,000d | 1.0-78,000d | 1.0-7,700d |
| Mean | | 44.0 | 0.08 | 0.70 | 0.0036 | 0.0008 | 134.0 | 5.3a | 140.6 | 6.15 | 17.3 | 18.9 |
| **INDUSTRIAL - METALS** | | | | | | | | | | | | |
| Range | Highly Variable | 4.0-150 | 0.0001-240.d | 0.034-11.0d | 0.001-0.22d | 0.001-0.009 | 2.0-530d | 2.0-110.0d | 1.0-83.0d | 1.0-46.0d | 1.0-500 | 1.0-85d |
| Mean | | 2.6 | 0.08 | 0.37 | 0.01 | 0.0002 | 6.2 | 1.5 | 1.5 | 3.3 | 2.9 | 1.0 |
| **COMMERCIAL** | | | | | | | | | | | | |
| Range | Highly Variable | 0-120b | 0.01-0.05b | 0.050-0.22b | 0.0001-0.0096 | 0.0001-0.014b | 0-150b | 0-16b | 0-110b | 0-28.0b | 0-335b | 0-115b |
| **SOLID WASTE (leachate)** | | | | | | | | | | | | |
| Range | Highly Variable | 0-400e | 0.0029-0.03e | 0.035-19.0e | 0.0001-0.016e | 0.002-0.0027e | 0-300e | 0-45 | 0-600e | 0-11e | 0-181e | 0-54e |

Notes:
(1) Tacoma-Pierce County Health Department, 1990.
(2) The mean is provided when available.
(3) Nitrate, nitrite, and organic and ammonia nitrogen.
mg/l = milligram per liter = ppm
ug/l = microgram per liter = ppb

Comments:
(a) Metcalf & Eddy, Wastewater Engineering.
(b) Draft A.2 Report, Collection System Modeling, Metro, May 1983.
(c) Metro Toxicant Study Report No. 2.
(d) Unpublished summary report data, TPPS Study, August 1983.
(e) Kent and Cedar Hills Landfills, Metro TPPS Study data, 1983.

**TABLE 2.5.9.**
**HAZARDOUS WASTE GENERATORS**

| Business Name | Address | Resource Conservation and Recovery Act Type |
|---|---|---|
| Lake Washington SD Redmond Jr. High School | 10055 166th Ave. N.E. Redmond | Generator 1. |
| Texaco Station 63 232 0273 | 11520 Avondale Rd. N.E. Redmond | Generator 2. |
| Chevron USA Inc. Service Station 98795 | 16000 Redmond Way Redmond | Generator 2. |
| Goodyear Auto Service Center | 16101 N.E. 87th St., Site. B Redmond | Generator 3. |
| Chevron USA Inc. Gary's | 16760 Redmond Way Redmond | Generator 3. |
| Overlake Cleaners | 16940 N.E. 79th St. Redmond | Generator 3. |
| Sign Pros. | 17425 N.E. 70th Redmond | Generator 1. |
| Pacific Circuits Inc. | 17550 N.E. 67th Ct. Redmond | Generator 1. |
| HO Sports Inc. | 17622 N.E. 67th Ct. Redmond | Generator 3. |
| Petersen Precision Engineering | 17642 N.E. 65th St. Redmond | Generator 2. |
| Guaranteed Auto Rebuild | 17657 1/2 Redmond Fall City Rd., Redmond | Generator 2. |
| ARCO Tech. Redmond | 17760 N.E. 67th Ct. Redmond | Generator 1. |

## TABLE 2.5.9.
## HAZARDOUS WASTE GENERATORS

| Business Name | Address | Resource Conservation and Recovery Act Type |
|---|---|---|
| Teijin Seiki America, Inc. | 17770 N.E. 78th Pl. Redmond | Generator 2. |
| Brown Bear Car Wash Redmond | 17809 Redmond-Fall City Rd., Redmond | Generator 3. |
| Redmond Transmission | 17825 N.E. 65th St., Site. 110, Redmond | Generator 2. |
| Kasco Corp. | 17830 N.E. 65th St. Redmond | Generator 2. |
| Super Rent, Inc. | 17950 Redmond Way Redmond | Generator 2. |
| United Parcel Service Redmond | 18001 N.E. Union Hill Rd. Redmond | Generator 2. |
| Ring & Pinion Service | 18014 Redmond Way, Unit 2, Redmond | Generator 2. |
| Guaranteed Radiator Repair, Inc. | 18014 Redmond Way Unit 45, Redmond | Generator 2. |
| City of Redmond of Maintenance Operations Center | 18080 N.E. 76th (Maint. Oper. Ctr.), Redmond | Generator 2. |
| Sajasa Construction, Inc. | 8124 N.E. 76th St. Redmond | Generator 2. |
| Redmond Automotive | 18130 Redmond Fall City Rd. Redmond | Generator 2. |
| Bell Industries Illuminated Displays | 18225 N.E. 76th St. Redmond | Generator 1. |

**TABLE 2.5.9.**
**HAZARDOUS WASTE GENERATORS**

| Business Name | Address | Resource Conservation and Recovery Act Type |
|---|---|---|
| Genie Ind. | 18340 N.E. 76th St. Redmond | Generator 1. |
| Super Rent Inc. | 18455 N.E. 76th St. Redmond | Generator 3. |
| Washington Department of Transportation | 18816 N.E. 80th Redmond | Generator 2. |
| Osborne Construction Co. | 19114 N.E. 84th Redmond | Generator 1. |
| Lakeside Ind. Lab. | 6500 187th Ave. N.E. Redmond | Generator 2. |
| Genetic Systems Corp. | 6565 185th Ave. N.E. Redmond | Generator 1. |
| Caremark Inc. | 6645 185th Ave. N.E. Site. 151, Redmond | Generator 2. |
| Trigon Packaging Corp. | 6812 185th Ave N.E. Redmond | Generator 3. |
| Queen City Auto Rebuild Inc. | 7502 159th Pl. N.E. Redmond | Generator 2. |
| Sterling Auto Body & Paint | 7520 159th Pl. N.E. Redmond | Generator 3. |
| Fitting Collision Ctr. | 7662 159th Pl. N.E. Redmond | Generator 3. |
| King Co. Soils & Materials Lab. | 7733 Leary Way N.E. Redmond | Generator 3. |
| Askew Auto Repair | 7903 170th Pl. N.E. Redmond | Generator 2. |

**TABLE 2.5.9.**
**HAZARDOUS WASTE GENERATORS**

| Business Name | Address | Resource Conservation and Recovery Act Type |
|---|---|---|
| Eastside Import Auto Rebuild Ltd. | 7927 159th Pl. N.E. Redmond | Generator 2. |
| Redmond Cleaners Inc. | 7981 Leary Way N.E. Redmond | Generator 2. |
| Hallmark Custom Cleaners | 8469 164th Ave. N.E. Redmond | Generator 3. |
| Redmond AAA Radiator Inc. | 7740 159th Pl. N.E. Redmond | Generator 2. |
| ETC Northwest | 6645 185th Ave. N.E. Redmond | Generator 1. |
| Vintage Racing Motors, Inc. | 7509 159th Pl. N.E. Redmond | Generator 3. |
| RP Auto Service | 7430 159th Pl. N.E. Redmond | Generator 2. |
| HFI Foods, Inc. | 17360 N.E. 67th Ct. Redmond | Generator 2. |
| Whirlpool Factory Service | 18047 N.E. 68th St., Site B100, Redmond | Generator 2. |
| Ecova Corp. | 18640 N.E. 67th Ct., Site. 200, Redmond | Generator 1. |
| Washington Department of Ecology Northwest Regional Office | Hwy 202 & 244th Ave. N.E., Redmond | Generator 2. |
| Lake Washington SD 98 | 1035 244th Ave. N.E. Redmond | Generator 2. |
| Northwest Pipeline Corp. Redmond MS | 22607 N.E. Union Hill Rd. Redmond | Generator 1. |

**TABLE 2.5.9.**
**HAZARDOUS WASTE GENERATORS**

| Business Name | Address | Resource Conservation and Recovery Act Type |
|---|---|---|
| Northwest Pipeline Corp Redmond Dist. | 22821 Redmond Fall City Rd., Redmond | Generator 1. |
| Lake Washington SD Evergreen Jr. High | 6900 208th Ave. N.E. Redmond | Generator 1. |

Key: Generator of dangerous/hazardous waste
1 = Generates or accumulates >2,200 pounds
2 = Generates or accumulates <2,200 pounds but >220 pounds
3 = Generates or accumulates <220 pounds (small quantity generators)

Source: Department of Ecology, Database, February 1994.

TABLE 2.5.10.
TOXIC CLEAN-UP PROGRAM

| Site Name | Address | Contaminant Status | Site Status | Comments | |
|---|---|---|---|---|---|
| A and A Foreign Auto Repair | 8004 Avondale Rd. N.E., Redmond 98052 | Suspected<br>Suspected<br>Suspected<br>Confirmed<br>Suspected | Awaiting assessment by Ecology. | | |
| All Sessions Construction | 8504 192nd Ave. N.E. Redmond 98053 | Suspected<br>Confirmed<br>Confirmed<br>Suspected | Awaiting assessment by Ecology. | | |
| Dunkin and Busch Painting, Inc. | 17301 N.E. 70th St., Redmond 98052 | Suspected<br>Suspected<br>Confirmed<br>Confirmed<br>Suspected<br>Confirmed | Awaiting assessment by Ecology. | | |
| Hancock Redmond Drug Lab | 2426 244th N.E. Redmond | Confirmed<br>Confirmed<br>Suspected<br>Confirmed<br>Suspected | Awaiting assessment by Ecology. | | |
| Johnny's Wrecking Yard | 16616 N.E. 185th St. Woodinville | Suspected<br>Suspected<br>Confirmed | Awaiting assessment by Ecology. | | |
| Northwest Pipeline/Redmond | 22607 N.E. Union Hill Rd. Redmond | Confirmed<br>Suspected<br>Suspected | Awaiting assessment by Ecology. | | |
| Olympian Precast, Inc. | 19150 Union Hill Rd. Redmond | Confirmed<br>Suspected<br>Suspected<br>Confirmed<br>Suspected | Independent remedial action. | Interim independent remedial action. Report received by Ecology. | |
| Truss Span | 19340 N.E. Union Hill Rd./N.E. 80th Redmond | Suspected<br>Suspected<br>Suspected<br>Suspected | .Awaiting assessment by Ecology. | | |

**TABLE 2.5.10.**
**TOXIC CLEAN-UP PROGRAM**

| Site Name | Address | Contaminant Status | Site Status | Comments | |
|---|---|---|---|---|---|
| Unocal Redmond Bulk Plant | 16631 Cleveland St. Redmond | Confirmed<br>Suspected<br>Suspected<br>Confirmed | Independent remedial action. | Interim independent remedial action. Report received by Ecology. | |

Source: Department of Ecology, February 1994.

TABLE 2.5.11.
UNDERGROUND STORAGE TANKS
REPORTED IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

| Site/Address | Substance | Size | Age(yr) | Status |
|---|---|---|---|---|
| Texaco Station<br>11520 Avondale Rd.<br>Redmond | Unleaded Gas | 10000-19999 gals | 7 | OPERAT |
| Texaco Station<br>11520 Avondale Rd.<br>Redmond | Unleaded Gas | 10000-19999 gals | 7 | OPERAT |
| Texaco Station<br>11520 Avondale Rd.<br>Redmond | Leaded Gas | 5000-9999 gals | 7 | OPERAT |
| Chevron<br>16000 Redmond Way<br>Redmond | Unleaded Gas | 10000-19999 gals | 3 | OPERAT |
| Chevron<br>16000 Redmond Way<br>Redmond | Unleaded Gas | 10000-19999 gals | 3 | OPERAT |
| Chevron<br>16000 Redmond Way<br>Redmond | Leaded Gas | 10000-19999 gals | 3 | OPERAT |
| Philips 66 Company Service Station #07<br>16401 Redmond Way<br>Redmond | Used Oil | 111-1100 gals | 25 | UNRESO |
| Philips 66 Company Service Station #07<br>16401 Redmond Way<br>Redmond | Unleaded Gas | 5000-9999 gals | 25 | UNRESO |
| Philips 66 Company Service Station #07<br>16401 Redmond Way<br>Redmond | | 111-1100 gals | 25 | UNRESO |
| Philips 66 Company Service Station #07<br>16401 Redmond Way<br>Redmond | Leaded Gas | 5000-9999 gals | 25 | UNRESO |
| Jackpot #305<br>16757 Redmond Way N.E.<br>Redmond | Leaded Gas | 10000-19999 gals | 22 | OPERAT |

**TABLE 2.5.11.**
**UNDERGROUND STORAGE TANKS**
**REPORTED IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA**

| Site/Address | Substance | Size | Age(yr) | Status |
|---|---|---|---|---|
| Jackpot #305<br>16757 Redmond Way N.E.<br>Redmond | Leaded Gas | 5000-9999 gals | 22 | OPERAT |
| Jackpot #305<br>16757 Redmond Way N.E.<br>Redmond | Leaded Gas | 5000-9999 gals | 22 | OPERAT |
| Chevron 96388<br>16760 Redmond Way<br>Redmond | Used oil | 5000-9999 gals | 11 | OPERAT |
| Chevron 96388<br>16760 Redmond Way<br>Redmond | Unleaded gas | 5000-9999 gals | 11 | OPERAT |
| Chevron 96388<br>16760 Redmond Way<br>Redmond | Unleaded gas | 5000-9999 gals | 11 | OPERAT |
| Chevron 96388<br>16760 Redmond Way<br>Redmond | Leaded gas | 5000-9999 gals | 11 | OPERAT |
| Minit-Lube #1109<br>17015 Avondale Way N.E.<br>Redmond | Used oil | 111-1100 gals | 15 | OPERAT |
| Minit-Lube #1109<br>17015 Avondale Way N.E.<br>Redmond | Other | 2001-4999 gals | 11 | OPERAT |
| Organizational Maintenance<br>17230 N.E. 95th<br>Redmond | Unleaded Gas | 10000-19999 gals | 39 | OPERAT |
| Brown Bear Car Wash<br>17809 Redmond Way<br>Redmond | Leaded gas | 5000-9999 gals | 29 | OPERAT |
| Brown Bear Car Wash<br>17809 Redmond Way<br>Redmond | Diesel Fuel | 5000-9999 gals | 29 | OPERAT |
| Brown Bear Car Wash<br>17809 Redmond Way<br>Redmond | Unleaded gas | 10000-19999 gals | 29 | OPERAT |

**TABLE 2.5.11.**
**UNDERGROUND STORAGE TANKS**
**REPORTED IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA**

| Site/Address | Substance | Size | Age(yr) | Status |
|---|---|---|---|---|
| Brown Bear Car Wash<br>17809 Redmond Way<br>Redmond | Unleaded gas | 10000-19999 gals | 29 | OPERAT |
| Super Rent Inc.<br>17950 Redmond Way<br>Redmond | Kerosene | 2001-4999 | 11 | OPERAT |
| Super Rent Inc.<br>17950 Redmond Way<br>Redmond | Unleaded gas | 2001-4999 | 11 | OPERAT |
| Super Rent Inc.<br>17950 Redmond Way<br>Redmond | Diesel Fuel | 2001-4999 | 11 | OPERAT |
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Diesel Fuel | 10000-19999 gals | 5 | OPERAT |
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Diesel Fuel | 10000-19999 gallons | 5 | OPERAT |
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Used oil | 111-1100 gals | 5 | OPERAT |
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Hazardous | 111-1100 gals | 5 | OPERAT |
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Hazardous | 111-1100 gals | 5 | OPERAT |
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Unleaded gas | 10000-19999 gals | 5 | OPERAT |
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Unleaded gas | 10000-19999 gals | 5 | OPERAT |
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Diesel Fuel | 10000-19999 gals | 5 | OPERAT |

**TABLE 2.5.11.**
**UNDERGROUND STORAGE TANKS**
**REPORTED IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA**

| Site/Address | Substance | Size | Age(yr) | Status |
|---|---|---|---|---|
| United Parcel Service-Red<br>18001 N.E. Union Hill Rd.<br>Redmond | Other | 111-1100 gals | 5 | OPERAT |
| Sammamish Point Texaco<br>18065 Redmond Way<br>Redmond | Unleaded Gas | 5000-9999 gals | 20 | OPERAT |
| Sammamish Point Texaco<br>18065 Redmond Way<br>Redmond | Leaded gas | 10000-19999 gals | 11 | OPERAT |
| Sammamish Point Texaco<br>18065 Redmond Way<br>Redmond | Unleaded gas | 5000-9999 gals | 20 | OPERAT |
| Sammamish Point Texaco<br>18065 Redmond Way<br>Redmond | Unleaded gas | 5000-9999 gals | 20 | OPERAT |
| Sammamish Point Texaco<br>18065 Redmond Way<br>Redmond | Diesel Fuel | 5000-9999 gals | 15 | OPERAT |
| City Shops<br>18080 N.E. 76th<br>Redmond | Used oil | 111-1100 gals | 15 | OPERAT |
| City Shops<br>18080 N.E. 76th<br>Redmond | Unleaded Gas | 5000-9999 gals | 15 | OPERAT |
| City Shops<br>18080 N.E. 76th<br>Redmond | Diesel Fuel | 5000-9999 gals | 15 | OPERAT |
| City Shops<br>18080 N.E. 76th<br>Redmond | Leaded gas | 5000-9999 gals | 15 | OPERAT |
| Redmond Science Ctr (2562)<br>18120 N.E. 68th St.<br>Redmond | Diesel Fuel | 111-1100 gals | 2 | OPERAT |
| Hos Bros. Construction, I<br>18120 N.E. 76th St.<br>Redmond | | 111-1100 gals | 25 | TEMP 0 |

TABLE 2.5.11.
UNDERGROUND STORAGE TANKS
REPORTED IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

| Site/Address | Substance | Size | Age(yr) | Status |
|---|---|---|---|---|
| Hos Bros. Construction, I<br>18120 N.E. 76th St.<br>Redmond | | | 20 | TEMP 0 |
| Hos Bros. Construction, I<br>18120 N.E. 76th St.<br>Redmond | | | 20 | TEMP 0 |
| Hos Bros. Construction, I<br>18120 N.E. 76th St.<br>Redmond | Diesel Fuel | 10000-19999 gals | 3 | OPERAT |
| Hos Bros. Construction, I<br>18120 N.E. 76th St.<br>Redmond | Used oil | 111-1100 gals | 25 | OPERAT |
| Redmond Service Center<br>18150 Red-Fall City Hwy<br>Redmond | Used oil | 111-1100 gals | 15 | OPERAT |
| Redmond Service Center<br>18150 Red-Fall City Hwy<br>Redmond | Diesel Fuel | 10000-19999 gals | 15 | OPERAT |
| Redmond Service Center<br>18150 Red-Fall City Hwy<br>Redmond | Unleaded Gas | 111-1100 gals | 15 | OPERAT |
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Diesel Fuel | 10000-19999 gals | 15 | OPERAT |
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Diesel Fuel | 10000-19999 gals | 15 | OPERAT |
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Leaded Gas | 111-1100 gals | 15 | OPERAT |
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Other | 111-1100 gals | 15 | OPERAT |
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Diesel Fuel | 1101-2000 gals | 20 | OPERAT |

**TABLE 2.5.11.**
**UNDERGROUND STORAGE TANKS**
**REPORTED IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA**

| Site/Address | Substance | Size | Age(yr) | Status |
|---|---|---|---|---|
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Diesel Fuel | 10000-19999 gals | 20 | OPERAT |
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Used Oil | 111-1100 gals | 15 | OPERAT |
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Other | 111-1100 gals | 15 | OPERAT |
| Cadman Gravel Company<br>18816 N.E. 80th<br>Redmond | Diesel Fuel | 10000-19999 gals | 20 | OPERAT |
| The Overlake School<br>20301 NE 108th<br>Redmond | Leaded Gas | 1101-2000 gals | 20 | OPERAT |
| King County Fire District<br>4200 228th Ave NE<br>Redmond | Diesel Fuel | 111-1100 gals | 2 | OPERAT |
| PDQ Oil Co. #1120<br>5040 148th Ave NE<br>Redmond | Unleaded Gas | 10000-19999 gals | 3 | OPERAT |
| Marymoor Park<br>6046 West Lake Sammamish<br>Redmond | Unleaded Gas | 111-1100 gals | 2 | OPERAT |
| Jackpot #304<br>7725 159th Pl NE<br>Redmond | Unleaded Gas | 5000-9999 gals | 10 | OPERAT |
| Jackpot #304<br>7725 159th Pl NE<br>Redmond | Leaded Gas | 10000-19999 gals | 10 | OPERAT |
| Jackpot #304<br>7725 159th Pl NE<br>Redmond | Unleaded Gas | 10000-19999 gals | 10 | OPERAT |
| A & G Leasing<br>7740 159th Pl NE<br>Redmond | Used Oil | 111-1100 gals | 20 | TEMP O |

**TABLE 2.5.11.**
**UNDERGROUND STORAGE TANKS**
**REPORTED IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA**

| Site/Address | Substance | Size | Age(yr) | Status |
|---|---|---|---|---|
| Shultz Distributing Inc.<br>7822 180th Ave NE<br>Redmond | Leaded Gas | 20000-29999 gals | 29 | OPERAT |
| Shultz Distributing Inc.<br>7822 180th Ave NE<br>Redmond | Unleaded Gas | 20000-29999 gals | 29 | OPERAT |
| Shultz Distributing Inc.<br>7822 180th Ave NE<br>Redmond | Unleaded Gas | 20000-29999 gals | 29 | OPERAT |
| ARCO 6067<br>8009 164th Ave NE<br>Redmond | Unleaded Gas | 10000-19999 gals | 8 | OPERAT |
| ARCO 6067<br>8009 164th Ave NE<br>Redmond | Unleaded Gas | 10000-19999 gals | 8 | OPERAT |
| ARCO 6067<br>8009 164th Ave NE<br>Redmond | Used Oil | 111-1100 gals | 26 | OPERAT |
| ARCO 6067<br>8009 164th Ave NE<br>Redmond | Leaded Gas | 10000-19999 gals | 8 | OPERAT |
| City of Redmond Fire Dept<br>8450 161st Ave NE<br>Redmond | Unleaded gas | 1101-2000 gals | 11 | OPERAT |
| City of Redmond Fire Dept<br>8450 161st Ave NE<br>Redmond | Diesel Fuel | 1101-2000 gals | 11 | OPERAT |
| City of Redmond Fire Dept<br>8450 161st Ave NE<br>Redmond | Unleaded Gas | 1101-2000 gals | 11 | OPERAT |
| Lake Washington School Dist<br>9426 195th Ave NE<br>Redmond | Heating Fuel | | 32 | UNRESO |
| Lake Washington School Dist<br>9426 195th Ave NE<br>Redmond | Heating Fuel | | 32 | UNRESO |

TABLE 2.5.11.
UNDERGROUND STORAGE TANKS
REPORTED IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

| Site/Address | Substance | Size | Age(yr) | Status |
|---|---|---|---|---|
| Lake Washington School Dist<br>9426 195th Ave NE<br>Redmond | Heating Fuel | 111-1100 gals | 32 | UNRESO |
| Lake Washington School Dist<br>9426 195th Ave NE<br>Redmond | Heating Fuel | | 32 | UNRESO |
| Lake Washington School Dist<br>9426 195th Ave NE<br>Redmond | Heating Fuel | 111-1100 gals | 32 | UNRESO |

OPERAT = Underground storage tanks in operation/use
TEMPO = Underground storage tanks temporary out of service (tank emptied but not removed, or closed in place).
UNRESOLV = Ecology is unaware of what is going on at the site. Ecology has or will correspond with the site owner.

TABLE 2.5.12.
AGE OF UNDERGROUND STORAGE TANKS IN OPERATION IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

| Age (years) | Number of Tanks | Percentage of Total |
|---|---|---|
| 1-2 | 3 | 4.1 |
| 3-5 | 14 | 19.2 |
| 6-10 | 9 | 12.3 |
| 11-15 | 27 | 36.9 |
| 16-20 | 7 | 9.6 |
| 21-30 | 12 | 16.4 |
| Greater than 30 | 1 | 1.4 |
| TOTAL | 73 | 100.0 |

Source: Department of Ecology, 1994.

TABLE 2.5.13.
SUBSTANCES CONTAINED IN UNDERGROUND STORAGE TANKS IN OPERATION IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

| Substance | Number of Tanks | Percentage of Total |
|---|---|---|
| Leaded Gas | 13 | 17.8 |
| Unleaded Gas | 28 | 38.4 |
| Diesel Fuel | 17 | 23.3 |
| Kerosene | 1 | 1.4 |
| Used/Waste/Oil | 8 | 10.9 |
| Unknown | 6 | 8.2 |
| TOTAL | 73 | 100.0 |

Source: Department of Ecology, 1994.

**TABLE 2.5.14.**
**SIZE OF UNDERGROUND STORAGE TANKS IN OPERATION IN THE REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA**

| Size (gallons) | Number of Tanks | Percentage of Total |
|---|---|---|
| 111-1100 | 18 | 24.7 |
| 1101-2000 | 5 | 6.9 |
| 2001-4999 | 4 | 5.5 |
| 5000-9999 | 16 | 21.9 |
| 10000-19999 | 27 | 36.9 |
| 20000-29999 | 3 | 4.1 |
| TOTAL | 73 | 100.00 |

Source: Department of Ecology, 1994.

**TABLE 2.5.15.**
**DEPARTMENT OF ECOLOGY**
**CURRENT AND FORMER CONTAMINATED UNDERGROUND STORAGE TANK SITES**

| Site Name | Address | City | Clean-up Status | Media |
|---|---|---|---|---|
| Lake Washington School Mann El | 17001 NE 104 | Redmond | In progress | D |
| McEachern Property | 19805 NE Novelty Hill Rd | Redmond | Conducted | D |
| WA State Military Army Nat'l G | 17230 NE 95th | Redmond | Conducted | D |
| A & A Auto | 8004 Avondale Rd | Redmond | In Progress | D |
| UPS Redmond | 18001 NE Union Hill Rd | Redmond | In Progress | D |
| Arco Station #6067 | 8009 164th Ave NE | Redmond | In Progress | D |
| Kelly Realty | 16450 Redmond Way | Redmond | Conducted | D |
| Chevron Station #9-6388 | 16760 Redmond Way | Redmond | In Progress | A |
| Unocal Station #4870 | 16909 Redmond Way | Redmond | In Progress | A,D |
| Car Wash Enterprises Redmond | 17809 Redmond Way | Redmond | In Progress | A,D |
| Schultz Distrib Plant Redmond | 7822 180th Ave NE | Redmond | In Progress | A,D |
| Down to Earth Bulldozing | 20840 NE 89th | Redmond | Conducted | D |

Media
A = Ground Water
D = Soil

Clean-up Status
Conducted = Ecology received final independent action clean up report -no further action.
In Progress = Site clean-up in progress/ongoing.

### TABLE 2.5.16.
### RANGES OF SUSPENDED SOLIDS AND HEAVY METALS DETECTED IN STORMWATER NATIONAL URBAN RUNOFF PROGRAM

| Constituent | Concentration Range (mg/l) |
|---|---|
| Total Suspended Solids | 180 - 548 |
| Total Copper | 43 - 118 |
| Total Lead | 182- 443 |
| Total Zinc | 202 - 633 |
| Pesticides | <0.05 |
| Nitrates | <1.0-6.0 |

### TABLE 2.5.17.
### VEHICLE ACCIDENT SUMMARY

| Roadway Location | 1993 Average Daily Traffic Total Roadway # of Vehicles | Total 1993 Accidents | Estimated Number of Hazardous Waste Accidents (Per Year) |
|---|---|---|---|
| Avondale Road (Redmond) | 28,000 | 28 | <1 |
| Union Hill Road (Redmond) | 17,000 | 12 | <1 |
| Highway 202 | 23,900 | 76 | <1 |

Source: City of Redmond, February 1994.

TABLE 2.5.18.
CITY OF REDMOND TRUCK ACCIDENTS

| YEAR | TRUCK ACCIDENTS | TRUCK ACCIDENTS INVOLVING HAZARDOUS MATERIALS |
|---|---|---|
| 1991 | 33 | 0 |
| 1990 | 45 | 1 |
| 1989 | 34 | 1 |

Source: Washington Utilities and Transportation Commission, March 1994.

Note: Information unavailable prior to 1989.

## Table 2.6.1

## Delineation of Wells by Aquifer Zone

| Alluvial Aquifers | | Local Upland Aquifers | | Sea Level Aquifers | | Regional Aquifers | |
|---|---|---|---|---|---|---|---|
| Well ID | Approximate Intake Elevation | Well ID | Approximate Intake Elevation | Well ID | Approximate Intake Elevation | Well ID | Approximate Intake Elevation |
| 8 | 68 | 1 | 292 | 6 | 54 | 14 | -156 |
| 9 | 64 | 2 | 210 | 15 | -124 | 16 | -175 |
| 23 | -59 | 3 | 216 | 26 | | 34 | -278 |
| 24 | | 4 | 219 | 27 | | 35 | -224 |
| 33 | -9 | 5 | 171 | 28 | -31 | 36 | -224 |
| 37 | 22 | 7 | 171 | 29 | | 75 | -631 |
| 40 | -66 | 10 | 187 | 30 | 44 | 79 | -205 |
| 41 | 12 | 11 | 161 | 31 | -15 | | |
| 42 | -10 | 12 | 231 | 32 | 51 | | |
| 43 | 50 | 13 | 186 | 68 | | | |
| 44 | -10 | 17 | 172 | 74 | | | |
| 45 | 4 | 18 | 227 | 77 | -2 | | |
| 46 | 23 | 19 | 272 | 78 | | | |
| 47 | 24 | 20 | 251 | 79 | | | |
| 48 | | 21 | 184 | 80 | 49 | | |
| 50 | 15 | 22 | | | | | |
| 51 | -37 | 69 | 424 | | | | |
| 52 | -23 | 71 | | | | | |
| 53 | -23 | 72 | 388 | | | | |
| 54 | 10 | 82 | | | | | |
| 55 | 10 | | | | | | |
| 56 | -8 | | | | | | |
| 57 | 2 | | | | | | |
| 58 | | | | | | | |
| 59 | 23 | | | | | | |
| 60 | 10 | | | | | | |
| 62 | 1 | | | | | | |
| 63 | 6 | | | | | | |
| 64 | -73 | | | | | | |
| 65 | 60 | | | | | | |
| 66 | 31 | | | | | | |
| 67 | 40 | | | | | | |
| 70 | -9 | | | | | | |
| 73 | -54 | | | | | | |
| 76 | 8 | | | | | | |
| 81 | -129 | | | | | | |

NOTE: 1 Elevation = feet above or below mean sea level.

## Table 2.6.2

### Recharge Potential of SCS Soil Units

| SCS Map Symbol | SCS Soil Unit Name | Recharge Potential Classification |
|---|---|---|
| AgC | Alderwood | moderate |
| AgD | Alderwood | moderate |
| AkF | Alderwood | moderate |
| AmC | Arents | moderate |
| Bh | Bellingham | low |
| Br | Briscot | moderate |
| EvB | Everett | high |
| EvC | Everett | high |
| EvD | Everett | high |
| Ea | Earlmont | moderate |
| InA | Indianola | high |
| InC | Indianola | high |
| KpB | Kitsap | moderate |
| KpD | Kitsap | moderate |
| No | Norma | moderate |
| Os | Oridia | moderate |
| Pu | Puget | low |
| Pc | Pilchuck | high |
| RdC | Ragnar-Indianola | high |
| Re | Renton | high |
| So | Snohomish | moderate |
| Su | Sultan | moderate |
| Sk | Seattle muck | moderate |
| Tu | Tukwila muck | moderate |

## Table 2.6.3

## Recharge Potential of USGS Geologic Units

| Geologic Symbol | Geologic Unit Name | Recharge Potential Classification |
|---|---|---|
| Qaf | Alluvial fan deposits | high |
| Qyal | Younger alluvium | moderate |
| Qual | Older alluvium | high |
| Qsw | Swamp deposits | low |
| Qc | Colluvium | moderate |
| Qls | Landslide deposits | moderate |
| Qmw | Mass wasting deposits | moderate |
| Qvr | Recessional outwash | high |
| Qvry | Recessional outwash | high |
| Qvrc | Clay | low |
| Qvrb | Recessional outwash | high |
| Qvrd | Redmond delta | high |
| Qvro | Older recessional outwash | high |
| Qvt | Glacial till | low |
| Qva | Advance outwash | moderate |
| Qtb | Transitional beds | low |
| Qob | Olympia beds | moderate |

## Table 2.6.4

## Recharge Potential for Slopes and Depth to Water Criteria

| | |
|---|---|
| **DEPTH TO WATER** | |
| **Depth Below Ground Surface (feet)** | **Recharge Potential Classification** |
| 0 - 25 | high |
| 25 - 75 | moderate |
| >75 | low |
| | |
| **SLOPE** | |
| **Percent Slope** | |
| 0 - 40% | high |
| 40 - 80% | moderate |
| >80% | low |

## Table 2.6.5

## Physical Conditions Rating Criteria

| Criterion Classifications | Composite Classification |
|---|---|
| H-H-H-H | High |
| H-H-H-M | High |
| H-H-M-M | High |
| H-H-H-L | High |
| H-M-M-L | Moderate |
| H-M-M-M | Moderate |
| H-H-L-L | Moderate |
| H-M-L-L | Moderate |
| H-L-L-L | Moderate |
| M-M-M-M | Moderate |
| M-M-M-L | Moderate |
| M-M-L-L | Moderate |
| M-L-L-L | Low |
| L-L-L-L | Low |

## Table 2.6.6

## Typical Resistivity Values of Materials

| Material Description | Resistivity |
|---|---|
| Silt/clay mixture (full to partial saturation) | 10 to 100 |
| Sandy silts and clays and possible sandstone/shale bedrock (full to partial saturation) | 50 to 150 shale |
| Silty sand and saturated sand/gravel | 100 to 500 |
| Sand to gravel (fine to coarse)<br>Dry sandstone/shale bedrock | 200 to 1,500 |
| Gravel (full to partial saturation) | 1,000 to 2,000 |
| Gravel (dry) | 1,500 and above |

## Table 2.6.7

## VES Interpretation

| Depth (feet) | Resistivity (in ohm meters) | Geologic Interpretation |
|---|---|---|
| **VES-37** | | |
| 0 to 11<br>11 to 17<br>17 to 24 | 300+<br>173<br>91 | Silty sandy gravel |
| 24 to 35 | 75 | Sandy silt and gravel layers |
| 35 to 78 | 84 | |
| | | Silty sand and gravel |
| 78 to 115 | 65 | Fine to coarse sand |
| 115 to 171 | 51 | Fine sand |
| 171 to 254 | 64 | Silty sand and gravel and layers of silt |
| 254 to 366 | 116 | Gray fine sand, silt and clay |
| 366 to 546 | 69 | |
| 546 to 600 +/- | low | Gray water-bearing silty fine sand |
| **VES-40** | | |
| 0 to 4<br>4 to 6 | 5,000+<br>3,275 | Coarse dry sand and gravel |
| 6 to 8 | 771 | Siltier material |
| 8 to 11 | 149 | Water table |
| 11 to 14 | 33 | Silty layer |
| 14 to 24<br>24 to 36 | 261<br>539 | Coarse sand and gravel beneath the water table |
| 36 to 93 | 250 | Interpreted top of rock at 36 |
| 93 to 142 | 390 | Sandstone |

## Table 2.6.8

## Summary of Well Drilling and Aquifer Testing Data

| | | | | | Pump Testing Results | | | |
|---|---|---|---|---|---|---|---|---|
| Test Well Site | Total Depth of Hole (ft) | Depth of Well(s) (ft) | Screened Intervals (ft) | Well Casing Diameter (mhos) | Pumping Rate (gpm) | Specific Capacity (gpm/ft) | Potential Yield (gpm) | Transmissivity (gpd/ft) |
| Woodinville | 490 | 85 | 75-85 | 6 | 200 | 18 | 1200 | 80,000 |
| Redmond | 500 | 75 | 65-75 | 2 | NA | NA | NA | NA |
| Lower Evans Creek | 160 | 153 | 143-153 | 6 | 150 | 6 | 700 | 20,000 |
| Upper Evans Creek | 237 | 160/200 | 140-160/ 180-200 | 2 | NA | NA | NA | NA |
| Marymoor | 170 | 161 | 151-161 | 6 | 100 | 4 | 100 | 5,000 |

NOTE: NA Not applicable.

150969

| YEAR | MONTH | STATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Woodinville | Union Hill | Sahalee | Redmond | Hollywood | North Ridge | Blakely Ridge |
| 1989 | Jan | ND | ND | 5.85 | 2.72 | 3.97 | 5.81 | ND |
| | Feb | ND | ND | 3.07 | 1.11 | 3.34 | 4.46 | ND |
| | Mar | 5.09 | ND | 6.85 | 3.04 | 5.56 | 6.79 | ND |
| | Apr | 1.47 | 2.00 | 2.45 | 0.97 | 1.32 | 2.30 | ND |
| | May | 3.33 | 3.78 | 3.95 | 3.81 | 3.54 | 4.28 | ND |
| | June | 1.58 | 1.36 | 1.72 | 1.20 | 1.21 | 1.45 | ND |
| | July | 0.19 | ND | 1.07 | 0.54 | 0.73 | 0.80 | ND |
| | Aug | ND | 1.37 | 1.05 | ND | 0.87 | 1.21 | ND |
| | Sept | ND | 0.37 | 0.35 | 0.13 | 0.38 | 0.42 | ND |
| | Oct | ND | 4.17 | 4.40 | 3.51 | 4.19 | 4.48 | 4.48 |
| | Nov | ND | 5.59 | 7.05 | 4.29 | 4.36 | 5.86 | 5.86 |
| | Dec | ND | 5.73 | 5.60 | 4.28 | 4.60 | 5.97 | 5.97 |
| | total | 11.66 | 24.37 | 43.41 | 25.60 | 34.07 | 43.83 | 16.31 |
| 1990 | Jan | ND | 9.02 | 9.70 | 7.68 | 8.02 | 9.99 | 9.99 |
| | Feb | 3.83 | 4.66 | 3.15 | 2.89 | 2.91 | 3.88 | 3.88 |
| | Mar | 3.02 | 3.89 | 3.50 | 3.11 | 3.92 | 4.14 | 4.14 |
| | Apr | 3.40 | 3.66 | 2.75 | 2.32 | 3.58 | 3.91 | 3.91 |
| | May | 2.52 | 3.42 | 2.35 | 1.81 | 2.50 | 2.78 | 2.78 |
| | June | 3.34 | 3.78 | 4.10 | 2.82 | 3.13 | 3.97 | 3.73 |
| | July | 0.77 | 0.98 | 1.20 | 0.74 | 0.74 | 1.09 | 0.86 |
| | Aug | 1.06 | 1.66 | 1.75 | 0.87 | 0.72 | 1.35 | 1.29 |
| | Sept | 0.08 | 0.04 | ND | 0.02 | 0.11 | 0.21 | 0.41 |
| | Oct | 7.03 | 8.38 | 7.85 | 5.80 | 6.87 | 8.30 | 8.76 |
| | Nov | 8.04 | 8.05 | 7.95 | 6.29 | 6.91 | 6.06 | 6.83 |
| | Dec | 4.86 | 4.39 | 5.35 | 4.02 | 5.10 | 4.34 | 5.29 |
| | total | 37.95 | 51.93 | 49.65 | 38.37 | 44.51 | 50.02 | 51.87 |
| 1991 | Jan | 3.82 | 4.86 | 5.00 | 3.72 | 3.68 | 5.02 | 4.60 |
| | Feb | 5.98 | 5.08 | 5.15 | 4.38 | 5.51 | 5.26 | 5.86 |
| | Mar | 5.04 | 5.82 | 6.05 | 4.24 | 4.79 | 7.27 | 6.52 |
| | Apr | 5.83 | 6.57 | 6.40 | 5.35 | 5.46 | 6.41 | 5.87 |
| | May | ND | 2.63 | 2.45 | 1.28 | 1.73 | 2.55 | 2.10 |
| | June | ND | 2.79 | 2.75 | 1.58 | 2.16 | 2.78 | 2.54 |
| | July | ND | 0.08 | 0.30 | 0.36 | 0.39 | 0.42 | 0.04 |
| | Aug | ND | ND | 1.80 | 1.41 | 1.62 | 1.75 | 1.83 |
| | Sept | ND | ND | 0.00 | 0.44 | 0.33 | 0.38 | 0.36 |
| | Oct | ND | ND | 1.70 | 1.64 | ND | ND | ND |
| | Nov | ND | ND | 2.38 | ND | ND | ND | ND |
| | Dec | ND | ND | 0.00 | ND | ND | ND | ND |
| | total | 20.67 | 27.83 | 33.98 | 24.40 | 25.67 | 31.84 | 29.72 |

ND - No Data Available

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Table 2.6.9
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**MONTHLY PRECIPITATION DATA (inches)**

## TABLE 2.6.10. SUMMARY OF STREAM DISCHARGE GAUGING DATA

This table was not printed for the draft plan. The information can be found in Appendix G Stream Flow Measurement Data, which is available upon request.

# Table 2.6.11

## Ground Water Monitoring Sites

| Well Identification | Well Name | Use | Monitoring Type |
|---|---|---|---|
| 1 | Doughty, Lee | D | WL/WQ |
| 2 | Woodinville Water | D | WL/WQ |
| 3 | Paradise Park | D | WL/WQ |
| 4 | Bondo, Paul | D | WL/WQ |
| 5 | Odegard, David | D | WL/WQ |
| 6 | Kloepfer, Ryan | D | WL/WQ |
| 7 | Hosey #1 | D | WL/WQ |
| 8 | Morgan, James | D | WL |
| 9 | Rigger Assoc. | D | WL |
| 10 | Tainter, Gordon | D | WL/WQ |
| 11 | Smith, Don | D | WL |
| 12 | Sharp, Grant | D | WL/WQ |
| 13 | Nelson, Gordon | D | WL/WQ |
| 14 | Thenos Dairy | D | WL/WQ |
| 15 | Thompson, Steve | D | WL |
| 16 | Ulrich Meats | D | WL/WQ |
| 17 | Heller, Charles | D | WL |
| 18 | Whyte, Myrna | D | WL |
| 19 | O'Leary, Chris | D | WL |
| 20 | Weide, Mike | D | WL/WQ |
| 21 | Stern, William | D | WL/WQ |
| 22 | Fischer, Leo | D | WL |
| 23 | Lien, William | D | WL/WQ |
| 24 | Larson (Stetler) | D | WL |
| 25 | Tollfeldt, Harvey | D | WL |
| 26 | Bauman, John | D | WL |
| 27 | Webster, Walt | D | WL/WQ |
| 28 | Sorenson | D | WL |
| 29 | Goss, Gordon | D | WL/WQ |
| 30 | Hutchinson, Ron | D | WL |
| 31 | Macklin | D | WL |

## Table 2.6.11

## Ground Water Monitoring Sites (Continued)

| Well Identification | Well Name | Use | Monitoring Type |
|---|---|---|---|
| 32 | McGlothlin, Del | D | WL |
| 33 | Home Port Farm | D | WL/WQ |
| 34 | Patterson, Stan | D | WL/WQ |
| 35 | Bowman, Carl | D | WL/WQ |
| 36 | Loveless (Stensland) | D | WL |
| 37 | Redmond Well #3 | P | WL/WQ |
| 38 | McClan, Robert | D | WL/WQ |
| 39 | Keller Dairy | D | WL |
| 40 | Olympian Precast | I | WL/WQ |
| 41 | King County Shops | I | WL/WQ |
| 42 | Eastside Masonary | I | WL |
| 43 | Barrett, Del | D | WL/WQ |
| 44 | Redmond GWMA Test Well | MW | WL/WQ |
| 45 | Lacher | D | WL |
| 46 | Science Park B-1 | MW | WL |
| 47 | Science Park B-2 | MW | WL |
| 48 | Redmond Well #5 | P | WL/WQ |
| 49 | Redmond Test Well #5 | MW | WL |
| 50 | Redmond Cemetary | I | WL |
| 51 | Cedar Lawns Cem. | I | WL/WQ |
| 52 | Redmond Well #1 | P | WL/WQ |
| 53 | Redmond Well #2 | P | WL/WQ |
| 54 | Redmond Oil Co. #1 | MW | WL |
| 55 | Redmond Oil Co. #2 | MW | WL |
| 56 | Town Center I | I | WL |
| 57 | Washington Voc-Tech | I | WL |
| 58 | Gateway Piezometer #1 | MW | WL |
| 59 | Gateway Piezometer #2/3 | | |
| 60 | Redmoor Corporation | I | WL |
| 61 | Campton Community | D | WQ |

## Table 2.6.11

## Ground Water Monitoring Sites (Continued)

| Well Identification | Well Name | Use | Monitoring Type |
|---|---|---|---|
| 62 | Sportsman Park | I | WL/WQ |
| 63 | Welcome | D | WL |
| 64 | Evans Creek Test Well 1 | MW | WL/WQ |
| 65 | Turpsmith | D | WL |
| 66 | Ingalls, Robert | D | WL |
| 67 | Zimmerman, Margret | D | WL |
| 68 | Ramsey | D | WL |
| 69 | Tutko Landscape | D | WL/WQ |
| 70 | NEL Samm #6 | P | WL |
| 71 | Varney | D | WL |
| 72 | Robretson, Richard | D | WL |
| 73 | Union Hill | P | WL/WQ |
| 74 | Evans Creek Test Well 2 | MW | WL/WQ |
| 75 | NELS Test Well #1 | MW | WL/WQ |
| 76 | NE L. Samm #2 | P | WL/WQ |
| 76 | NE L. Sam #2R | MW | WL |
| 77 | NE L. Sam #4 | P | WL/WQ |
| 78 | NE L. Sam #5 | P | WL |
| 79 | NE L. Sam #3 | P | WQ |
| 80 | Sahalee | I | WL |
| 81 | Marymoor | MW | WL/WQ |
| 82 | Flippen | D | WL |

NOTES:
WL = Water Level Monitoring
WQ = Water Quality Monitoring
D = Domestic Water Supply (includes irrigation use)
P = Public Water Supply
MW = Dedicated Monitoring Well
I = Industrial as Commercial

## Table 2.6.12

### Redmond-Bear Creek Ground Water Management Area
### Ground Water Sampling Locations and Parameters

| Well Identification | | Analyses Performed | |
|---|---|---|---|
| Well Number | Well Owner's Name | December 1989 Sampling | May 1990 Sampling |
| 1 | Doughty, Lee | PDW, SDW, GWC, TOX | PDW, SDW, GWC, Others |
| 3 | Paradise Park | PDW, SDW, GWC, TOX | PDW, SDW, GWC |
| 4 | Bondo, Paul | PDW, SDW, GWC, TOX | PDW, SDW, GWC, Others |
| 5 | Odegard, David | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 6 | Kloepfer, Ryan | PDW, SDW, GWC, TOX | PDW, SDW, GWC, Others |
| 7 | Hosey #1 | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 10 | Tainter, Gordon | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 12 | Sharp, Grant | PDW, SDW, GWC, TOX | PDW, SDW, GWC, Others |
| 13 | Nelson, Gordon | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 14 | Thenos Dairy | PDW, SDW, GWC, TOX | PDW, SDW, GWC, Others |
| 16 | Ulrich Meats | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 20 | Weide, Mike | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 21 | Stern, William | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 23 | Lein, William | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 27 | Webster, Walt | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 29 | Goss, Gordon | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 33 | Home Port Farm | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 34 | Patterson, Stan | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 35 | Bowman, Carl | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 38 | McClan, Robert | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 40 | Olympian Precast | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX, Others |
| 41 | King County Shops | PDW, SDW, GWC, TOX | PDW, SDW, GWC, Others |
| 43 | Barrett, Del | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 48 | Redmond Well #5 | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 51 | Cedar Lawns | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 53 | Redmond Well #2 | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX, Others |
| 61 | Campton Community | PDW, SDW, GWC, TOX | PDW, SDW, GWC, Others |
| 62 | Sportsman Park | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |

## Table 2.6.12

## Redmond-Bear Creek Ground Water Management Area (Continued)

| Well Identification | | Analyses Performed | |
|---|---|---|---|
| Well Number | Well Owner's Name | December 1989 Sampling | May 1990 Sampling |
| 64 | Evans Creek Well #1 | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 69 | Tutko Landscape | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 73 | Union Hill | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 74 | Evans Creek Well #2 | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 76 | NE Sammamish #2 | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 77 | NE Sammamish #4 | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |
| 79 | NE Sammamish # | PDW, SDW, GWC, TOX | PDW, SDW, GWC, TOX |

NOTES: PDW: Primary Drinking Water Analytes (see Section 5.2.1)
SDW: Secondary drinking water analytes (see Section 5.2.2)
GWC: Ground water characteristic constituents (see Section 5.2.3)
TOX: Total organic halogen (see Section 5.2.4)
Others: Cyanide, phenol, volatile and semivolatile organic compounds, chlorinated pesticides, PCVs, antimony, beryllium, nickel, and thallium (see Section 5.2.4)

## Table 2.6.13

### Normal Abundance of Inorganic Dissolved Solids in Ground Water

| Category | Normal Concentration Range[a] | Analytes Examined for this Study |
|---|---|---|
| Major constituents | 1.0 to 1000 mg/L | Bicarbonate, calcium, chloride, magnesium, silica, sodium, sulfate |
| Secondary constituents | 0.01 to 10.0 mg/L | Carbonate, iron, fluoride, nitrate, potassium |
| Minor constituents | 0.0001 to 0.1 mg/L | Antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, nickel, phosphate, selenium, zinc |
| Trace constituents | <0.001 mg/L | Beryllium, silver, thallium |

[a] Modified from Davis and DeWiest, 1966.

# Table 2.6.14
## Redmond-Bear Creek GWMP
### Summary of Ground Water Quality Testing Results

| Well ID (map) | Sample Number | Well Name | Sampling Date | Total Coliforms (MPN/100ml) | Fecal Coliforms (MPN/100ml) | TDS (mg/l) | Total Hardness (mg/l as CaCO3) | Total Alkalinity (mg/l as CaCO3) | Carbonate Alkalinity (mg/l as CaCO3) | Bicarbonate Alkalinity (mg/l as CaCO3) | Hydroxide Alkalinity (mg/l as CaCO3) | TOX (ug/l) | Calcium (mg/l) | Iron (mg/l) | Manganese (mg/l) | Magnesium (mg/l) | Potassium (mg/l) | Sodium (mg/l) | Silica (mg/l) | Zinc (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | D-30 | KING C. SHOPS DUPL | 05/14/90 | 1 L | 1 L | 166 | 87 | 74 | 1 L | 74 | 1 L | | 19 | 0.05 | 0.002 L | 9.5 | 1.7 | 8.3 | 28 | 0.1 |
| 6 | R-7 | KLOEPFER, RYAN | 05/14/90 | 1 L | 1 L | 104 | 48 | 48 | 1 L | 48 | 1 L | | 7.5 | 0.25 | 0.003 | 7.2 | 0.69 | 5.2 | 30 | 0.27 |
| 61 | R-16 | CAMPTON COMMUNITY | 05/14/90 | 1 L | 1 L | 178 | 94 | 72 | 1 L | 72 | 1 L | | 21 | 0.01 L | 0.005 | 10 | 1.4 | 8.8 | 28 | 0.02 L |
| 51 | R-17 | CEDAR LAWNS | 05/14/90 | 1 L | 1 L | 136 | 71 | 52 | 1 L | 52 | 1 L | | 18 | 0.74 | 0.005 | 7.5 | 0.17 | 9.9 | 23 | 0.2 |
| 41 | R-30 | KING C. SHOPS | 05/14/90 | 1 L | 1 L | 158 | 90 | 74 | 1 L | 74 | 1 L | | 20 | 0.03 | 0.002 L | 9.7 | 1.7 | 8.8 | 30 | 0.1 |
| | 5-11 | TRIP BLANKS | 05/14/90 | 1 L | 1 L | 6 | 1 L | 2 | 1 L | 2 | 1 L | | 0.01 L | 0.01 L | 0.002 L | 0.01 L | 1 L | 0.02 L | 11 | 0.02 L |
| 29 | R-5 | GOSS, GORDON | 05/14/90 | 1 L | 1 L | 264 | 31 | 131 | 1 L | 131 | 1 L | 5 L | 8.4 | 0.03 | 0.015 | 2.5 | 2.2 | 44 | 23 | 0.03 |
| 13 | R-9 | NELSON, GORDON | 05/14/90 | 1 L | 1 L | 134 | 73 | 70 | 1 L | 70 | 1 L | 5 L | 11 | 0.03 | 0.002 L | 11 | 1.9 | 6.5 | 34 | 0.02 |
| 10 | R-11 | TAINTER, GORDON | 05/14/90 | 1 L | 1 L | 82 | 39 | 50 | 1 L | 50 | 1 L | 5 L | 8.2 | 0.72 | 0.061 | 4.5 | 0.51 | 5.2 | 26 | 0.22 |
| 20 | R-13 | WEIDE, MIKE | 05/14/90 | 1 L | 1 L | 110 | 55 | 53 | 1 L | 53 | 1 L | 5 L | 9 | 9.1 | 0.03 | 7.9 | 1.5 | 5 | 30 | 0.21 |
| 16 | R-24 | ULRICH MEATS | 05/14/90 | 2 | 1 L | 448 | 68 | 293 | 1 L | 293 | 1 L | 5 L | 12 | 11 | 0.21 | 9.3 | 8.8 | 110 | 51 | 0.12 |
| 3 | D-4 | PARADISE PARK DUPL | 05/15/90 | 1 L | 1 L | 114 | 55 | 62 | 1 L | 62 | 1 L | | 13 | 0.1 | 0.161 | 5.5 | 1.3 | 6.9 | 30 | 0.02 L |
| 1 | R-3 | DOUGHTY, LEE | 05/15/90 | 7 | 1 L | 110 | 57 | 60 | 1 L | 60 | 1 L | | 8.9 | 0.01 | 0.002 L | 8.4 | 1 | 5.8 | 23 | 0.01 |
| 3 | R-4 | PARADISE PARK | 05/15/90 | 1 L | 1 L | 114 | 54 | 60 | 1 L | 60 | 1 L | | 13 | 0.11 | 0.151 | 5.2 | 1.2 | 6.8 | 30 | 0.45 |
| 4 | R-1 | BONDO, PAUL | 05/15/90 | 1 L | 1 L | 86 | 41 | 42 | 1 L | 42 | 1 L | | 7.7 | 0.02 | 0.002 L | 5.3 | 0.67 | 5.3 | 23 | 0.12 |
| 12 | R-21 | SHARP, GRANT | 05/15/90 | 8 | 1 L | 220 | 124 | 122 | 1 L | 122 | 1 L | | 20 | 0.49 | 0.023 | 18 | 1.5 | 9.2 | 28 | 0.37 |
| 7 | R-06 | HOSEY #1 | 05/15/90 | 1 L | 1 L | 120 | 55 | 44 | 1 L | 44 | 1 L | 5 L | 9.2 | 0.19 | 0.03 | 7.8 | 0.92 | 5 | 23 | 0.15 |
| 5 | R-10 | ODEGARD, DAVID | 05/15/90 | 5 | 1 L | 92 | 39 | 40 | 1 L | 40 | 1 L | 5 L | 10 | 0.06 | 0.02 | 3.3 | 0.63 | 5.8 | 23 | 0.03 |
| 27 | R-14 | WEBSTER, WALT | 05/15/90 | 1 L | 1 L | 196 | 51 | 130 | 1 L | 130 | 1 L | 5 L | 13 | 0.31 | 0.07 | 4.4 | 4.2 | 34 | 30 | 0.03 |
| 34 | R-20 | PATTERSON, STAN | 05/15/90 | 1 L | 1 L | 142 | 54 | 84 | 1 L | 84 | 1 L | 5 L | 14 | 0.16 | 0.043 | 4.7 | 2.7 | 13 | 26 | 0.05 |
| 21 | R-23 | STERN, WILLIAM | 05/15/90 | 1 L | 1 L | 132 | 58 | 62 | 1 L | 62 | 1 L | 5 L | 12 | 0.04 | 0.114 | 6.9 | 2 | 5 | 28 | 0.01 |
| 77 | D-27 | NE SAMMAMISH #4 DUPL | 05/16/90 | 1 L | 1 L | 110 | 63 | 66 | 1 L | 66 | 1 L | 5 L | 19 | 0.03 | 0.049 | 3.6 | 0.72 | 6.1 | 26 | 0.02 L |
| 23 | R-6 | LEIN, WILLIAM | 05/16/90 | 1 L | 1 L | 180 | 33 | 31 | 1 L | 31 | 1 L | 5 L | 8.7 | 0.1 | 0.047 | 3.9 | 5.4 | 28 | 32 | 0.02 L |
| 35 | R-15 | BOWMAN, CARL | 05/16/90 | 1 L | 1 L | 140 | 61 | 74 | 1 L | 74 | 1 L | 5 L | 15 | 7.1 | 0.065 | 5.7 | 2.4 | 7.6 | 32 | 0.66 |
| 33 | R-18 | HOME PORT FARM | 05/16/90 | 1 L | 1 L | 194 | 72 | 110 | 1 L | 110 | 1 L | 5 L | 18 | 0.11 | 0.057 | 6.5 | 4 | 17 | 30 | 0.02 |
| 62 | R-22 | SPORTSMAN PARK | 05/16/90 | 6 | 1 L | 250 | 92 | 76 | 1 L | 76 | 1 L | 5 L | 17 | 1.2 | 0.066 | 12 | 2.4 | 7.7 | 20 | 0.06 |
| 76 | R-25 | NE SAMMAMISH #2 | 05/16/90 | 1 L | 1 L | 110 | 51 | 56 | 1 L | 56 | 1 L | 5 L | 11 | 1.3 | 0.045 | 5.8 | 0.72 | 5.7 | 26 | 0.04 |
| 79 | R-26 | NE SAMMAMISH #3 | 05/16/90 | 1 L | 1 L | 120 | 63 | 84 | 1 L | 84 | 1 L | 5 L | 20 | 0.03 | 0.041 | 3.1 | 0.64 | 7.7 | 21 | 0.02 L |
| 77 | R-27 | NE SAMMAMISH #4 | 05/16/90 | 1 L | 1 L | 102 | 59 | 70 | 1 L | 70 | 1 L | 5 L | 18 | 0.01 L | 0.042 | 3.5 | 0.61 | 5.5 | 23 | 0.02 L |
| 48 | R-35 | REDMOND WELL #5 | 05/16/90 | 2 | 1 L | 160 | 69 | 70 | 1 L | 70 | 1 L | 5 L | 20 | 0.01 L | 0.012 | 9.5 | 2.4 | 12 | 28 | 0.02 L |
| 53 | R-37 | REDMOND WELL #2 | 05/16/90 | 1 L | 1 L | 196 | 63 | 88 | 1 L | 88 | 1 L | 5 L | 15 | 0.01 L | 0.025 | 11 | 1.8 | 9.5 | 28 | 0.02 |
| 40 | D-32 | OLYMPIAN PRECAST | 05/17/90 | 1 L | 1 L | 138 | 46 | 98 | 1 L | 98 | 1 L | 5 L | 13 | 0.05 | 0.089 | 3.4 | 2.8 | 28 | 34 | 0.06 |
| 43 | R-28 | BARRET, DEL | 05/17/90 | 1 L | 1 L | 122 | 54 | 62 | 1 L | 62 | 1 L | 5 L | 12 | 0.17 | 0.111 | 5.8 | 1.3 | 9.6 | 30 | 0.03 |
| 38 | R-31 | McCLAN, ROBERT | 05/17/90 | 1 L | 1 L | 108 | 48 | 56 | 1 L | 56 | 1 L | 5 L | 9.7 | 0.04 | 0.086 | 5.8 | 1.6 | 3.5 | 41 | 0.02 |
| 69 | D-33 | TUTKO LANDSCAPE | 05/17/90 | 1 L | 1 L | 260 | 100 | 100 | 1 L | 100 | 1 L | 5 L | 21 | 0.15 | 0.057 | 12 | 1.1 | 13 | 30 | 0.02 L |
| 73 | R-34 | UNION HILL | 05/17/90 | 1 L | 1 L | 85 | 46 | 60 | 1 L | 60 | 1 L | 5 L | 10 | 0.11 | 0.095 | 5.6 | 1.1 | 6.2 | 32 | 0.02 |
| 74 | D-50 | EVANS CREEK WELL #2 | 05/17/90 | 17 | 1 L | 92 | 65 | 52 | 1 L | 52 | 1 L | 5 L | 11 | 29 | 0.374 | 9.2 | 2 | 5.9 | 56 | 0.06 |
| 64 | R-51 | EVANS CREEK WELL #1 | 05/17/90 | 110 | 1 L | 220 | 2300 | 170 | 1 L | 170 | 1 L | 23 | 260 | 1000 | 13 | 400 | 135 | 100 | 300 | 3.2 |
| 14 | R-12 | THENOS DAIRY | 05/17/90 | 1 L | 1 L | 590 | 47 | 300 | 1 L | 300 | 1 L | | 7.6 | 0.46 | 0.06 | 6.7 | 12 | 130 | 47 | 0.03 |
| 40 | R-32 | OLYMPIAN PRECAST | 05/17/90 | 1 L | 1 L | 160 | 50 | 100 | 1 L | 100 | 1 L | | 14 | 0.11 | 0.064 | 3.6 | 2.3 | 28 | 36 | 0.02 |
| 43 | R-28 | BARRETT, DEL | 12/06/89 | 1 L | 1 L | 186 | 59 | 66 | 1 L | 66 | 1 L | 5 L | 13 | 0.71 | 0.078 | 6.4 | 2.6 | 9.3 | 24 | 0.054 |
| 4 | R-1 | BONDO, PAUL | 12/06/89 | 1 L | 1 L | 120 | 42 | 39 | 1 L | 39 | 1 L | 5 L | 7.6 | 0.01 L | 0.002 L | 5.5 | 1.3 | 4.6 | 24 | 0.12 |
| 29 | RD-5 | GOSS, GORDON DUPL | 12/06/89 | 1 L | 1 L | 74 | 42 | 40 | 1 L | 40 | 1 L | 15 | 7.7 | 0.04 | 0.002 L | 5.6 | 1.2 | 4.7 | 24 | 0.121 |
| 38 | RD-73 | McCLAN, ROBERT DUPL | 12/06/89 | 1 L | 1 L | 178 | 48 | 52 | 1 L | 52 | 1 L | 5 L | 9.5 | 0.29 | 0.049 | 5.8 | 2.3 | 4.6 | 32 | 0.374 |

# Table 2.6.14
## Redmond-Bear Creek GWMP
### Summary of Ground Water Quality Testing Results

| Well ID (map) | Sample Number | Well Name | Sampling Date | Total Coliforms (MPN/100ml) | Fecal Coliforms (MPN/100ml) | TDS (mg/l) | Total Hardness (mg/l as CaCO3) | Total Alkalinity (mg/l as CaCO3) | Carbonate Alkalinity (mg/l as CaCO3) | Bicarbonate Alkalinity (mg/l as CaCO3) | Hydroxide Alkalinity (mg/l as CaCO3) | TOX (ug/l) | Calcium (mg/l) | Iron (mg/l) | Manganese (mg/l) | Magnesium (mg/l) | Potassium (mg/l) | Sodium (mg/l) | Silica (mg/l) | Zinc (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 69 | R-33 | TUTKO LANDSCAPE | 12/06/89 | 1 L | 1 L | 160 | 93 | 88 | 1 L | 88 | 1 L | 5 L | 19 | 0.32 | 0.012 | 11 | 1.9 | 9.6 | 28 | 0.032 |
| 73 | R-34 | UNION HILL | 12/06/89 | 1 L | 1 L | 148 | 48 | 56 | 1 L | 56 | 1 L | 5 L | 10 | 0.15 | 0.077 | 5.6 | 1.6 | 5.1 | 24 | 0.021 |
| 51 | RD-17 | CEDAR LAWNS DUPL | 12/05/89 | 1 L | 1 L | 66 | 84 | 56 | 1 L | 56 | 1 L | 11 | 19 | 2 | 0.068 | 6.8 | 1.5 | 10 | 21 | 0.139 |
| 33 | R-18 | HOME PORT FARM | 12/05/89 | 1 L | 1 L | 78 | 73 | 107 | 1 L | 107 | 1 L | 5 L | 18 | 0.16 | 0.065 | 6.8 | 4.1 | 17 | 28 | 0.014 |
| 23 | R-8 | LEIN, WILLIAM | 12/05/89 | 1 L | 1 L | 144 | 33 | 103 | 1 L | 103 | 1 L | 5 L | 6.7 | 0.1 | 0.025 | 3.9 | 5.6 | 28 | 30 | 0.018 |
| 79 | RD-67 | NE SAMMAMISH #3 DUPL | 12/05/89 | 1 L | 1 L | 100 | 66 | 83 | 1 L | 83 | 1 L | 5 L | 21 | 0.01 L | 0.021 | 3.3 | 1.2 | 8 | 18 | 0.014 |
| 78 | R-25 | NE SAMMAMISH #2 | 12/05/89 | 1 L | 1 L | 80 | 48 | 56 | 1 L | 56 | 1 L | 5 L | 9.8 | 0.14 | 0.003 | 5.6 | 1.7 | 4.6 | 21 | 0.018 |
| 62 | R-22 | SPORTSMAN PARK | 12/05/89 | 19 | 1 L | 96 | 98 | 78 | 1 L | 78 | 1 L | 5 L | 18 | 1.4 | 0.065 | 13 | 2.9 | 7.3 | 14 | 0.055 |
| 29 | R-5 | GOSS, GORDON | 12/04/89 | 11 | 1 L | 202 | 32 | 131 | 1 L | 131 | 1 L | 5 L | 8.6 | 0.01 L | 0.019 | 2.5 | 2.9 | 48 | 17 | 0.008 |
| 10 | R-11 | TAINTER, GORDON | 12/04/89 | 1 | 1 L | 114 | 42 | 49 | 1 L | 49 | 1 L | 5 L | 8.7 | 0.18 | 0.062 | 4.9 | 1.1 | 5.3 | 21 | 0.14 |
| 13 | R-9 | NELSON, GORDON | 12/04/89 | 1 L | 1 L | 158 | 70 | 60 | 1 L | 60 | 1 L | 5 L | 10 | 0.04 | 0.002 L | 11 | 2.2 | 6.2 | 30 | 0.108 |
| 13 | RD-9 | NELSON, GORDON DUPL | 12/04/89 | 1 L | 1 L | 166 | 70 | 60 | 1 L | 60 | 1 L | 5 L | 10 | 0.01 L | 0.002 L | 11 | 2.3 | 6.2 | 15 | 0.14 |
| 12 | R-21 | SHARPE, GRANT | 12/04/89 | 118 | 1 L | 192 | 128 | 114 | 1 L | 114 | 1 L | 14 | 20 | 2.1 | 0.055 | 19 | 2.8 | 8.1 | 15 | 0.248 |
| 14 | R-12 | THENOS DAIRY | 12/04/89 | 1 L | 1 L | 346 | 42 | 268 | 1 L | 268 | 1 L | 7 | 6.8 | 0.28 | 0.044 | 6 | 12 | 110 | 19 | 0.018 |
| 7 | R-6 | HOSEY #1 | 12/04/89 | 1 L | 1 L | 91 | 58 | 52 | 1 L | 52 | 1 L | 5 L | 9.5 | 0.84 | 0.017 | 6.3 | 1 L | 5 | 23 | 0.215 |
| 6 | R-7 | KLOEPFER, RYAN | 12/04/89 | 1 L | 1 L | 105 | 52 | 56 | 1 L | 56 | 1 L | 13 | 6 | 0.47 | 0.002 L | 7.8 | 1.2 | 5.2 | 28 | 0.318 |
| 5 | R-10 | ODEGARD, DAVID | 12/04/89 | 21 | 1 L | 80 | 32 | 36 | 1 L | 36 | 1 L | 5 L | 7.6 | 0.17 | 0.002 L | 3.1 | 1 L | 4.5 | 23 | 0.067 |
| 27 | R-14 | WEBSTER, WALT | 12/04/89 | 1 L | 1 L | 141 | 51 | 128 | 1 L | 128 | 1 L | 5 L | 13 | 0.14 | 0.056 | 4.5 | 4.4 | 34 | 32 | 0.013 |
| 53 | R-37 | REDMOND WELL #2 | 12/04/89 | 1 L | 1 L | 129 | 69 | 64 | 1 L | 64 | 1 L | 5 L | 16 | 0.01 L | 0.003 | 12 | 2.1 | 9.3 | 28 | 0.022 |
| 48 | R-35 | REDMOND WELL #5 | 12/04/89 | 1 | 1 L | 114 | 66 | 66 | 1 L | 66 | 1 L | 6 | 19 | 0.01 L | 0.002 L | 9.3 | 2.3 | 13 | 23 | 0.02 |
| 36 | R-15 | BOWMAN, CARL | 12/04/89 | 1 L | 1 L | 69 | 62 | 74 | 1 L | 74 | 1 L | 5 L | 15 | 0.31 | 0.036 | 6 | 2.3 | 7.6 | 28 | 0.066 |
| 77 | R-27 | NE SAMMAMISH #4 | 12/05/89 | 1 L | 1 L | 90 | 63 | 65 | 1 L | 65 | 1 L | 5 L | 19 | 0.01 L | 0.025 | 3.7 | 1 L | 5.4 | 19 | 0.01 |
| 79 | R-26 | NE SAMMAMISH #3 | 12/05/89 | 1 L | 1 L | 86 | 66 | 82 | 1 L | 82 | 1 L | 5 L | 21 | 0.01 L | 0.02 | 3.4 | 1.2 | 6 | 16 | 0.011 |
| 61 | R-16 | CAMPTON COMMUNITY | 12/05/89 | 1 L | 1 L | 168 | 100 | 71 | 1 L | 71 | 1 L | 15 | 22 | 0.01 L | 0.004 | 11 | 2.2 | 9.1 | 22 | 0.015 |
| 51 | R-17 | CEDAR LAWNS | 12/05/89 | 1 L | 1 L | 120 | 84 | 56 | 1 L | 56 | 1 L | 5 L | 19 | 2 | 0.069 | 6.8 | 1.9 | 10 | 21 | 0.145 |
| 34 | R-20 | PATTERSON, STAN | 12/05/89 | 1 L | 1 L | 96 | 55 | 82 | 1 L | 82 | 1 L | 5 L | 14 | 0.19 | 0.032 | 4.9 | 2.9 | 13 | 28 | 0.027 |
| 21 | R-23 | STERN, WILLIAM | 12/05/89 | 1 L | 1 L | 66 | 59 | 61 | 1 L | 61 | 1 L | 5 L | 12 | 0.11 | 0.105 | 7.1 | 2.5 | 4.6 | 30 | 0.059 |
| 16 | R-24 | ULRICH MEATS | 12/05/89 | 1 L | 1 L | 185 | 32 | 285 | 1 L | 285 | 1 L | 5 L | 4.7 | 0.27 | 0.037 | 4.6 | 9.4 | 110 | 39 | 0.019 |
| 20 | R-13 | WEIDE, MIKE | 12/06/89 | 1 L | 1 L | 92 | 55 | 52 | 1 L | 52 | 1 L | 5 L | 6.7 | 0.66 | 0.036 | 6.1 | 2.7 | 4.9 | 24 | 0.018 |
| 40 | R-32 | OLYMPIAN PRECAST | 12/06/89 | 1 L | 1 L | 210 | 47 | 100 | 1 L | 100 | 1 L | 5 L | 13 | 0.01 L | 0.055 | 3.6 | 3.4 | 23 | 28 | 0.017 |
| 41 | R-30 | KING C. SHOPS | 12/06/89 | 1 L | 1 L | 198 | 63 | 72 | 1 L | 72 | 1 L | 20 | 14 | 0.01 L | 0.002 L | 6.8 | 2.7 | 9 | 22 | 0.052 |
| 38 | R-31 | McCLAN, ROBERT | 12/06/89 | 1 L | 1 L | 136 | 47 | 60 | 1 L | 60 | 1 L | 5 L | 9.3 | 0.14 | 0.047 | 5.7 | 2.6 | 4.6 | 32 | 0.304 |
| 1 | R-3 | DOUGHTY, LEE | 12/07/89 | 1 L | 1 L | 92 | 61 | 56 | 1 L | 56 | 1 L | 5 L | 9.5 | 0.01 L | 0.002 L | 9.1 | 1.6 | 5.4 | 28 | 0.0004 ??? |
| 3 | R-4 | PARADISE PARK | 12/12/89 | 1 L | 1 L | 130 | 55 | 60 | 1 L | 60 | 1 L | 5 L | 13 | 0.31 | 0.167 | 5.5 | 2.1 | 10 | 34 | 0.04 |

# Table 2.6.14
## Redmond-Bear Creek GWMP
### Summary of Ground Water Quality Testing Results

| Well ID (MAP) | Sample Number | Well Name | Sampling Date | Silver (mg/l) | Selenium (mg/l) | Mercury (mg/l) | Barium (mg/l) | Copper (mg/l) | Cadmium (mg/l) | Lead (mg/l) | Chromium (mg/l) | Arsenic (mg/l) | Chloride (mg/l) | Nitrite (mg/l) | Sulfate (mg/l) | Nitrate (mg/l) | Fluoride (mg/l) | Antimony (mg/l) | Beryllium (mg/l) | Nickel (mg/l) | Thallium (mg/l) | Cyanide (mg/l) | Phenol (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | D-30 | KING C. SHOPS DUPL | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.007 | 0.062 | 0.002 L | 0.001 | 0.006 L | 0.002 | 8.1 | 0.5 L | 24 | 3.1 | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 6 | R-7 | KLOEPFER, RYAN | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.003 | 0.002 L | 0.005 | 0.006 L | 0.002 | 3.7 | 0.5 L | 8.4 | 0.85 | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 61 | R-16 | CAMPTON COMMUNITY | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.009 | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.001 | 9.5 | 0.5 L | 42 | 0.2 L | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 51 | R-17 | CEDAR LAWNS | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.009 | 0.017 | 0.002 L | 0.006 | 0.006 L | 0.001 | 7.6 | 0.5 L | 30 | 0.2 L | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 41 | R-30 | KING C. SHOPS | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.006 | 0.061 | 0.002 L | 0.001 | 0.006 L | 0.003 | 5.9 | 0.5 L | 24 | 3.1 | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| | S-11 | TRIP BLANKS | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.001 | 0.5 L | 0.5 L | 0.5 L | 0.2 L | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 29 | R-5 | GOSS, GORDON | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.005 | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.025 | 2 | 0.5 L | 0.5 L | 0.2 L | 0.2 L | | | | | | |
| 13 | R-9 | NELSON, GORDON | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.004 | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.004 | 4.4 | 0.5 L | 9.6 | 3.6 | 0.2 L | | | | | | |
| 10 | R-11 | TAINTER, GORDON | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.004 | 0.003 | 0.002 L | 0.006 | 0.006 L | 0.006 | 2.1 | 0.5 L | 1.6 | 0.2 L | 0.2 L | | | | | | |
| 20 | R-13 | WEIDE, MIKE | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.02 | 0.002 L | 0.002 L | 0.006 | 0.006 L | 0.027 | 2.5 | 0.5 L | 14 | 0.2 L | 0.2 L | | | | | | |
| 16 | R-24 | ULRICH MEATS | 05/14/90 | 0.01 L | 0.001 L | 0.0002 L | 0.043 | 0.126 | 0.002 L | 0.01 | 0.014 | 0.004 | 2.8 | 0.5 L | 0.5 L | 0.2 L | 0.2 L | | | | | | |
| 3 | D-4 | PARADISE PARK DUPL | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.016 | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.001 | 3.6 | 0.5 L | 4.6 | 0.2 L | 0.2 L | | | | | | |
| 1 | R-3 | DOUGHTY, LEE | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.004 | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.002 | 3.8 | 0.5 L | 5.1 | 1.3 | 0.2 L | | | | | | |
| 3 | R-4 | PARADISE PARK | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.016 | 0.002 L | 0.002 L | 0.015 | 0.006 L | 0.001 | 3.7 | 0.5 L | 4.4 | 0.2 L | 0.2 L | | | | | | |
| 4 | R-1 | BONDO, PAUL | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.006 | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.005 | 10 | 0.5 L | 75 | 1.3 | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 12 | R-21 | SHARP, GRANT | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.015 | 0.004 | 0.002 L | 0.13 | 0.014 | 0.007 | 7.9 | 0.5 L | 8.1 | 3.6 | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 7 | R-06 | HOSEY #1 | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.006 | 0.002 L | 0.009 | 0.006 L | 0.002 | 2.9 | 0.5 L | 8.3 | 1.8 | 0.2 L | | | | | | |
| 5 | R-10 | ODEGARD, DAVID | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.005 | 0.002 L | 0.002 | 0.006 L | 0.001 L | 2.9 | 0.5 L | 3.5 | 2.6 | 0.2 L | | | | | | |
| 27 | R-14 | WEBSTER, WALT | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.01 | 0.002 L | 0.002 | 0.006 L | 0.004 | 1.6 | 0.5 L | 0.5 L | 0.2 L | 0.2 L | | | | | | |
| 34 | R-20 | PATTERSON, STAN | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.001 L | 1.9 | 0.5 L | 2.9 | 0.2 L | 0.2 L | | | | | | |
| 21 | R-23 | STERN, WILLIAM | 05/15/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.001 | 2.2 | 0.5 L | 9 | 0.2 L | 0.2 L | | | | | | |
| 77 | D-27 | NE SAMMAMISH #4 DUPL | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.002 | 0.006 L | 0.009 | 2 | 0.5 L | 2.2 | 0.2 L | 0.2 L | | | | | | |
| 23 | R-8 | LEIN, WILLIAM | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.002 | 0.006 L | 0.001 L | 1.3 | 0.5 L | 0.5 L | 0.2 L | 0.2 L | | | | | | |
| 35 | R-15 | BOWMAN, CARL | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.003 | 0.002 L | 0.016 | 0.006 L | 0.001 | 2 | 0.6 L | 4 | 0.2 L | 0.2 L | | | | | | |
| 33 | R-18 | HOME PORT FARM | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.023 | 2.8 | 0.5 L | 2.4 | 0.2 L | 0.2 L | | | | | | |
| 62 | R-22 | SPORTSMAN PARK | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.003 | 0.002 L | 0.001 | 0.006 L | 0.003 | 10 | 0.5 L | 23 | 0.2 L | 0.2 L | | | | | | |
| 78 | R-25 | NE SAMMAMISH #2 | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.059 | 0.006 | 0.002 L | 0.017 | 0.006 L | 0.003 | 2.5 | 0.5 L | 2.3 | 0.2 | 0.2 L | | | | | | |
| 79 | R-26 | NE SAMMAMISH #3 | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.003 | 0.002 L | 0.001 | 0.006 L | 0.01 | 2 | 0.5 L | 0.6 | 0.2 L | 0.2 L | | | | | | |
| 77 | R-27 | NE SAMMAMISH #4 | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.002 | 0.006 L | 0.009 | 2 | 0.5 L | 2.2 | 0.2 L | 0.2 L | | | | | | |
| 48 | R-35 | REDMOND WELL #5 | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.005 | 0.002 L | 0.001 | 0.006 L | 0.002 | 1.7 | 0.5 L | 1.4 | 0.4 | 0.2 L | | | | | | |
| 53 | R-37 | REDMOND WELL #2 | 05/16/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.017 | 0.002 L | 0.003 | 0.006 L | 0.001 | 10 | 0.5 L | 9 | 2 | 0.2 L | | | | | | |
| 40 | D-32 | OLYMPIAN PRECAST | 05/17/90 | 0.01 L | 0.001 | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.003 | 0.006 L | 0.005 | 1.8 | 0.5 L | 1.6 | 0.2 L | 0.2 L | | | | | | |
| 43 | R-28 | BARRET, DEL | 05/17/90 | 0.01 L | 0.001 | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.006 | 0.006 L | 0.001 | 3.9 | 0.5 L | 6.5 | 0.31 | 0.2 L | | | | | | |
| 38 | R-31 | McCLAN, ROBERT | 05/17/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.003 | 0.006 L | 0.012 | 1.3 | 0.5 L | 4.8 | 0.2 L | 0.2 L | | | | | | |
| 69 | D-33 | TUTKO LANDSCAPE | 05/17/90 | 0.01 L | 0.001 L | 0.0002 | 0.003 L | 0.004 | 0.002 L | 0.001 | 0.006 L | 0.001 | 15 | 0.5 L | 22 | 0.59 | 0.2 L | | | | | | |
| 73 | R-34 | UNION HILL | 05/17/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.005 | 1.7 | 0.5 L | 7.3 | 0.2 L | 0.2 L | | | | | | |
| 74 | D-50 | EVANS CREEK WELL #2 | 05/17/90 | 0.01 L | 0.001 L | 0.0002 L | 0.1 | 0.055 | 0.002 L | 0.026 | 0.022 | 0.018 | 2.1 | 0.5 L | 7.7 | 0.2 L | 0.2 L | | | | | | |
| 64 | R-51 | EVANS CREEK WELL #1 | 05/17/90 | 0.01 L | 0.008 | 0.0028 | 5.4 | 1.5 | 0.002 L | 0.31 | 1.3 | 0.43 | 10 | 0.5 L | 40 | 0.2 L | 0.2 L | | | | | | |
| 14 | R-12 | THENOS DAIRY | 05/17/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.009 | 0.002 L | 0.001 L | 0.006 L | 0.003 | 8.3 | 0.5 L | 6.6 | 0.2 L | 0.2 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 40 | R-32 | OLYMPIAN PRECAST | 05/17/90 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.001 | 0.006 L | 0.005 | 2.7 | 0.1 L | 1.6 | 0.1 L | 0.1 L | 0.02 L | 0.005 L | 0.01 L | 0.001 L | 0.005 L | 0.005 L |
| 43 | R-28 | BARRETT, DEL | 12/06/89 | 0.01 | 0.001 L | 0.0002 L | 0.012 | 0.002 L | 0.002 L | 0.005 | 0.013 | 0.001 | 8.56 | 0.1 L | 5.7 | 0.369 | 0.1 L | | | | | | |
| 4 | R-1 | BONDO, PAUL | 12/06/89 | 0.01 L | 0.001 L | 0.0002 L | 0.006 | 0.002 L | 0.002 L | 0.001 | 0.015 | 0.003 | 3.21 | 0.1 L | 7.76 | 0.77 | 0.1 L | | | | | | |
| 29 | RD-5 | GOSS, GORDON DUPL | 12/06/89 | 0.01 L | 0.001 L | 0.0002 L | 0.006 | 0.002 L | 0.002 L | 0.001 | 0.014 | 0.003 | 7.29 | 0.1 L | 7.46 | 0.77 | 0.1 L | | | | | | |
| 38 | RD-73 | McCLAN, ROBERT DUPL | 12/06/89 | 0.01 L | 0.001 L | 0.0002 L | 0.006 | 0.002 L | 0.002 L | 0.002 | 0.011 | 0.009 | 2.4 | 0.1 L | 3.9 | 0.1 L | 0.1 L | | | | | | |

# Table 2.6.14
## Redmond-Bear Creek GWMP
### Summary of Ground Water Quality Testing Results

| Well ID (MAP) | Sample Number | Well Name | Sampling Date | Silver (mg/l) | Selenium (mg/l) | Mercury (mg/l) | Barium (mg/l) | Copper (mg/l) | Cadmium (mg/l) | Lead (mg/l) | Chromium (mg/l) | Arsenic (mg/l) | Chloride (mg/l) | Nitrite (mg/l) | Sulfate (mg/l) | Nitrate (mg/l) | Fluoride (mg/l) | Antimony (mg/l) | Beryllium (mg/l) | Nickel (mg/l) | Thallium (mg/l) | Cyanide (mg/l) | Phenol (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 69 | R-33 | TUTKO LANDSCAPE | 12/06/89 | 0.01 L | 0.001 L | 0.0002 L | 0.008 | 0.014 | 0.002 L | 0.002 | 0.015 | 0.001 L | 18 | 0.1 L | 9.9 | 3.5 | 0.1 L | | | | | | |
| 73 | R-34 | UNION HILL | 12/06/89 | 0.01 | 0.001 L | 0.0002 L | 0.007 | 0.002 L | 0.002 L | 0.002 | 0.012 | 0.004 | 3.4 | 0.1 L | 8.1 | 0.1 L | 0.1 L | | | | | | |
| 51 | RD-17 | CEDAR LAWNS DUPL | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.009 | 0.108 | 0.002 L | 0.006 | 0.009 | 0.001 | 10 | 0.1 L | 67 | 1 L | 1 L | | | | | | |
| 33 | R-16 | HOME PORT FARM | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.017 | 0.018 | 0.002 L | 0.001 L | 0.009 | 0.024 | 4.2 | 0.1 L | 3.9 | 1 L | 1 L | | | | | | |
| 23 | R-6 | LEIN, WILLIAM | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.008 | 0.002 L | 0.002 L | 0.001 L | 0.007 | 0.001 L | 2.1 | 0.28 | 0.2 L | 0.1 L | 0.1 L | | | | | | |
| 79 | RD-67 | NE SAMMAMISH #3 DUPL | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.008 | 0.007 | 0.002 L | 0.001 L | 0.008 | 0.003 | 2 | 0.33 | 1.5 | 0.1 L | 0.1 L | | | | | | |
| 78 | R-25 | NE SAMMAMISH #2 | 12/05/89 | 0.01 | 0.001 L | 0.0002 L | 0.009 | 0.002 L | 0.002 L | 0.003 | 0.012 | 0.003 | 2.3 | 0.1 L | 3.6 | 0.32 | 0.1 L | | | | | | |
| 62 | R-22 | SPORTSMAN PARK | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.016 | 0.005 | 0.002 L | 0.002 | 0.012 | 0.003 | 2.4 | 0.1 L | 52 | 1.7 | 1 L | | | | | | |
| 29 | R-5 | GOSS, GORDON | 12/04/89 | 0.01 L | 0.001 L | 0.0002 L | 0.005 | 0.002 L | 0.002 L | 0.001 L | 0.008 L | 0.027 | 2 | 0.1 L | 0.48 | 0.1 L | 0.1 L | | | | | | |
| 10 | R-11 | TAINTER, GORDON | 12/04/89 | 0.01 L | 0.001 | 0.0002 | 0.003 | 0.008 | 0.002 L | 0.001 | 0.008 L | 0.005 | 2.1 | 0.1 L | 2.7 | 0.1 L | 0.1 L | | | | | | |
| 13 | R-9 | NELSON, GORDON | 12/04/89 | 0.01 L | 0.001 L | 0.0003 | 0.004 | 0.004 | 0.002 L | 0.001 L | 0.01 | 0.004 | 5.9 | 0.1 L | 10 | 2.7 | 0.1 L | | | | | | |
| 13 | RD-9 | NELSON, GORDON DUPL | 12/04/89 | 0.01 L | 0.001 L | 0.0002 L | 0.004 | 0.002 L | 0.002 L | 0.001 | 0.008 L | 0.004 | 5.8 | 0.1 L | 10 | 2.7 | 0.1 L | | | | | | |
| 12 | R-21 | SHARPE, GRANT | 12/04/89 | 0.01 L | 0.001 L | 0.0003 | 0.02 | 0.031 | 0.002 L | 0.33 | 0.042 | 0.011 | 6.8 | 0.1 L | 13 | 3.6 | 0.1 L | | | | | | |
| 14 | R-12 | THENOS DAIRY | 12/04/89 | 0.01 L | 0.001 L | 0.0002 L | 0.007 | 0.02 | 0.002 L | 0.004 | 0.008 L | 0.002 | 4.7 | 0.1 L | 0.2 L | 0.1 L | 0.1 L | | | | | | |
| 7 | R-8 | HOSEY #1 | 12/04/89 | 0.01 L | 0.001 L | 0.0002 L | 0.003 L | 0.002 L | 0.002 L | 0.005 | 0.01 | 0.002 | 3.5 | 0.1 L | 7.7 | 1.4 | 0.1 L | | | | | | |
| 6 | R-7 | KLOEPFER, RYAN | 12/04/89 | 0.01 L | 0.001 L | 0.0002 | 0.003 | 0.01 | 0.002 L | 0.002 | 0.014 | 0.003 | 4 | 0.1 L | 8.5 | 1 | 0.1 L | | | | | | |
| 5 | R-10 | ODEGARD, DAVID | 12/04/89 | 0.01 L | 0.001 L | 0.0002 L | 0.004 | 0.008 | 0.002 L | 0.001 | 0.008 | 0.001 L | 2.9 | 0.1 L | 4.1 | 0.67 | 0.1 L | | | | | | |
| 27 | R-14 | WEBSTER, WALT | 12/04/89 | 0.01 L | 0.001 L | 0.0002 L | 0.008 | 0.01 | 0.002 L | 0.001 | 0.01 | 0.003 | 1.9 | 0.1 L | 1.5 | 0.1 L | 0.1 L | | | | | | |
| 53 | R-37 | REDMOND WELL #2 | 12/04/89 | 0.01 L | 0.001 L | 0.0002 L | 0.009 | 0.013 | 0.002 L | 0.002 | 0.009 | 0.001 | 6.7 | 0.1 L | 12 | 1.5 | 0.1 L | | | | | | |
| 48 | R-35 | REDMOND WELL #5 | 12/04/89 | 0.01 L | 0.001 L | 0.0002 L | 0.009 | 0.002 L | 0.002 L | 0.001 | 0.009 | 0.002 | 12 | 0.1 L | 12 | 1.3 | 0.1 L | | | | | | |
| 35 | R-15 | BOWMAN, CARL | 12/04/89 | 0.01 L | 0.001 L | 0.0003 | 0.011 | 0.002 L | 0.002 L | 0.001 | 0.008 L | 0.001 | 2.5 | 0.1 L | 5.6 | 0.1 L | 0.1 L | | | | | | |
| 77 | R-27 | NE SAMMAMISH #4 | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.004 | 0.007 | 0.002 L | 0.002 | 0.011 | 0.008 | 2.3 | 0.33 | 0.1 L | 0.1 L | 0.1 L | | | | | | |
| 79 | R-26 | NE SAMMAMISH #3 | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.008 | 0.002 L | 0.002 L | 0.001 | 0.008 | 0.007 | 2 | 0.32 | 1.8 | 0.1 L | 0.1 L | | | | | | |
| 61 | R-18 | CAMPTON COMMUNITY | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.011 | 0.008 | 0.002 L | 0.001 L | 0.01 | 0.001 L | 11 | 1 L | 62 | 0.24 | 1 L | | | | | | |
| 51 | R-17 | CEDAR LAWNS | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.009 | 0.119 | 0.002 | 0.008 | 0.011 | 0.001 | 11 | 1 L | 41 | 0.55 | 1 L | | | | | | |
| 34 | R-20 | PATTERSON, STAN | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.012 | 0.005 | 0.002 L | 0.001 L | 0.008 | 0.001 L | 2.7 | 1 L | 50 | 1 L | 1 L | | | | | | |
| 21 | R-23 | STERN, WILLIAM | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.008 | 0.002 L | 0.002 L | 0.001 L | 0.009 | 0.002 | 2.5 | 1 L | 12 | 1 L | 1 L | | | | | | |
| 16 | R-24 | ULRICH MEATS | 12/05/89 | 0.01 L | 0.001 L | 0.0002 L | 0.008 | 0.017 | 0.002 L | 0.001 | 0.007 | 0.003 | 3.3 | 0.6 | 0.1 L | 0.1 L | 0.45 | | | | | | |
| 20 | R-13 | WEIDE, MIKE | 12/06/89 | 0.01 L | 0.001 L | 0.0002 L | 0.01 | 0.013 | 0.002 L | 0.001 L | 0.009 | 0.003 | 13 | 0.1 L | 15 | 0.1 L | 0.1 L | | | | | | |
| 40 | R-32 | OLYMPIAN PRECAST | 12/06/89 | 0.01 | 0.001 L | 0.0002 L | 0.011 | 0.013 | 0.002 L | 0.001 L | 0.012 | 0.004 | 5.2 | 0.1 L | 1.4 | 0.1 L | 0.1 L | | | | | | |
| 41 | R-30 | KING C. SHOPS | 12/06/89 | 0.01 | 0.001 L | 0.0003 | 0.008 | 0.024 | 0.002 L | 0.001 L | 0.012 | 0.003 | 7.6 | 0.1 L | 8.8 | 0.1 L | 0.1 L | | | | | | |
| 38 | R-31 | McCLAN, ROBERT | 12/06/89 | 0.01 | 0.001 L | 0.0002 L | 0.007 | 0.008 | 0.002 L | 0.001 | 0.015 | 0.009 | 2.4 | 0.1 L | 3.9 | 0.1 L | 0.1 L | | | | | | |
| 1 | R-3 | DOUGHTY, LEE | 12/07/89 | 0.01 L | 0.001 L | 0.0002 L | 0.005 | 0.002 L | 0.002 L | 0.001 | 0.014 | 0.002 | 15 | 0.1 L | 7.5 | 1.8 | 0.1 L | | | | | | |
| 3 | R-4 | PARADISE PARK | 12/12/89 | 0.01 L | 0.001 L | 0.0002 L | 0.017 | 0.002 L | 0.002 L | 0.002 | 0.008 L | 0.001 L | 2.6 | 0.1 L | 7.5 | 0.1 L | 0.1 L | | | | | | |

Note: Well number corresponds to numbers on map in Figure 5-1.
mg/l = milligrams per liter (parts per million).
L = laboratory method reporting limit.

## Table 2.6.15

## Analyte Classifications and Standards

| Analyte | National Primary Drinking Water MCL[a] (mg/l) | National Secondary Drinking Water MCL[b] (mg/l) | Ground Water Characteristic Constituent | Priority Pollutant | Regulated Pollutant |
|---|---|---|---|---|---|
| Alkalinity | | | | | |
| Total | NR | NR | Yes | No | No |
| Bicarbonate | NR | NR | Yes | No | No |
| Carbonate | NR | NR | Yes | No | No |
| Hydroxide | NR | NR | Yes | No | No |
| Arsenic | 0.05 | NR | No | Yes | Yes |
| Barium | 1 | NR | No | No | Yes |
| Beryllium | NR | NR | No | Yes | No |
| Cadmium | 0.010 | NR | No | Yes | Yes |
| Calcium | NR | NR | Yes | No | No |
| Chloride | NR | 250 | Yes | No | No |
| Chlorinated Pesticides and PCBs | [c] | NR | Yes | No | Yes |
| Chromium | 0.05 | NR | No | Yes | Yes |
| Coliforms | | | | | |
| Total | 1/100 ml | NR | No | No | Yes |
| Fecal | 1/100 ml | NR | No | No | Yes |
| Copper | NR | 1 | No | Yes | No |
| Cyanide | NR | NR | No | Yes | No |
| Fluoride | 4.0 | 2.0[d] | Yes | No | Yes |
| Iron | NR | 0.3 | Yes | No | No |
| Lead (at tap) | 0.05 | NR | No | Yes | Yes |
| Magnesium | NR | NR | Yes | No | No |
| Manganese | NR | 0.05 | No | No | No |
| Mercury | 0.002 | NR | No | Yes | Yes |
| Nickel | NR | NR | No | Yes | Yes |
| Nitrate (as N) | 10 | NR | Yes | No | Yes |
| Nitrite (as N) | NR | NR | No | No | Yes |

## Table 2.6.15

## Analyte Classifications and Standards (Continued)

| Analyte | National Primary Drinking Water MCL[a] (mg/l) | National Secondary Drinking Water MCL[b] (mg/l) | Ground Water Characteristic Constituent | Priority Pollutant | Regulated Pollutant |
|---|---|---|---|---|---|
| Nitrate + Nitrite (as N) | NR | NR | No | No | Yes |
| Phenol | NR | NR | No | Yes | Yes |
| Potassium | 0.01 | NR | No | Yes | Yes |
| Selenium | NR | NR | Yes | No | No |
| Semivolatile Organic Compounds (BNAs) | [c] | NR | No | No | Yes |
| Silica | NR | NR | Yes | No | No |
| Silver | 0.05 | NR | No | Yes | Yes |
| Sodium | NR | NR | Yes | No | No |
| Sulfate | NR | 250 | Yes | No | No |
| Thallium | NR | NR | No | Yes | No |
| Total Dissolved Solids | NR | 500 | No | No | No |
| Total Hardness | NR | NR | Yes | No | No |
| Total Organic Halides (TOX) | NR[e] | NR | No | No | No[e] |
| Volatile Organic Compounds (VOCs) | | | | | |
| Acetone | NR | NR | No | No | Yes |
| Carbon Tetrachloride | 0.005[f] | NR | No | No | Yes |
| Others | [c] | NR | No | No | Yes |
| Zinc | NR | 5 | No | Yes | No |

NOTES: MCL Maximum Contaminant Level permitted under federal law.
mg/l micrograms per liter (parts per million)
NR Not Regulated

[a] These values are exactly equal to the Washington State Primary Drinking Water Contaminant Criteria and Primary Ground Water Contaminant Criteria.
[b] These values are exactly equal to the Washington State Secondary Drinking Water Contaminant Criteria and Secondary Ground Water Contaminant Criteria unless otherwise noted.
[c] MCL depends upon specific analyte.
[d] Washington State has no secondary ground water contaminant criterion for fluoride.
[e] Although concentrations of TOX are not regulated as TOX, the concentrations of some individual organic halides which contribute to the total concentration are regulated under National Interim Primary Drinking Water Regulations.
[f] The Washington State ground water quality standard for carbon tetrachloride is 0.0003 mg/l.

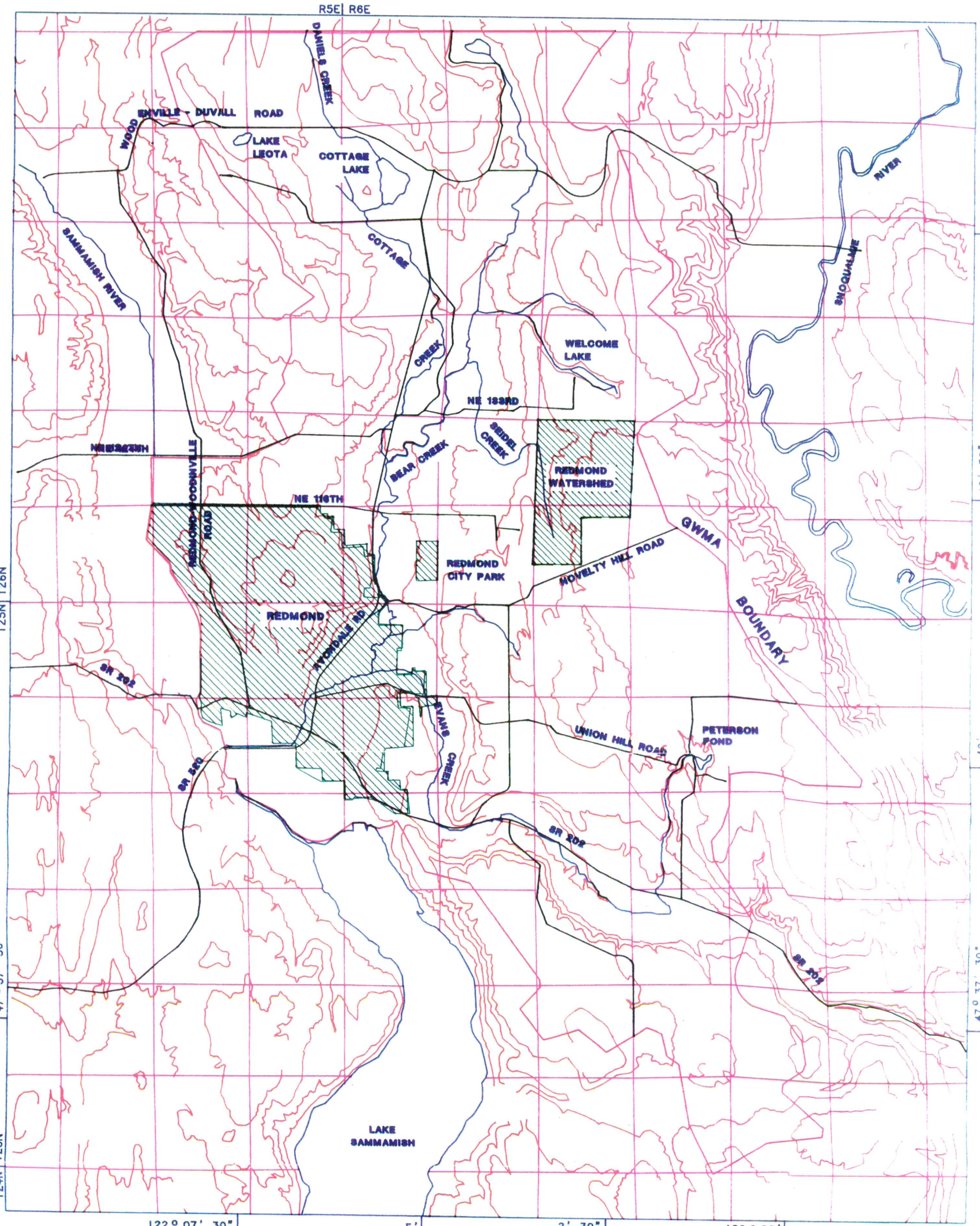
## TABLE 2.7.1

## HYDROLOGIC BUDGET FOR RBC-GWMA STUDY AREA

| Item | Recharge[a] (acre-feet/year) | Ground Water Loss[a] (acre-feet/year) |
|---|---|---|
| Precipitation - Average | 112,000 | -- |
| Ground Water Extraction | -- | -- |
| City of Redmond | -- | 8,900 |
| Rural UAA | -- | 2,700 |
| Water Loss to Surface Water | -- | 35,000 |
| Evapotranspiration | -- | 64,000 |
| Surface Runoff - Precipitation | -- | 13,300 |
| Wastewater Recycling | -- | -- |
| Rural UAA | 1,465 | -- |
| Flux (ground water under flow) | -- | -- |
| Out of UAA | -- | 1,626 |
| Into UAA | 12,061 | -- |
| TOTAL | 125,526 | 125,526 |

[a] Refer to sections 2.7.2 through 2.7.4 for discussion on value determination

Figures




LEGEND

GWMA BOUNDARY

ROADS

STREAMS/RIVERS

LAKES

CITY OF REDMOND

KING COUNTY

0 1 2

SCALE (MILES)

N

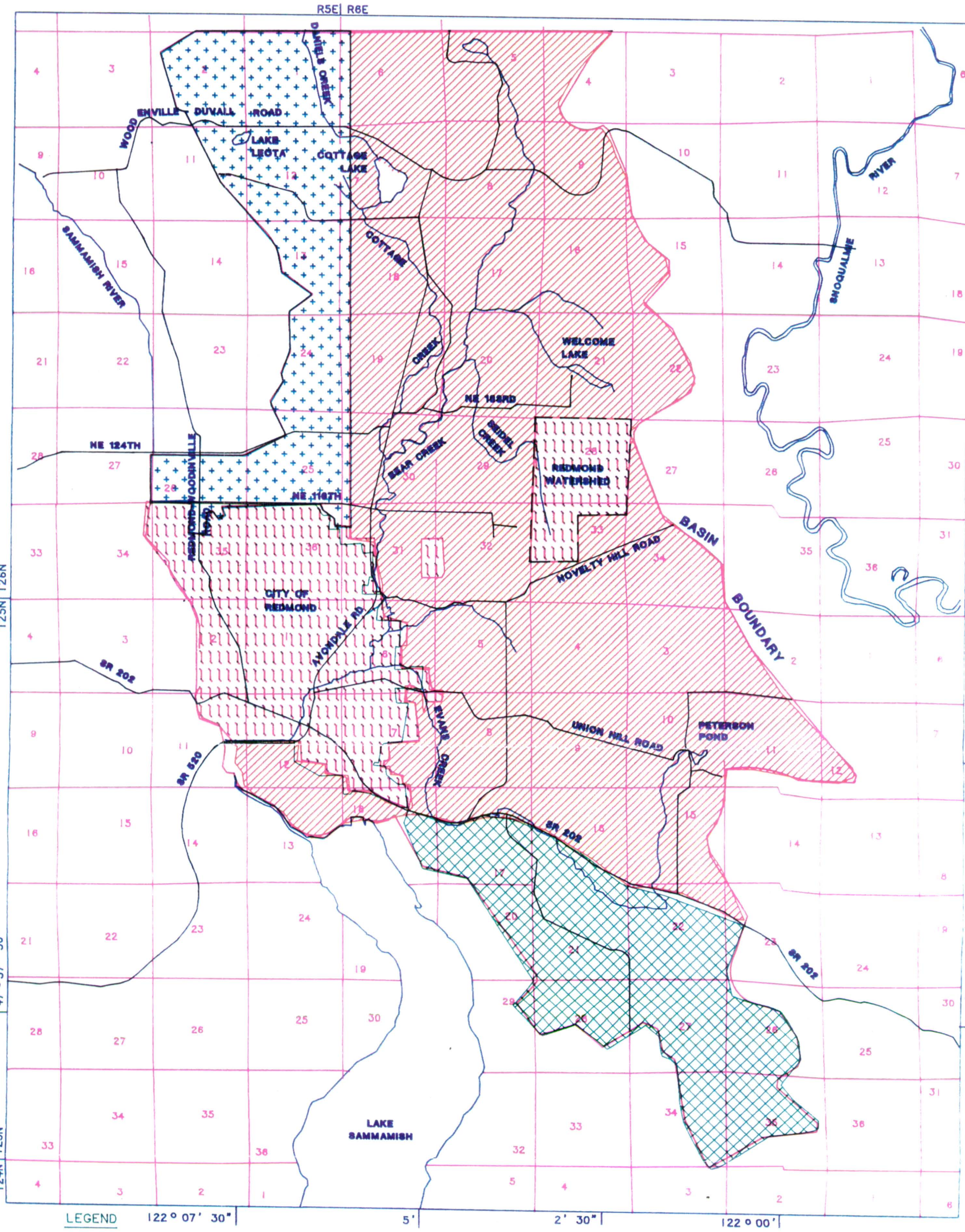
CADD FILE: MLP\JURISDIC(RBC)
REV. DATE: 5-21-91

# REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.2.1
STUDY AREA AND JURISDICTIONAL BOUNDARIES

SEATTLE-KING COUNTY
DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE
DEPARTMENT OF ECOLOGY
1989




LEGEND

- BASIN BOUNDARY
- ROADS
- STREAMS/RIVERS
- LAKES
- CITY LIMITS
- BEAR CREEK COMMUNITY PLAN
- EAST SAMMAMISH COMMUNITY PLAN
- NORTHSHORE COMMUNITY PLAN
- REDMOND COMMUNITY DEVELOPMENT GUIDE

0 1 2

N

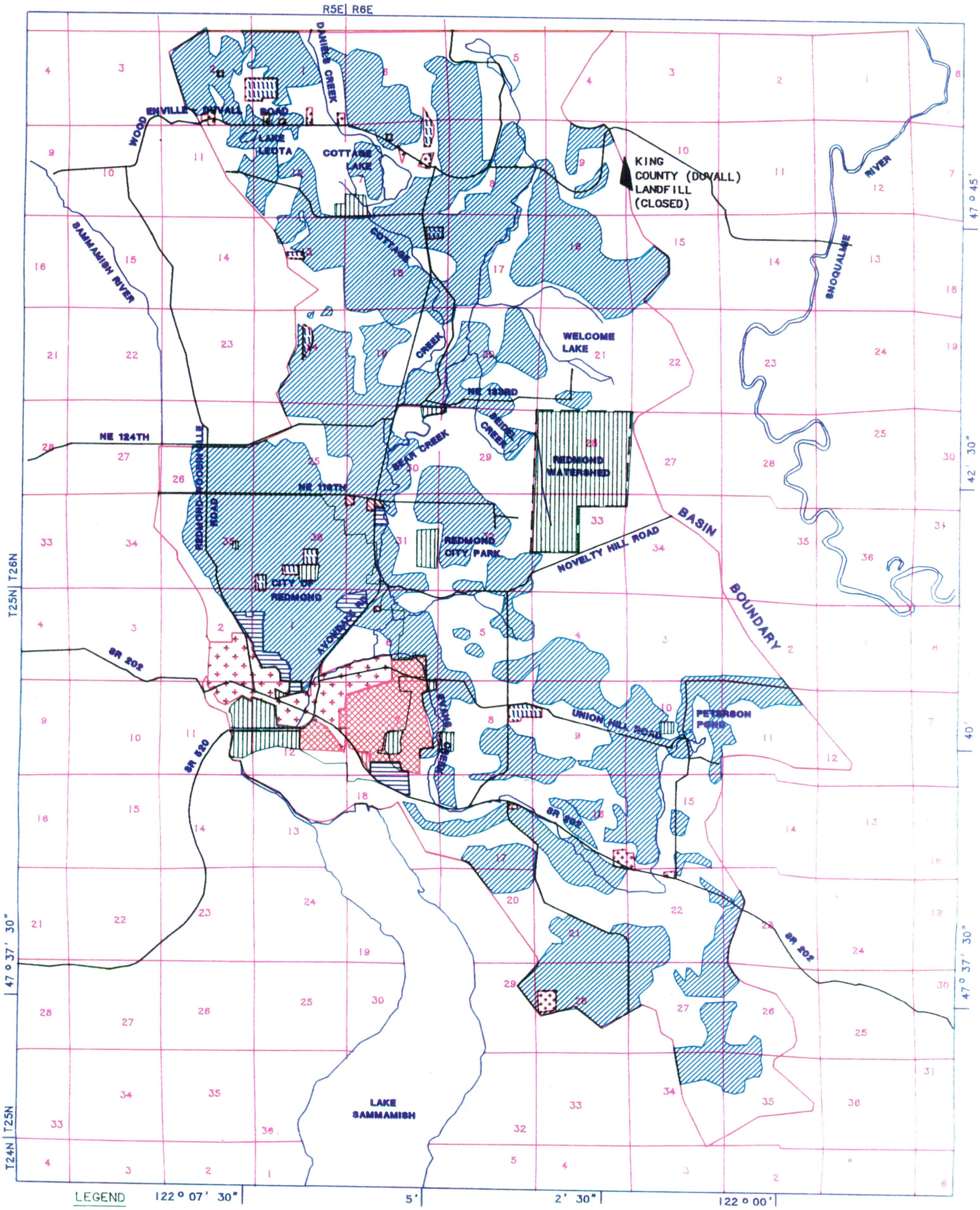
CADD FILE: MLP\RBI(LOCOMM)
REV. DATE: 7-10-90

# REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.5.1
LOCAL COMMUNITY DEVELOPMENT PLANS

SEATTLE-KING COUNTY
DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE
DEPARTMENT OF ECOLOGY
1989




LEGEND

- BASIN BOUNDARY
- ROADS
- STREAMS/RIVERS
- LAKES
- REDMOND CITY LIMITS
- Industrial / Business Park
- Commercial
- Multifamily
- Parks, Recreation and Open Space
- Community Facilities Public & Private Schools
- Landfill
- Single Family (>1-6 homes per acer)
- Low Density and/or Undeveloped (≤1 home per acer)

0 1 2

N

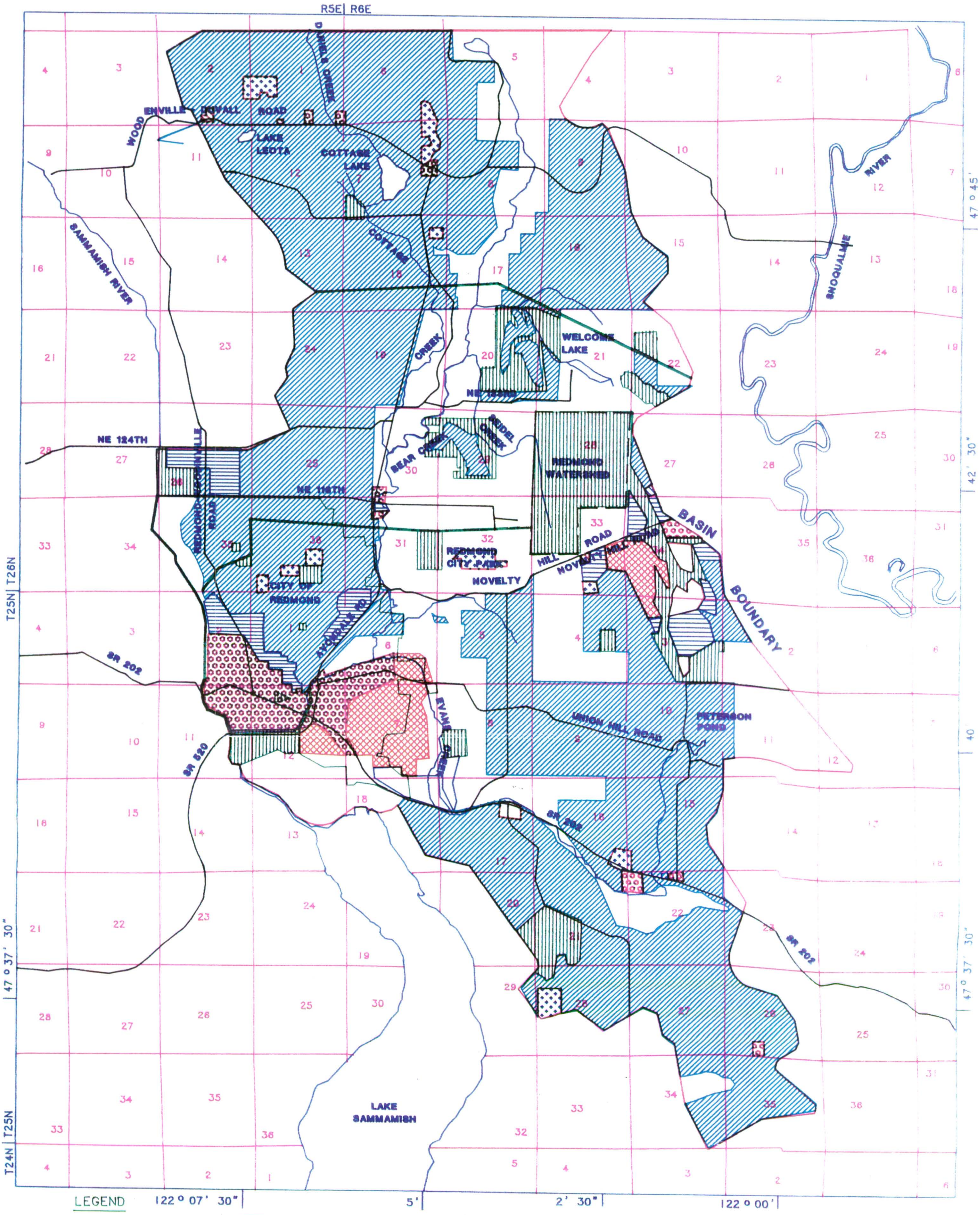
CADD FILE: TEB(MLP)\RBI(LAND USE)
REV. DATE: 7-10-90

# REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.5.2
EXISTING LAND USE

SEATTLE-KING COUNTY DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE DEPARTMENT OF ECOLOGY
1989




LEGEND

BASIN BOUNDARY
ROADS
STREAMS/RIVERS
LAKES
REDMOND CITY LIMITS

Industrial/Business Park
Commercial
Multifamily
Parks, Recreation and Open Space
Community Facilities, Public and Private Schools

Single Family (>1–6 homes per acer)
Low Density and/or Undeveloped (≤1 home per acer)

0 1 2

N

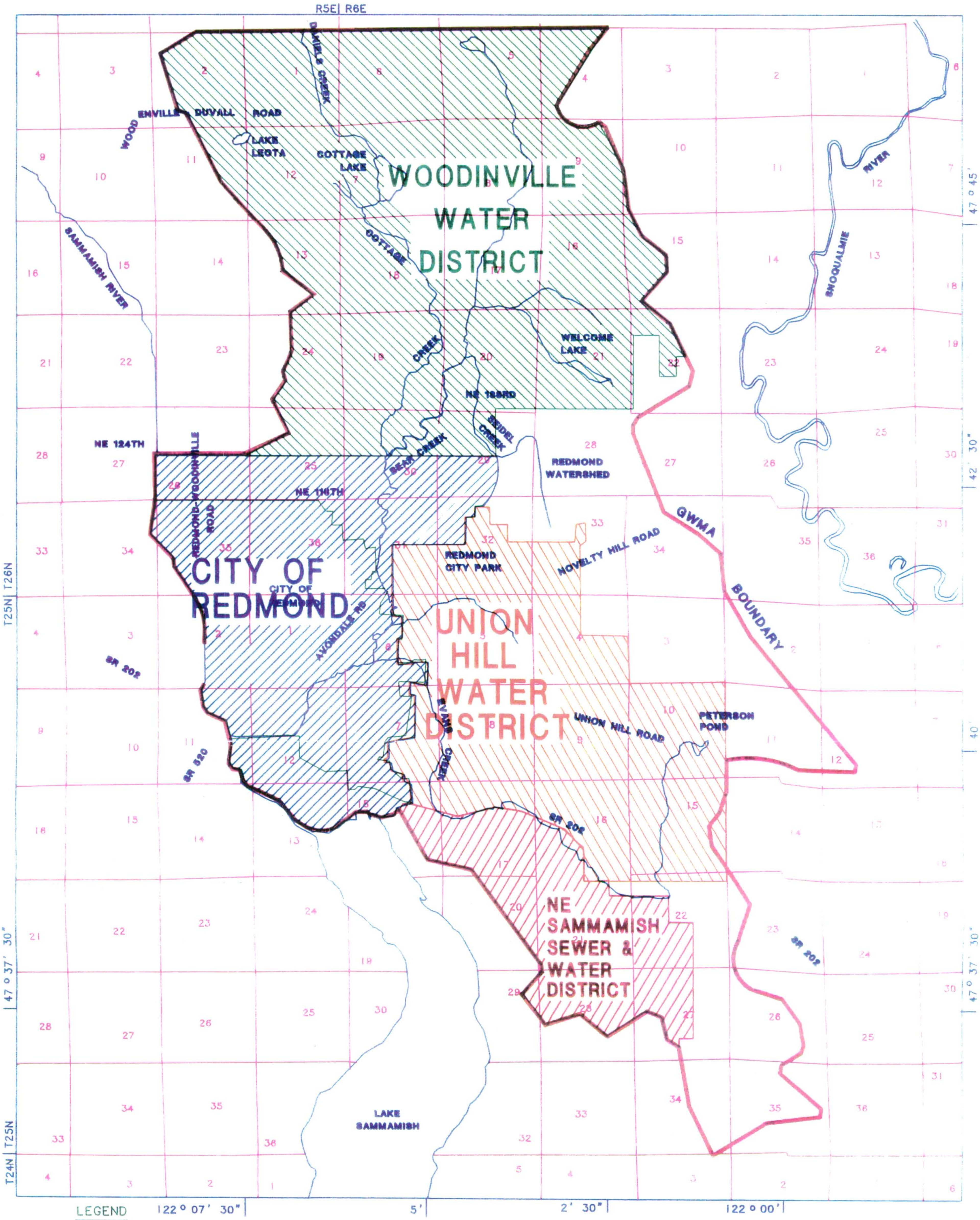
CADD FILE: TEB(MLP)\RBI(FUTUREUSE)
REV. DATE: 7-10-90

# REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.5.3
PROPOSED FUTURE LAND USE

SEATTLE–KING COUNTY DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE DEPARTMENT OF ECOLOGY
1989




LEGEND

GWMA BOUNDARY

ROADS

STREAMS/RIVERS

LAKES

CITY LIMITS

WATER PURVEYORS BOUNDARIES

0 1 2

SCALE (MILES)

N

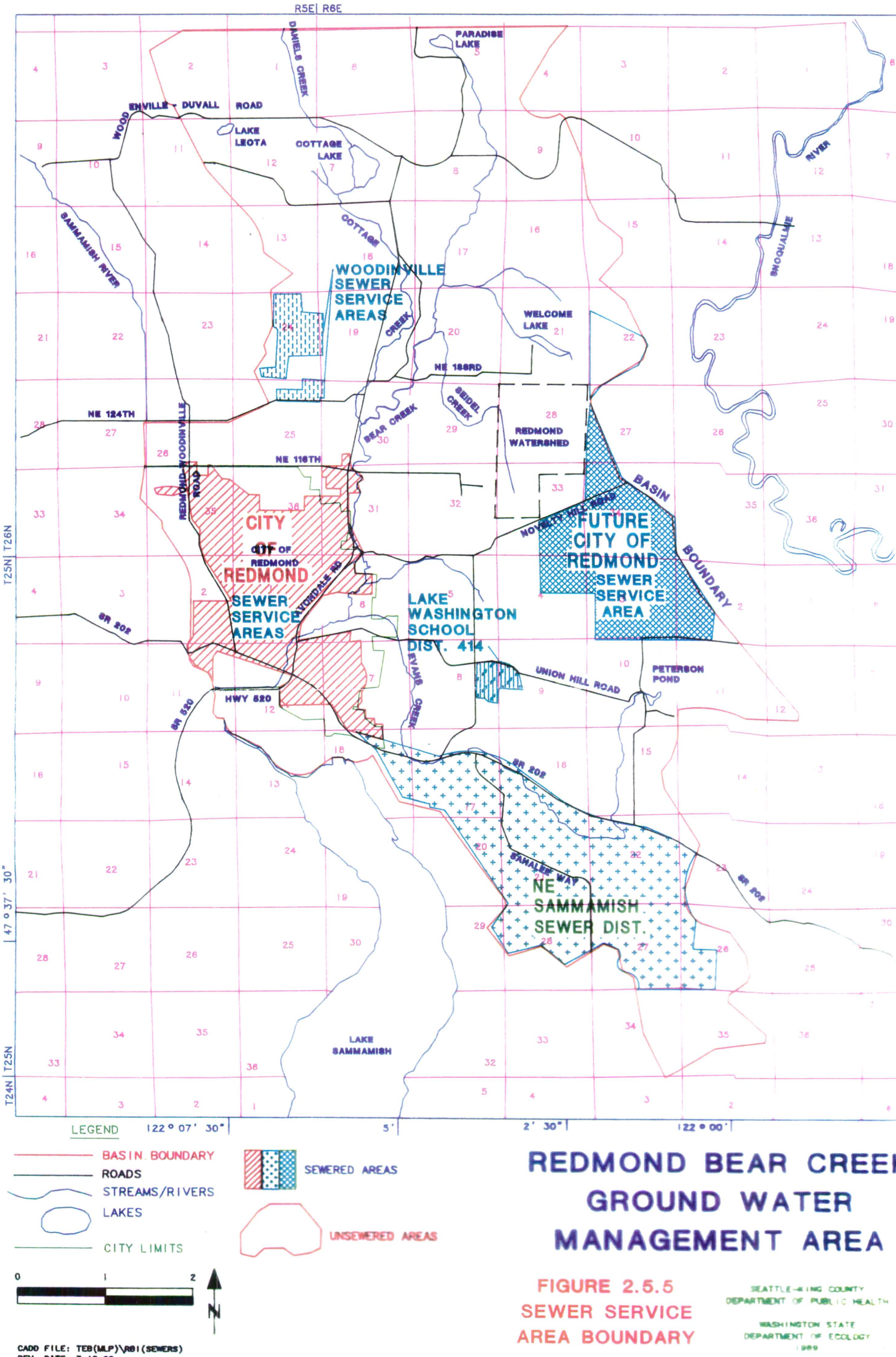
CADD FILE: REDMOND\RBI-K6\2/8/91

# REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.5.4
WATER DISTRICT BOUNDARIES
GROUP A PURVEYORS SERVICE AREA BOUNDARIES

SEATTLE-KING COUNTY
DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE
DEPARTMENT OF ECOLOGY
1989



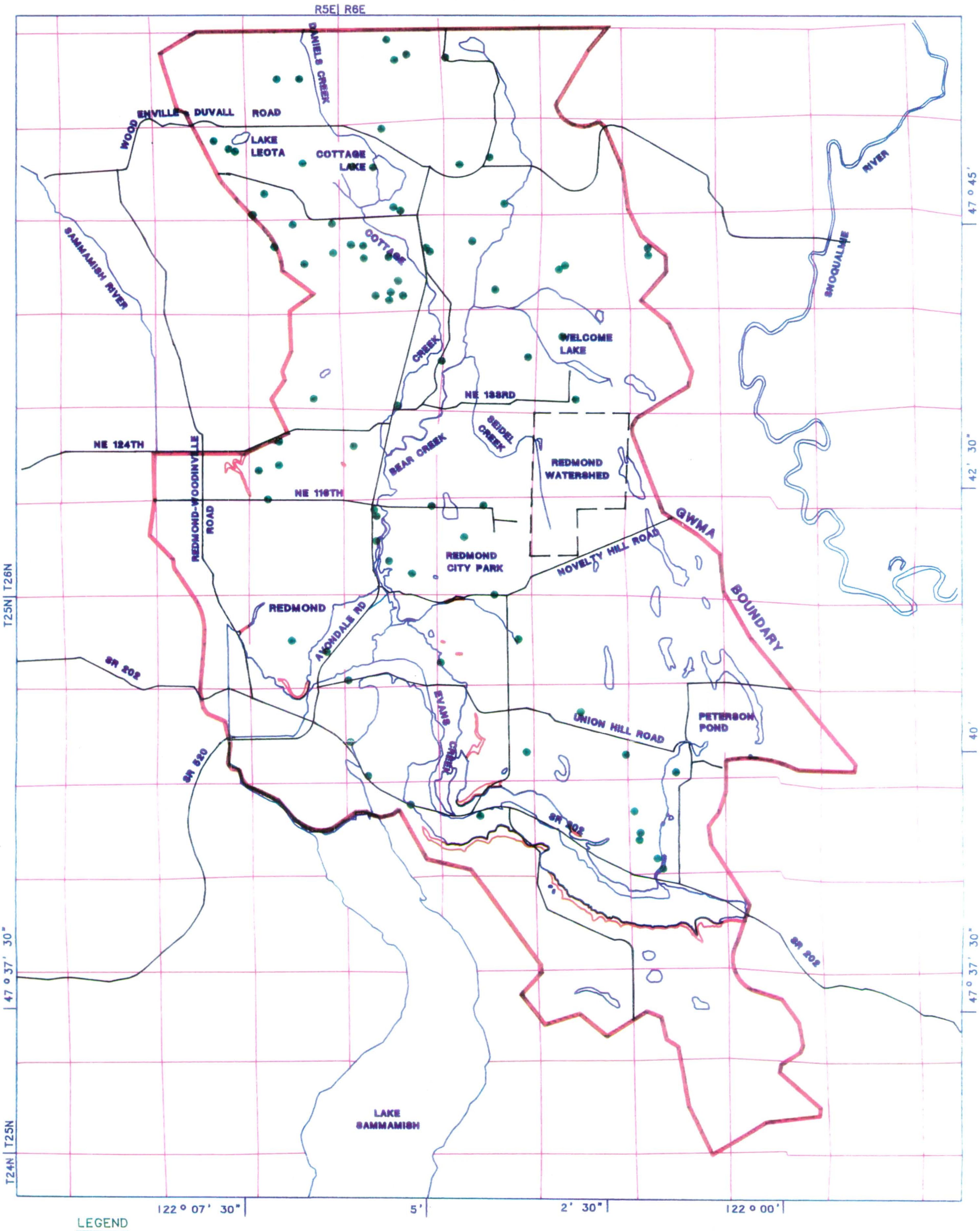

REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.5.5
SEWER SERVICE AREA BOUNDARY

SEATTLE-KING COUNTY DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE DEPARTMENT OF ECOLOGY

1989




LEGEND

GWMA BOUNDARY

SEPTIC SYSTEM LOCATION

ROADS

STREAMS/RIVERS

LAKES

0 1 2

SCALE (MILES)

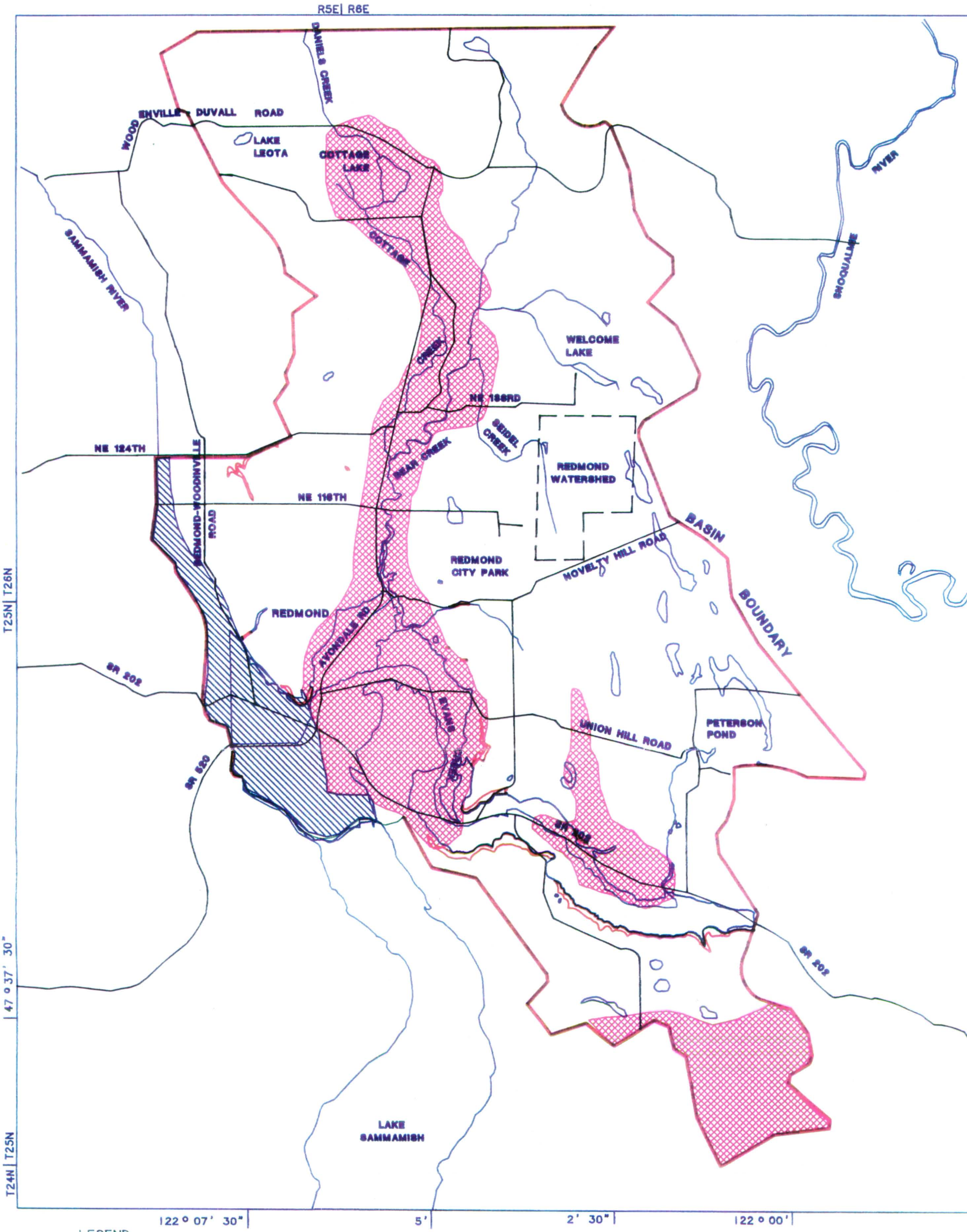
N

# REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.5.6
DISTRIBUTION OF SEPTIC SYSTEM REPAIR PERMITS (1987)

SEATTLE-KING COUNTY
DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE
DEPARTMENT OF ECOLOGY
1989




LEGEND

BASIN BOUNDARY

ROADS

STREAMS/RIVERS

LAKES

ALDERWOOD ASSOCIATION

EVERETT ASSOCIATION

PUGET–EARLMOUNT–SNOHOMISH ASSOCIATION

0 1 2

SCALE (MILES)

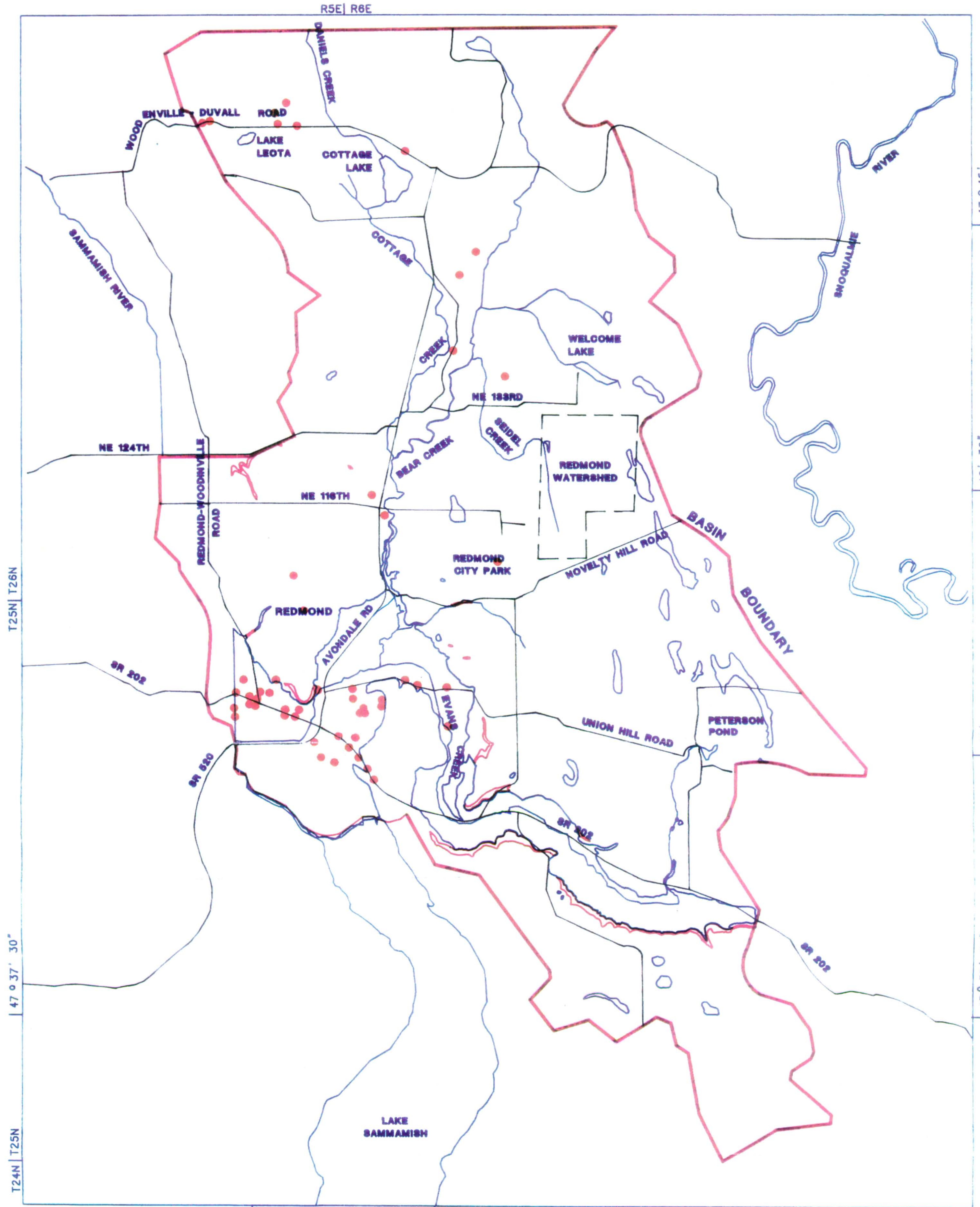
N

# REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.5.7
GENERAL SOIL MAP

SEATTLE–KING COUNTY
DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE
DEPARTMENT OF ECOLOGY
1989




LEGEND

- BASIN BOUNDARY
- UNDERGROUND STORAGE TANK
- ROADS
- STREAMS/RIVERS
- LAKES

0 1 2

SCALE (MILES)

N

# REDMOND BEAR CREEK GROUND WATER MANAGEMENT AREA

FIGURE 2.5.8
LOCATION OF
UNDERGROUND STORAGE TANKS


SEATTLE-KING COUNTY
DEPARTMENT OF PUBLIC HEALTH

WASHINGTON STATE
DEPARTMENT OF ECOLOGY
1989

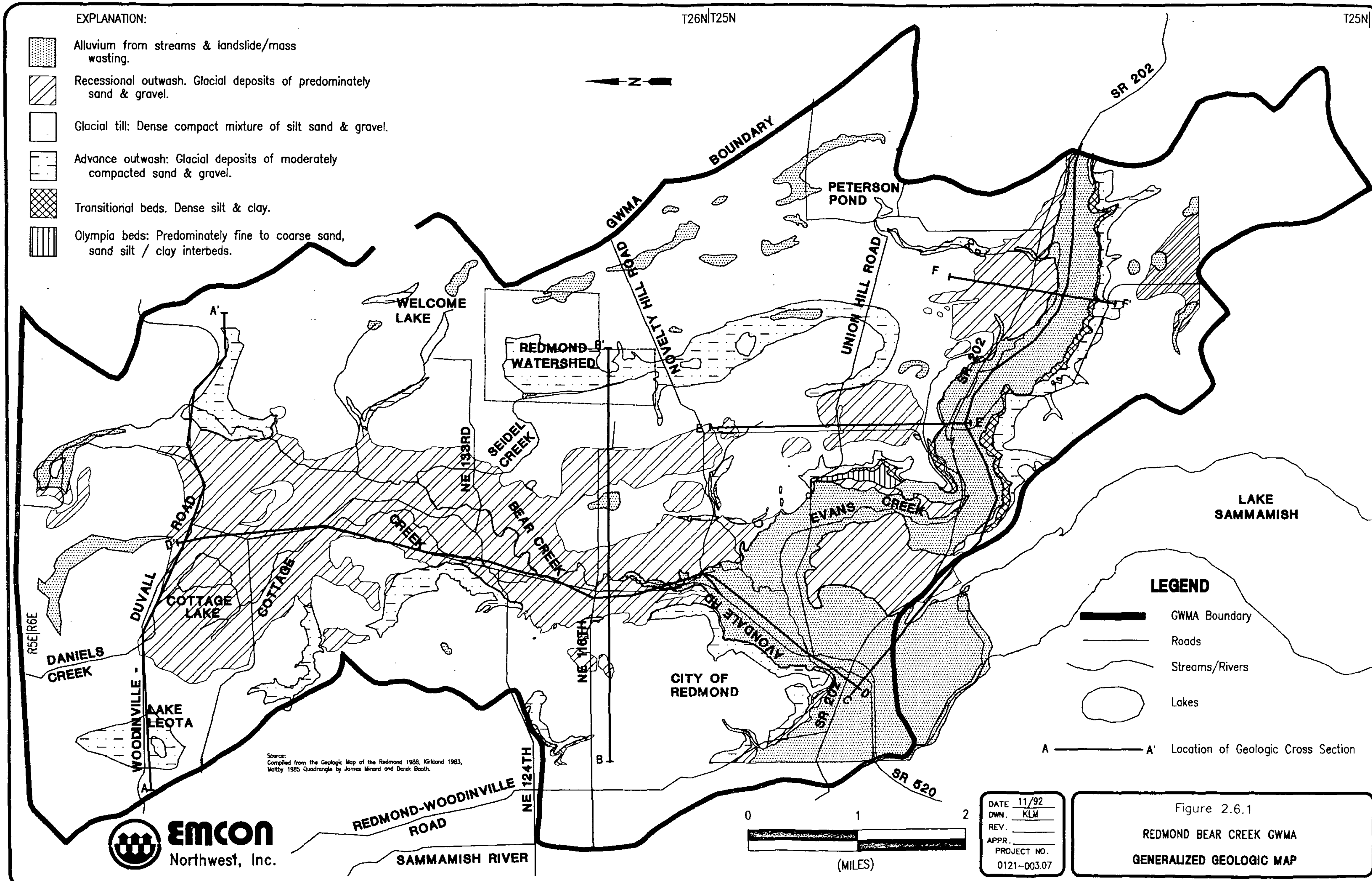
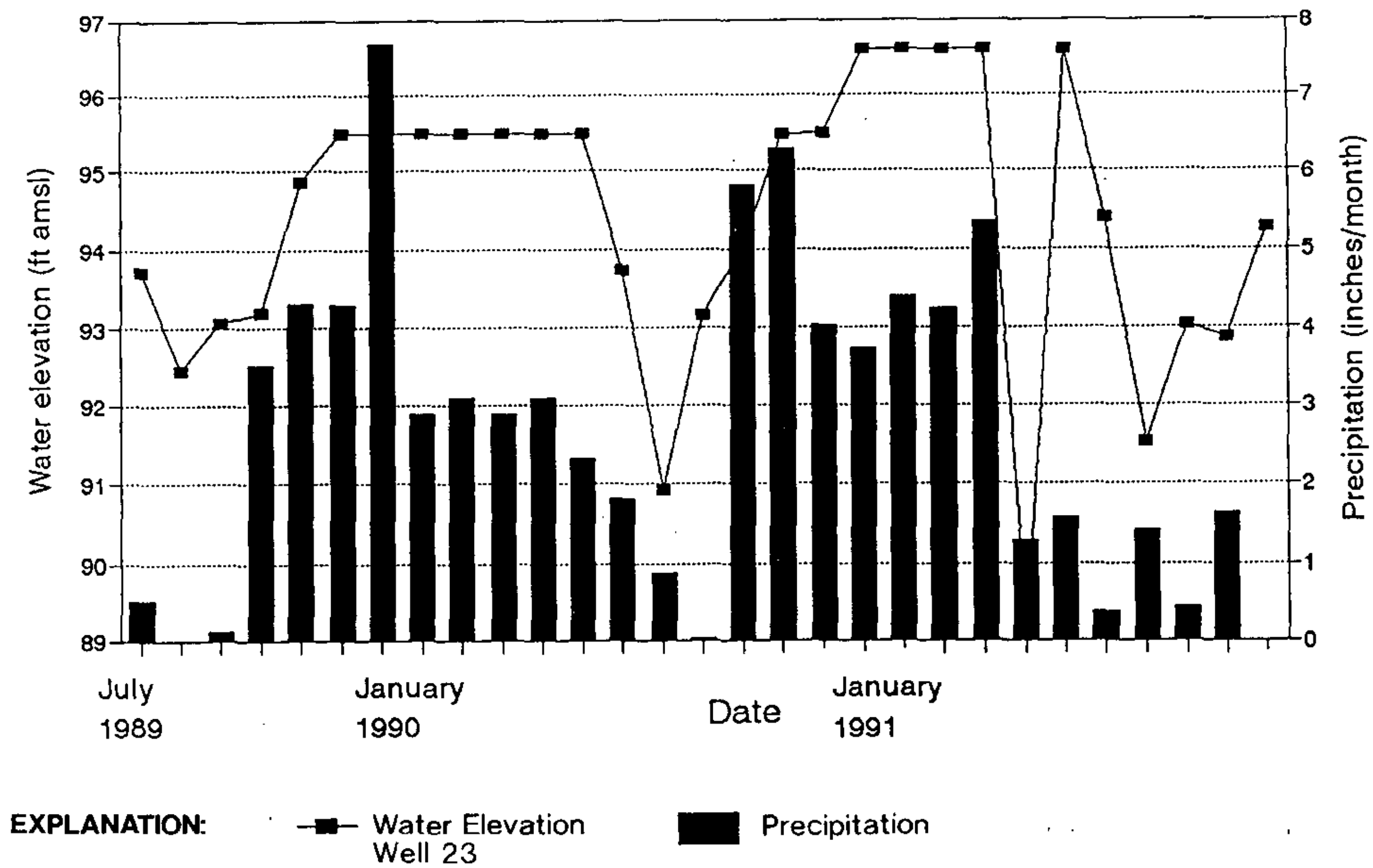



Figure 2.6.1
REDMOND BEAR CREEK GWMA
GENERALIZED GEOLOGIC MAP

1=4000 3-08-93 0121\003\07C19

150969

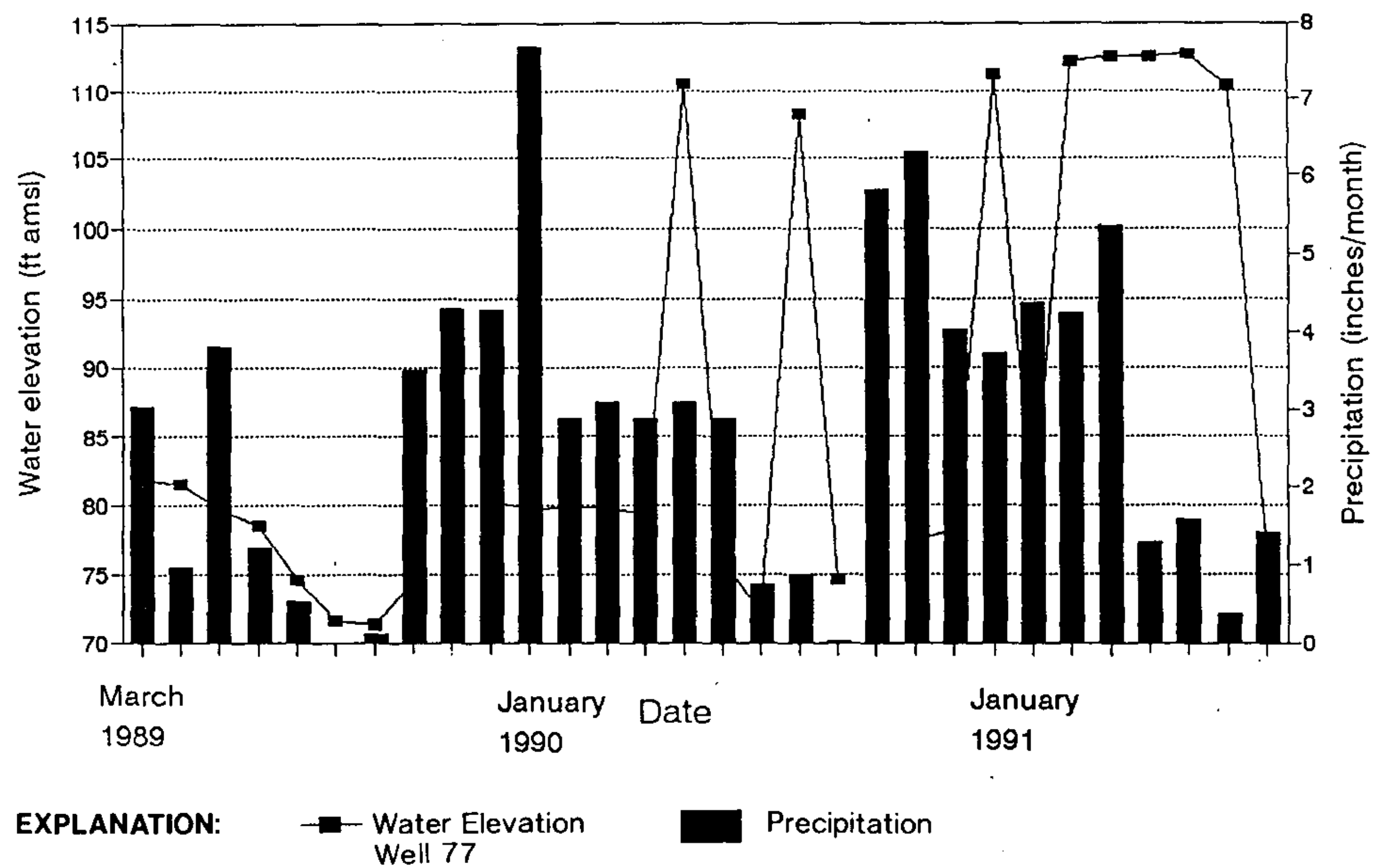



EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.9
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**WATER LEVEL VS. PRECIPITATION HYDROGRAPH**
**ALLUVIAL AQUIFERS**

150969

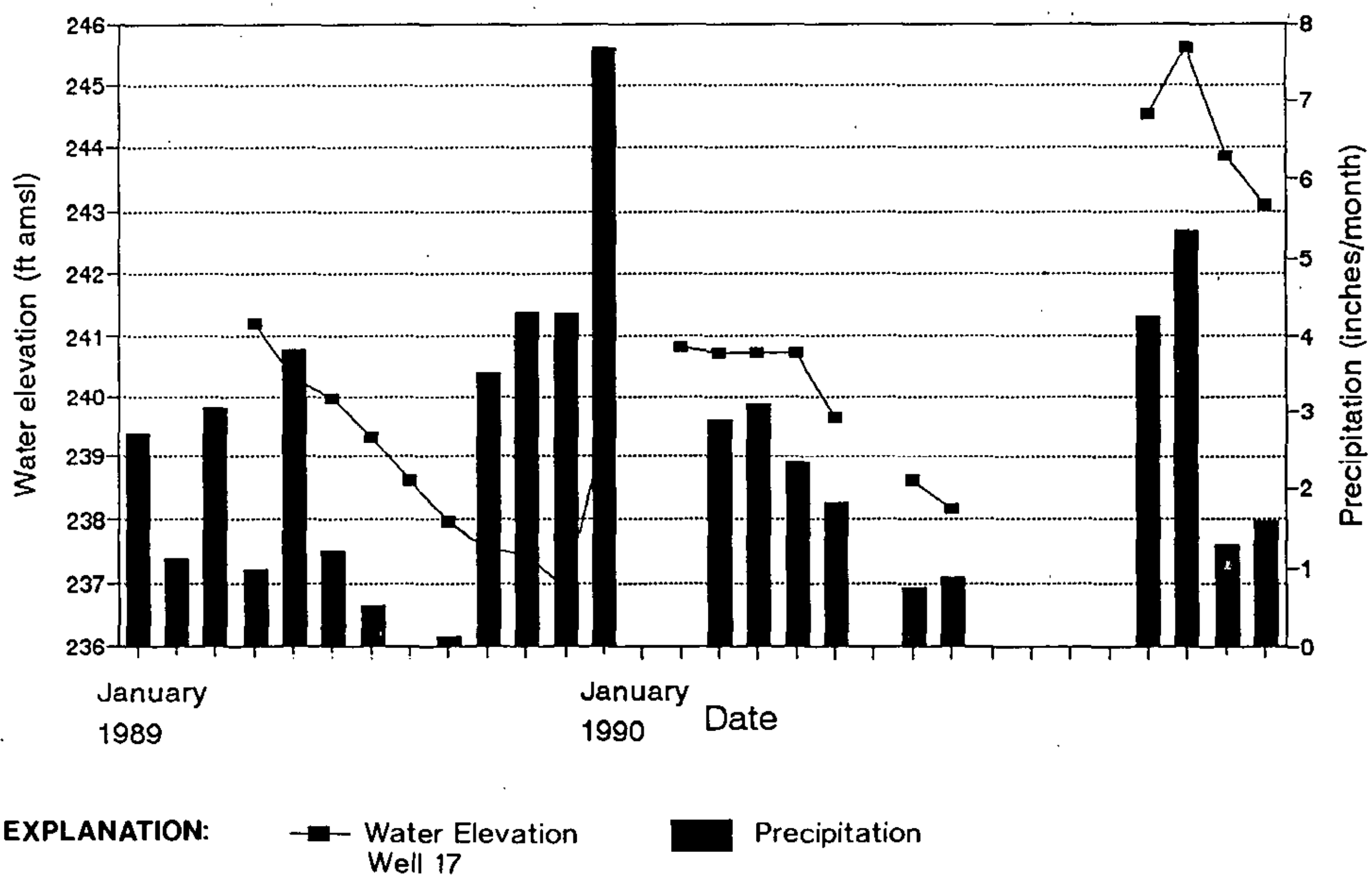



EMCON
Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.10
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**WATER LEVEL VS. PRECIPITATION HYDROGRAPH**
**SEA LEVEL AQUIFERS**

150969

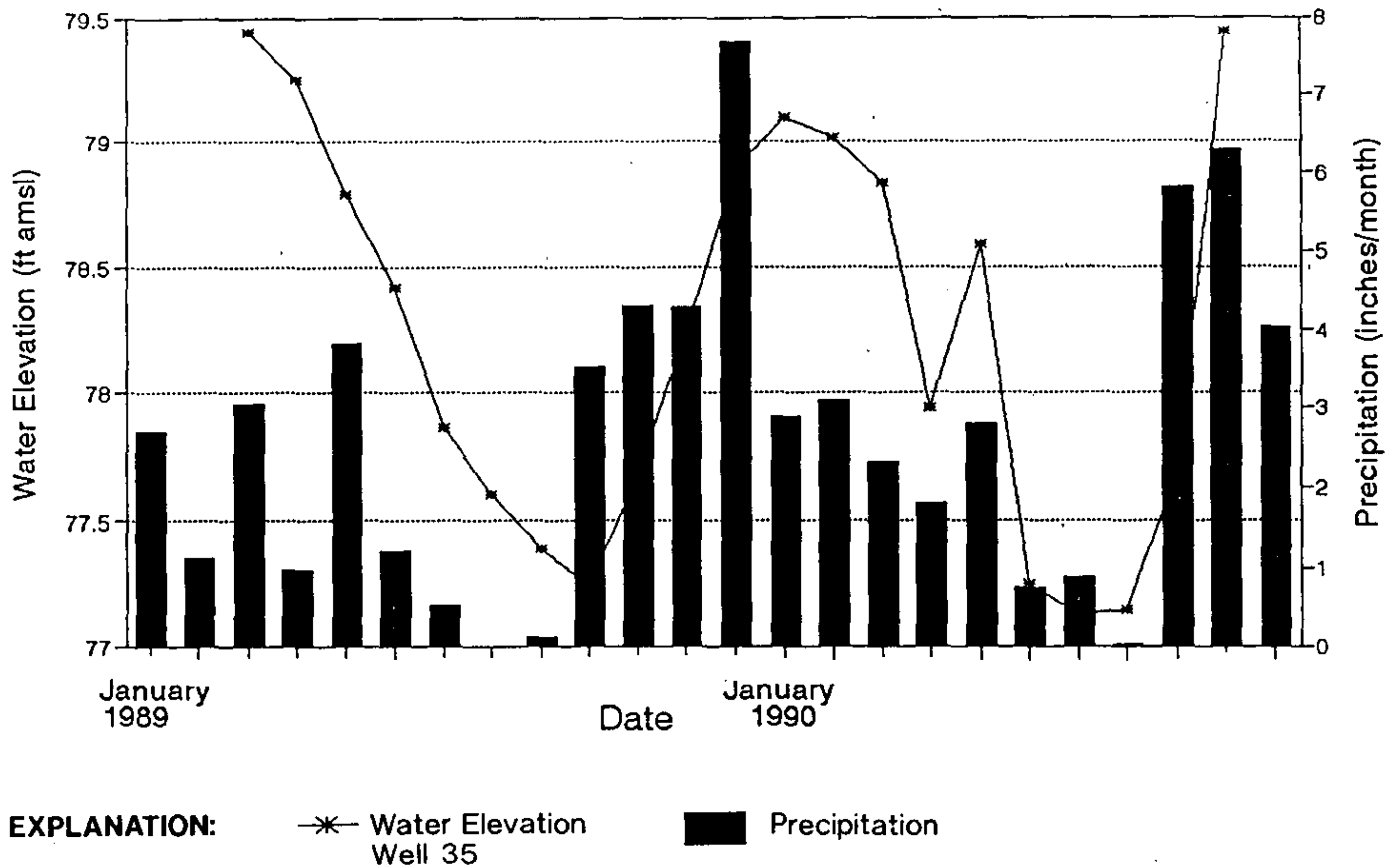



EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.11
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**WATER LEVEL VS. PRECIPITATION HYDROGRAPH**
**LOCAL UPLAND AQUIFERS**

150969




EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.12
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**WATER LEVEL VS. PRECIPITATION HYDROGRAPH**
**REGIONAL AQUIFERS**

| GEOLOGIC | | | FORMATION | |
|---|---|---|---|---|
| PERIOD | EPOCH | YEARS BEFORE PRESENT | DESCRIPTION | YEARS BEFORE PRESENT |
| | | 0 | | 0 |
| QUATERNARY | HOLOCENE | | ALLUVIUM (Qal) AND RECESSIONAL OUTWASH (Qvr) | |
| | | 12,000 yr | | 12,000 yr |
| | PLEISTOCENE | | VASHON GLACIAL DEPOSITS (Qvt & Qva) | |
| | | | | 20,000 yr |
| | | | OLYMPIA INTERGLACIAL (Qtb & Qog) | |
| | | | | 40,000 yr |
| | | | OLDER UNDIFFERENTIATED GLACIAL AND NONGLACIAL DEPOSITS | |
| | | 2 my | | 2 my |
| TERTIARY | PLIOCENE | | NO UNITS PRESENT IN STUDY AREA | |
| | | | | 4.7 my |
| | | 5 my | | ? |
| | MIOCENE | | | 6.5 my |
| | | | | 17 my |
| | | 24 my | | |
| | OLIGOCENE | | SEDIMENTARY ROCKS (Ts) | |
| | | 38 my | | |
| | EOCENE | | | |
| | | 55 my | | |
| | PALEOCENE | | | |
| | | 63 my | | 63 my |
| PRETERTIARY | | | PRETERTIARY METAMORPHIC AND VOLCANIC ROCKS UNDIFFERENTATED | |

EMCON Northwest, Inc.

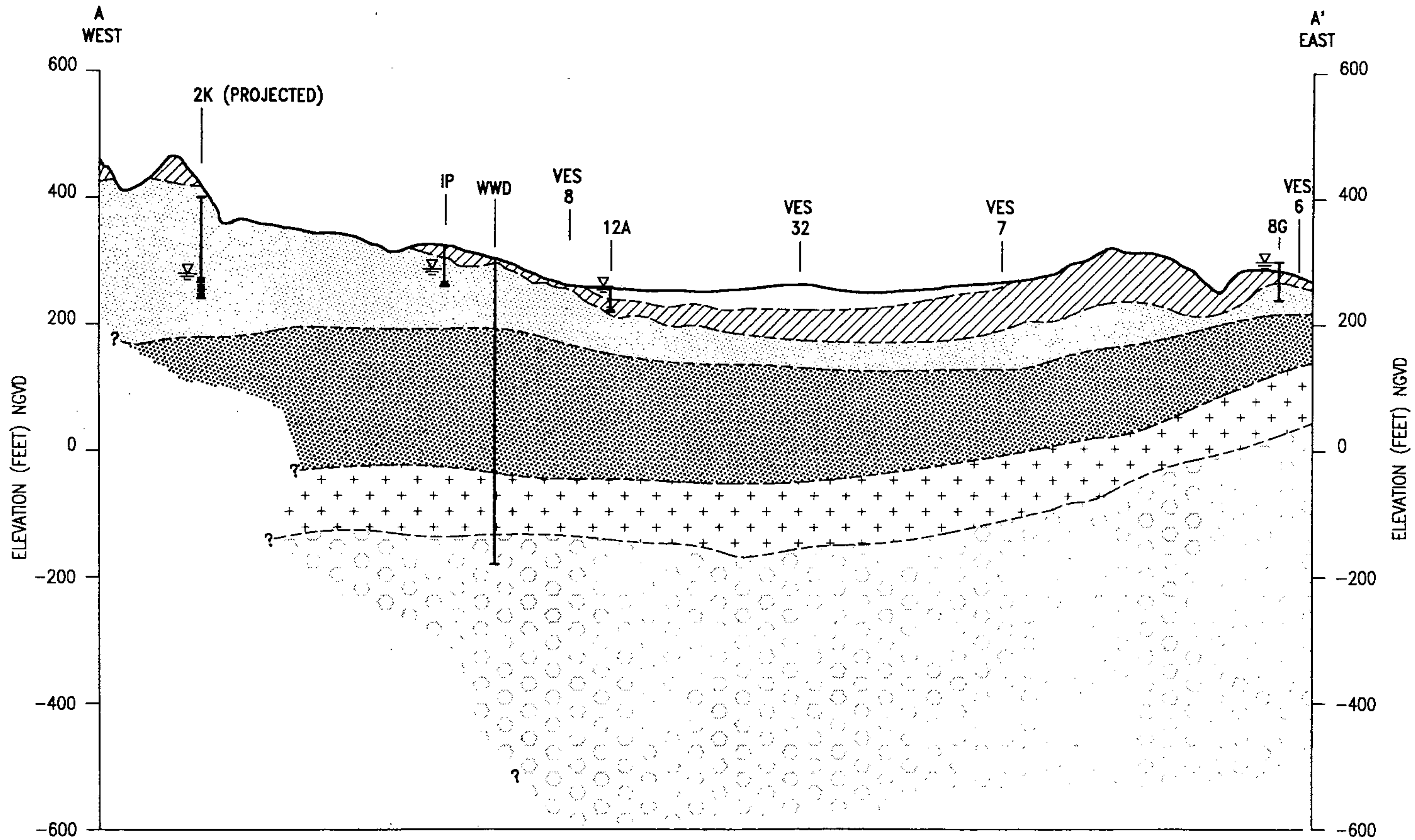
DATE 11/92
DWN JC
REV.
APPR.
PROJECT NO. 0121-003.07

Figure 2.6.2

REDMOND BEAR CREEK GWMA

**GENERALIZED STRATIGRAPHIC COLUMN**

1= 1 11-16-92 0121\003\07C01




**LEGEND**

| | |
|---|---|
| Glacial-Fluvial Recessional Outwash | Transitional Beds |
| Glacial Till | Olympia Gravel |
| Glacial Advance Outwash | Older Undifferentiated Deposits |

Ves-29 Location of Resistivity Sounding

**WWD** Well Number

—?— — Inferred Geologic Contact

Scale:

Horizontal 1"=2,000'

Vertical 1"=200'

Note: Vertical Exaggeration 10X

EMCON Northwest, Inc.

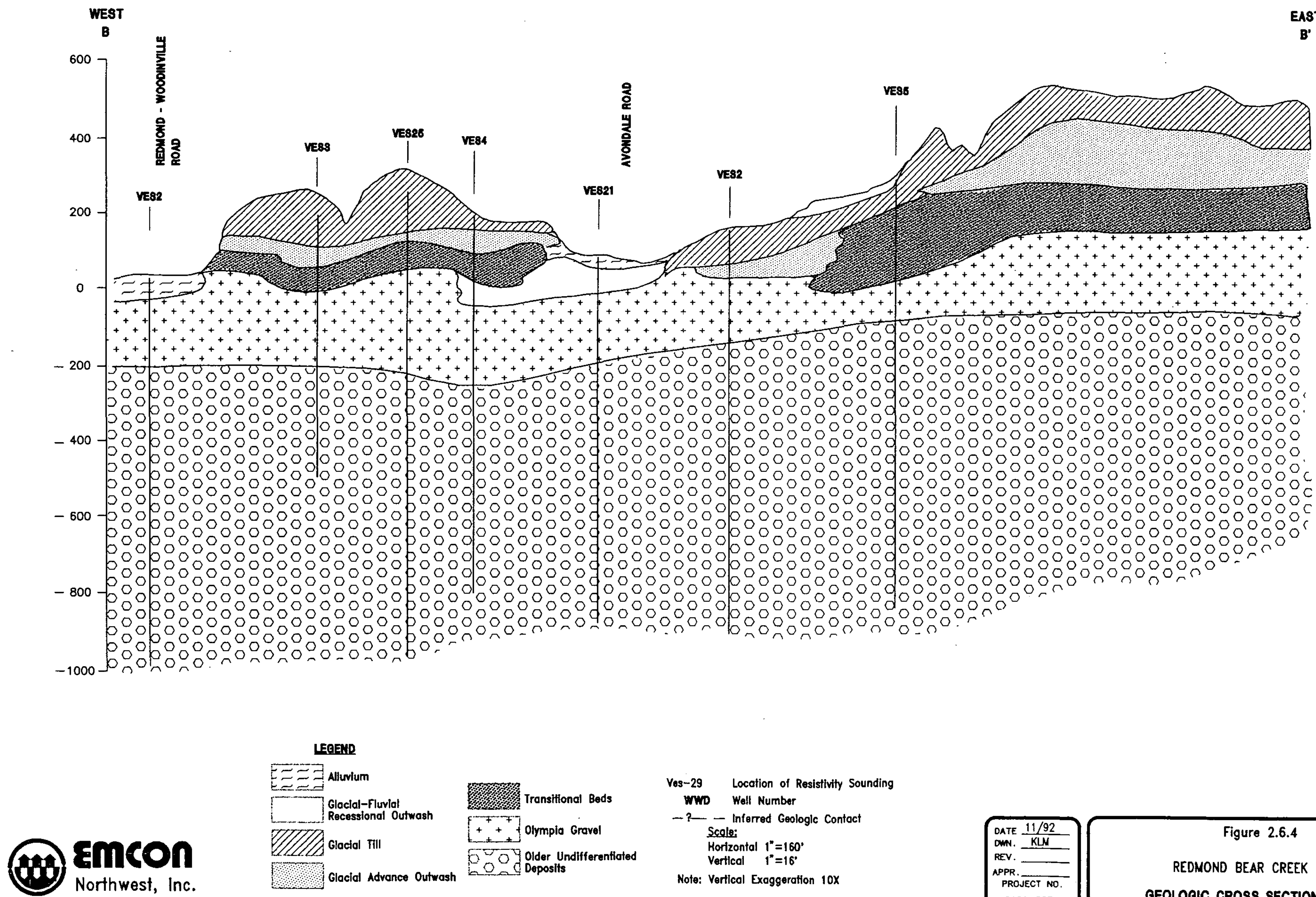
DATE 10/92
DWN. JG
REV.
APPR.
PROJECT NO. 0121003.03

Figure 2.6.3

REDMOND BEAR CREEK GWMA

**GEOLOGIC CROSS-SECTION A-A'**

1= 1 3-08-93 D:\0121\003\03C12

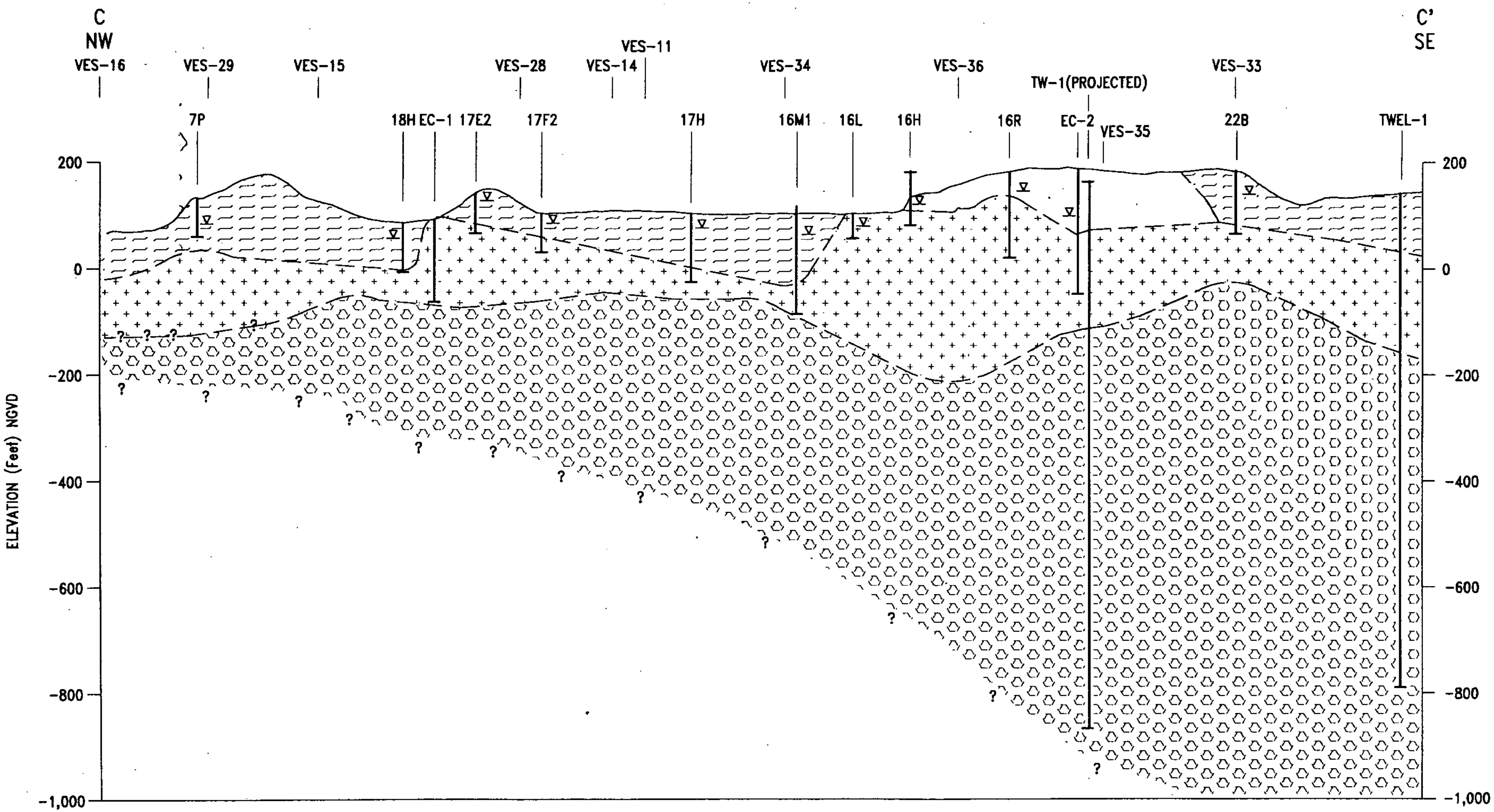



DATE 11/92
DWN. KLM
REV.
APPR.
PROJECT NO. 0121-003.07

Figure 2.6.4

REDMOND BEAR CREEK GWMA

**GEOLOGIC CROSS SECTION B - B'**




**LEGEND**

Alluvium

Glacial-Fluvial Recessional Outwash

Glacial Till

Glacial Advance Outwash

Transitional Beds

Olympia Gravel

Older Undifferentiated Deposits

Ves-29 Location of Resistivity Sounding

WWD Well Number

—?— — Inferred Geologic Contact

Scale:

Horizontal 1"=2,000'

Vertical 1"=200'

Note: Vertical Exaggeration 10X

EMCON Northwest, Inc.

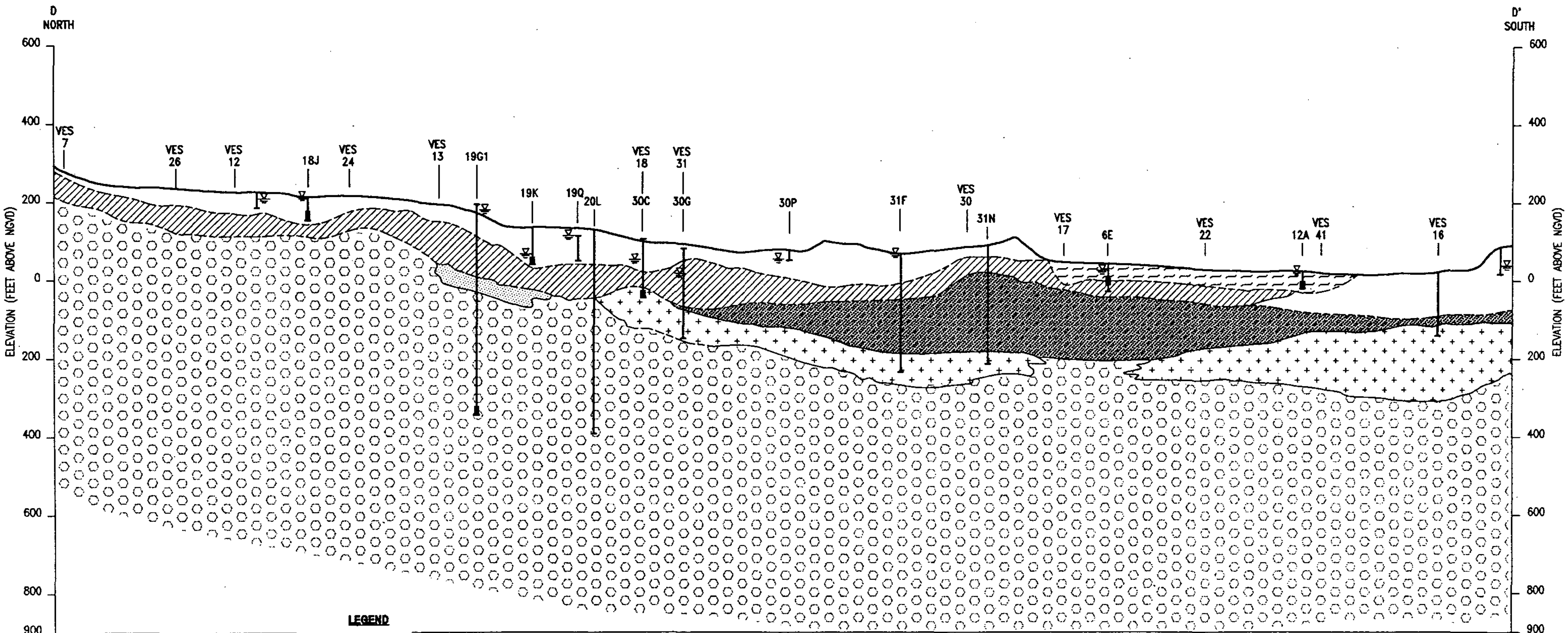
| | |
|---|---|
| DATE | 11/92 |
| DWN. | KLM |
| REV. | |
| APPR. | |
| PROJECT NO. | 0121-003.07 |

Figure 2.6.5

REDMOND BEAR CREEK GWMA

**GEOLOGIC CROSS-SECTION C-C'**

1= 1 3-08-93 J:..\0121\003\07C03




**LEGEND**

Alluvium

Glacial-Fluvial Recessional Outwash

Glacial Till

Glacial Advance Outwash

Transitional Beds

Olympia Gravel

Older Undifferentiated Deposits

Ves-29 Location of Resistivity Sounding

WWD Well Number

—?— — Inferred Geologic Contact

Scale:

Horizontal 1"=2,000'

Vertical 1"=200'

Note: Vertical Exaggeration 10X

EMCON Northwest, Inc.

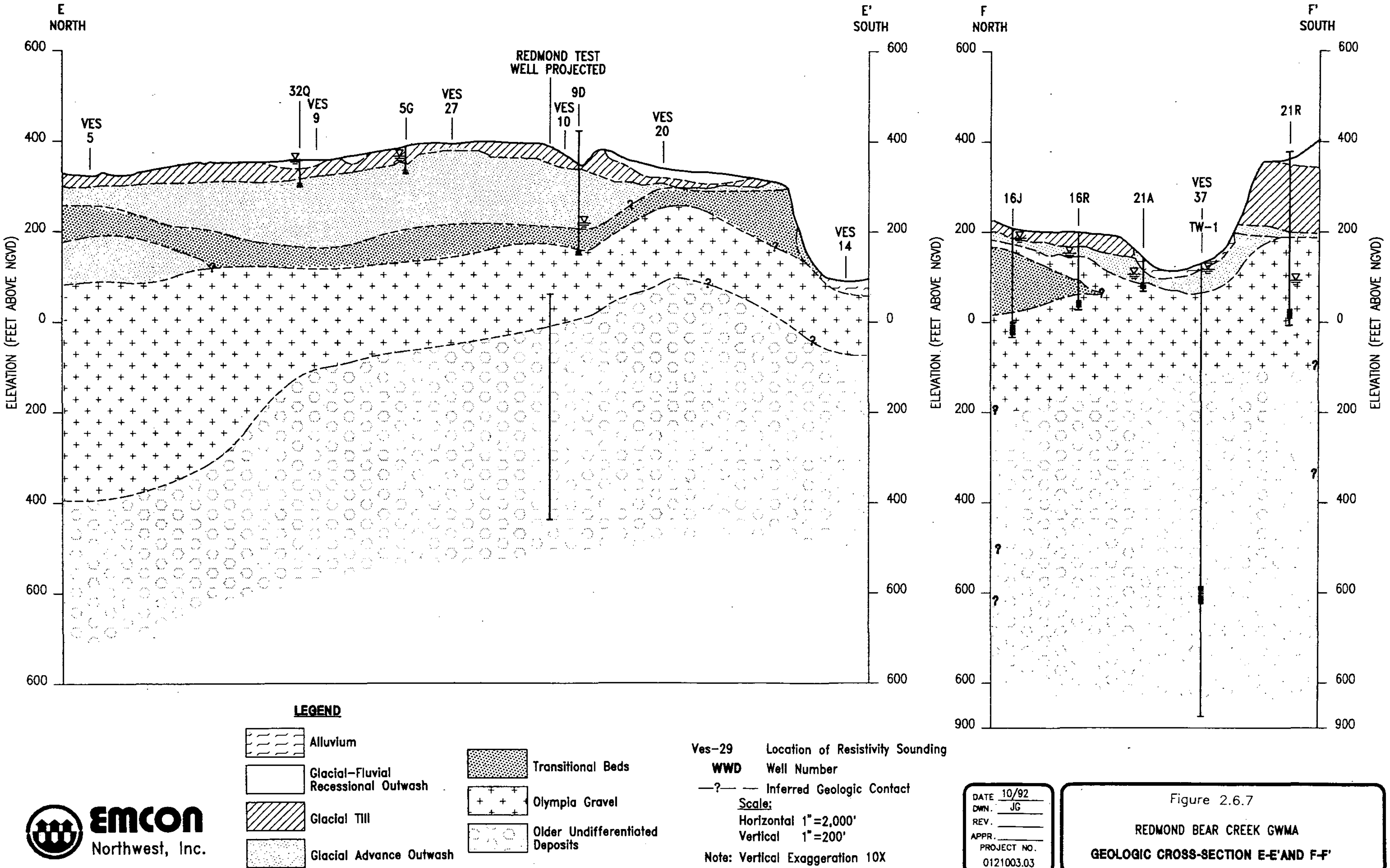
DATE 10/92
DWN. JG
REV.
APPR.
PROJECT NO.
0121003.03

Figure 2.6.6

REDMOND BEAR CREEK GWMA

**GEOLOGIC CROSS-SECTION D-D'**

1= 1 11-16-92 D:\0121\003\03C13




DATE 10/92
DWN. JG
REV.
APPR.
PROJECT NO.
0121003.03

Figure 2.6.7

REDMOND BEAR CREEK GWMA

**GEOLOGIC CROSS-SECTION E-E' AND F-F'**

1= 1 11-15-92 D:\0121\003\03C14

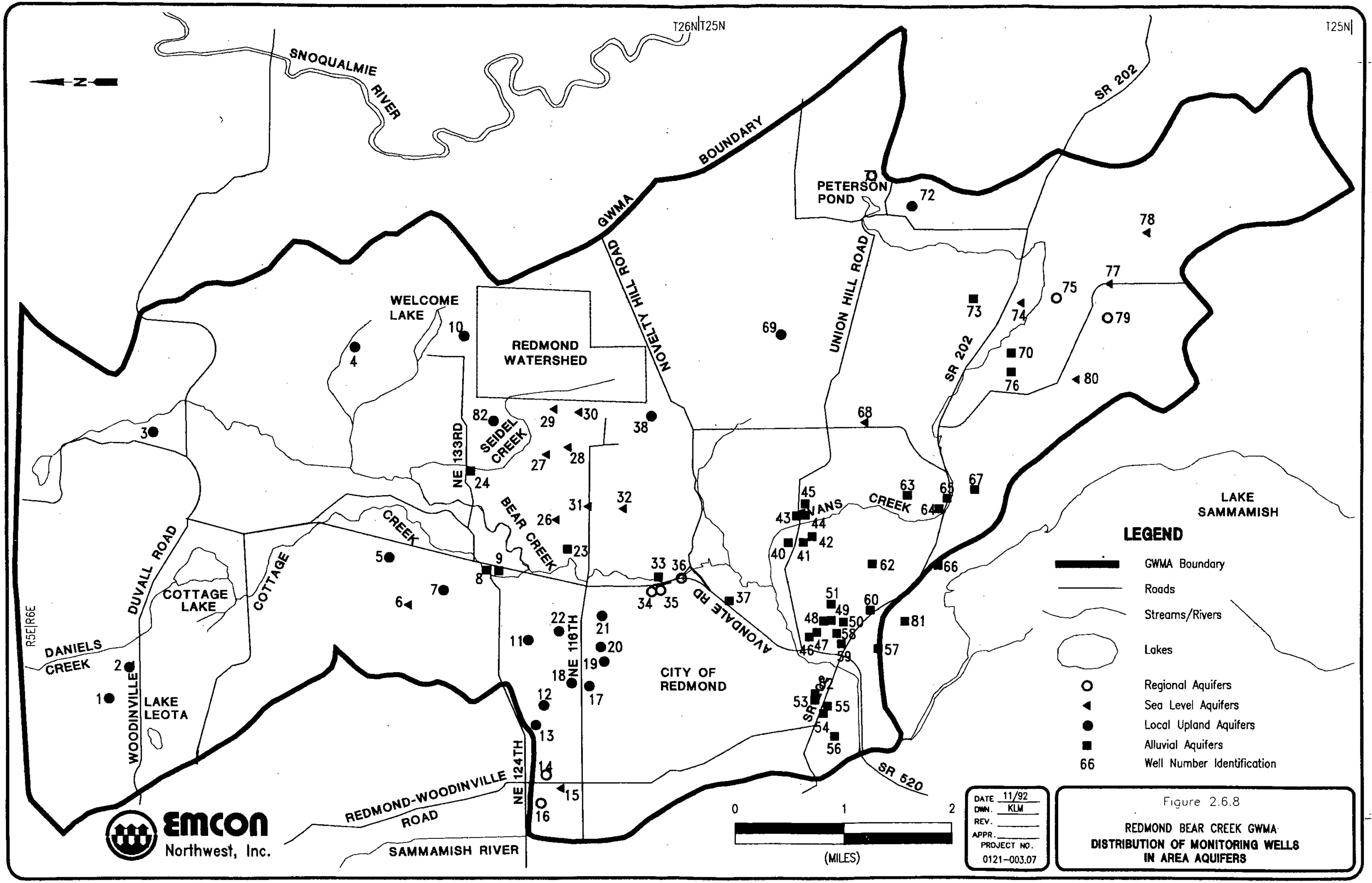



Figure 2.6.8

REDMOND BEAR CREEK GWMA
DISTRIBUTION OF MONITORING WELLS IN AREA AQUIFERS

1=4000 11-13-92 0121\003\07C15

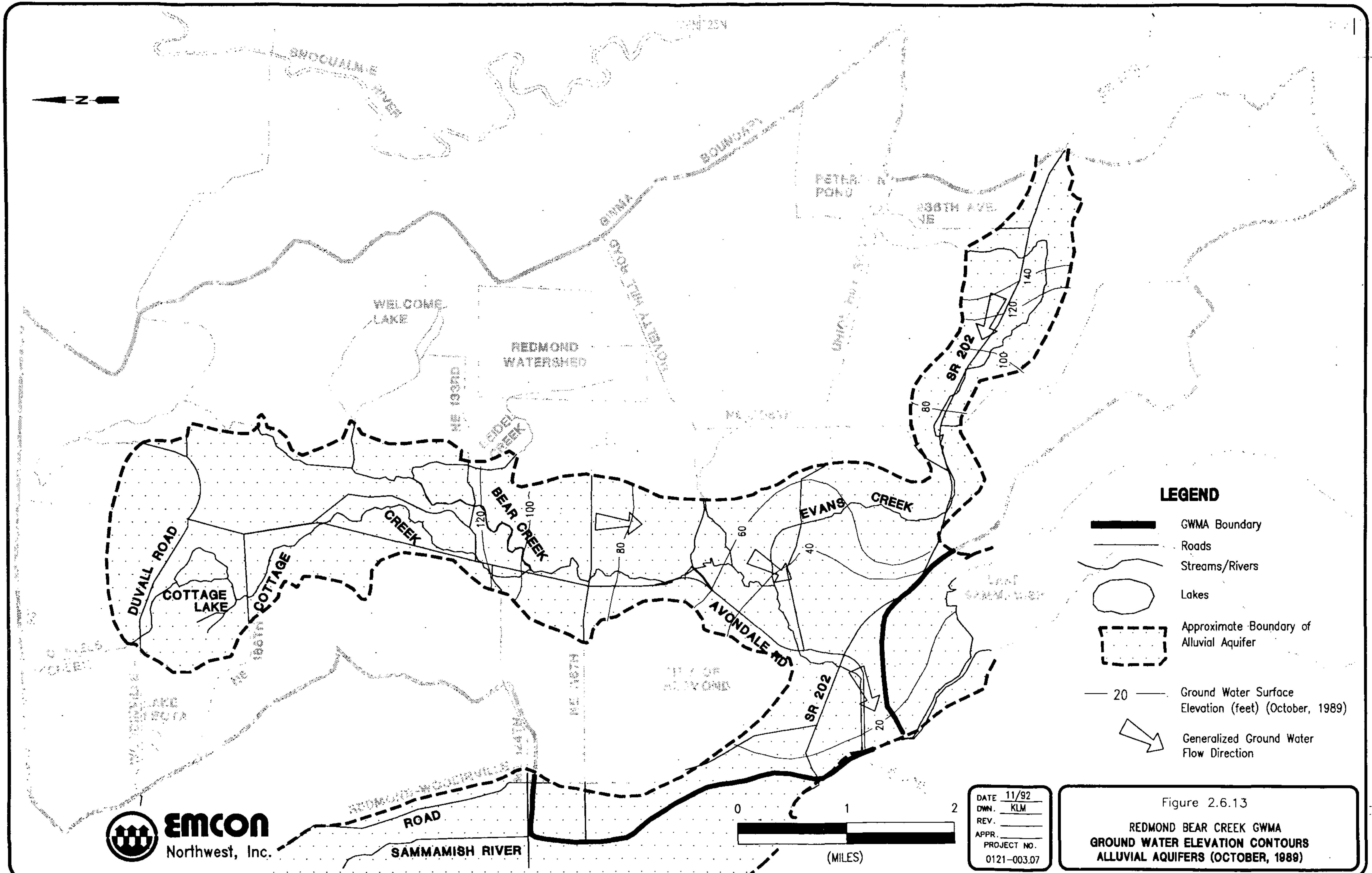



Figure 2.6.13

REDMOND BEAR CREEK GWMA
GROUND WATER ELEVATION CONTOURS
ALLUVIAL AQUIFERS (OCTOBER, 1989)

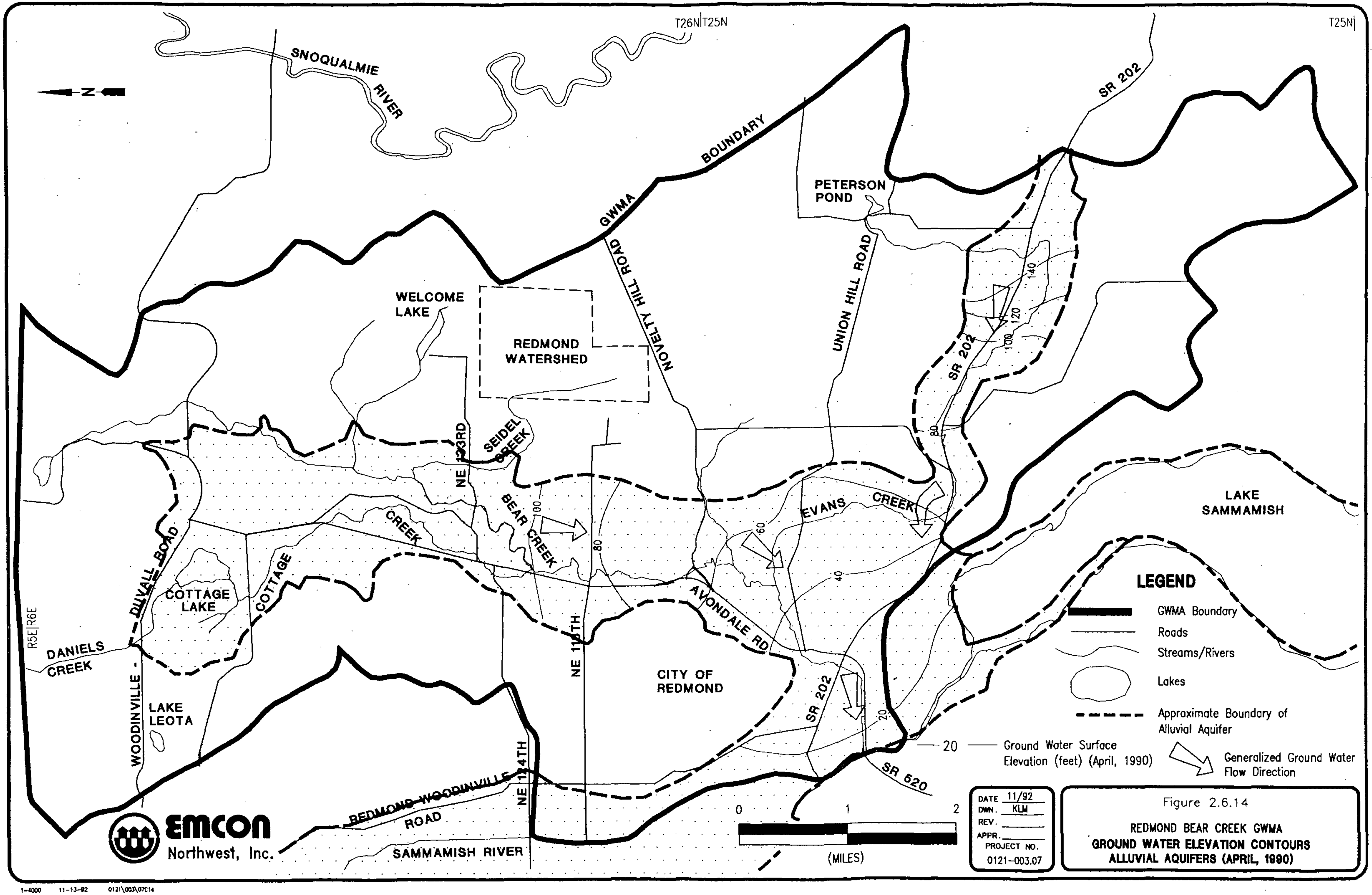



Figure 2.6.14

REDMOND BEAR CREEK GWMA
GROUND WATER ELEVATION CONTOURS
ALLUVIAL AQUIFERS (APRIL, 1990)

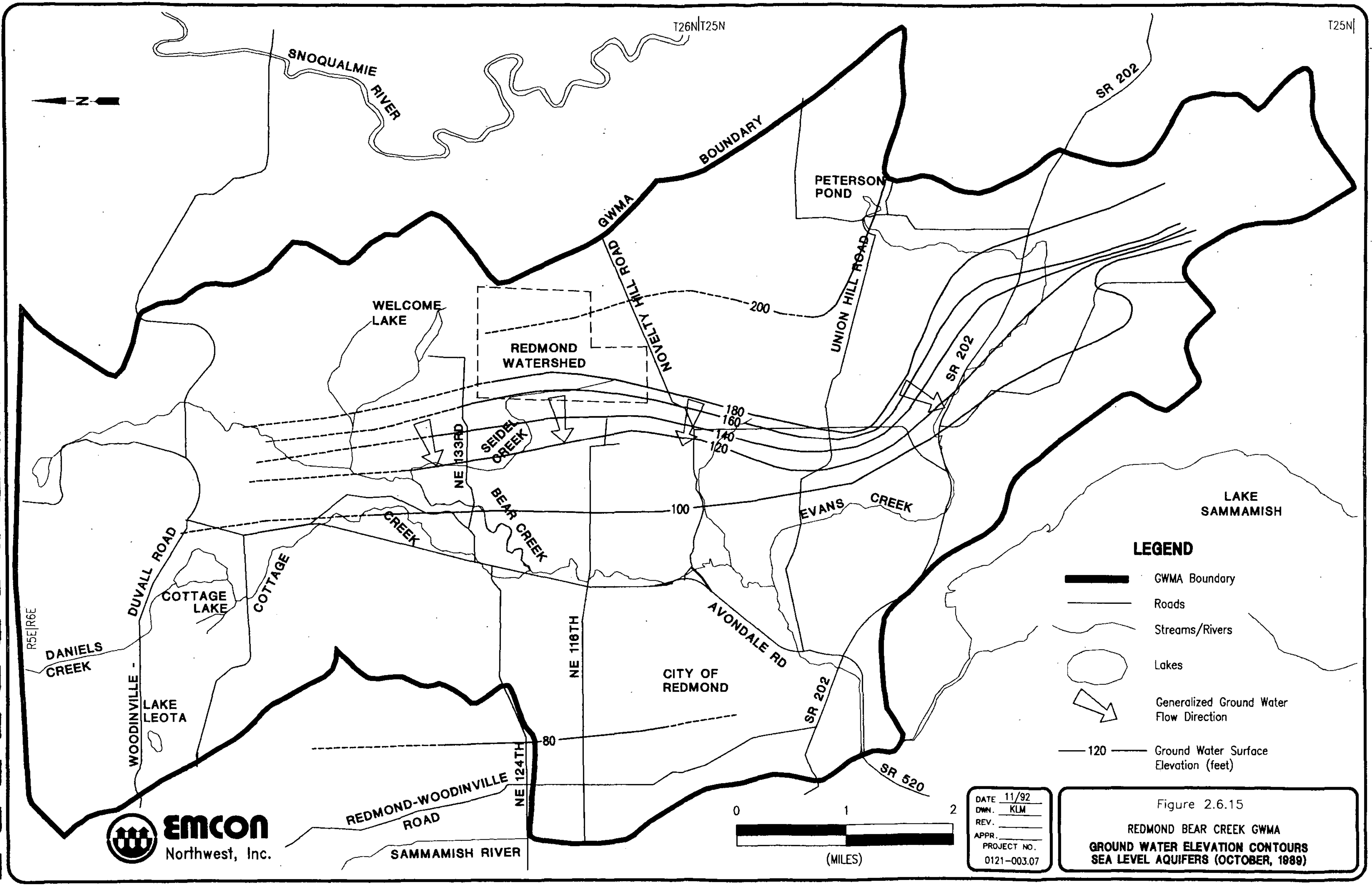
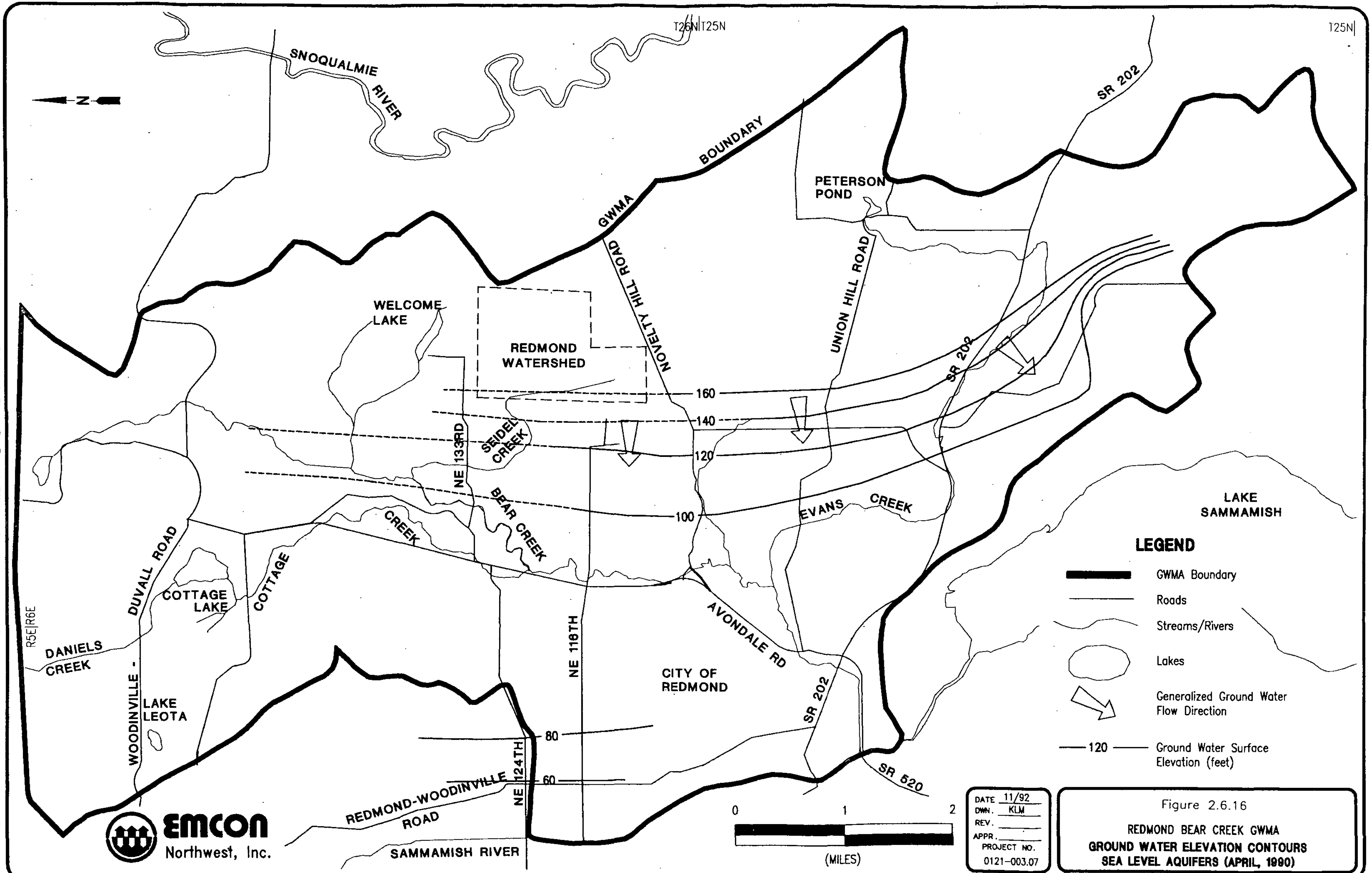



Figure 2.6.15

REDMOND BEAR CREEK GWMA

**GROUND WATER ELEVATION CONTOURS SEA LEVEL AQUIFERS (OCTOBER, 1989)**

1=4000 11-13-92 0121\003\07C09




| | |
|---|---|
| DATE | 11/92 |
| DWN. | KLM |
| REV. | |
| APPR. | |
| PROJECT NO. | 0121-003.07 |

Figure 2.6.16

REDMOND BEAR CREEK GWMA

**GROUND WATER ELEVATION CONTOURS SEA LEVEL AQUIFERS (APRIL, 1990)**

1=4000 11-13-92 0121\003\07C08

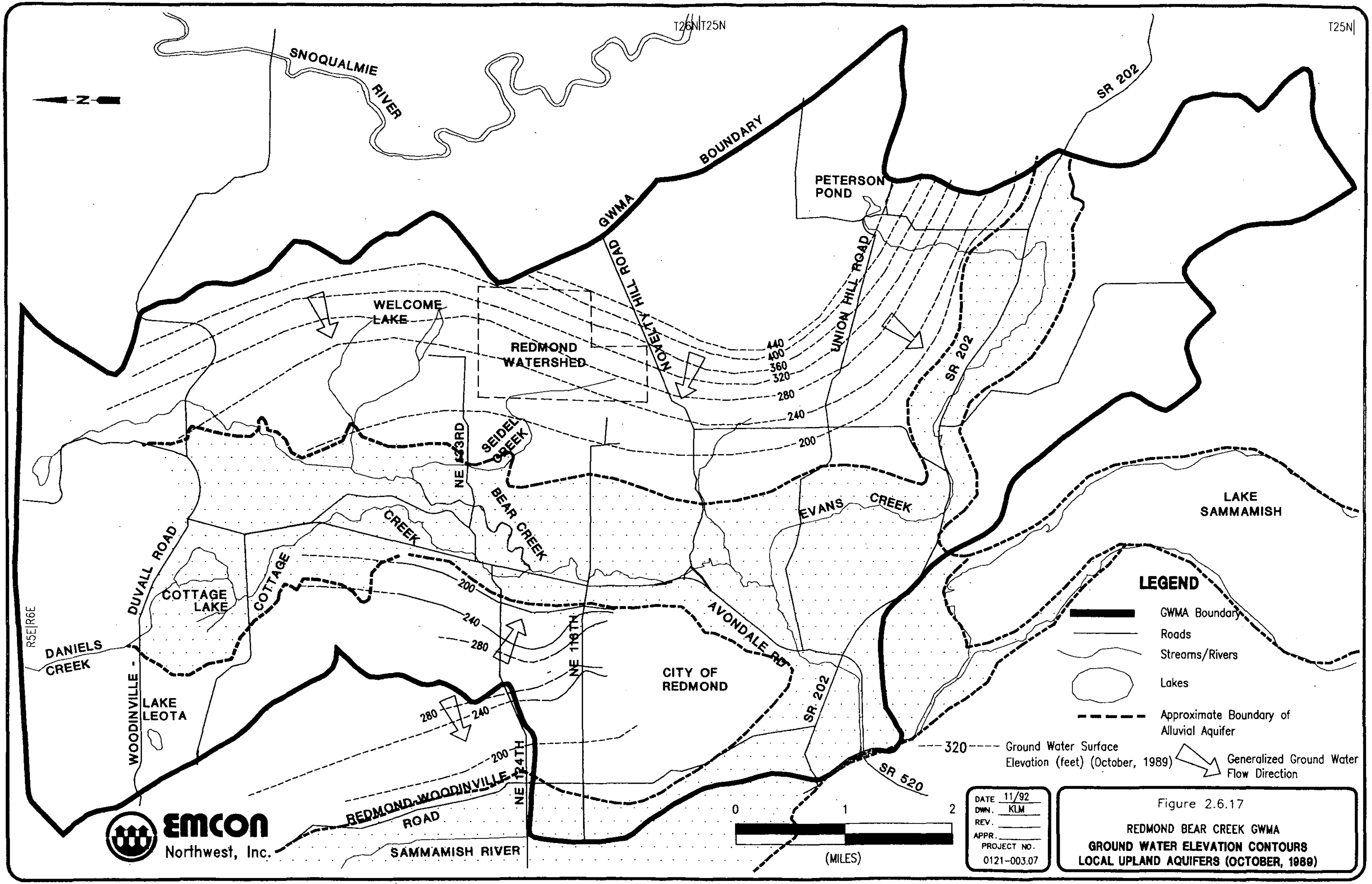



Figure 2.6.17

REDMOND BEAR CREEK GWMA
GROUND WATER ELEVATION CONTOURS
LOCAL UPLAND AQUIFERS (OCTOBER, 1989)

1=4000 11-13-92 0121\003\07C12

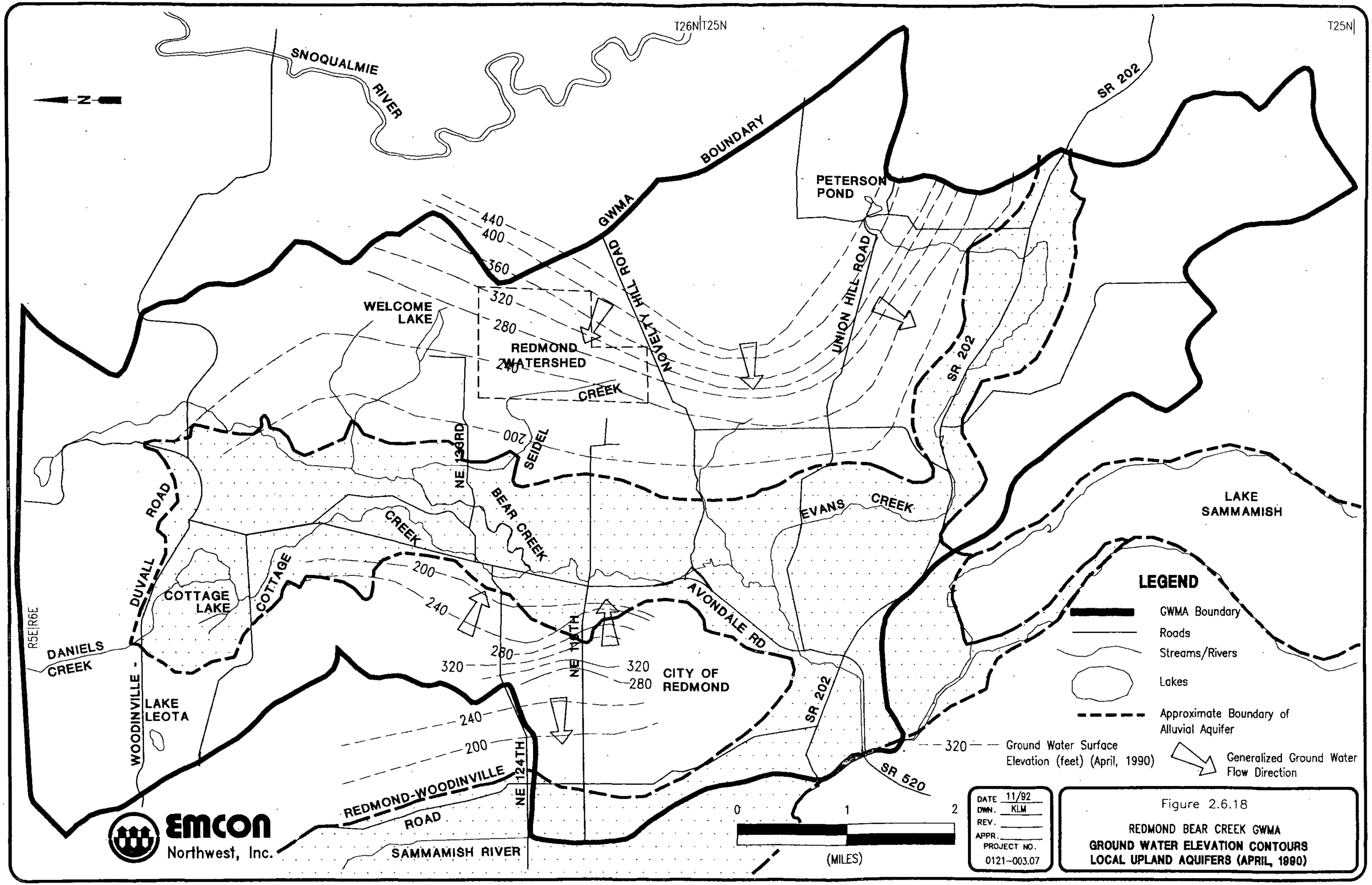



Figure 2.6.18

REDMOND BEAR CREEK GWMA
**GROUND WATER ELEVATION CONTOURS LOCAL UPLAND AQUIFERS (APRIL, 1990)**

1=4000 11-17-92 0121\003\07C11

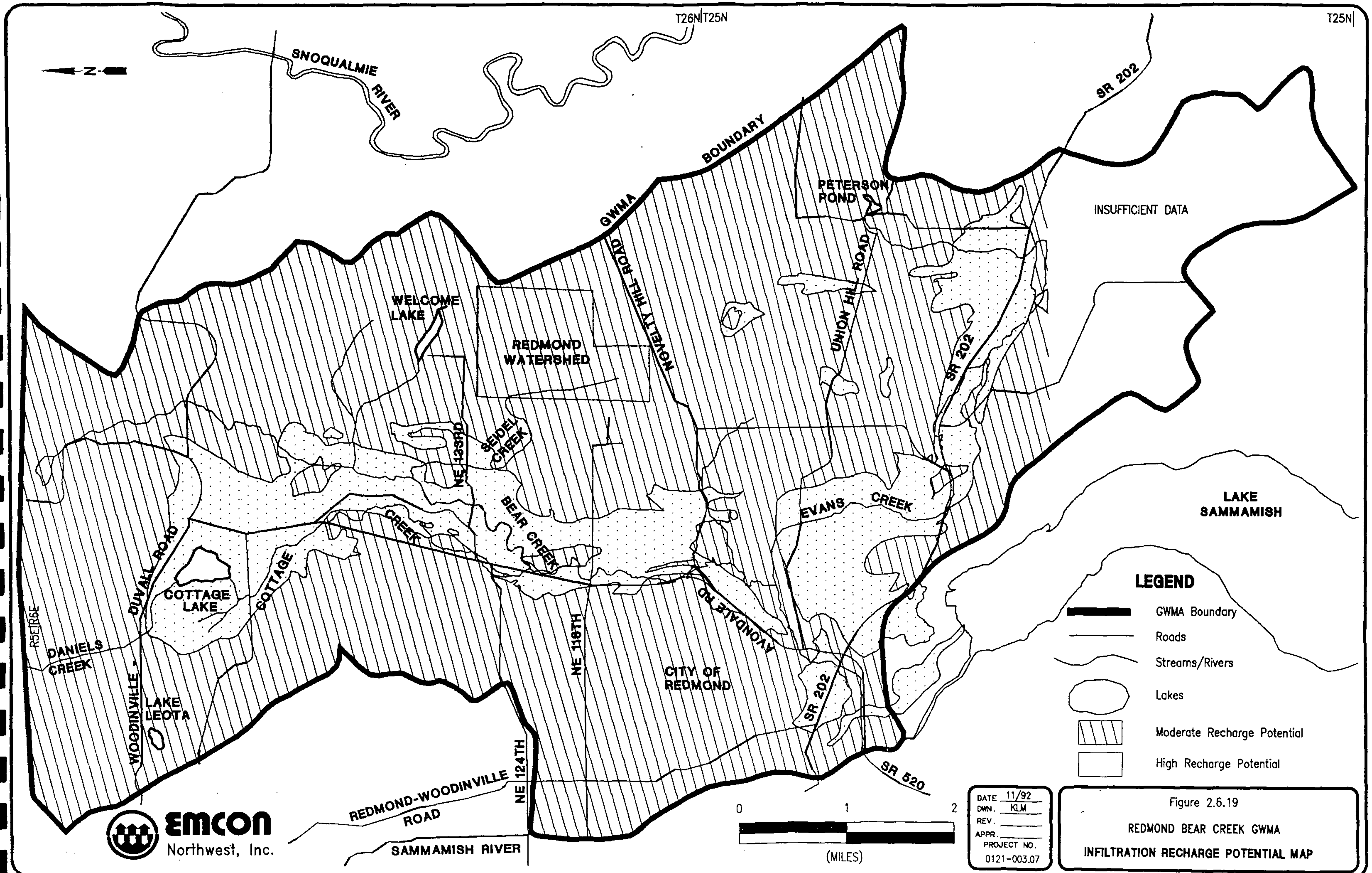



Figure 2.6.19

REDMOND BEAR CREEK GWMA

INFILTRATION RECHARGE POTENTIAL MAP

1=4000 11/9/94 0121\003\07C18

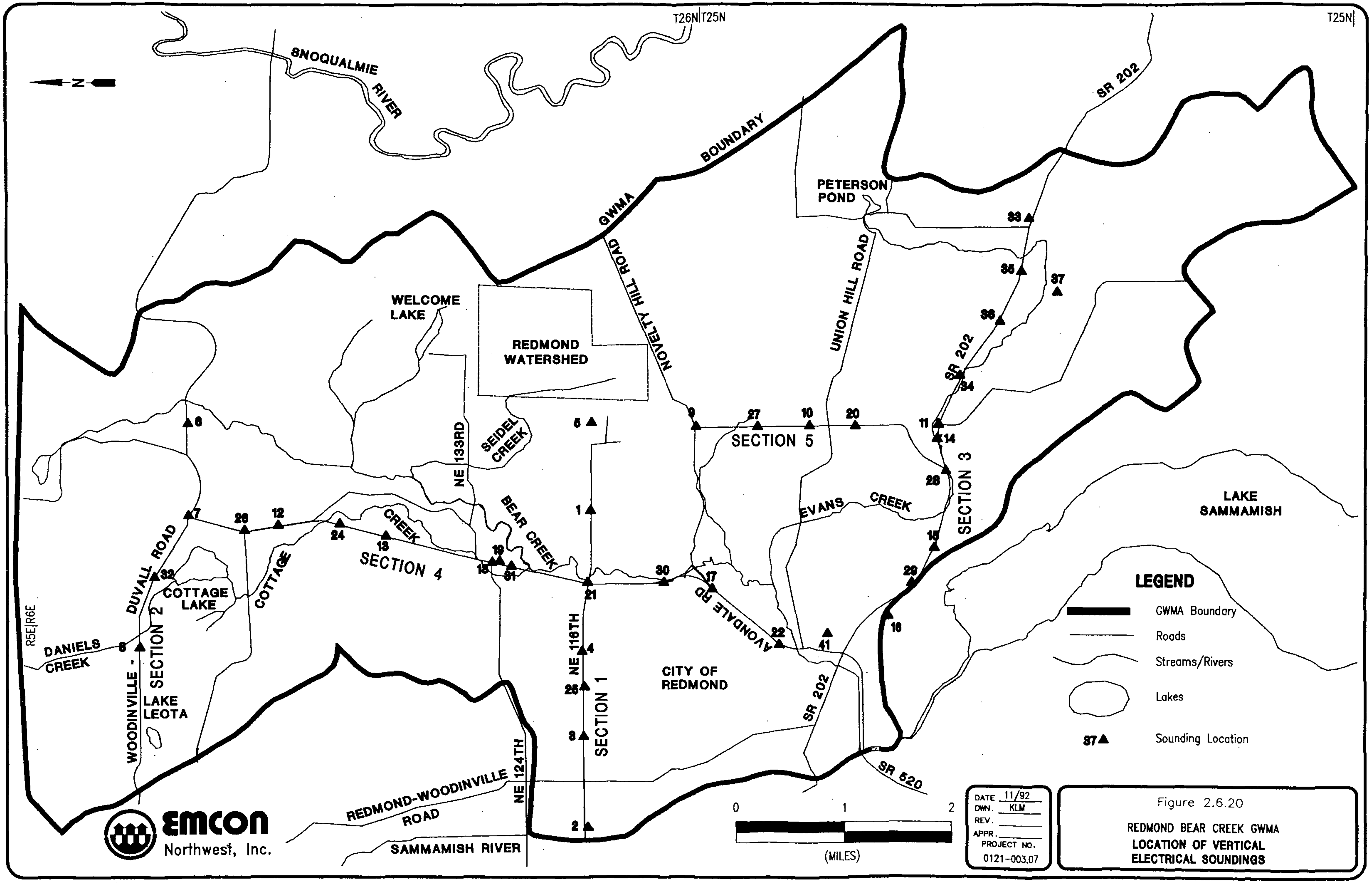
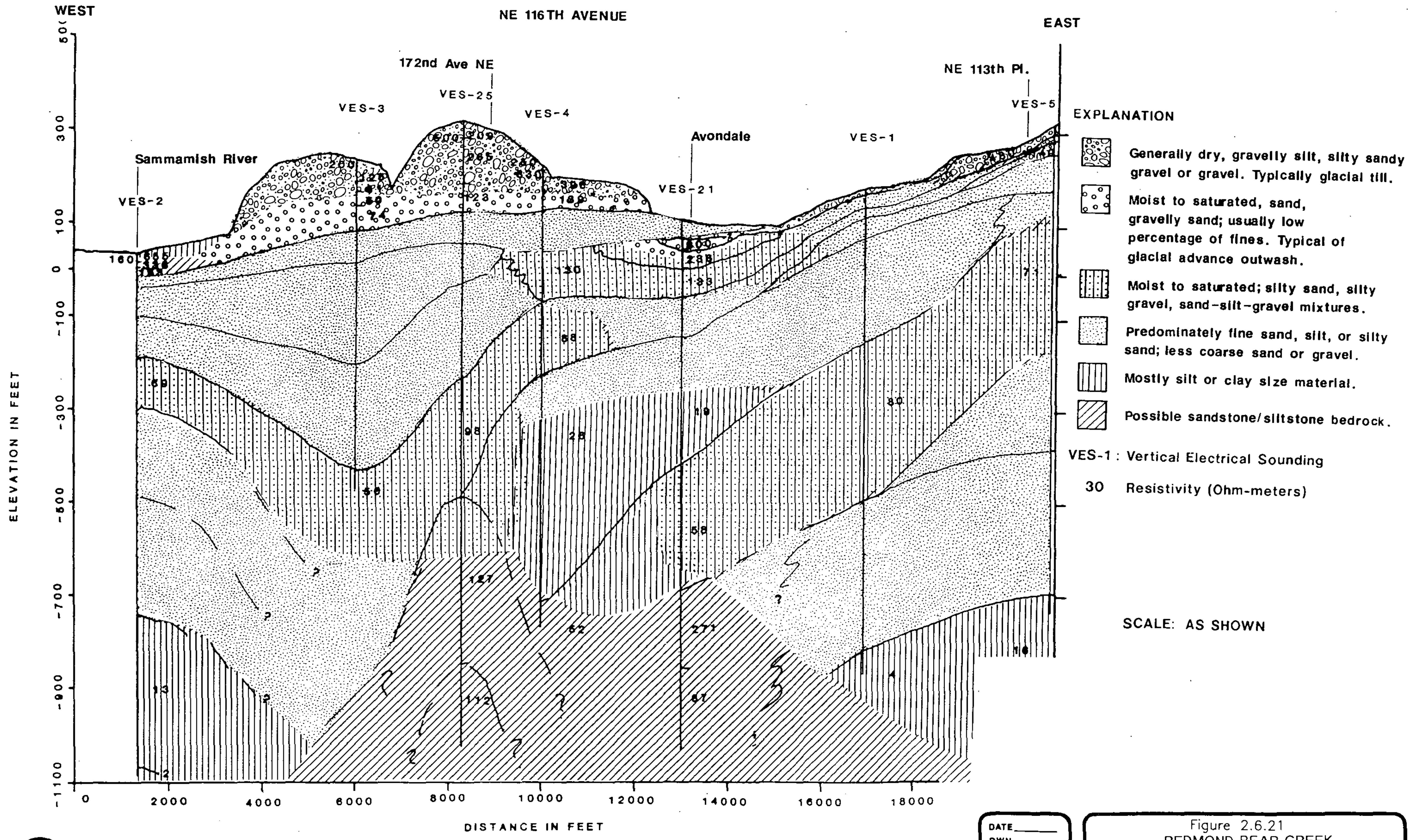



Figure 2.6.20

REDMOND BEAR CREEK GWMA
LOCATION OF VERTICAL ELECTRICAL SOUNDINGS

150969

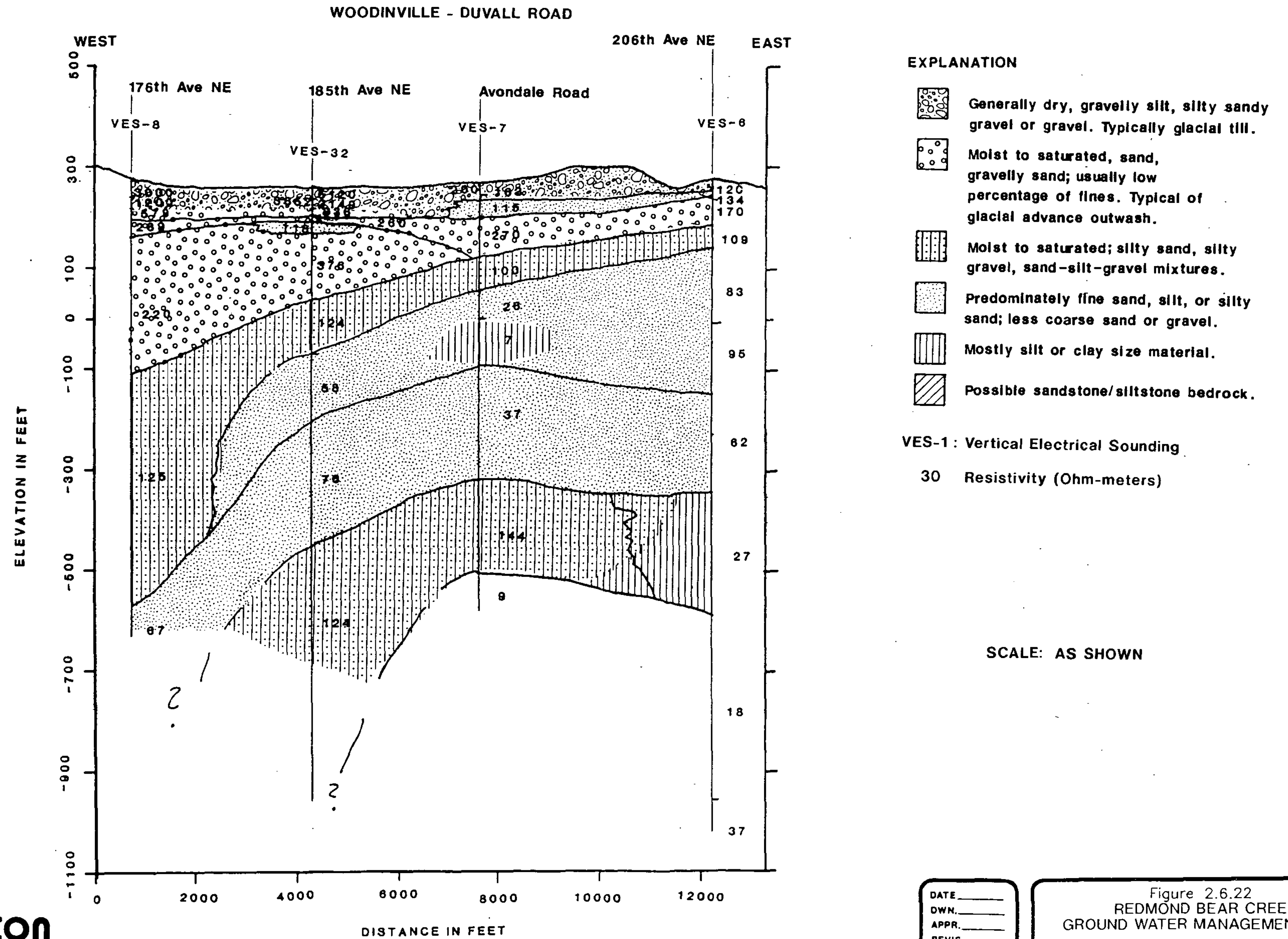



EMCON Northwest, Inc.

DATE____
DWN.____
APPR.____
REVIS.____
PROJECT NO. 0121-003.07

Figure 2.6.21
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
ELECTRICAL RESISTIVITY STUDY
GEOLOGIC INTERPRETATION SECTION 1

150969



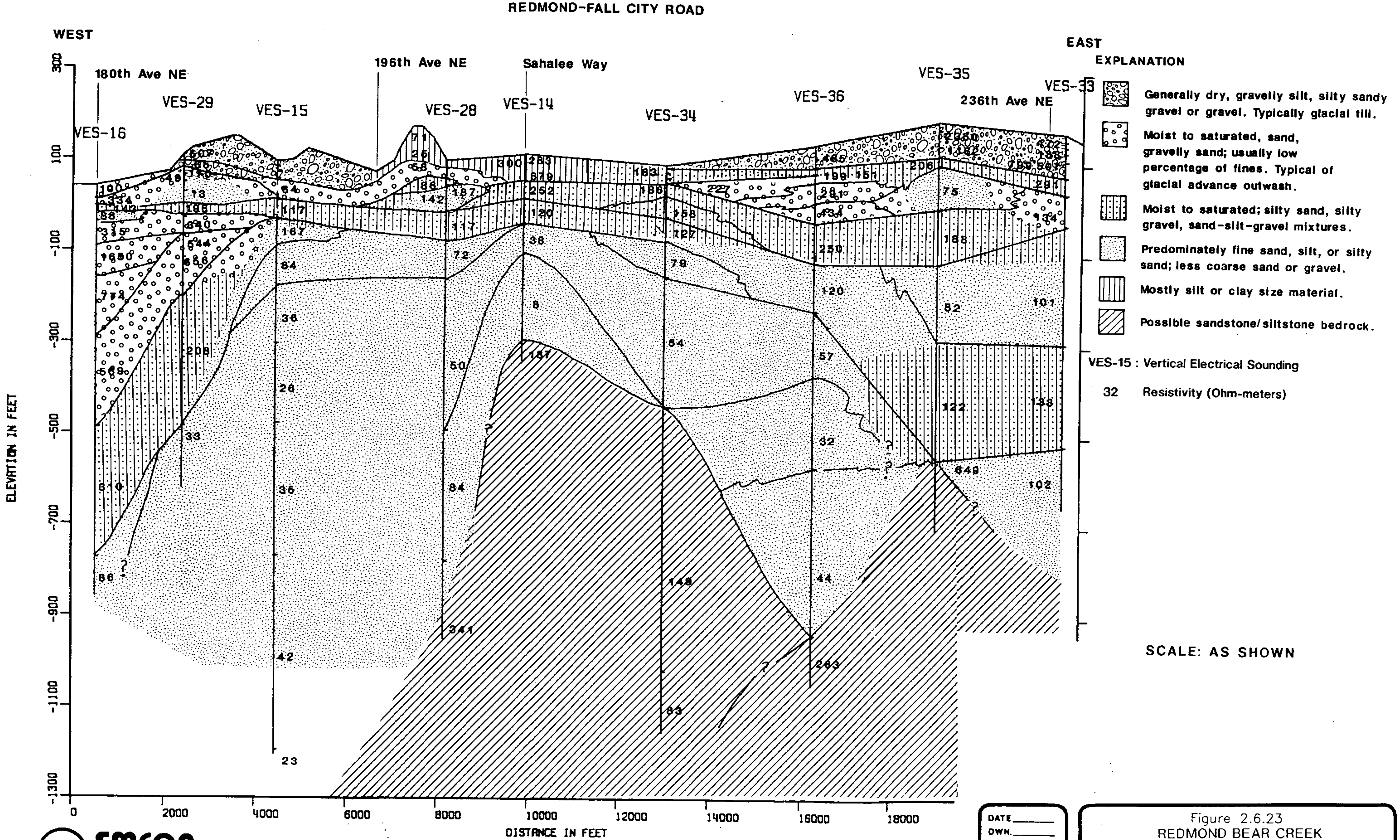

EMCON Northwest, Inc.

DATE ______
DWN. ______
APPR. ______
REVIS. ______
PROJECT NO. 0121-003.07

Figure 2.6.22
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

ELECTRICAL RESISTIVITY STUDY
GEOLOGIC INTERPRETATION SECTION 2

150969

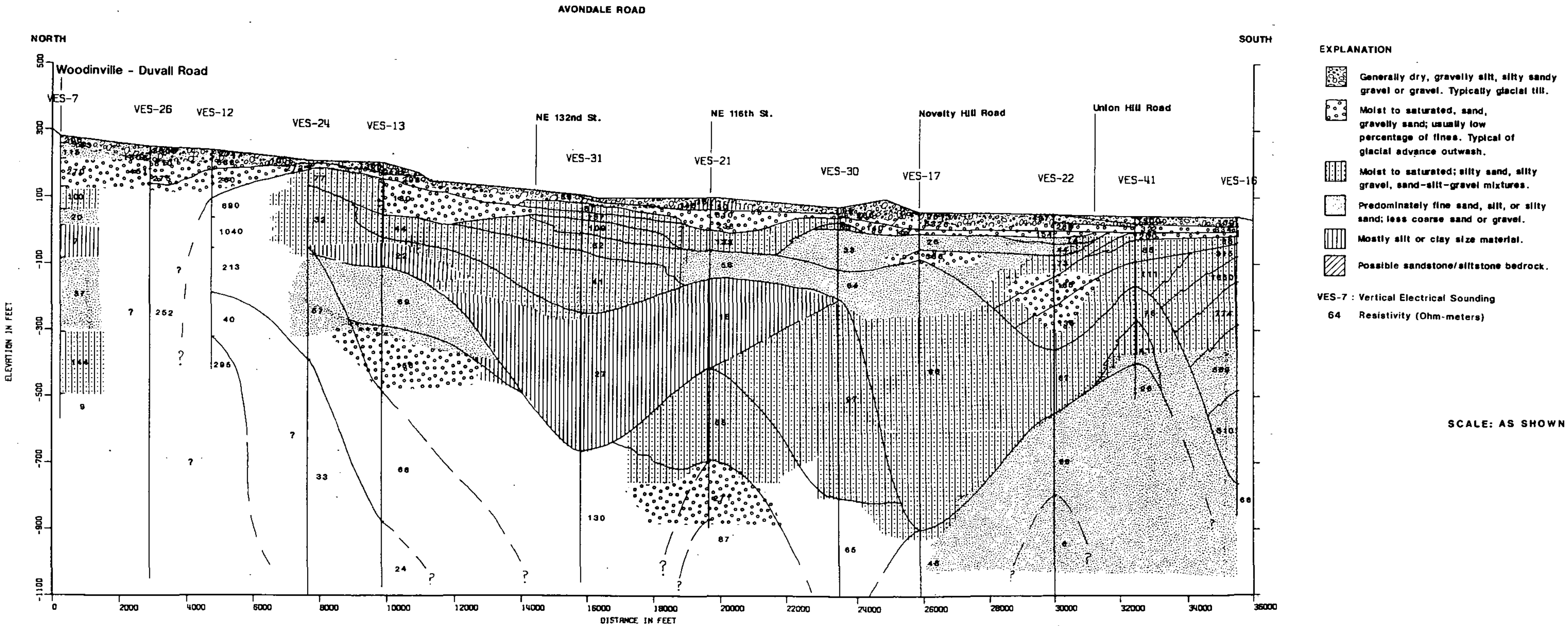



EMCON Northwest, Inc.

DATE
DWN.
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.23
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
ELECTRICAL RESISTIVITY STUDY
GEOLOGIC INTERPRETATION SECTION 3

150969

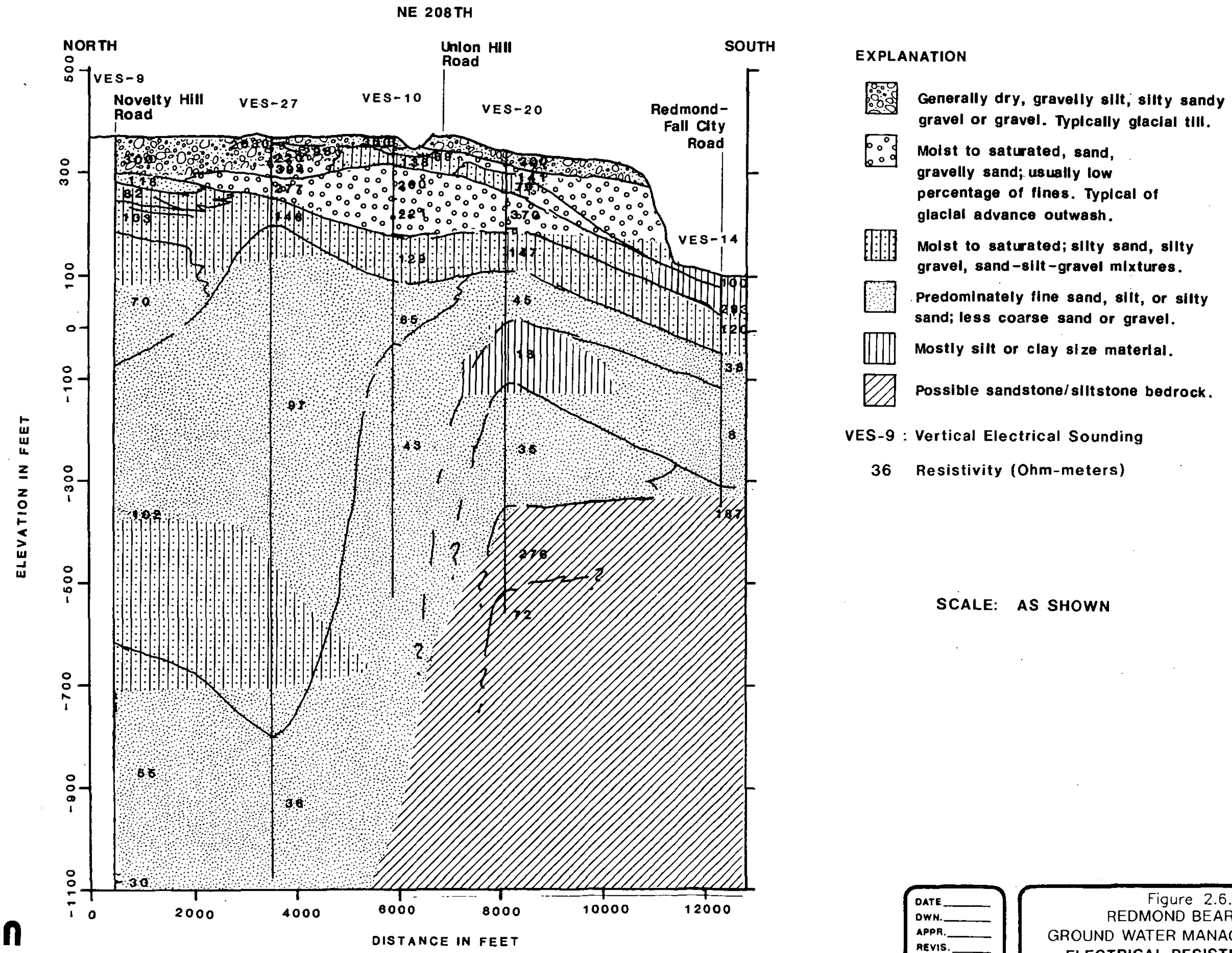



EMCON Northwest, Inc.

DATE______
DWN.______
APPR.______
REVIS.______
PROJECT NO.
0121-003.07

Figure 2.6.24
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
ELECTRICAL RESISTIVITY STUDY
GEOLOGIC INTERPRETATION SECTION 4

150969




EMCON Northwest, Inc.

DATE____
DWN.____
APPR.____
REVIS.____
PROJECT NO. 0121-003.07

Figure 2.6.25
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
ELECTRICAL RESISTIVITY STUDY
GEOLOGIC INTERPRETATION SECTION 5

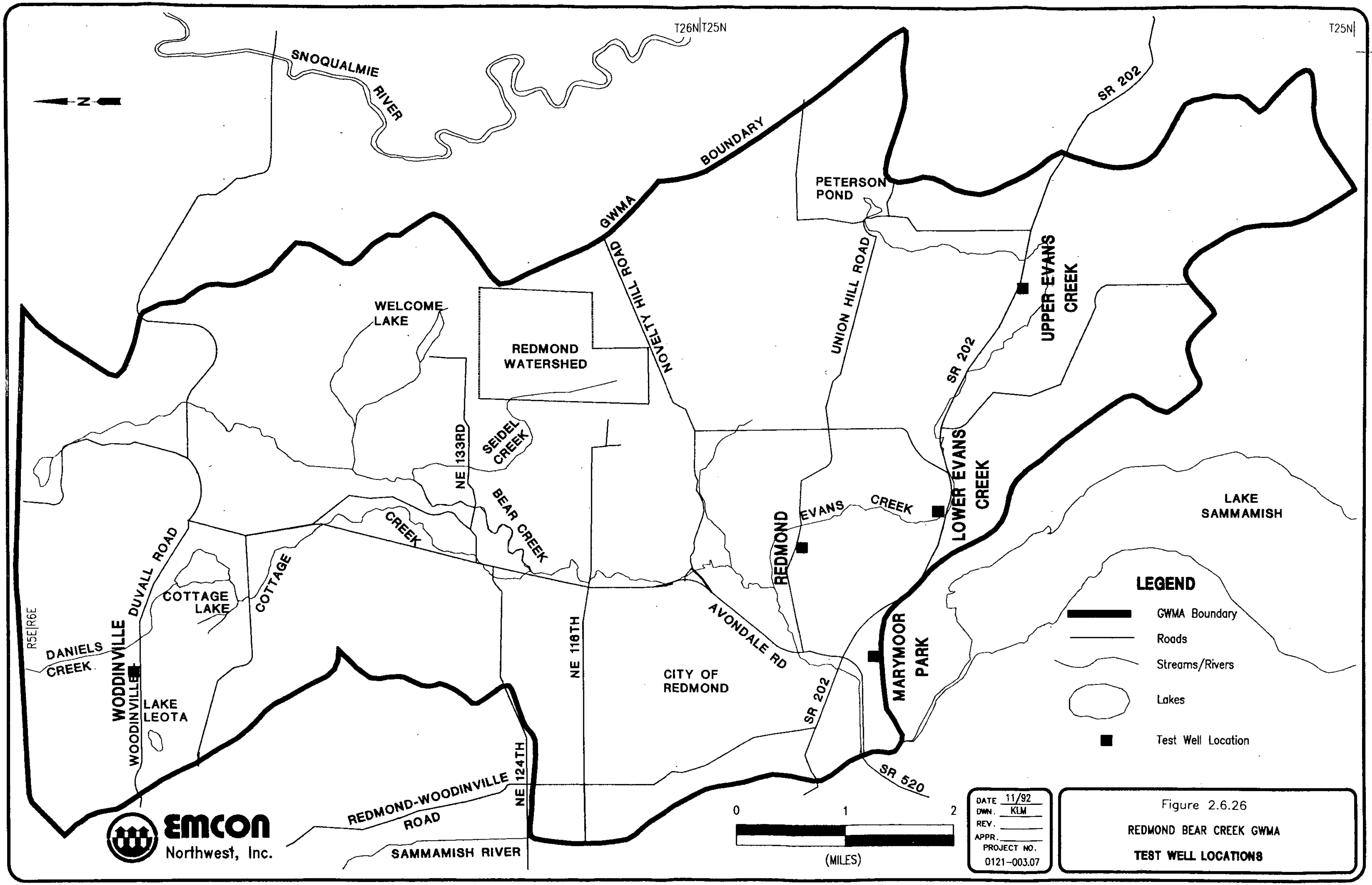



Figure 2.6.26
REDMOND BEAR CREEK GWMA
TEST WELL LOCATIONS

1=4000 11-13-92 0121\003\07C06

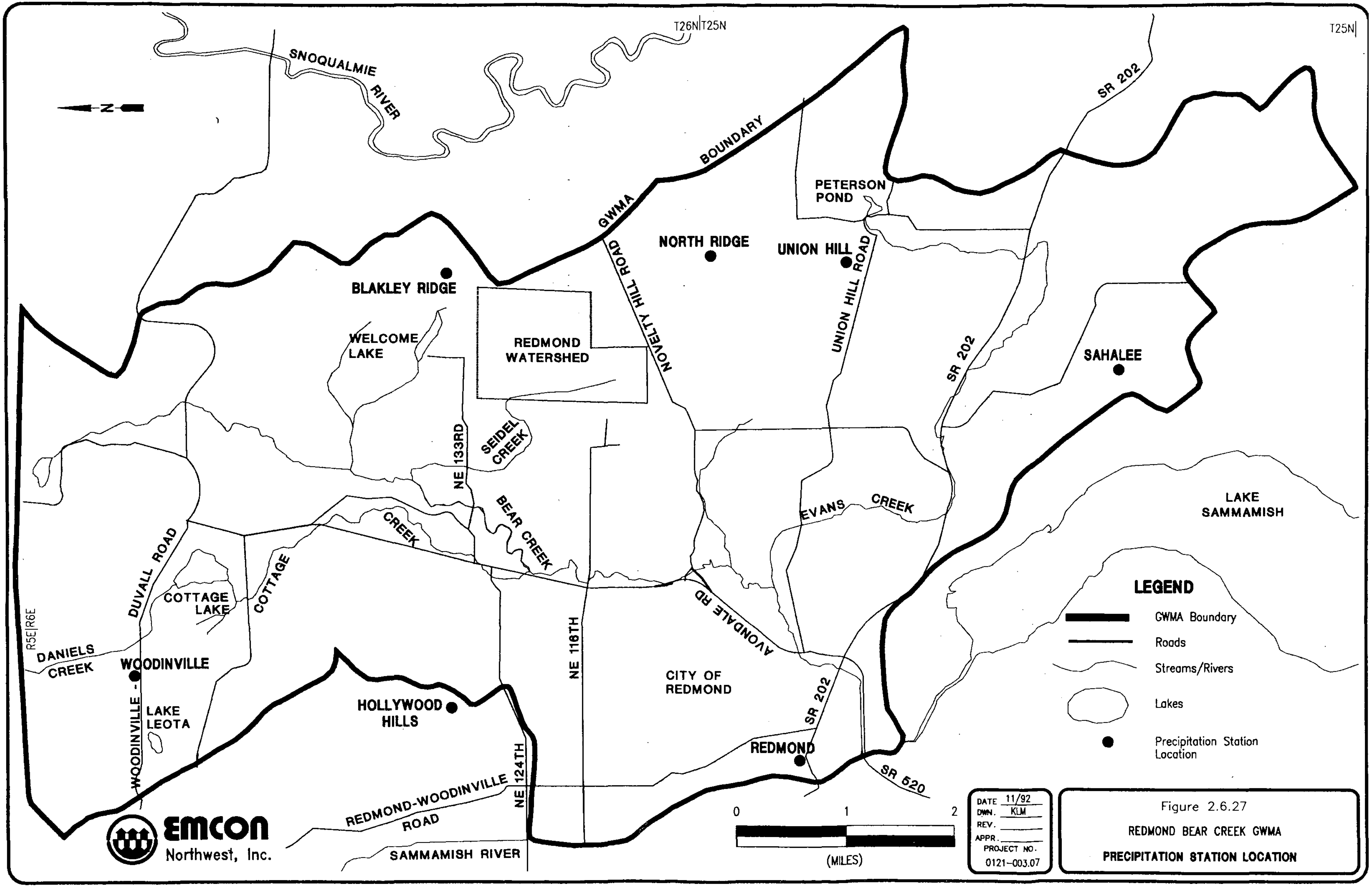
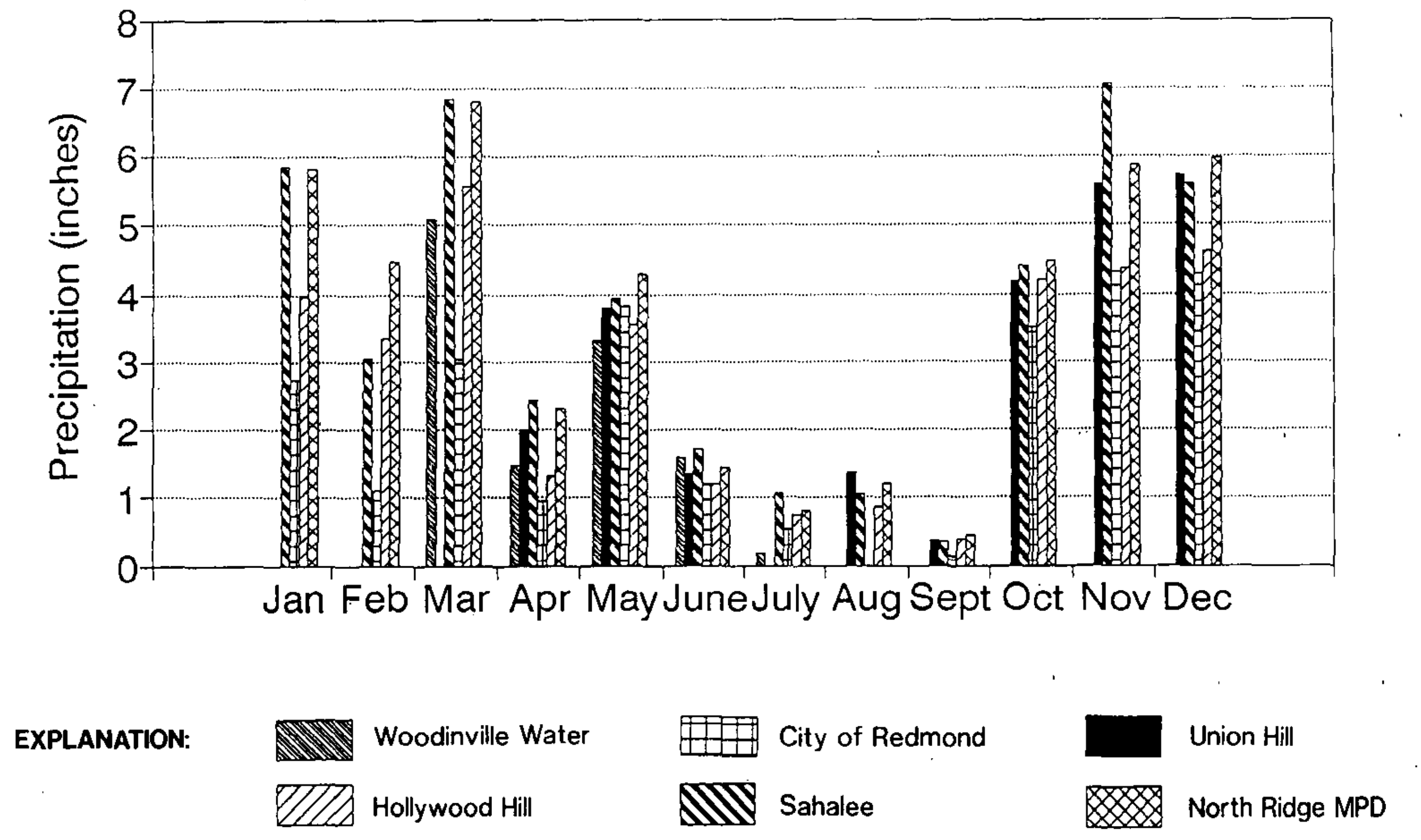



Figure 2.6.27
REDMOND BEAR CREEK GWMA
PRECIPITATION STATION LOCATION

1=4000 11-17-92 0121\003\07C05

150969



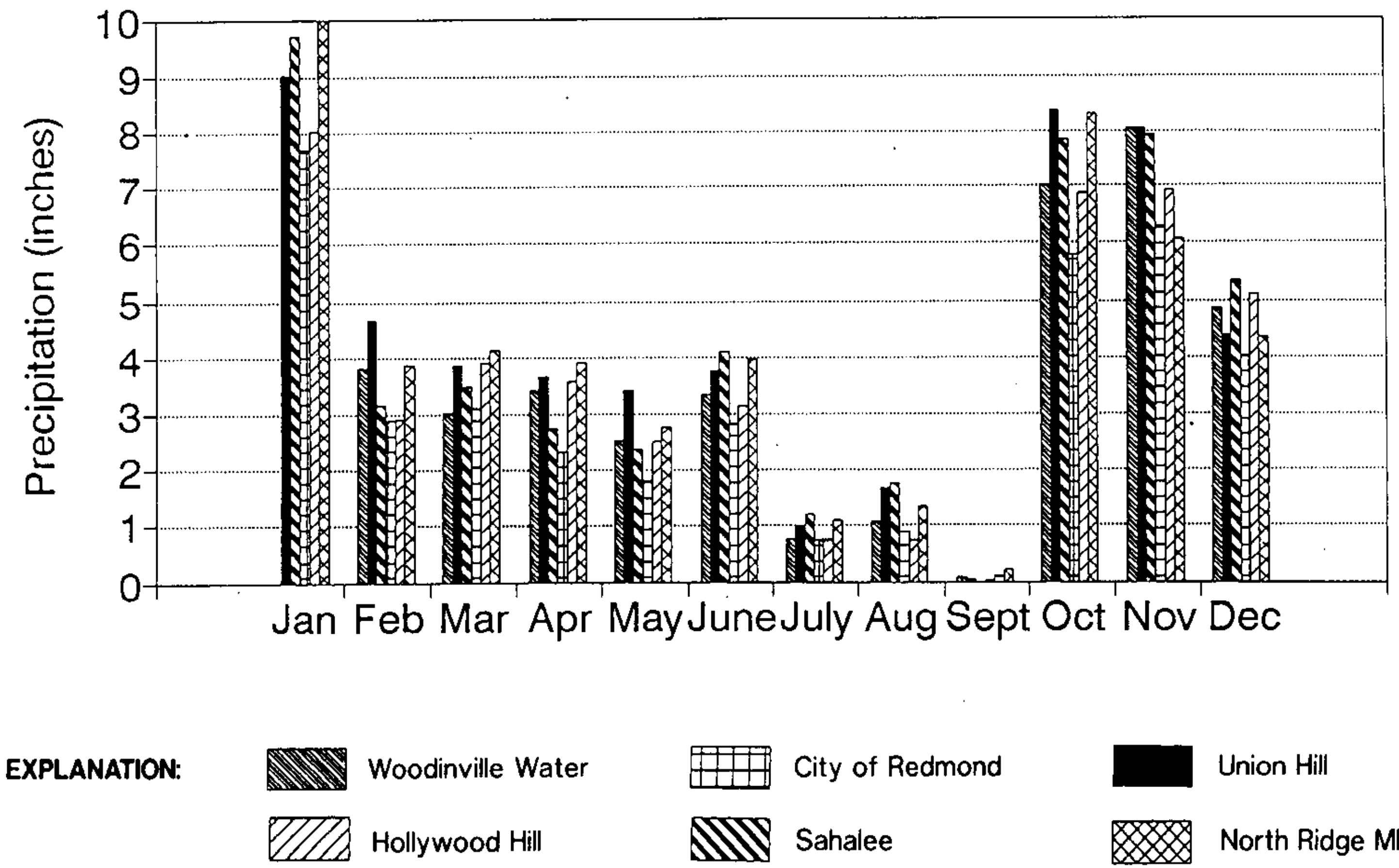

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.28
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**MONTHLY PRECIPITATION 1989**

150969



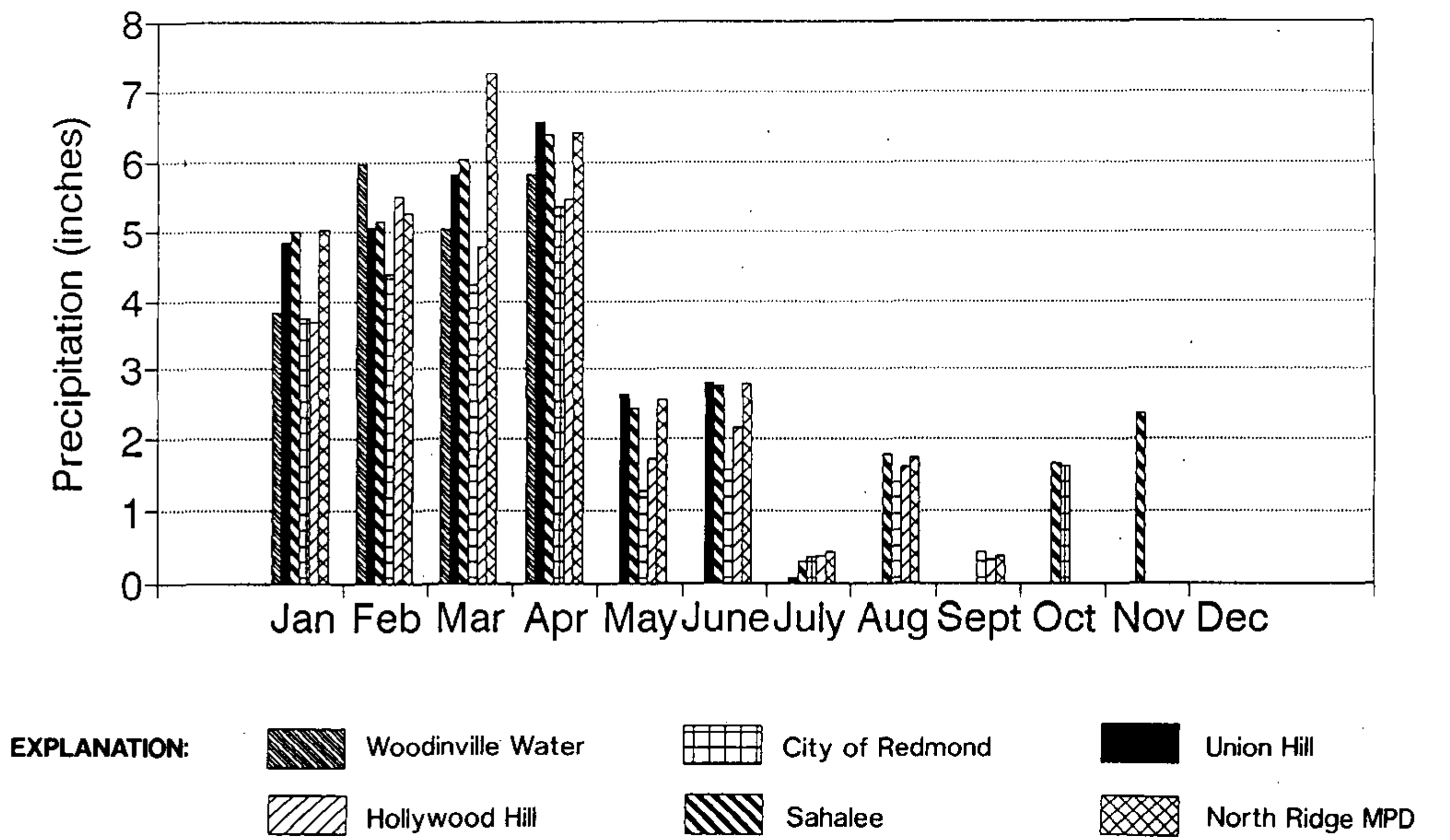

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.29
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**MONTHLY PRECIPITATION 1990**

150969




EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.30
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**MONTHLY PRECIPITATION 1991**

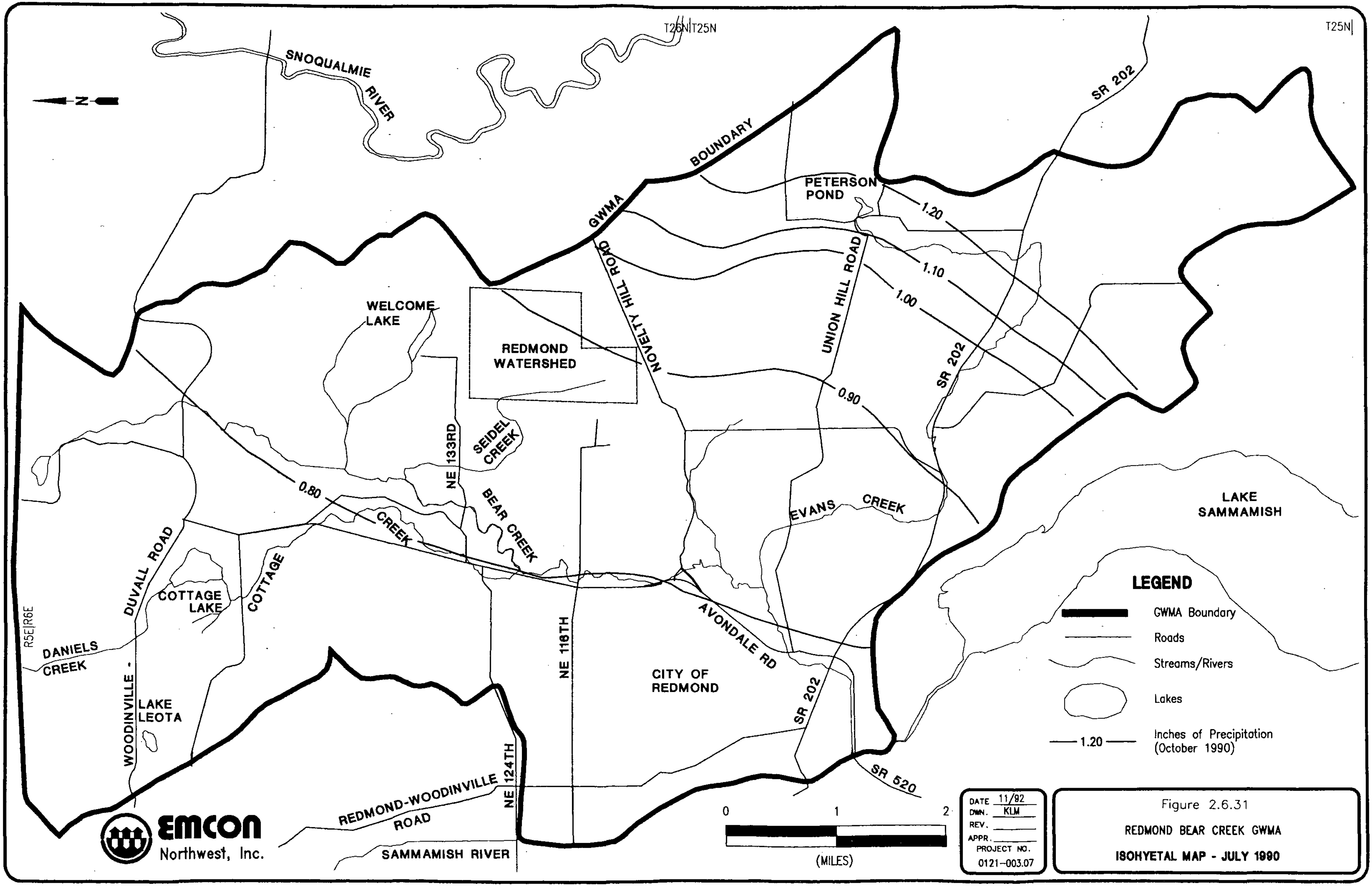



Figure 2.6.31

REDMOND BEAR CREEK GWMA

ISOHYETAL MAP - JULY 1990

1=4000 11-17-92 0121\003\07C21

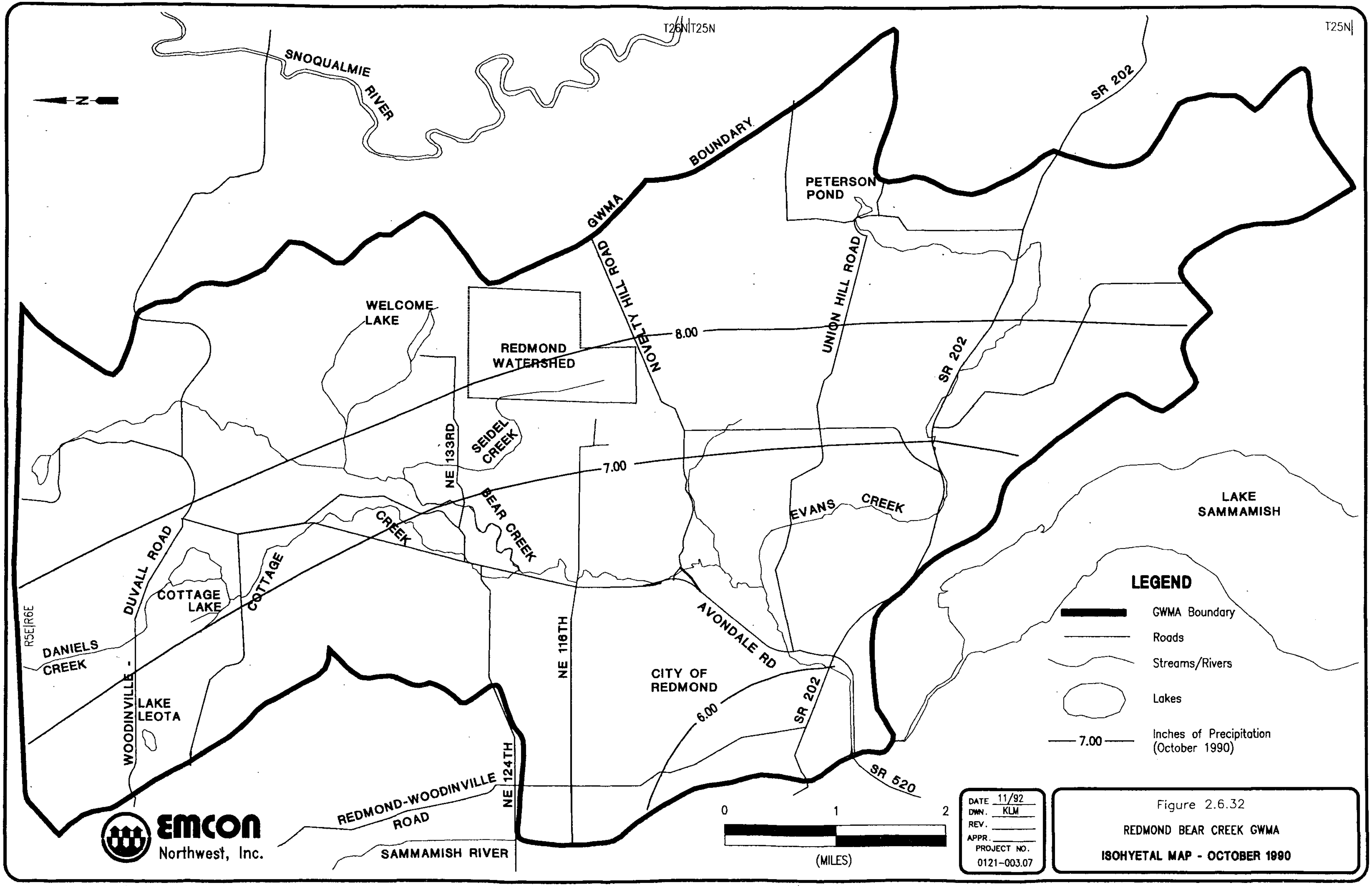


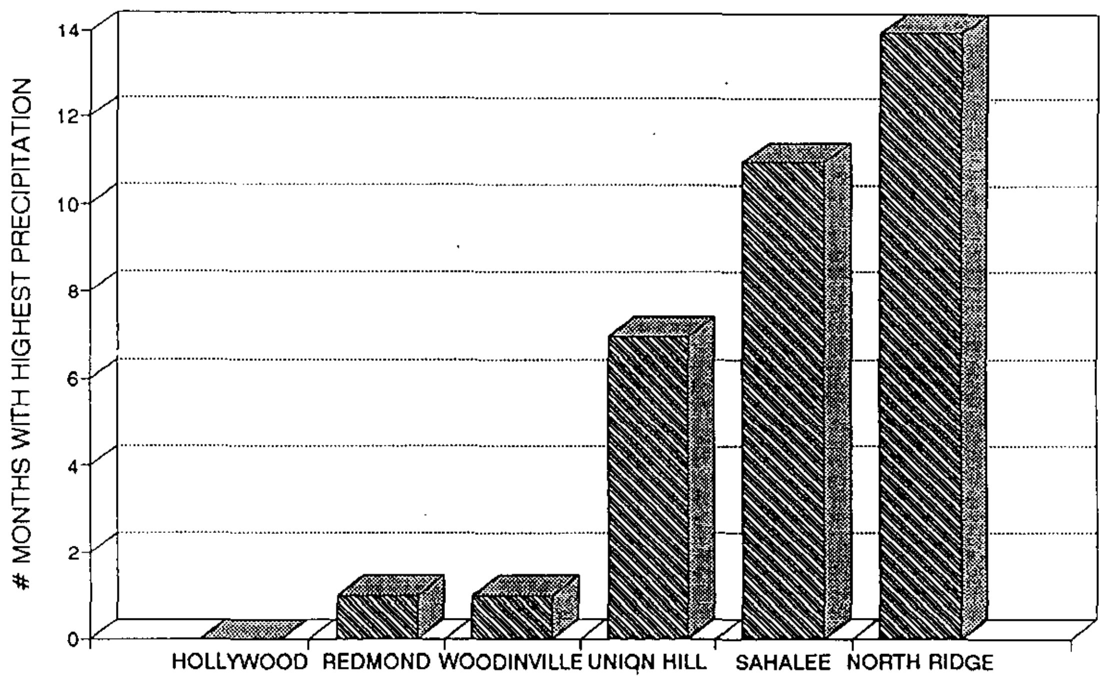

Figure 2.6.32

REDMOND BEAR CREEK GWMA

ISOHYETAL MAP - OCTOBER 1990

1=4000 11-13-92 0121\003\07C07

150969




EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.33
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**FREQUENCY OF HIGHEST PRECIPITATION**

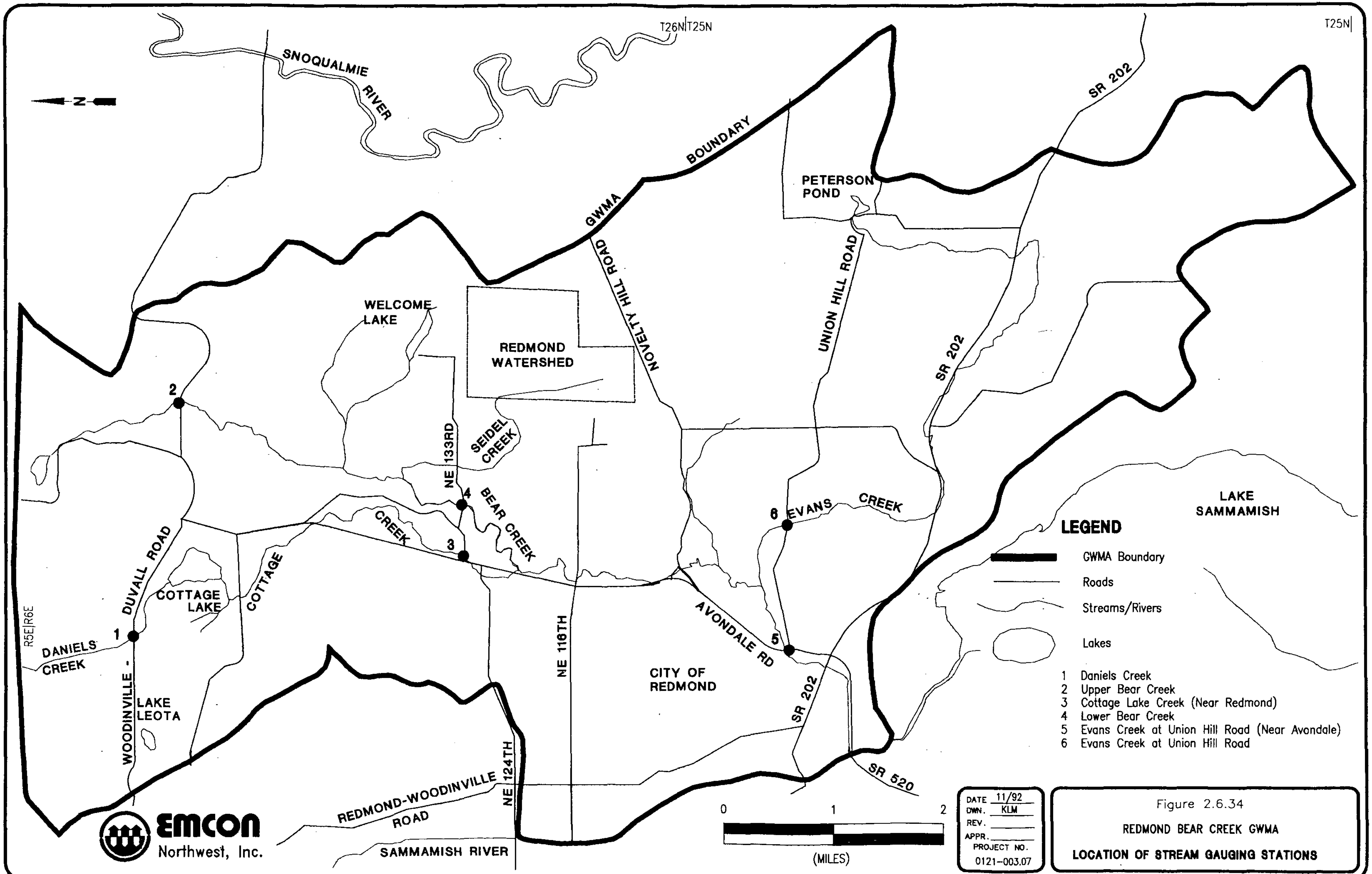
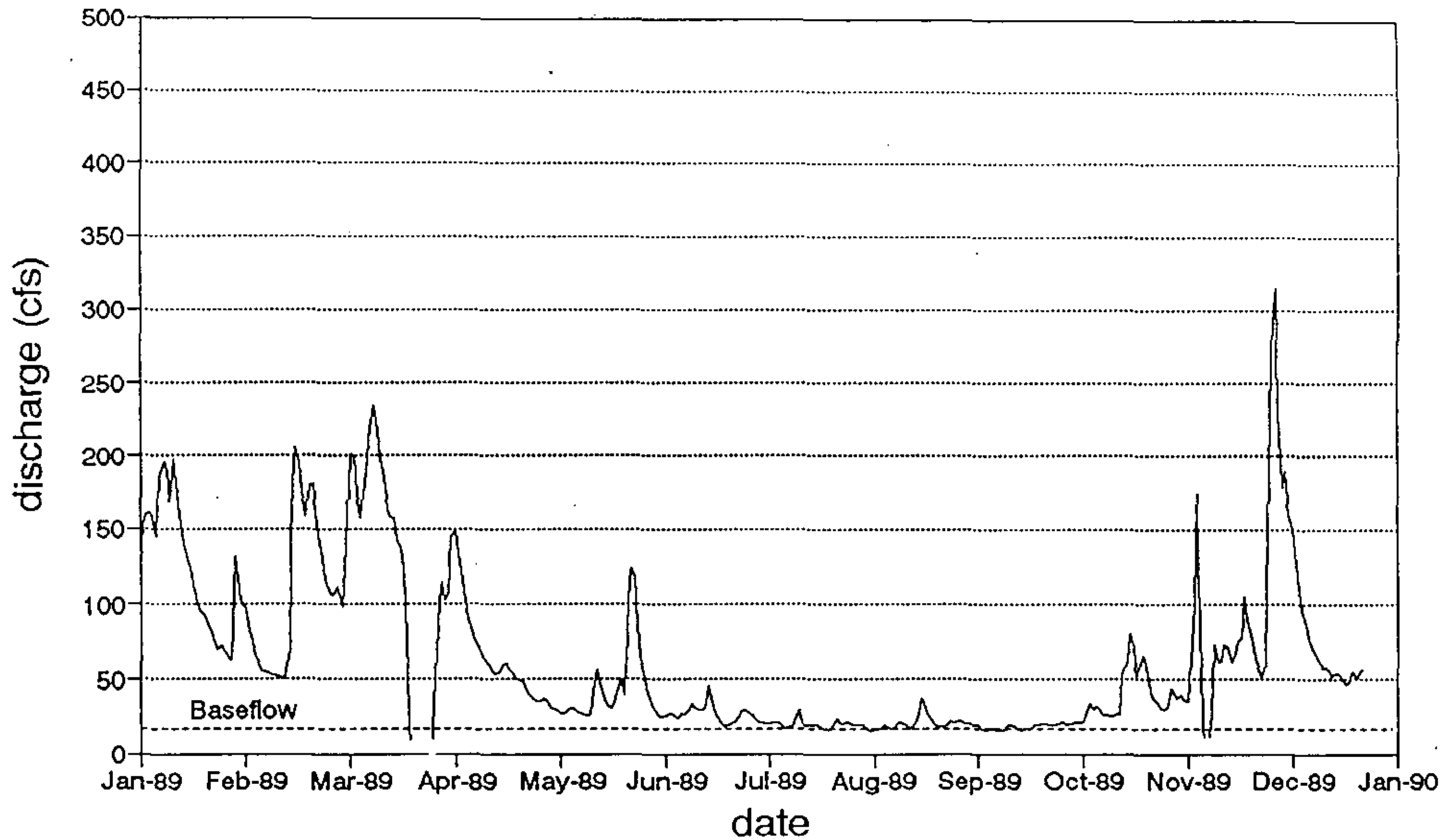



Figure 2.6.34

REDMOND BEAR CREEK GWMA

LOCATION OF STREAM GAUGING STATIONS

150969



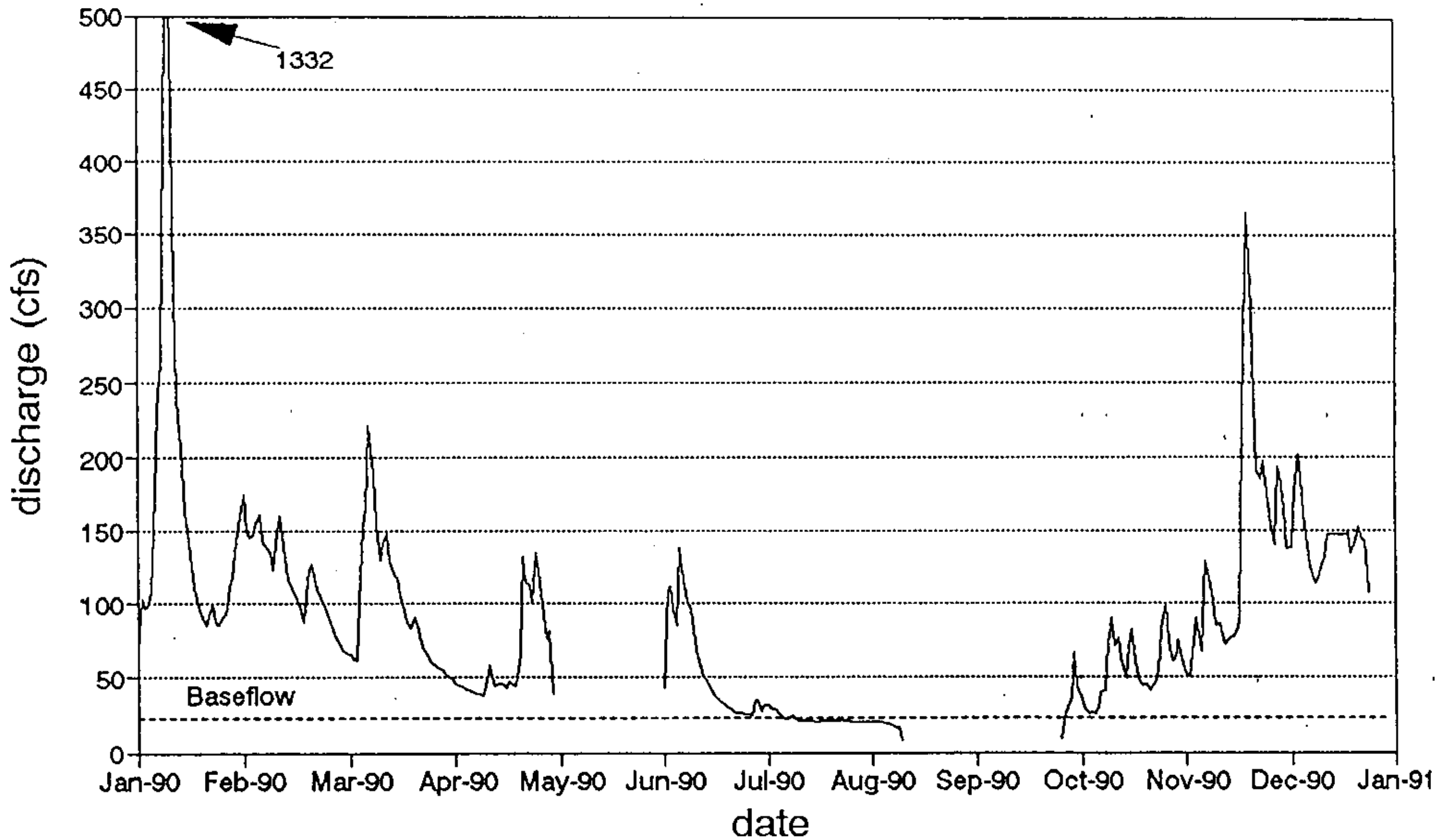

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.35
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**STATION 5 - EVANS CREEK (1989)**

150969



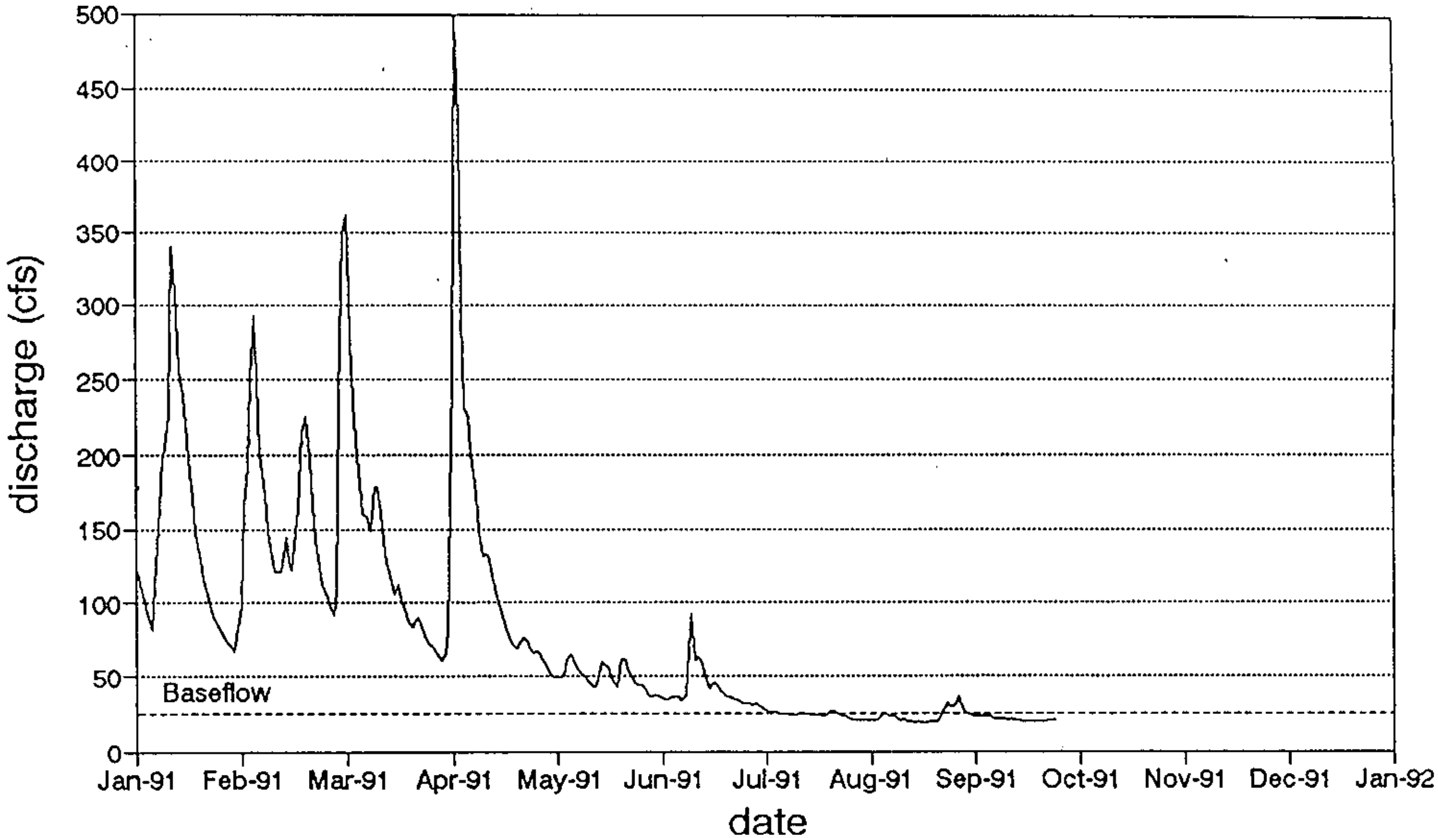

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.36
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**STATION 5 - EVANS CREEK (1990)**

150969



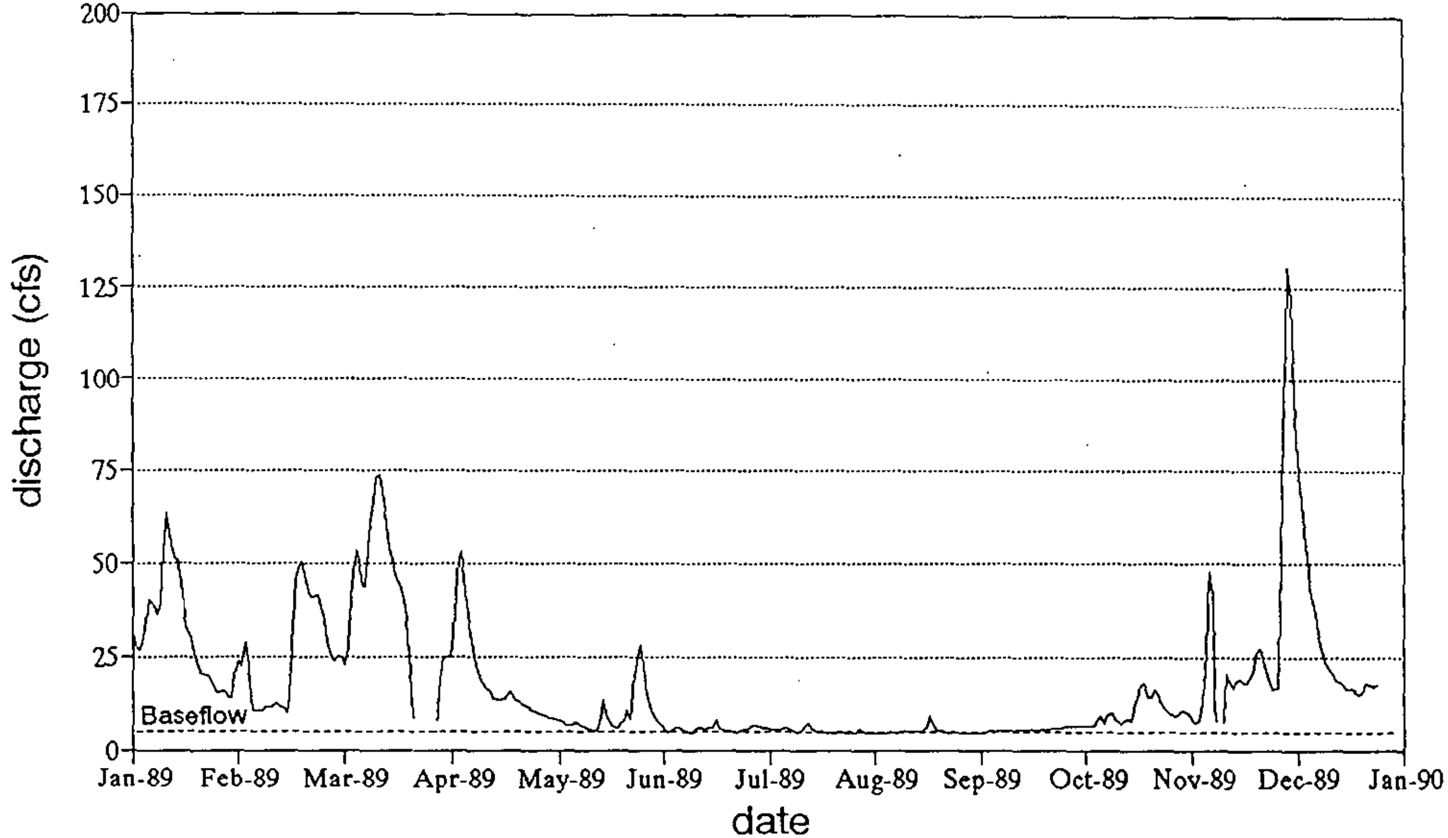

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.37
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

STATION 5 - EVANS CREEK (1990)

150969



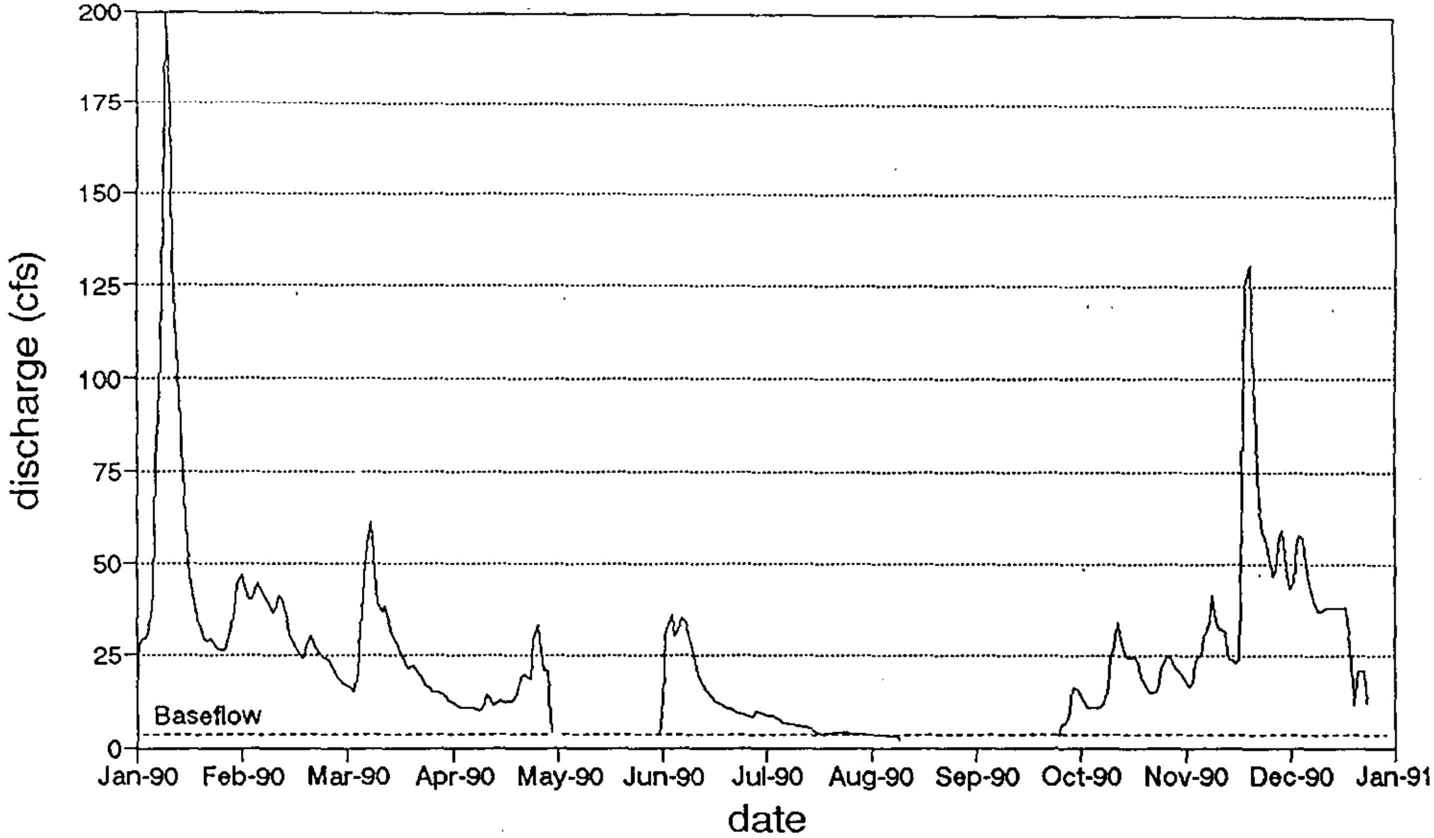

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.38
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**STATION 6 - EVANS CREEK (1989)**

150969



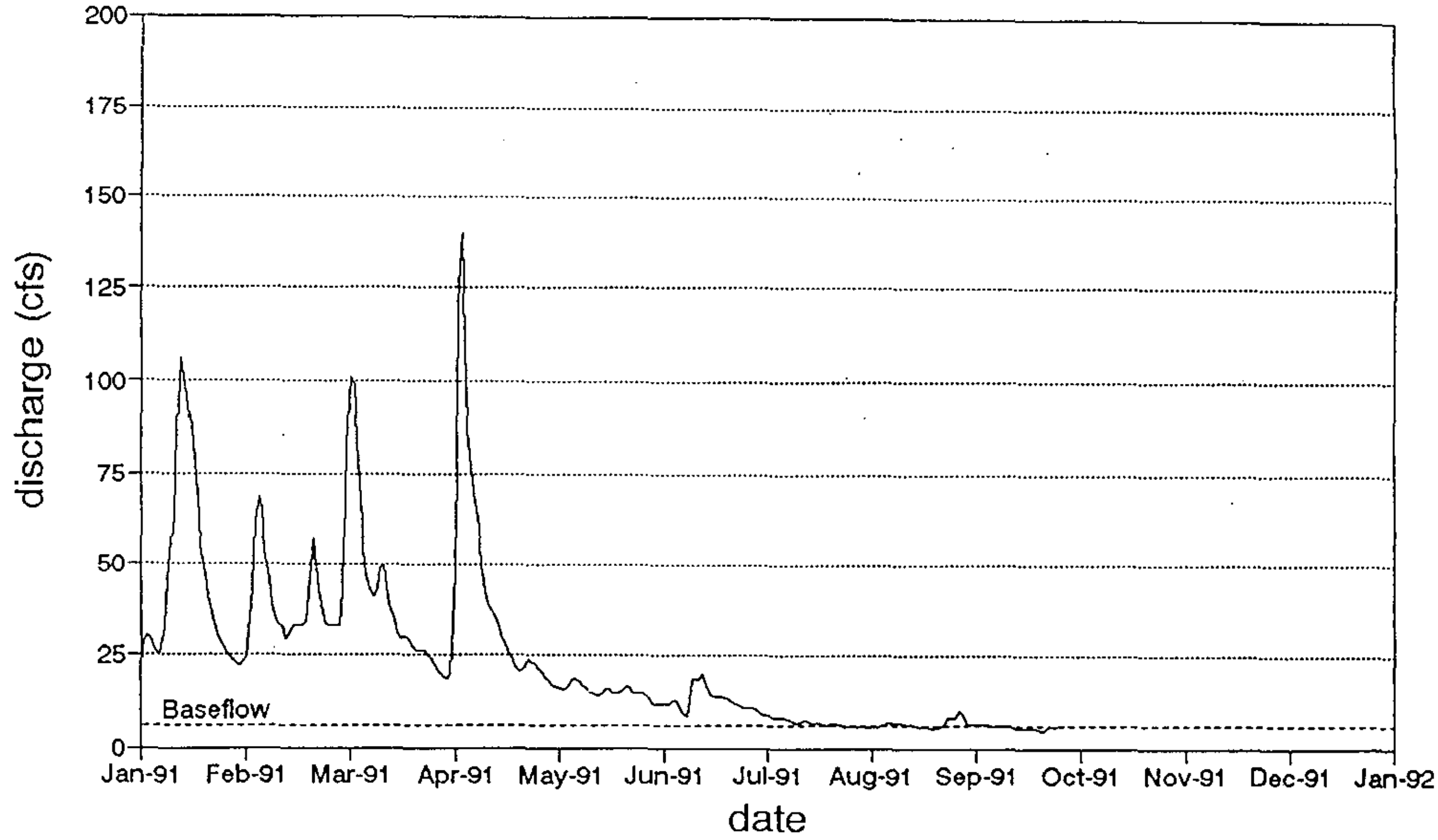

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.39
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**STATION 6 - EVANS CREEK (1990)**

150969



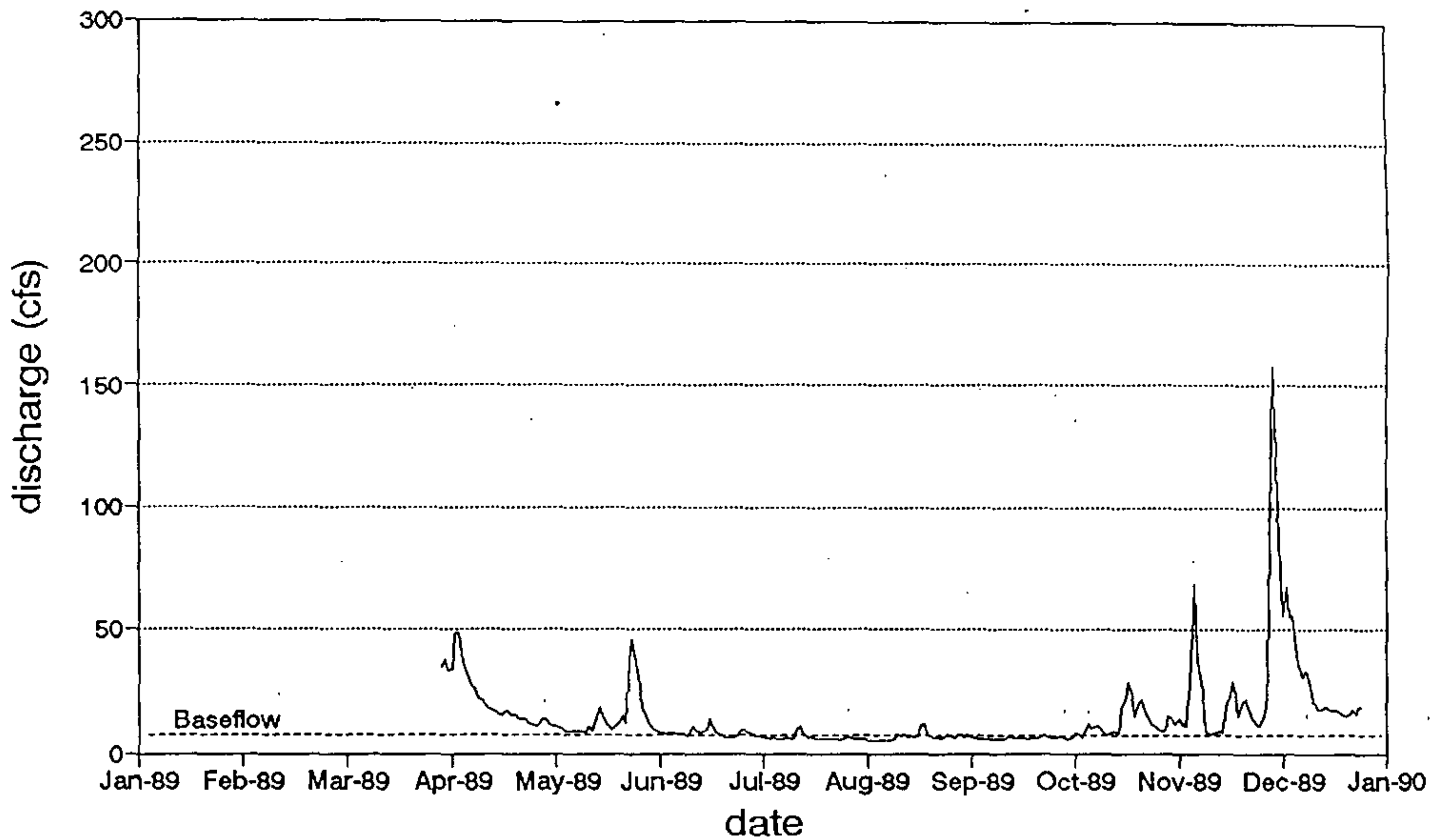

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR. ______
REVIS. ______
PROJECT NO. 0121-003.07

Figure 2.6.40
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**STATION 6 - EVANS CREEK (1991)**

150969



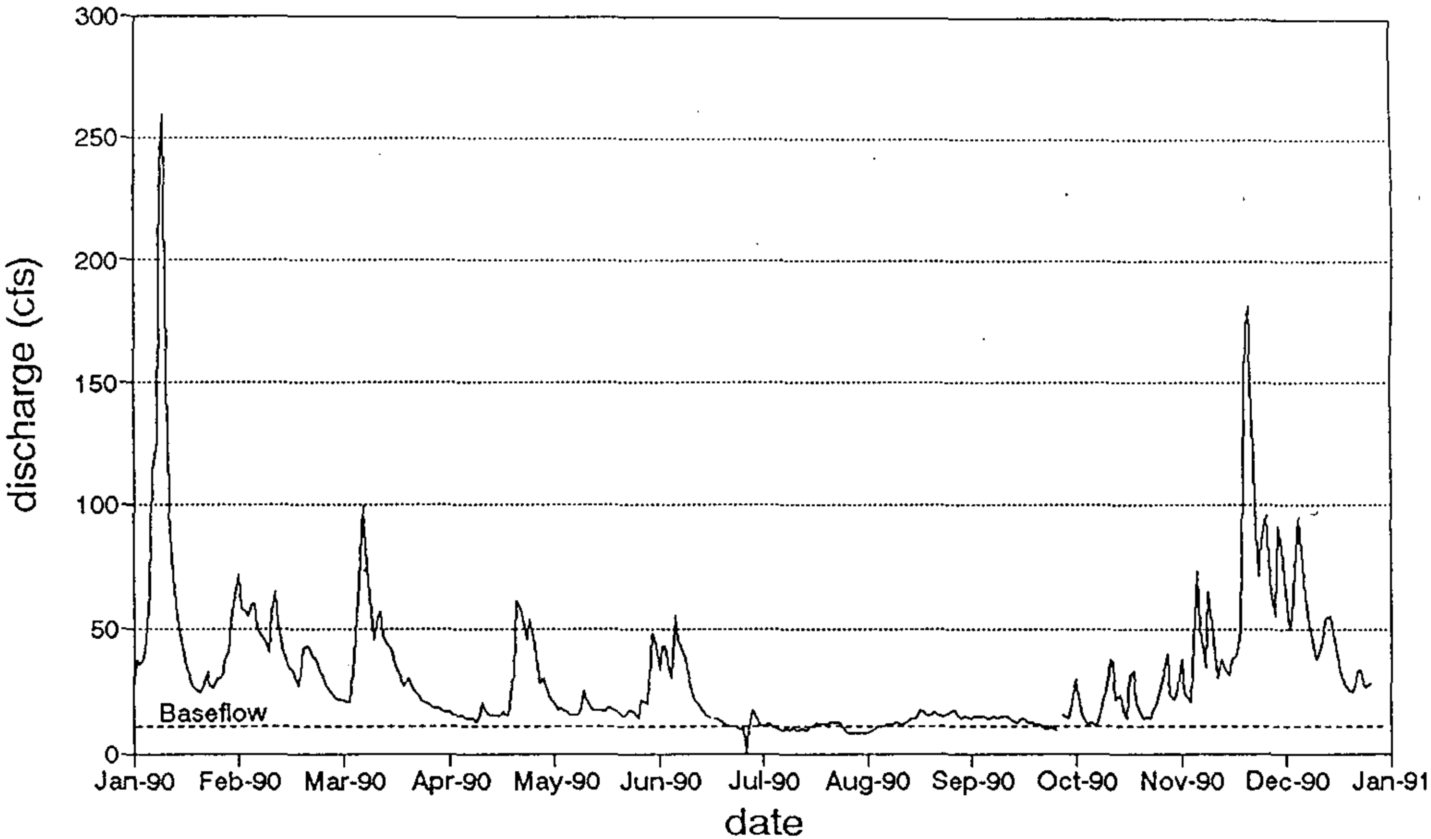

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR. ______
REVIS. ______
PROJECT NO. 0121-003.07

Figure 2.6.41
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**STATION 4 - BEAR CREEK (1989)**

150969



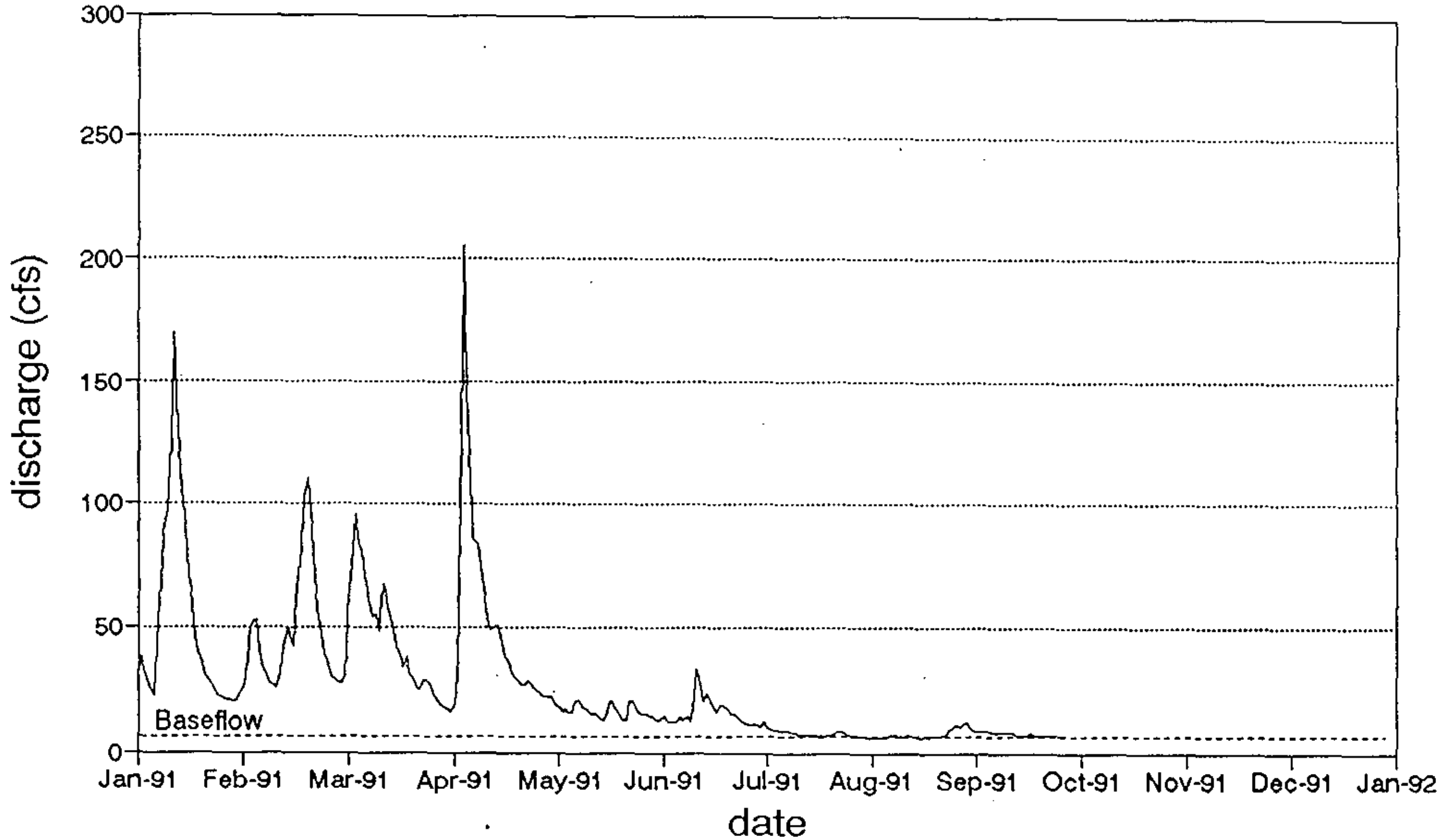

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR. ______
REVIS. ______
PROJECT NO. 0121-003.07

Figure 2.6.42
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**STATION 4 - BEAR CREEK (1990)**

150969




EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.43
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**STATION 4 - BEAR CREEK (1991)**

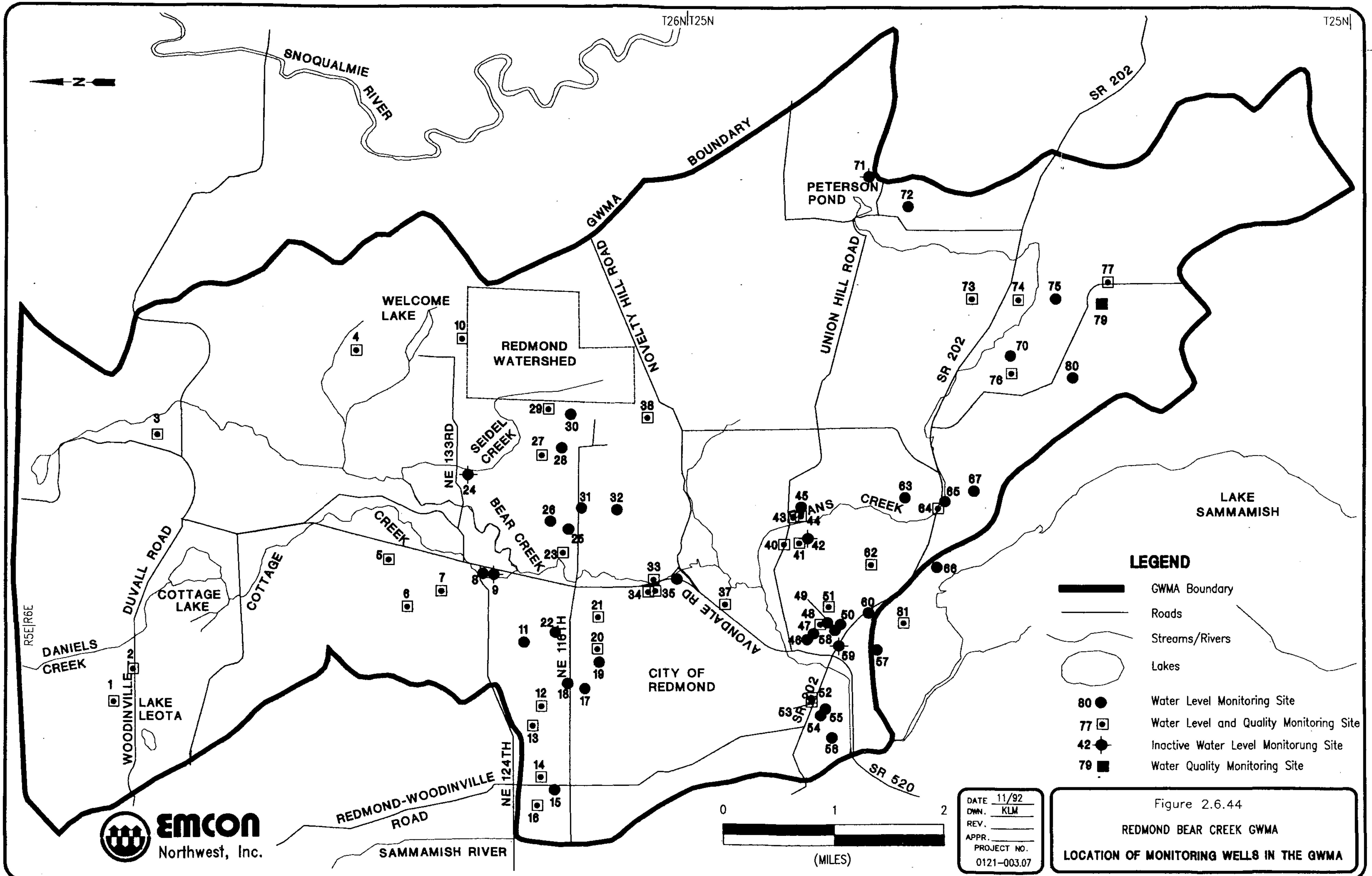
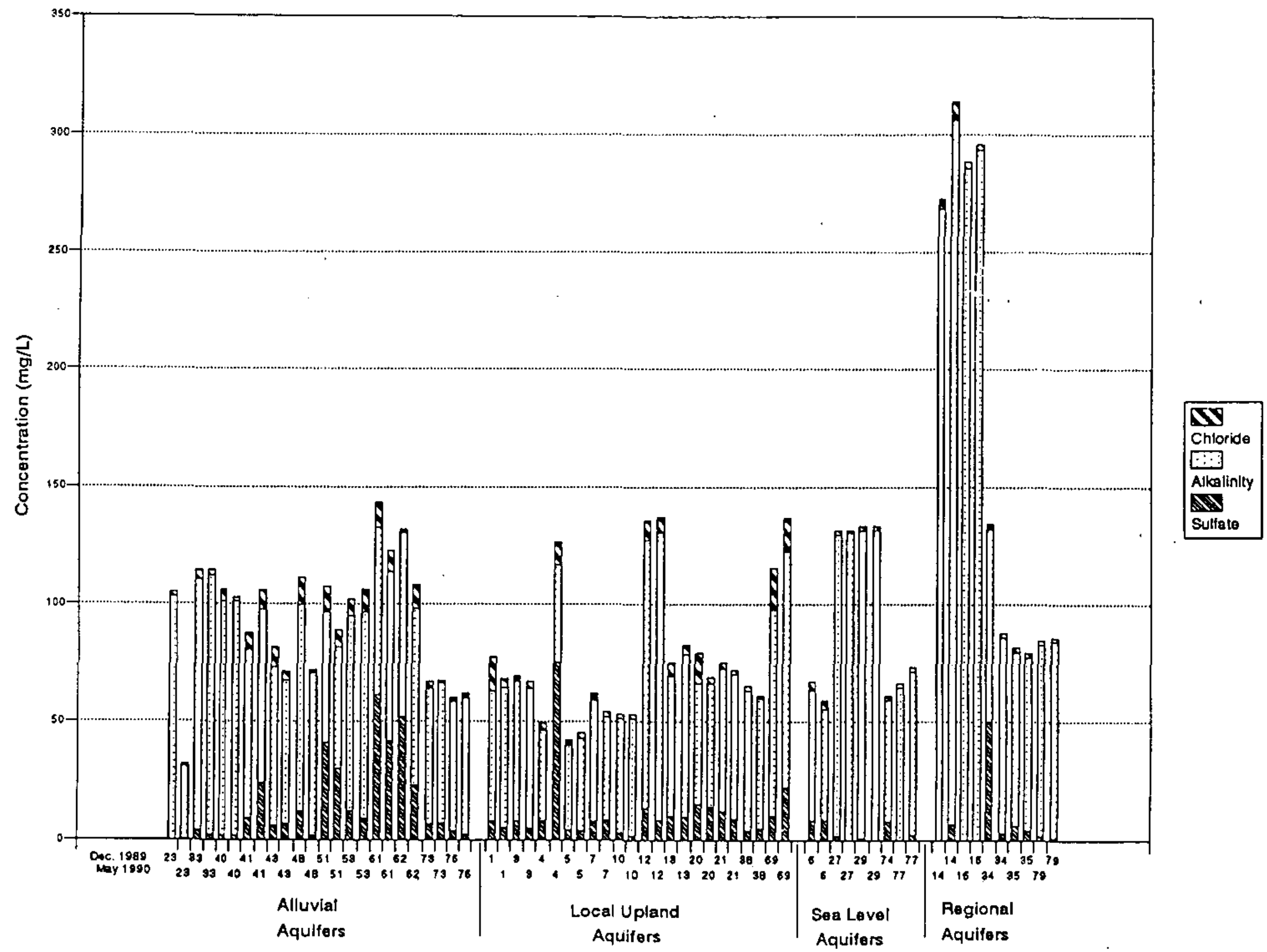



Figure 2.6.44

REDMOND BEAR CREEK GWMA

LOCATION OF MONITORING WELLS IN THE GWMA

150969

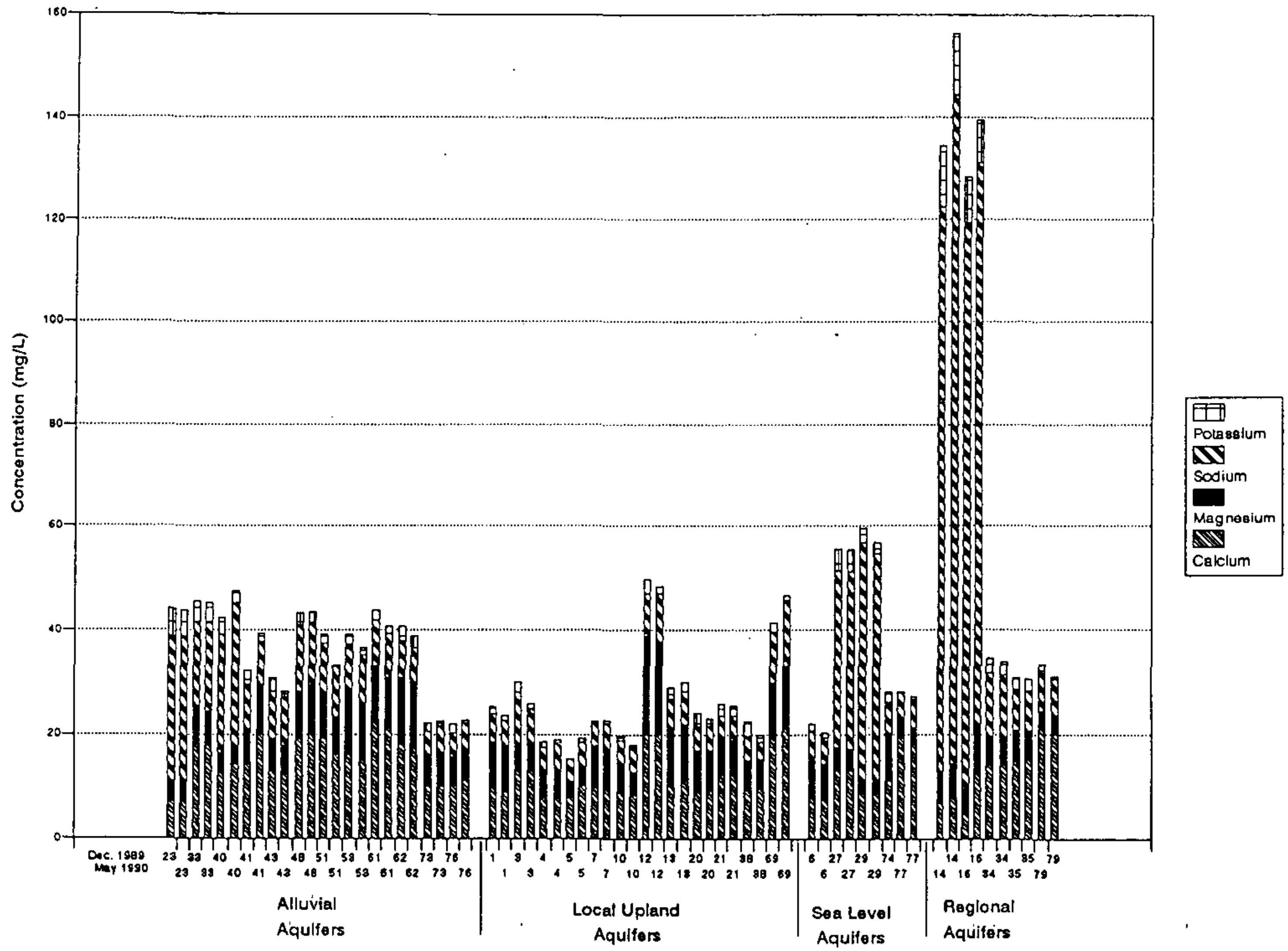



EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR. ______
REVIS. ______
PROJECT NO. 0121-003.07

Figure 2.6.45
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**DISTRIBUTION OF MAJOR ANION CONCENTRATIONS IN GROUND WATER**

150969




EMCON Northwest, Inc.

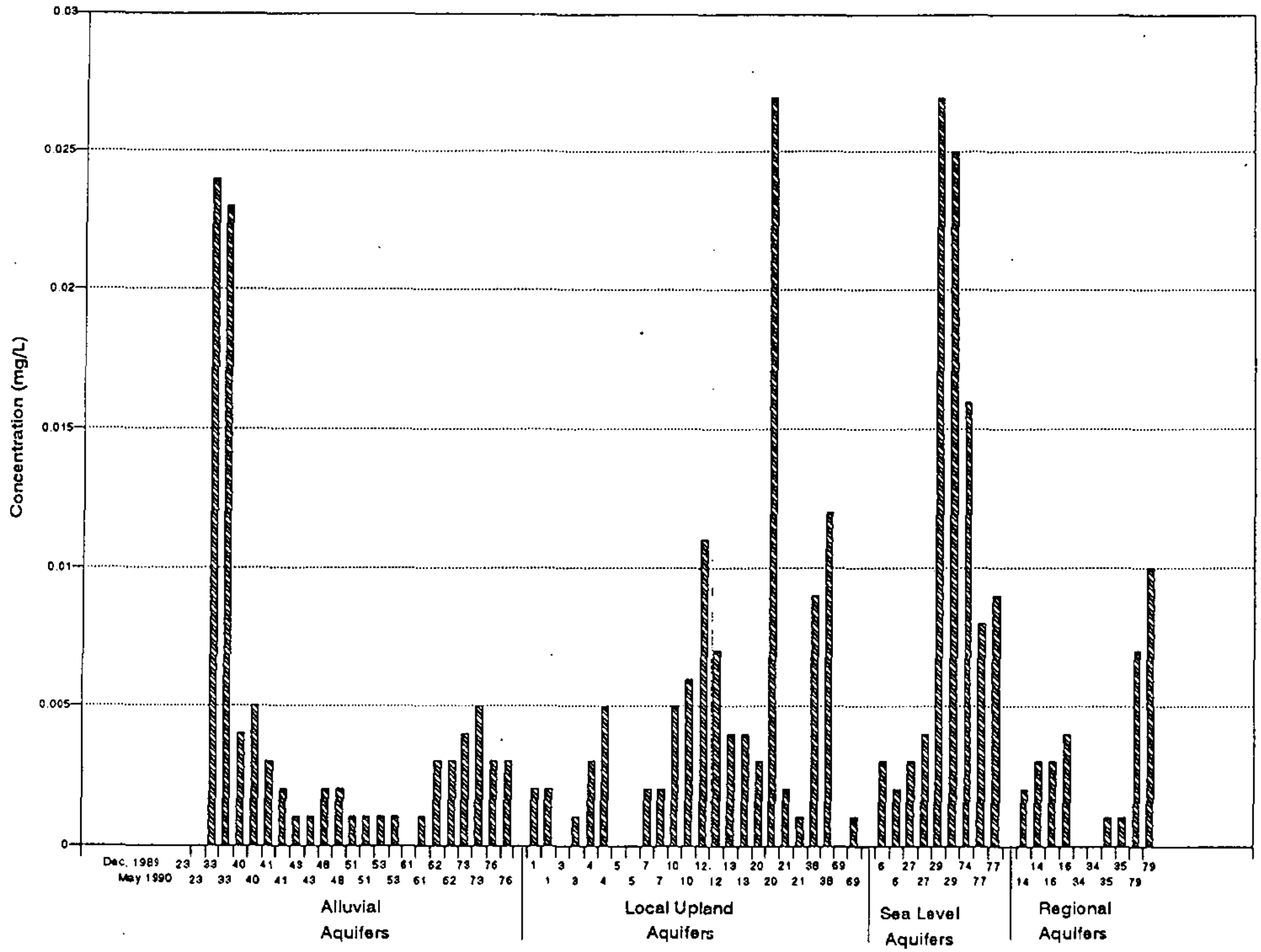
DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.46

REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**MAJOR CATION CONCENTRATIONS IN GROUND WATER**

150969



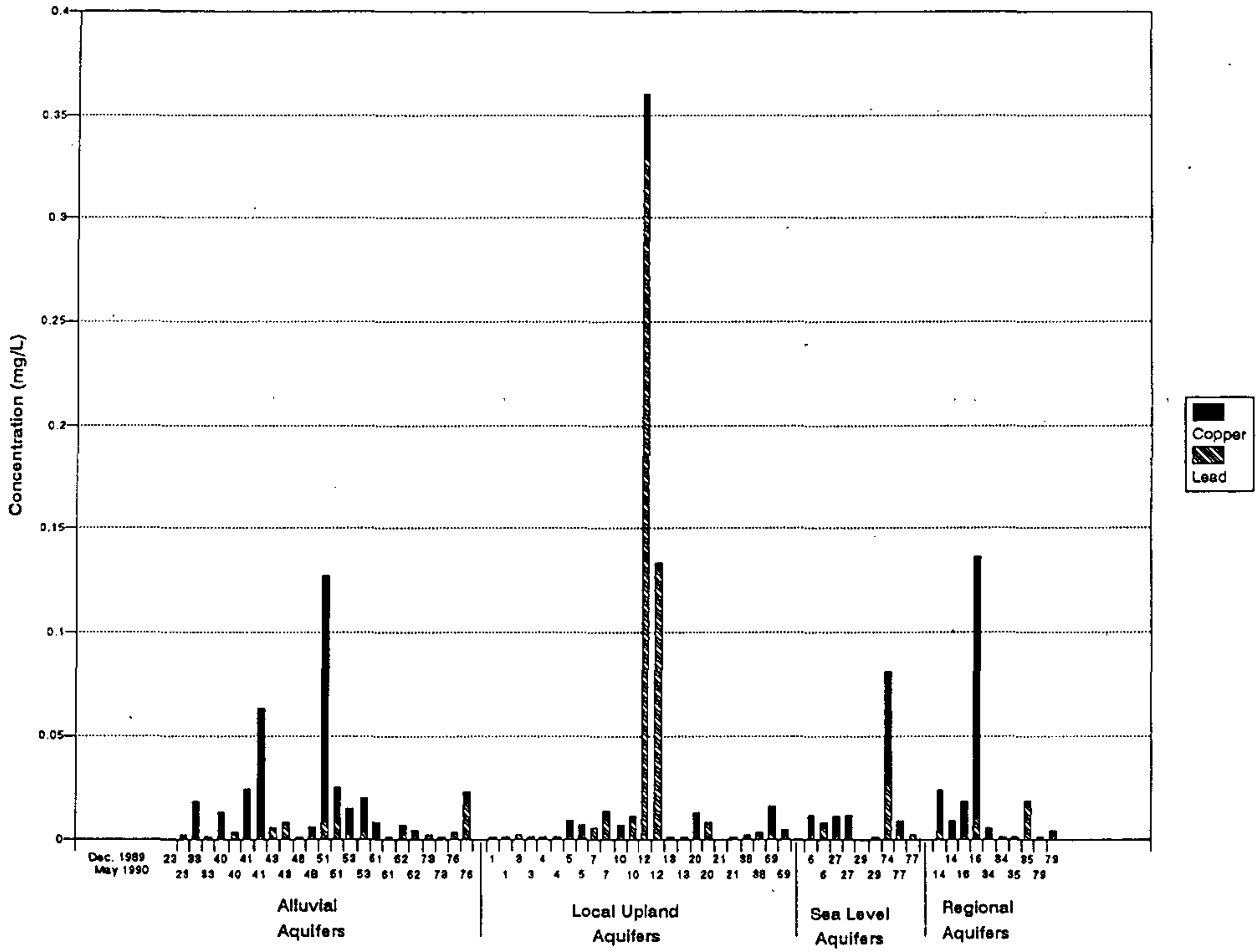

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.47
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**ARSENIC CONCENTRATIONS IN GROUND WATER**

150969




EMCON Northwest, Inc.

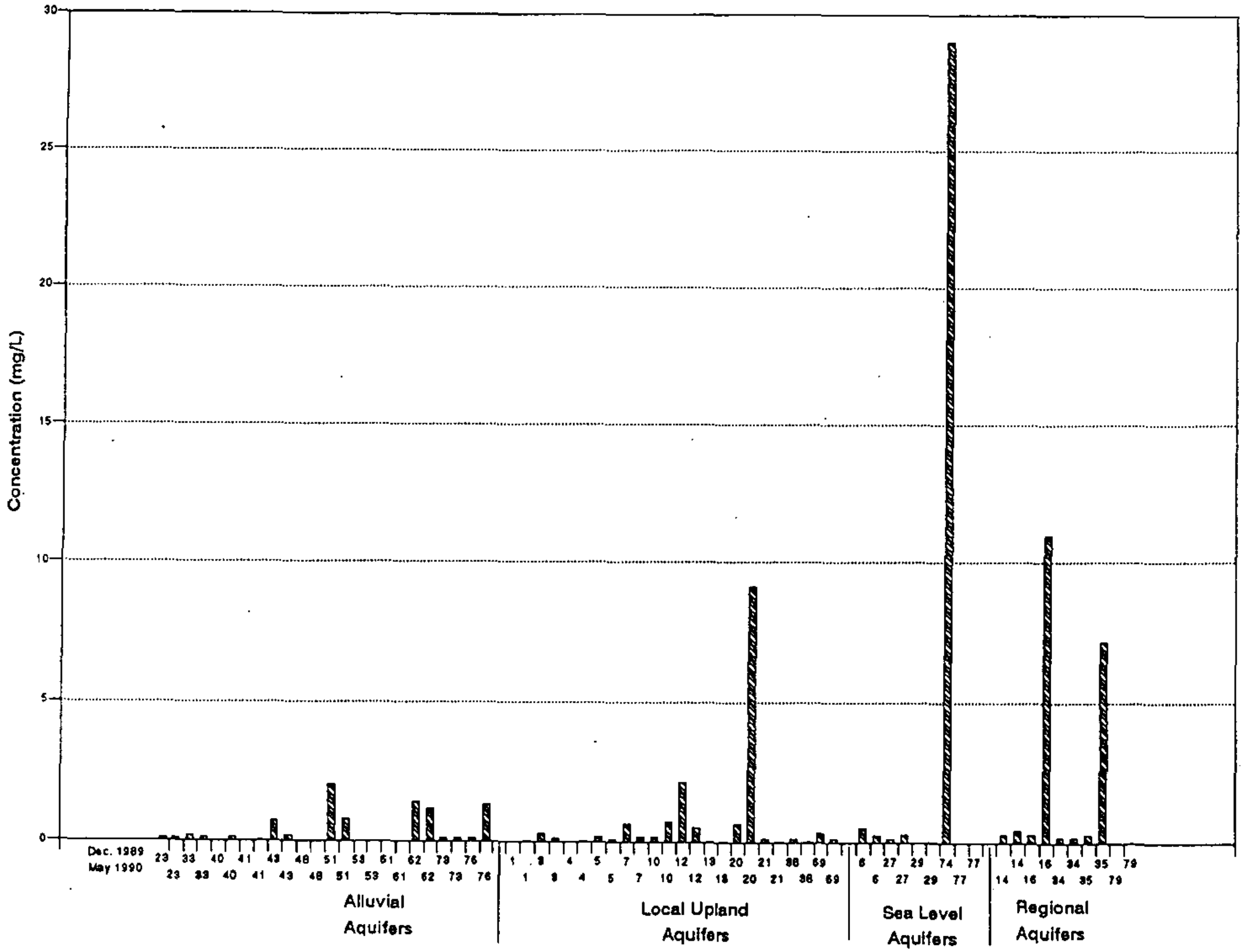
DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.48

REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**COPPER AND LEAD CONCENTRATIONS IN GROUND WATER**

150969



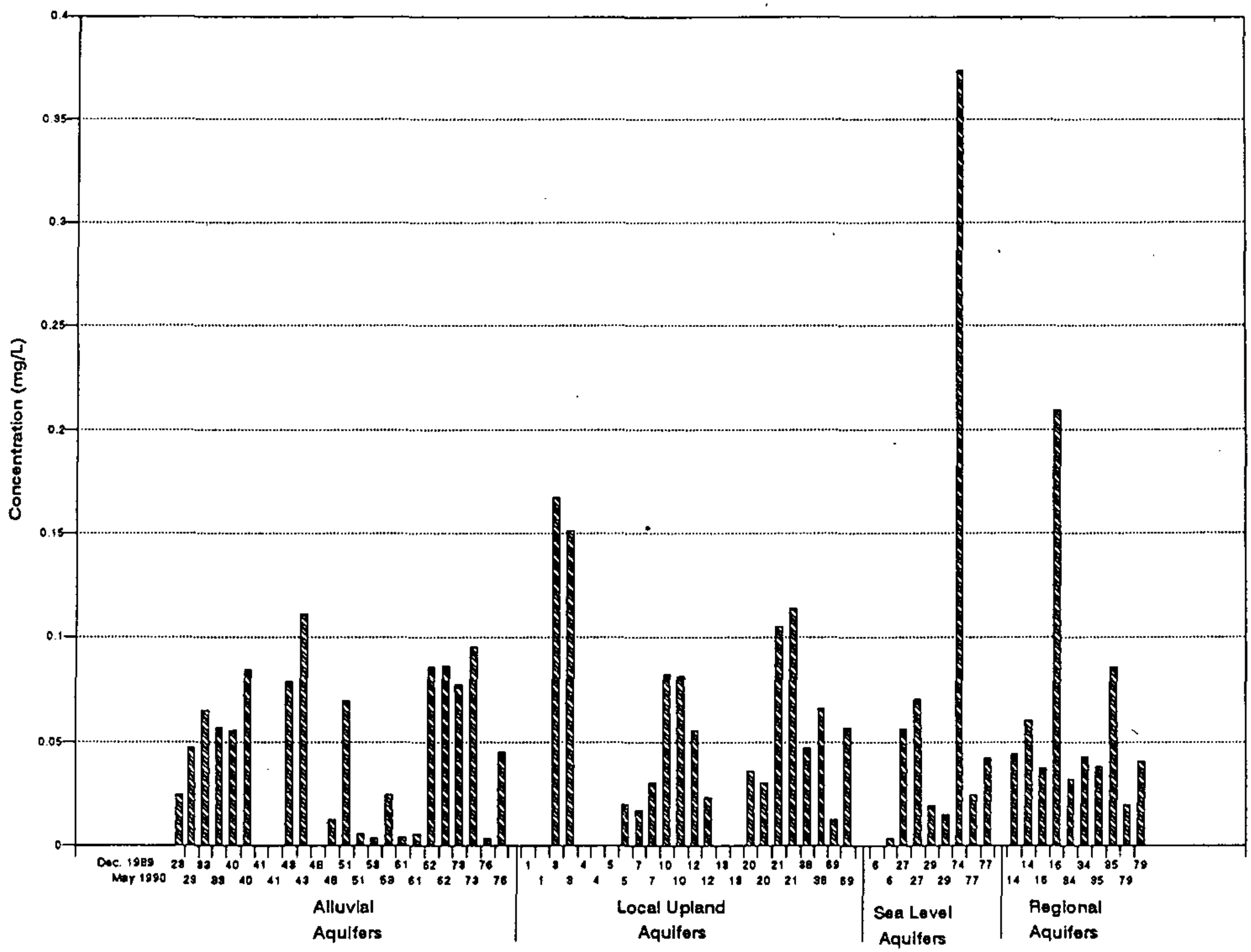

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR. ______
REVIS. ______
PROJECT NO 0121-003.07

Figure 2.6.49
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**IRON CONCENTRATIONS IN GROUND WATER**

150969



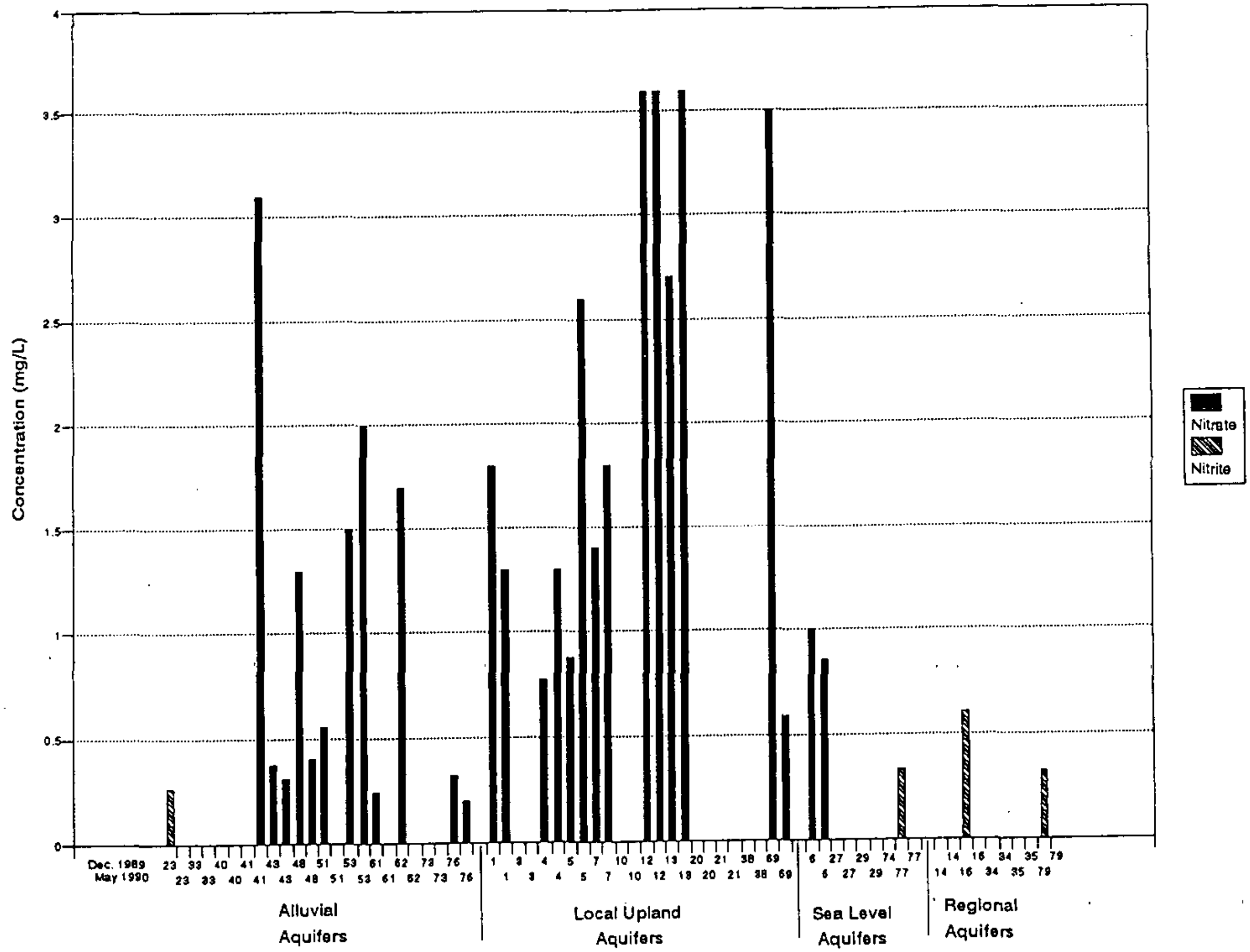

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.50
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA

**MANGANESE CONCENTRATIONS IN GROUND WATER**

150969

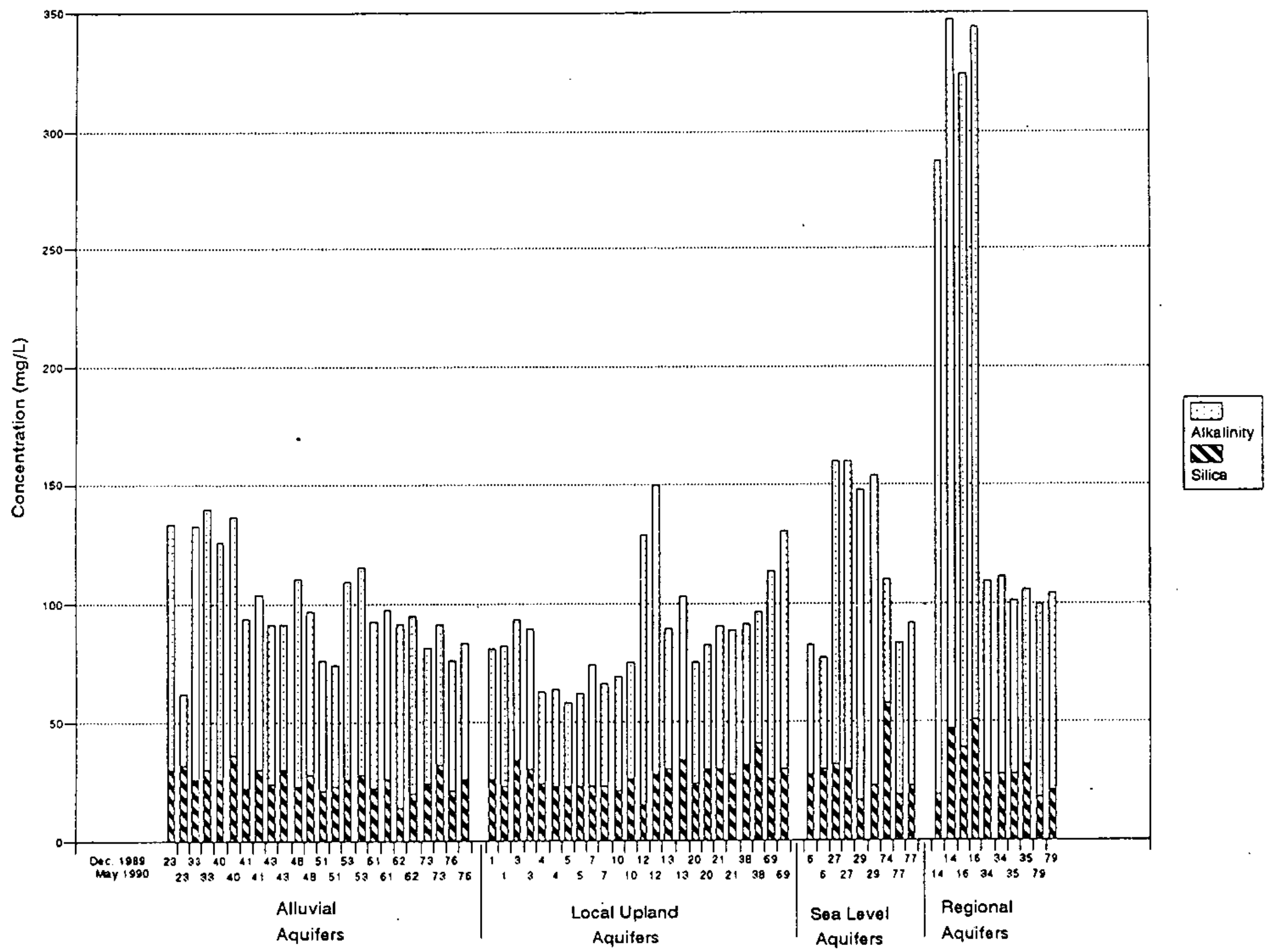



EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.51
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**NITRATE AND NITRITE CONCENTRATIONS IN GROUND WATER**

150989



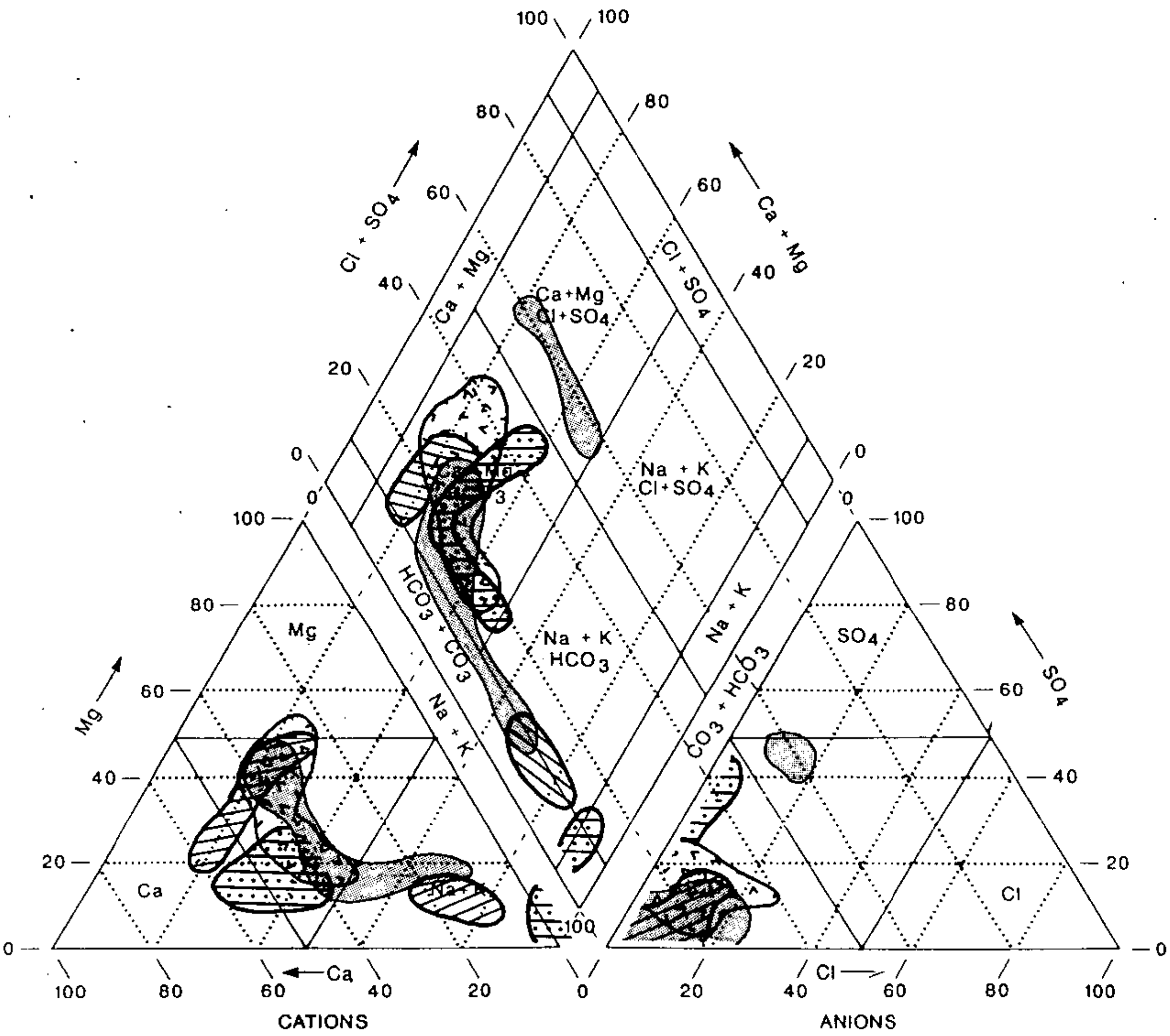

EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.52

REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**SILICA AND ALKALINITY CONCENTRATIONS IN GROUND WATER**

142322




LEGEND:

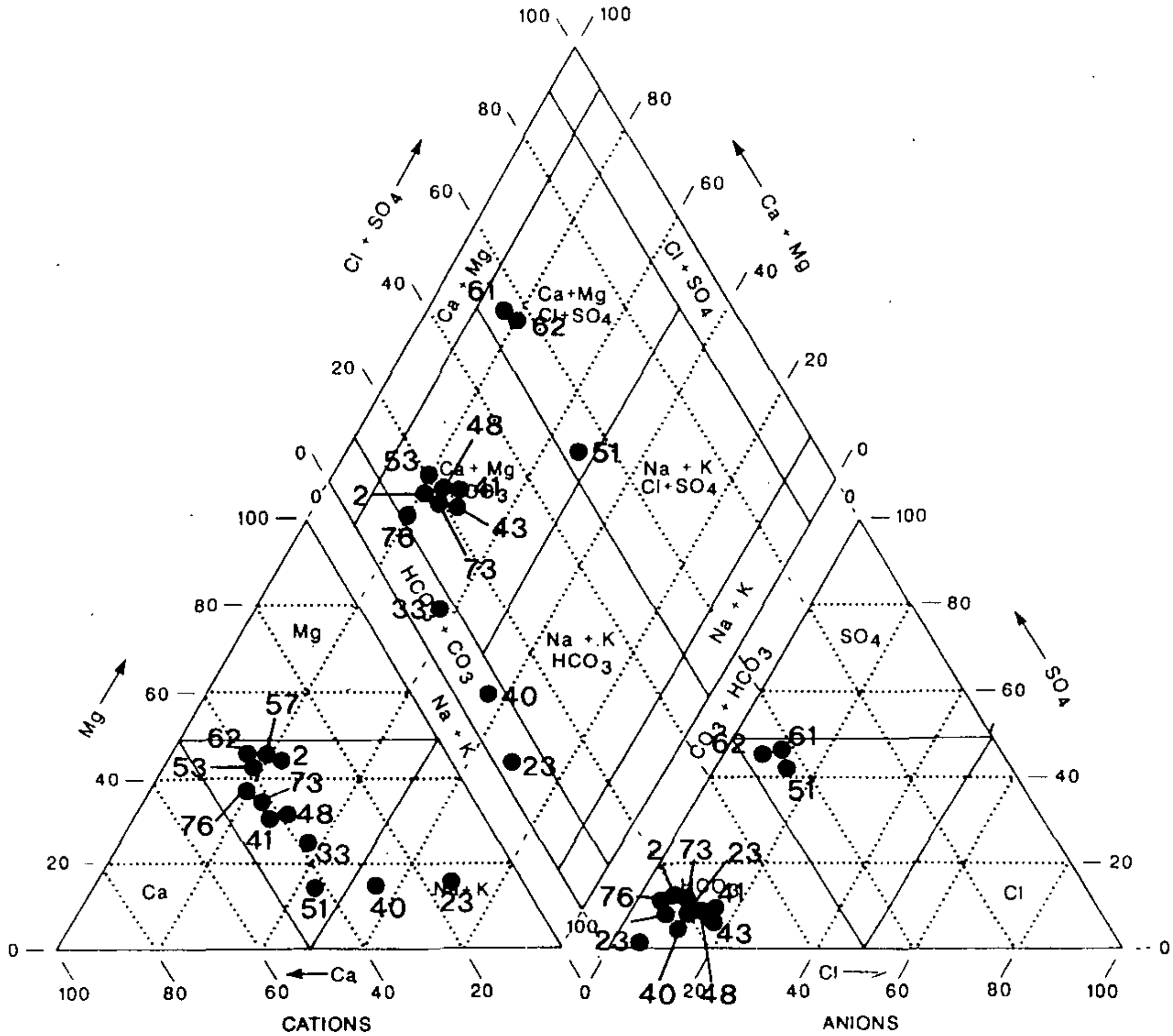
| | |
|---|---|
| Alluvial | Local Upland |
| Sea Level | Regional |

EMCON Northwest, Inc.

| | |
|---|---|
| DATE | 10-92 |
| DWN. | MLP |
| APPR. | |
| REVIS. | |
| PROJECT NO. | 0121-003.07 |

Figure 2.6.53
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
TRILINEAR PLOT OF MAJOR ION
CONCENTRATIONS BY AQUIFER ZONE

142322

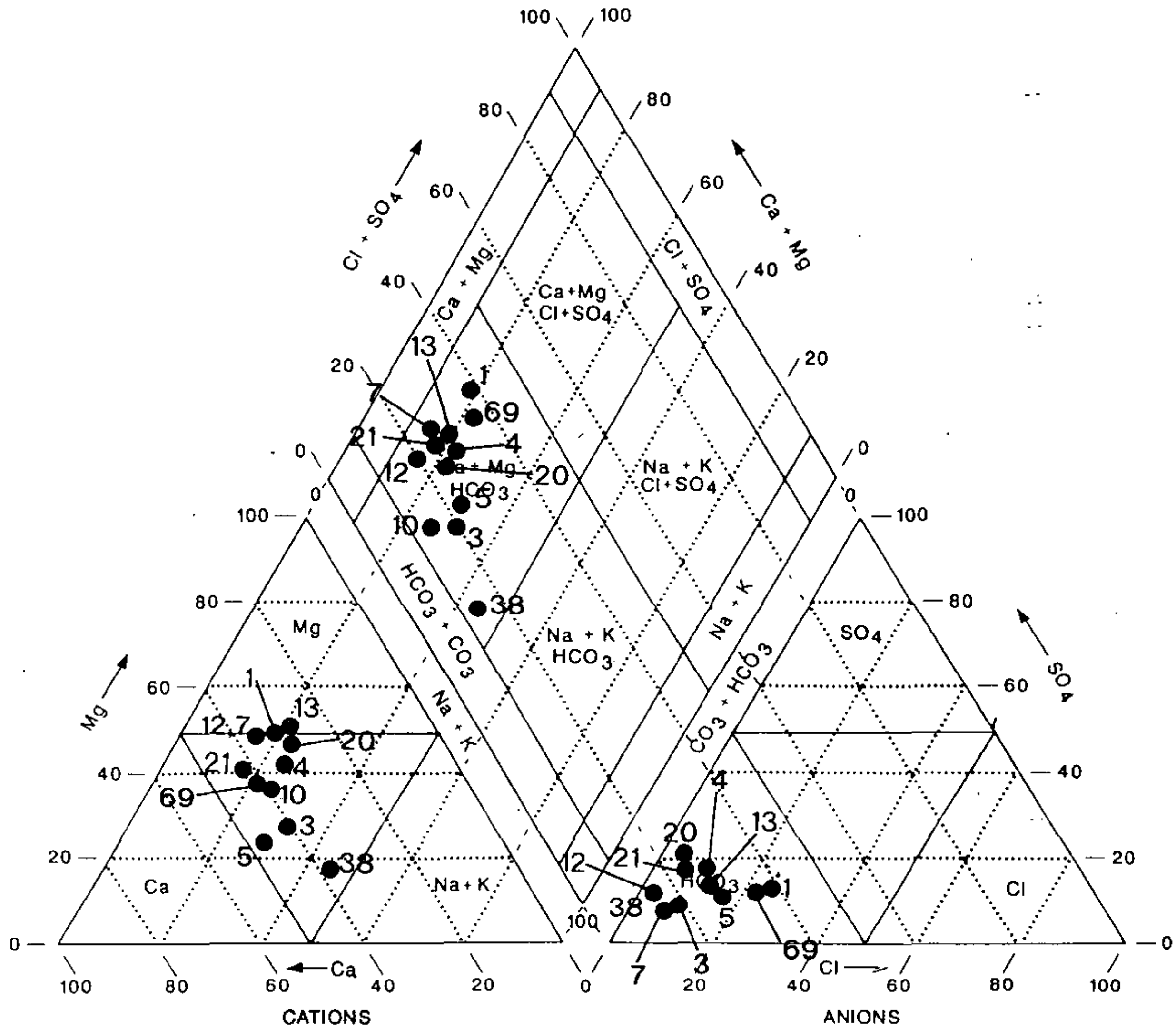



EMCON
Northwest, Inc.

DATE 10-92
DWN. MLP
APPR. ______
REVIS. ______
PROJECT NO.
0121-003.07

Figure 2.6.54
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**TRILINEAR PLOT OF MAJOR ION CONCENTRATIONS FOR ALLUVIAL AQUIFERS**

142322

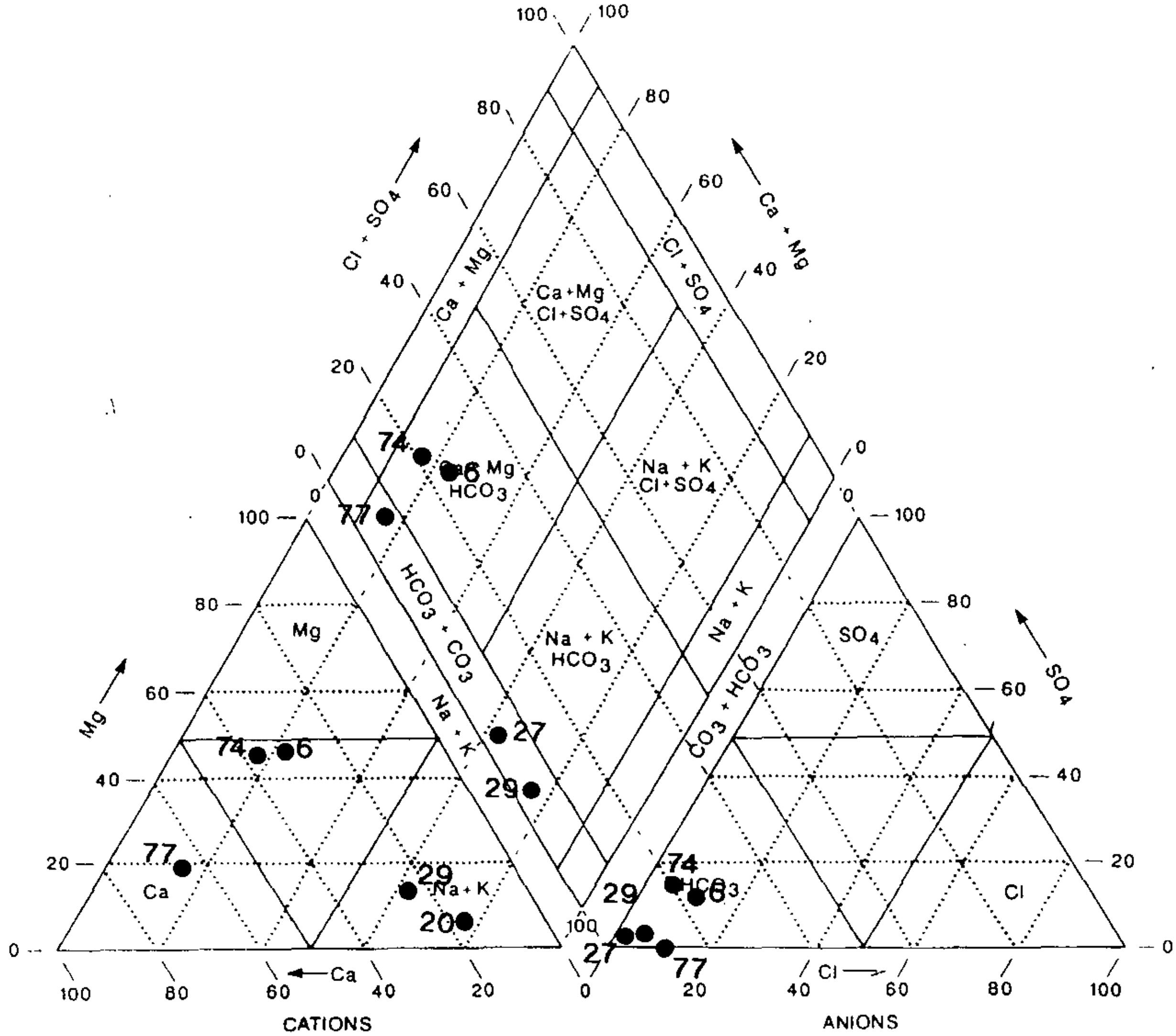



EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.55
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**TRILINEAR PLOT OF MAJOR ION CONCENTRATIONS FOR LOCAL UPLAND AQUIFERS**

142322

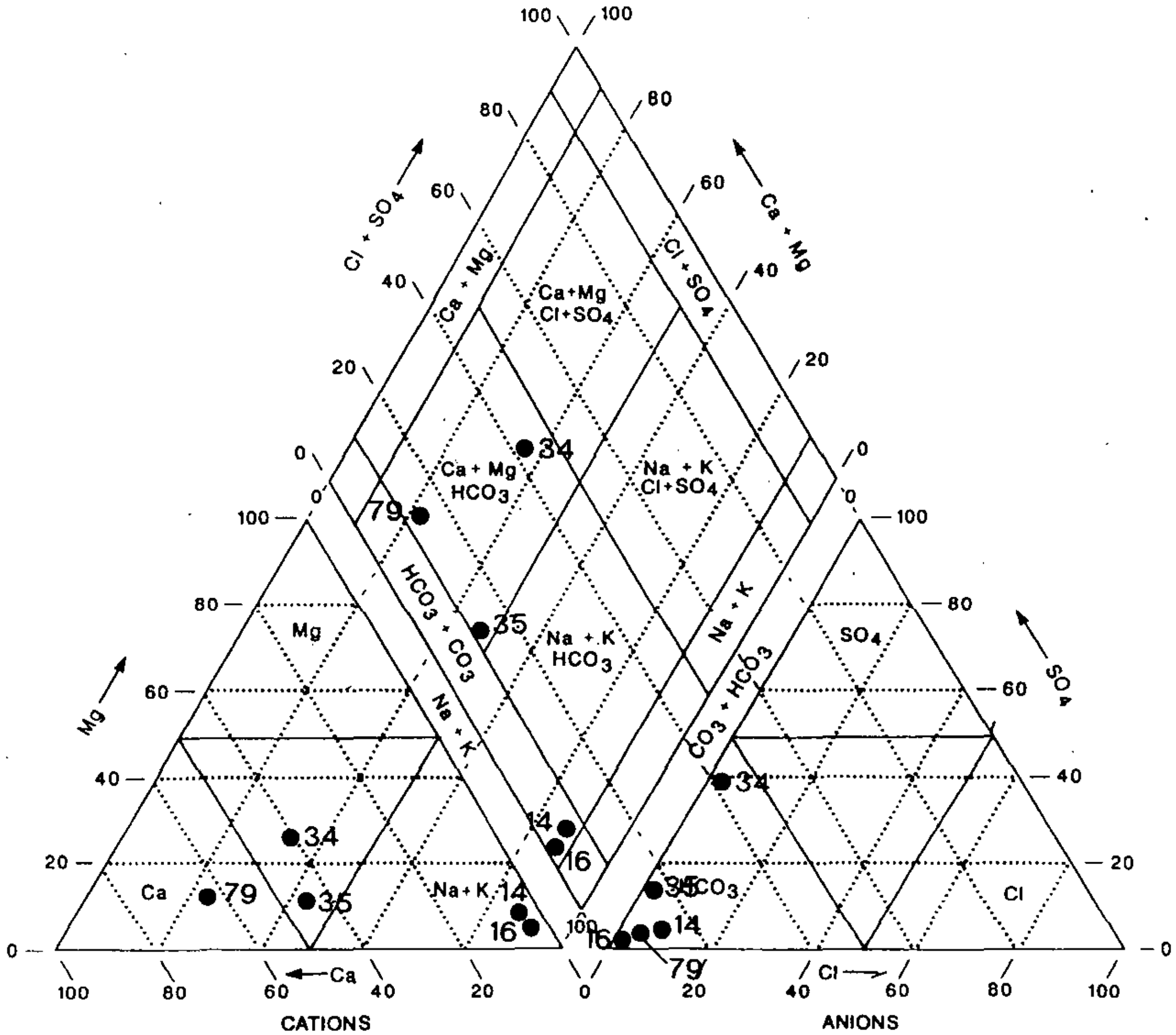



EMCON Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.56
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**TRILINEAR PLOT OF MAJOR ION CONCENTRATIONS FOR SEA LEVEL AQUIFERS**

142322




EMCON
Northwest, Inc.

DATE 10-92
DWN. MLP
APPR.
REVIS.
PROJECT NO. 0121-003.07

Figure 2.6.57
REDMOND BEAR CREEK
GROUND WATER MANAGEMENT AREA
**TRILINEAR PLOT OF MAJOR ION CONCENTRATIONS FOR REGIONAL AQUIFERS**

Chapter 3. Recommended
Ground Water
Management Program

# CHAPTER 3 - MANAGEMENT STRATEGIES

## 3.1. INTRODUCTION

In accordance with Chapter 173-100 WAC, each ground water management plan must contain strategies to address all perceived threats to ground water quality and quantity in the planning area. The Redmond-Bear Creek Valley Ground Water Advisory Committee (RBC-GWAC) identified the potential water quality and quantity problems or issues and adopted corresponding management strategies. The RBC-GWAC identified the following as issues to be addressed in the ground water management plan: Special Area Designations to Enhance Ground Water Quality and Quantity; Data Collection and Management; Stormwater Management; Hazardous Materials Management; Underground Storage Tank Management; On-Site Sewage Disposal System Use; Pesticides and Fertilizer Use; Well Construction and Abandonment; Sewer Pipes; Solid Waste Landfills; Burial of Human Remains; Sand and Gravel Mining; Land Application of Biosolids and Sewage Effluent; and Ground Water Quantity.

These topics were presented to the RBC-GWAC in an issue paper format developed jointly by the Seattle-King County Health Department (SKCHD) and the project consultants. The issue papers contained technical information about each topic, a description of the existing regulations and management programs affecting the topic, and alternative management strategies for addressing unresolved issues. After consideration and discussion, the RBC-GWAC selected a number of preferred alternative strategies and discarded or choose not to pursue a number of other proposed strategies. In addition, through the deliberative process, several additional strategies were identified and added to the preferred alternatives. As regulations and management programs related to preferred management strategies changed, further modifications to the strategies occurred between initial RBC-GWAC consideration of the issue papers and final management strategy adoption. The final adopted strategies as presented in this chapter address all of the issues or topics identified above for the Redmond-Bear Creek Valley Ground Water Management Area (RBC-GWMA).

In developing the management strategies, the RBC-GWAC attempted to make maximum use of existing governmental programs and regulatory structures. The RBC-GWAC was determined to build on existing efforts rather than developing new and potentially duplicative programs. The management strategies were based upon thorough research into the problems as presented in the issue papers. Each strategy was evaluated for feasibility, including implementation cost. The RBC-GWAC opted for strategies that could be easily understood and supported by the citizens in the RBC-GWMA. The RBC-GWAC recognized that increasing an agency's responsibilities would result in a corresponding increase in that agencies need for funding. The funding source for each management strategy is discussed in Chapter 4.

This Chapter contains discussions of the identified topics of ground water concern and the adopted management strategies. The structure for presentation of each topic is as follows: a summary of the key background information considered by the RBC-GWAC, the adopted goal(s), important protection issues, selected management strategies, rationale for the selected strategies, and a suggested implementation plan. Please note that as the RBC-GWAC considered each issue, data collection and management strategies and educational strategies were adopted for many of the issues. These are compiled into the Data Collection and Management Program and the Education Program, described in the first section of this Chapter. The original issue papers are listed in **Appendix P**, and may be obtained from SKCHD.

In conclusion, the RBC-GWAC realized that the adopted strategies would not totally prevent contamination problems from occurring in the Redmond-Bear Creek aquifers, but that it should greatly limit the frequency and severity of such problems. The Redmond Bear Creek Valley Ground Water Management Plan is intended to provide a framework to facilitate cooperation between various regulatory agencies through implementation of the adopted ground water protection strategies. It is also intended to guide to further, focused research on the aquifers to address data and regulatory protection gaps.

## 3.2. PROGRAMS RELATED TO GROUND WATER QUALITY AND QUANTITY

### 3.2.1. Special Area Designations to Enhance Ground Water Protection

There are a number of special federal, state, and local area designations that may potentially enhance a Ground Water Management Plan. These designations may offer such benefits as a source of funds to implement ground water protection measures, enhanced eligibility for grant funds, or expanded review of development proposals. Additionally, increased public recognition of the value of an aquifer may be an important consequence of a special area designation.

The special area designations discussed in this chapter are:

- Areas with a critical recharging effect on aquifers used for potable water per Chapter 36.70A RCW, Growth Management Act;

- Wellhead Protection Areas per the 1986 amendments to the federal Safe Drinking Water Act;

- Environmentally Sensitive Areas per Chapter 197-11 WAC, State Environmental Policy Act Rules;

- Special Protection Areas per Chapter 173-200 WAC, Water Quality Standards for Ground Waters of the State of Washington;

- Sole Source Aquifers per the federal Safe Drinking Water Act of 1974; and
- Aquifer Protection Areas per Chapter 36.36 RCW.

**Areas with a Critical Recharging Effect on Aquifers Used for Potable Water per Chapter 36.70A RCW, Growth Management Act**

The Growth Management Act (GMA) of 1990 requires all counties and cities in Washington to plan in order to manage growth. This act, much of which is codified in Chapter 36.70A RCW, requires that the largest and fastest growing counties (and the cities within them) conduct land use planning to achieve the following:

- Conservation of important timber, agricultural, and mineral resource lands;
- Protection of critical areas;
- Coordination of planning with neighboring jurisdictions;
- Consistency of capital and transportation plans with land use plans; and
- Early and continuous public participation in the land use planning process.

Counties and cities must adopt comprehensive plans and development regulations to protect designated critical areas and timber, agricultural, and mineral resource lands. The Growth Management Act requires the designation and protection of the following "critical areas": wetlands; areas with a critical recharging effect on aquifers used for potable water; fish and wildlife habitat conservation areas; frequently flooded areas; and geologically hazardous areas. The Growth Management Act also requires that the comprehensive plans contain land use controls to protect quality and quantity of ground water used for public water supplies (RCW 36.70A.070(1)).

The Growth Management Act requires that the comprehensive plans of adjacent jurisdictions or those who share related regional issues must be coordinated and consistent, a requirement of utmost importance for effective ground water protection. Meaningful protection of a dynamic resource that is shared by several jurisdictions is impossible without the cooperation of those jurisdictions.

Chapter 365-190 WAC, Minimum Guidelines to Classify Agriculture, Forest, Mineral Lands, and Critical Areas were adopted by the Washington Department of Community Development (DCD) pursuant to the Growth Management Act. The Guidelines, which are advisory in nature, provide a general framework for classification, designation, and regulation of critical areas.

The Guidelines define "areas with a critical recharging effect upon aquifers used for potable water" as "areas where an aquifer that is a source of drinking water is vulnerable to contamination that would affect the potability of the water." Although this definition is somewhat circular, it is clear that aquifers used for drinking water are deserving of particular attention. In addition, it is suggested that those aquifers that are vulnerable to significant contamination be targeted.

The Guidelines refer frequently to "aquifer recharge areas" without defining the term. The term is used very generally and appears to refer to the entire drainage basin in which an aquifer is contained and from which it receives water from infiltration of precipitation, runoff, and other surface water.

Mapping of known critical areas is encouraged as the best way to communicate to developers and regulators the location of the protected lands. It is recognized, however, that mapping aquifer recharge areas can be difficult and imprecise. Section 040(2)(g) of the Guidelines recommends that changes in designated areas be allowed as new information is available and errors are found.

The Guidelines suggest that the following be included in local government designation of aquifer recharge areas that are to receive protection under the Growth Management Act:

- Sole Source Aquifers designated pursuant to the Federal Safe Drinking Water Act of 1974;

- Areas established for special protection pursuant to Chapter 90.44 RCW, Chapter 90.54 RCW, and Chapter 173-200 WAC; and

- Wellhead Protection Areas designated pursuant to the 1986 amendments to the federal Safe Drinking Water Act.

King County and cities within the county have adopted at least interim criteria for designating aquifer critical areas in order to meet deadlines contained in the Growth Management Act. Interim development regulations have been adopted or existing authority to regulate has been clarified. Comprehensive interjurisdictional coordination envisioned by the Growth Management Act has not occurred; although, considerable discussion between local governments has taken place.

**The Wellhead Protection Program under the Federal Safe Drinking Water Act**

The 1986 amendments to the Safe Drinking Water Act established a Wellhead Protection Program intended to safeguard ground waters that are tapped by public water supply wells. Each state is required to develop and implement a Wellhead Protection Program in accordance with criteria established by the Environmental Protection Agency.

A state Wellhead Protection Program must:

- Specify the roles and duties of state agencies, local government entities, and public water suppliers in a wellhead protection;
- Provide the criteria for delineating the boundaries of Wellhead Protection Areas;
- Establish procedures for identifying sources of contamination within each Wellhead Protection Area;
- Develop management programs to protect ground water supplies within each Wellhead Protection Area from sources of contamination;
- Develop contingency plans for each public water supply system to respond to well contamination;
- Provide siting criteria for new public water system wells to maximize yield and minimize contamination; and
- Ensure public participation.

A Wellhead Protection Area is defined in the Safe Drinking Water Act as "the surface and subsurface area around a well or wellfield supplying a public water system through which contaminants are reasonably likely to move toward and reach such water well or wellfield (42 U.S.C.A. 300h-7(e))." The first step in the implementation of a Wellhead Protection Program is to delineate the Wellhead Protection Area boundaries.

The Washington Department of Health has been designated by the governor as the lead agency for developing and administering the Wellhead Protection Program in this state. Approximately 12,000 public water systems in the state will eventually be included in the Wellhead Protection Program. The State Board of Health Drinking Water Regulations (Chapter 246-290 WAC) are being revised to include the Wellhead Protection Program requirements.

Due to the nature of wellhead protection, much of the actual implementation efforts will be done by public water systems, local governments, and by those agencies with contaminant source-specific jurisdictional responsibilities. For example, the Washington Department of Ecology (Ecology) regulates underground storage tanks while the Washington Department of Agriculture regulates pesticide use. Those agencies would be responsible for emphasizing protection of the Wellhead Protection Areas within their jurisdictional authority.

The following are the principal requirements of the proposed Wellhead Protection Program for Washington:

- Delineation of a Wellhead Protection Area for each well or wellfield describing the 1, 5, and 10 year time of ground water travel (TOT) to the well from the recharge area;

- Inventory of potential sources of ground water contamination within the Wellhead Protection Area; and

- Development of management strategies to eliminate or minimize the possibility that the identified potential sources will contaminate ground water.

Public water system purveyors are responsible for delineating the WHPA and inventorying sources of contamination within their Wellhead Protection Area(s). State agencies are responsible for integrating wellhead protection measures into their existing programs. In many cases, this will be accomplished primarily by placing a priority on existing source control activities to emphasize Wellhead Protection Areas. Local land use authorities (cities, counties) are responsible for zoning controls and pollution sources outside the authority of the federal or state government. Local governments, where appropriate, may also be responsible for developing more stringent programs than federal and state governments currently provide.

It is clear that the Wellhead Protection Program will be of particular value to municipal water systems whose Wellhead Protection Areas are located completely or primarily within their boundaries. A number of municipalities including the City of Renton and the City of Tacoma have already successfully implemented a form of wellhead protection. The effectiveness of these programs was largely predicated on the ability of the municipal well owner to directly regulate land use in all or a large portion of the zone of contribution.

However, where public water system(s) do not control surrounding land use, the success of the Wellhead Protection Program will depend on the willingness of other city and county governments to impose necessary land use or other restrictions.

Considering that there are approximately 1,700 large and small public water system wells within King County, individualized land use controls for each public well or wellfield in the county would be unmanageable King County government. However, it should be possible to develop a generic, county-wide Wellhead Protection Program under which water purveyors could apply to the county for protection. This type of Wellhead Protection Program could be implemented under the auspices of the Aquifer Recharge Area provisions of the Growth Management Act. The preference towards county-wide requirements is reinforced in situations where well or wellfield owners lack sufficient resources to develop an individual Wellhead Protection Program. The state Wellhead Protection Program recommends a county-wide approach to wellhead protection. While a cooperative, multijurisdictional program would, by definition, involve compromise, individual public water system(s) could build upon the basic program at their discretion.

Development of minimum county-wide Wellhead Protection Program strategies involves an investment of time and money by the county, cities, and public water system purveyors. It will be technically demanding and politically challenging to develop a program that provides necessary protection for Wellhead Protection Areas while complementing the Ground Water Management Plan and other existing ground water protection efforts. However, development and implementation of such a program would be facilitated by taking advantage of the recent experience gained through similar efforts in many cities and states around the nation. There are now many models for wellhead protection to be studied.

Local jurisdictions in Washington are beginning to develop programs to facilitate the development of individual Well Head Protection Programs. There are also some efforts to develop coordinated approaches. For example, the adopted *Northern Thurston County Ground Water Management Plan* contains a provision for joint development of a county-wide Wellhead Protection Program by the county and participating cities. By interlocal agreement, jurisdictions will establish a committee to cooperatively develop the Wellhead Protection Program. Clark County is also making progress towards the cooperative development of Wellhead Protection Programs. It has been awarded a Centennial Clean Water Fund grant to create a process for implementation of a baseline, county-wide Well Head Protection Program.

In this area, the Union Hill Water Association completed the "Characterization and Protection of the Union Hill Aquifer System" (Carr and Associates, Inc., January 19, 1993). Also, the City of Redmond and the NE Sammamish Sewer and Water District have started to prepare their Wellhead Protection Programs.

**Environmentally Sensitive Area Designation Under the State Environmental Policy Act**

The State Environmental Policy Act (SEPA)(Chapter 43.21C RCW) is intended to provide decision makers and the public with sufficient information to evaluate the environmental consequences of proposed land, air, or water use activities when those activities involve an action by a governmental agency. Such an action could range from the issuance of a building permit to undertaking a major construction project such as a dam or a highway. The procedural provisions of the State Environmental Policy Act attempt to outline a process for distinguishing between actions that are likely to have significant adverse environmental impacts and those which are not. In cases where significant adverse impacts are anticipated, an Environmental Impact Statement (EIS) must be prepared.

The State Legislature authorized the Department of Ecology to develop rules for the implementation of the State Environmental Policy Act. The Department of Ecology subsequently developed and adopted Chapter 197-11 WAC, the State Environmental Policy Act Rules. These rules are intended to provide a uniform environmental review process in all political jurisdictions within the state. They are also intended to help define what constitutes a significant adverse environmental impact and to outline the content of environmental documents prepared under the State Environmental Policy Act.

The State Environmental Policy Act Rules are implemented in unincorporated King County through Chapter 20.44 of the King County Code, the County Environmental Procedures. The State Environmental Policy Act Section of the Department of Development and Environmental Services is responsible for ensuring adequate environmental review of proposed actions. Municipalities within King County have either adopted the State Environmental Policy Act Rules by reference or have developed their own regulations that incorporate the rules. Municipalities are responsible for ensuring proper environmental review of proposed actions occurring within their jurisdictional boundaries.

In developing the State Environmental Policy Act Rules, the Department of Ecology determined that, because of their size or nature, some classes or types of activities are not likely to represent a significant environmental impact and should, under ordinary circumstances, be exempt from the State Environmental Policy Act requirements. WAC 197-11-800 contains a list of these exempted types of activities, termed categorical exemptions. The categorical exemptions include some activities that could potentially create significant adverse environmental impacts in areas of unusual ground water sensitivity.

These activities include:

- Installation of underground chemical storage tanks with a capacity of less than 10,000 gallons;
- Construction of commercial buildings of less than 4,000 square feet and associated parking for up to 20 automobiles;
- Construction of parking lots for up to 20 vehicles;
- Construction of agricultural structures of under 10,000 square feet;
- Periodic use of Washington Department of Agriculture approved chemicals to maintain a utility or transportation right of way in its design condition; and
- Appropriation of 2,250 gallons per minute of ground water for any purpose.

Local governments have the authority to lower the thresholds for requiring environmental review by designating certain portions of their land use jurisdictions as Environmentally Sensitive Areas. These areas are generally more vulnerable to the adverse affects of land and water use activities. The State Environmental Policy Act Rules stipulate that Environmentally Sensitive Areas may include: "but [are] not limited to areas with unstable soils, steep slopes, unusual or unique plants or animals, wetlands, or areas that lie within flood plains."

In designating a portion of its jurisdictional area to be an Environmentally Sensitive Area, a county or city can eliminate many of the categorical exemptions found in WAC 197-11-800, including all but one of the land and water uses listed above. Categorical exemptions regarding appropriations of ground water cannot be revoked.

An Environmentally Sensitive Area designation may provide several important benefits for an area that is susceptible to ground water contamination. First, it would assist in raising the level of awareness of both the public and governmental agencies regarding the sensitivity of the aquifer system to contamination from overlying land use activities.

Secondly, designation would permit the King County Council and city councils to eliminate many of the categorical exemptions from environmental review that are currently allowed under the State Environmental Policy Act Rules. As a result, certain exempt land use activities that pose a relatively high risk of contaminating ground water, such as installation of underground chemical storage tanks of under 10,000 gallons, could be required to undergo environmental review.

In determining the number of categorical exemptions to be eliminated, caution should be taken to revoke only those exemptions that bear a direct and significant relationship to ground water quality. A wholesale elimination of categorical exemptions might result in an unfavorable public reaction since many relatively innocuous activities such as adding a recreation room to an existing house or constructing a garage would require environmental review. Not only would such an all-inclusive approach add unnecessary burdens on the public, it would potentially create a glut of environmental checklists that would significantly add to the workload of agencies that must review or process environmental documents without actually affording improvements in ground water protection.

One significant shortcoming of the State Environmental Policy Act process is that while environmental review assists the public and decision makers in identifying the probable adverse environmental impacts of a proposed activity or action, it does not provide basis for mitigation of the adverse impacts. Mitigation measures cannot be imposed unless some legally adopted ordinance, regulation, or policy exists that supports the requirement for mitigation. Adoption of the Ground Water Management Plan will provide the county and cities in the Ground Water Management Area legal basis for requiring mitigation because it contains ground water protection policies. These policies would be in addition to any existing regulations or policies already adopted.

**Special Protection Areas Established Under Washington Water Quality Standards for Ground Waters**

WAC 173-200-090 outlines procedures for the Department of Ecology to designate Special Protection Areas within the State of Washington. The purpose of designating Special Protection Areas is to identify portions of the state with ground waters that require extraordinary consideration or increased protection because of one or more unique characteristics.

Such characteristics include, but are not limited to:

- Recharge areas and wellhead protection areas that are vulnerable to pollution because of hydrologic characteristics;

- Ground waters that support a beneficial use or ecological system requiring more stringent ground water quality criteria than those based primarily on drinking water standards; and

- Sole Source Aquifers.

The Department of Ecology will grant a Special Protection Area designation if an area contains one or more of the three aforementioned characteristics and such a designation is deemed by the department to be in the public interest.

The department of Ecology can designate a Special Protection Area at its own discretion or at the request of a federal agency, another state agency, an Indian tribe, or local government. Requests for designation prepared by entities other than the Department of Ecology must provide sufficient information in support of the request to demonstrate that the designation would be appropriate under the conditions set forth in WAC 173-200. At a minimum the following information is required:

- A rationale for the proposed designation;

- Supporting technical and hydrogeologic data;

- A description of proposed boundaries for the Special Protection Area; and

- Documentation of coordination with affected state and local agencies, tribes, and water users.

Compliance with general procedures for public hearings, public involvement, and notification of affected governments including tribes is required before the Department of Ecology renders a decision concerning a request for designation of a Special Protection Area.

The Department of Ecology will consider the unique characteristics of a Special Protection Area when developing regulations, guidelines, and policies; when regulating activities; and when prioritizing department resources for ground water quality protection programs. Within Special Protection Areas, the Department of Ecology can choose to establish more stringent ground water quality criteria and contaminant enforcement limits.

In addition, the Department of Ecology can impose special requirements for permits issued under authority of Ecology administered programs. Examples would be the State Waste Discharge Permit Program (Chapter 173-216 WAC) and permits for the withdrawal of ground water (water rights) issued pursuant to Chapter 90.44 RCW (Regulation of Public Ground Waters).

**Sole Source Aquifer designation under the federal Safe Drinking Water Act**

The Sole Source Aquifer Program was established under section 1424 (e) of the Safe Drinking Water Act of 1974 and is administered by the Environmental Protection Agency. The primary intent of the program is to prevent projects that receive federal financial assistance from contaminating aquifers representing the sole or principal source of drinking water for an area. Projects that receive a portion, but not 100%, of their funding from the federal government are affected. An example would be a highway construction project funded jointly by the federal and state government. By contrast, a military installation is wholly financed by the federal government and, thus, is not restricted by the provisions of the Sole Source Aquifer Program.

In order to qualify for Sole Source designation, an aquifer must meet the following basic criteria:

- It must supply 50% or more of the drinking water consumed within the area for which the aquifer is supplying water; and

- Alternative sources of drinking water must be of inadequate quantity or not be economically feasible to develop as a replacement for the aquifer.

The Environmental Protection Agency is authorized to declare a ground water system to be a Sole Source Aquifer upon receipt of a satisfactory petition requesting such a designation. A petition can be submitted by any individual, corporation, company, partnership, municipality, state, or federal agency. The petition must contain sufficient technical documentation to demonstrate that the aquifer meets the criteria for Sole Source designation (U.S. Environmental Protection Agency, February 1987).

There is currently one Sole Source Aquifer in King County, the Cedar Valley. The Environmental Protection Agency has been petitioned to designate Vashon Island as a Sole Source Aquifer.

There are a number of positive aspects of a Sole Source Aquifer designation, the most important of which is its public awareness value. Sole Source Aquifer designation helps people recognize that an aquifer is unique or valuable and is worthy of protection. The designation can serve as a kind of rallying point around which support for ground water protection and management efforts can coalesce. Because of the attention that a Sole Source designation draws to an aquifer, new land development projects that may potentially harm underlying ground water may be more closely scrutinized by the public and by government agencies.

As discussed previously, the primary purpose of the Sole Source Aquifer Program is to prevent contamination of aquifers representing the sole or principal source of drinking water for an area. Once a Sole Source Aquifer has been designated, the Environmental Protection Agency will review all projects in the "project review area" that receive partially funding from the federal government. The project review area encompasses the surface area above the aquifer and the basin from which water potentially drains into or recharges the aquifer. The Environmental Protection Agency will determine whether projects pose a potential threat of contamination to the aquifer. Should it be determined that a project may contaminate the aquifer, the commitment for federal financial assistance may be withdrawn unless mitigation measures are implemented.

Sole Source Aquifer designation also has an impact on future solid waste landfill siting efforts, not as a result of provisions of the Safe Drinking Water Act, but due to requirements of the Washington Department of Ecology's Minimum Functional Standards for Solid Waste Handling (Chapter 173-304 WAC). The 1985 revision of the Minimum Functional Standards prohibited the construction of new or expansion of existing landfills over a Sole Source Aquifer in spite of the fact that Sole Source designation is not based upon the susceptibility of the aquifer to contamination. As a result, Sole Source Aquifer petitions have been submitted to Environmental Protection Agency by citizen groups as a means of preventing construction of a new landfill or the expansion of an existing landfill in their community.

In response to concerns expressed by solid waste utilities and some county governments, the Department of Ecology has modified its position concerning the prohibition of new landfills or the expansion of existing landfills located over a Sole Source Aquifer. A variance procedure has now been developed to allow the siting of new landfills or expansion of existing landfills overlying a Sole Source Aquifer if it can be demonstrated that ground water will not be adversely affected.

**Aquifer Protection Areas per RCW 36.36**

The Washington State Legislature passed legislation in 1986 which provided the authority for creation of local Aquifer Protection Areas. The purpose of an Aquifer Protection Area is to establish a funding base for ground water protection, preservation, and rehabilitation programs. An Aquifer Protection Area is established through an election ballot issue requiring approval from a simple majority of voters within the proposed Aquifer Protection Area boundaries. If voters approve the Aquifer Protection Area, the county can collect modest water and on-site sewage system user fees. Fees may only be collected from users of water withdrawn from an aquifer as opposed to a surface water source.

In 1987, voters in a portion of Spokane County established the first Aquifer Protection Area in Washington State. The water user fees established by the voters of Spokane County amount to $1.25 per month per residential equivalent. On-site sewage system user fees are also $1.25 per month per residential equivalent.

Until recently, the use of revenues generated from an Aquifer Protection Area has been limited to ground water protection planning, ground water treatment facilities, and wastewater treatment facilities. As originally adopted, the law did not authorize use of the Aquifer Protection Area revenues for a full spectrum of ground water protection activities. For example, regulatory programs aimed at controlling pollution from underground storage tanks, hazardous wastes, or on-site sewage disposal systems were not covered.

However, the 1991 Legislature rectified this shortcoming through passage of Substitute House Bill (SHB) 1019. SHB 1019 amended Chapter 36.36 RCW to allow Aquifer Protection Area revenues to be used to fund the following activities in addition to those described above:

- Ground water quality and quantity monitoring;
- Ongoing implementation of comprehensive plans to protect, preserve, and rehabilitate ground water, including Ground Water Management Programs;
- Enforcement of compliance with standards and rules relating to the quality and quantity of ground water; and
- Public education related to protecting, preserving, and enhancing ground water.

Thus, with these amendments, Aquifer Protection Area funding can support virtually all activities associated with the implementation of a Ground Water Management Plan.

Potential drawbacks to the use of an Aquifer Protection Area to fund the implementation of the Ground Water Management Plan include the following:

- There is little flexibility in the use of funds (intended use of funds must be specified in the ballot measure, changes in use require voter approval);
- A significant initial financial investment is required to educate the public regarding the need to fund ground water protection efforts;
- Adjustment of fees over time will require voter approval; and
- There are inequities in the fee structure.

The inequities or potential inequities in the fee structure include:

- Fees appear to be based on the assumption that septic users are more significant contributors to potential ground water contamination than other sources such as underground chemical storage and hazardous waste;
- Fees apply only to households, businesses are not assessed; and
- Fees are not related to amount of water used.

## GOAL

To use available special area designations in conjunction with local regulations and policies to enhance ground water protection efforts in the Redmond-Bear Creek Valley Ground Water Management Area.

## ISSUES

**Issue 1 - General protection of aquifers.** Effective aquifer protection requires cooperation between land use jurisdictions because aquifers do not coincide with jurisdictional boundaries. General policies that provide guidance for land use decisions could be adopted by King County and cities in the Ground Water Management Area to provide a basic level of protection for aquifers.

**SA-1A Designation of Environmentally Sensitive Areas:** King County and cities within Ground Water Management Areas will designate those areas to be Environmentally Sensitive Areas as authorized by the State Environmental Policy Act.

**SA-1B Elimination of categorical exemptions to Environmental Protection Agency:** King County and cities within Ground Water Management Areas will jointly determine categorical exemptions to the State Environmental Policy Act that should be eliminated in the Ground Water Management Areas, especially in ground water recharge areas as identified (mapped) in the Ground Water Management Plan.

**SA-1C Adoption of general aquifer protection policies:** King County and cities within Ground Water Management Areas adopt the following policies for Ground Water Management Plans:

- Ground water based public water supplies should be protected by minimizing land use impacts on ground water quality or quantity to preserve the supply of high quality drinking water for present and future populations.
- In the ground water recharge areas that are mapped for the Ground Water

Management Plan per SA-1E:

- In rural areas:

  land uses that retain a high ratio of permeable to impermeable surface area and that maintain or augment the infiltration capacity of the natural soil are preferred; and

  standards for seasonal and maximum vegetation clearing limits, impervious surface limit, and, where appropriate, infiltration of surface water will be required.

- In urban areas:

  methods that infiltrate runoff where site conditions permit, except where potential ground water contamination cannot be prevented by pollution source controls and stormwater pretreatment will be promoted, to protect ground water recharge quantity;

  best management practices for new development, forestry, agriculture and mining operations will be developed to promote aquifer recharge quality and to maintain ground water recharge.

- Wellhead Protection Programs will provide direction for focusing intense aquifer protection efforts in those areas where the existing built environment presents very significant risks to public drinking water systems.

**SA-1D Enhanced environmental review to protect aquifers:** King County and cities in Ground Water Management Areas will jointly develop guidance to assist environmental reviewers to:

- Identify proposed development that may significantly impact ground water in aquifer recharge areas mapped in the Ground Water Management Plan,

- Recognize and require adequate information to assess impacts upon ground water, and

- Recognize and propose effective mitigation.

**SA-1E Ground water recharge areas:** King County and cities will place a priority on implementation of the Ground Water Management Plan in ground water concern areas. These areas include areas susceptible to ground water contamination and aquifer recharge areas. These areas are defined as follows:

Areas of unusual susceptibility to ground water contamination (important to identify to protect ground water quality) are mapped according to the following criteria:

- Soil permeability - Soil units are defined by the Soil Conservation Service in the *Soil Survey of the King County Area* (Soil Conservation Service, 1973). The units are rated high, moderate, or low permeability according to the description in the Survey.

- Geologic materials - United States Geological Survey maps provide information on surficial geology. High, moderate, or low permeability is determined by professional judgement.

- Depth to water - Drillers logs and previous investigations are used to determine depth to water. Existing water table elevation maps are used, if available. High (0-25 feet from surface), moderate (25-75 feet from surface), and low (>75 feet from surface) contamination potentials are assigned.

- Topography - Percent slope is obtained from topographic maps and the Soil Conservation Service soil survey. High (0-40 percent), moderate (40-80 percent), and low (>80 percent) recharge potentials are assigned. The intent of the slope factor is to exclude an area from a "high" rating only if it has what would be generally considered a very steep slope. Consequently, the "high" category is quite inclusive at 0-40 percent.

Areas receive overall ratings through use of an overlay map that integrates ratings from the four physical parameters. All parameters are assigned equal weight. A combined rating score is assigned to each portion of the mapped area. Determination of whether an area has a high, moderate, or low potential for recharge is then made by conservative interpretation of the combined rating. For example, a combined rating score of high-high-moderate-moderate is given an overall rating of high while a rating of high-moderate-low-low is given an overall rating of moderate. A composite map shows the overall ratings.

Aquifer recharge areas (important to identify to protect ground water quantity): recharge only occurs where water reaches an aquifer by surface infiltration, and where there is a downward component of hydraulic head (pressure head). However, the presence of a downward component of hydraulic head cannot be determined without extensive research on water levels, well completion and well location data. Therefore, to provide a conservative estimate, a downward component of hydraulic head is assumed to be present in all areas.

**Discussion:** Actions 1A through 1E provide broad protection for aquifers. Actions 1A and 1B will provide protection by bringing projects through State Environmental Policy Act review that are now exempt but that may have significant impacts upon ground water. It will be important to determine which categorical exemptions should be eliminated so that minor projects that would have little effect upon ground water will not require State Environmental Policy Act review. A two-tiered approach to categorical exemptions could be considered. For example, more categorical exemptions could be eliminated in ground water recharge areas.

Action 1C provides a general policy framework for aquifer protection. This framework includes a commitment to protect public water systems; provision for addressing the potential for aquifer contamination from the existing and new built environment and a direction for the Wellhead Protection Programs (that each public water system purveyor will be required to develop by state regulations) to provide specific protection for drinking water sources.

Wellhead Protection Programs will consist of a core of county-wide protection strategies supplemented by water system specific strategies developed by individual purveyors. Strategies to protect water systems may include such measures as education, technical assistance, regulation, monitoring, emergency response, business relocation assistance, and land acquisition. Efficiencies will be achieved by making full use of existing programs and initiating new programs only as needed.

Action 1D provides a means for the county and cities to jointly develop guidance documents and informational materials for optimal environmental review. The purpose is to raise the level of understanding of aquifers among those responsible for reviewing environmental documents. Maps of aquifers, aquifer recharge areas, and high potential recharge areas will be refined and presented in an easy-to-use format.

Action 1E provides for identification of those portions of the Ground Water Management Area that are most in need of protection. Maps of these areas will primarily be used to determine priorities for implementation of the Ground Water Management Plan. For example, the GWAC has adopted a policy of monitoring for pesticide and fertilizer contamination in agricultural areas. The maps of aquifer recharge areas will be used to determine where to focus this effort. Maps will also be used to educate and assist the public, elected officials, land use planners, environmental reviewers, and others who make decisions that may affect ground water quality or recharge. These maps will also be valuable to purveyors who are determining wellhead protection priorities. It is expected that these maps will be updated and refined based upon information from the Wellhead Protection Programs and from other ground water studies.

All of the actions proposed under Issue 1 are joint actions recognizing that aquifer protection cannot be accomplished by one land use jurisdiction alone. Joint action by the county and cities is consistent with Growth Management Act requirements to coordinate protection of aquifers. Joint action is practical because costs can be reduced and the regulated community will experience consistent policy towards protected areas. This is particularly important with an area that is large and located in more than one land use jurisdiction.

**Implementation:**

**Task 1:** Designate Environmentally Sensitive Areas. (SA-1A)

| | |
|---|---|
| Who: | King County and cities initially accomplish this task by concurring with the Ground Water Management Plan. |

**Task 2:** Amend local environmental ordinances to reflect the adoption of Environmentally Sensitive Areas. (SA-1B)

| | |
|---|---|
| Who: | Seattle-King County and cities. |
| When: | Year 1. |
| Cost: | 1 staff per local government; 12 local governments involved. About 3 months of work. Cost estimates to be developed during concurrence. SKCHD: 0.25 FTE - $26,100. |
| Source of funds: | Aquifer Protection Fund. |

**Task 3:** Determine which of the existing categorical exemptions to eliminate. (SA-1B)

| | |
|---|---|
| Who: | King County and cities via the Management Committee. |
| When: | Year 1. |
| Cost: | 1 staff per local government; 12 local governments involved. About 3 months of work. Cost estimates to be developed during concurrence. SKCHD: 0.25 FTE = $26,100. City of Redmond: $204,800. |
| Source of funds: | Aquifer Protection Fund. |

**Task 4:** Adopt general aquifer protection policies. This task is accomplished by concurring with the Ground Water Management Plan. At their discretion, King County and cities may wish to amend comprehensive land use plans. (SA-1C)

**Task 5:** Develop guidance to assist environmental reviewers. (SA-1D)

| | |
|---|---|
| Who: | Seattle-King County Health Department (SKCHD) for the approval of the Management Committee. |
| When: | Year 2. |
| Cost: | 1 staff for 6 months at SKCHD $52,200. The cost of review, amendment, and approval of the guidance will be included in the cost of participation in the Management Committee. See Chapter 4. City |

| | |
|---|---|
| | of Redmond: $51,200 + $10,240. |
| Source of funds: | Aquifer Protection Fund. |

**Task 6:** Ground Water Recharge Areas. (SA-1E)

| | |
|---|---|
| Who: | King County, cities |
| When: | Year 1. |
| Cost: | No initial cost; accomplished by concurring with Ground Water Management Plan. King County expects costs associated with further refinement of the maps. |
| Source of funds: | General agency funds would be used to disseminate mapped information. The Aquifer Protection Fund would support further revision of the maps. |

**Issue 2 - Wellhead Protection:** Public water system purveyors are required to develop state mandated Wellhead Protection Programs. Purveyors must delineate and adopt measures to protect Wellhead Protection Areas (WHPAs) for each well or wellfield. The Ground Water Management Plan will fulfill some wellhead protection needs. However, specific strategies to provide an increased level of protection to public water systems will be required by the Washington Department of Health. In order to accommodate the needs of hundreds of large public water systems, King County needs purveyor assistance in developing a basic approach to Wellhead Protection in the unincorporated areas.

**SA-2 Wellhead Protection:** King County, cities, public water system purveyors, and others jointly facilitate Wellhead Protection in King County by assigning to the Ground Water Management Committee (Management Committee) the following tasks:

Develop and recommend for adoption by the King County Board of Health minimum Wellhead Protection strategies for public water systems in two size categories:

- Those serving more than 1000 connections; and
- Those serving from 2 to 1000 connections.

Incorporate minimum wellhead protection strategies into the Ground Water Management Plan in order for their implementation to be eligible for funding by the Aquifer Protection Fund.

**Discussion:** In the context of the larger aquifer protection program, Wellhead Protection can fill a vital need to focus intense aquifer protection efforts in those areas, usually urban, where there are existing sources of contamination that present very significant risks to public drinking water supplies.

Minimum Wellhead Protection strategies developed by the Management Committee will build upon the Ground Water Management Plan. Some of the issues considered by the RBC-GWAC will probably be considered by the Management Committee. A determination should be made as to whether additional protective strategies are needed within a certain zone around the well in relation to these issues. The need for additional protection may be dependent upon the hydrogeology of the zone.

Additional protection may include such measures as education, technical assistance, regulation, monitoring, and emergency response. Business relocation assistance and land acquisition may be considered on a case-by-case basis. Efficiencies will be achieved by making full use of existing programs and initiating new programs only as needed.

Minimum county-wide Wellhead Protection strategies will not address delineation or contaminant source inventory requirements of the state Wellhead Protection Program. The Management Committee effort will focus instead upon steps taken to protect a well once its Wellhead Protection Area has been delineated and potential sources of contamination have been inventoried. Cooperative efforts by purveyors in the delineation and source inventory phases are encouraged.

It is anticipated that individual purveyors will have system-specific needs they will want included in individual Wellhead Protection Programs. The funding proposal outlined in Chapter 4 includes financial support for those programs.

Active participation by the Washington Department of Health will be sought in developing minimum Wellhead Protection strategies. Inclusion of a minimum program that is supported by Washington State Department of Health will speed approval by that department of Wellhead Protection Programs submitted by individual purveyors.

It is possible that certain aspects of a minimum Wellhead Protection Program may be conducive to codification in county laws. This will be explored by the SKCHD in the course of development of the Wellhead Protection Strategies.

The Management Committee should address the issue of overlapping Wellhead Protection Areas. It will not be unusual for a number of smaller Wellhead Protection Areas to be contained within the protection area for a larger system. There are also situations in which the Wellhead Protection Areas for very large systems will overlap. Protection Zones 1, 2, and 3 will be designated within the Wellhead Protection Areas. Zone 1 (requiring the highest protection standard) for one system may be located in Zone 3 of a second system. The area should be protected to the higher of the two standards. Responsibility for management of the area could be assigned to the purveyor for whom the area has a higher protection standard. A shared management strategy might also be possible. However, this is an issue that should be considered by the Management Committee.

**Implementation plan for SA-2:**

**Task 1:** Develop minimum Wellhead Protection Strategies and recommend for adoption by the King County Board of Health.

| | |
|---|---|
| Who: | King County and cities via the Management Committee. |
| When: | Year 1 and 2. |
| Cost: | Included in the cost of participation in the Management Committee. See Chapter 4 for estimate. |
| Source of funds: | Aquifer Protection Fund. |

**Task 2:** Incorporate minimum Wellhead Protection Strategies into the Ground Water Management Plan.

| | |
|---|---|
| Who: | King County and cities via the recommendations of the Management Committee. |
| When: | With the first Ground Water Management Plan update or sooner by special action taken by elected official. |
| Cost: | Included in the cost of participation in the Management Committee. See Chapter 4 for estimate. City of Redmond: $10,240. |
| Source of funds: | Aquifer Protection Fund. |

(Note: The GWAC did not take action on the Growth Management Act, Special Area designation and funding through Aquifer Protection Area. The following discusses why the GWAC did not take separate action.)

**Growth Management Act.** No actions are proposed to implement the Growth Management Act requirements to designate areas with a critical recharging effect on aquifers used for potable water. It was determined that development of county-wide criteria to implement the Growth Management Act are outside of the scope of the Ground Water Management Plan. However, since the subject is so closely related to the goals and policies of the Ground Water Management Plans in King County, an alternate method of addressing with this matter will be pursued by SKCHD concurrently with release of the draft Ground Water Management Plan for public review. SKCHD will propose to the King County Council that the following be considered as critical areas for purposes of compliance with the Growth Management Act: Ground Water Management Areas, Sole Source Aquifers, and Wellhead Protection Areas. It will be further proposed that the King county Council contact cities in King County and suggest that the same areas be included in their critical areas designation. These proposals will be presented to the King County Council when the Ground Water Management Plan is presented for concurrence.

**Aquifer Protection Area funding:** An alternate method to Aquifer Protection Area funding is proposed in Chapter 4. Some of the drawbacks of Aquifer Protection Area funding were outlined in the text of the issue paper. The primary purpose in pursuing a Board of Health fee is that it would provide greater flexibility for implementation of the Ground Water Management Plan.

**Special Protection Area status:** Special Protection Area status is not proposed for the initial Ground Water Management Plan for several reasons:

- It is not certain that significant benefit would accrue from obtaining this designation. Ecology permit reviewers know where Ground Water Management Areas are located and they are attentive to ground water concerns in those areas. Funding priority is already given to Wellhead Protection Programs by the Water Quality Financial Assistance Program. SPA designation for Wellhead Protection Areas would, in terms of funding priority, be redundant.

- There is concern that too many special area designations would create more confusion than protection. SPA designation may be less important than some of the other designations that are proposed.

- Considerable effort is necessary in order to obtain this designation. It would detract from other important efforts that the Ground Water Management Plan proposes.

- Ecology is nearing completion of its guidance for applicants. It is not possible to draw upon the experience of other applicants since there have been none.

A decision to apply for SPA status can always be made at a later date if it appears that the designation is needed.)

3.2.2. Data Collection and Management Program

Long-term data collection of ground water quality and quantity, precipitation, and stream flow is necessary for the continued development of a conceptual characterization of ground water hydrology within the RBC-GWMA. The collected data needs to be entered into a database and analyzed to provide useful information for making resource management decisions.

When rain falls and infiltrates into the ground, the water which collects in the spaces between the mineral grains or the cracks in dense rock in the saturated zone (i.e., when all voids are full of water) is called ground water. This saturated zone of ground water is known as an aquifer. An aquifer is a formation, group of formations, or part of a formation that contains sufficient saturated permeable material to economically yield quantities of water to wells and springs. Ground water is always moving, is sometimes in hydraulic continuity with surface water, can provide the base flow of creeks and rivers, and may recharge surface water features such as lakes, ponds, and wetlands.

When water is pumped from a well, the level of water in the well drops. When the water level falls below the water level of the surrounding aquifer, ground water flows into the well. When more water is withdrawn or discharged from an aquifer than is recharged, the volume of water in the aquifer will diminish. Development of natural areas may affect water quantity in two ways:

- The creation of impermeable surfaces (roofs, parking lots, etc.) reduces the amount of recharge, and

- An increase in the number of water users can result in a corresponding increase in the amount of water pumped out of an aquifer.

Potential ground water recharge is also lost when treated sewage effluent is discharged into Puget Sound.

Ground water quality is potentially affected by all land use activities including leaking underground storage tanks, landfills, stormwater infiltration systems, on-site sewage systems, pesticide and fertilizer use, hazardous waste generation, and sand and gravel mining operations.

Data is collected and analyzed so that state and local agencies can:

- Determine water resource trends in ground water quality and quantity;

- Make informed decisions on such issues as land use and water rights;

- Plan for peak water use and population growth impacts;

- Conduct water programs such as well construction and abandonment, operation, and maintenance;

- Develop and refine a water resource model;

- Respond to data requests from water agencies and other interested parties; and

- Respond to incidents such as water level declines.

Long-term collection of data obtained from monitoring of water levels in selected wells will indicate trends in ground water fluctuations related to water use, recharge, and land use and will provide information for managing ground water resources. Similarly, regular collection of water quality data will verify that the resource is potable and will detect any changes or trends in water quality. Precipitation and stream flow data is necessary for the determination of recharge and runoff quantities.

The current ground water management program at Seattle-King County Health Department (SKCHD) has established a ground water monitoring network. Data collected within this network has contributed to the establishment of a database containing precipitation, stream discharge, water level, and water quality data. Descriptions of rock and soil encountered in the drilling of wells have been obtained from well logs and entered into the database. This data, combined with existing precipitation, stream flow, and water level data from other agencies, has proven adequate to conduct only an initial water balance and ground water flow analysis.

The Background Land and Water Use Report, the Background Hydrology Report, the Data Collection and Analysis Plan, and Data Analysis\Area Characterization Report (which are products of the Ground Water Scope of Work) identified where future data collection is needed (see Appendix 1). Further data collection and analysis is needed along with an expanded network of existing and new wells for the development of a conceptual model of ground water hydrology.

## GOAL

To protect ground water quantity and quality by developing and implementing a long-term data collection and management program.

## ISSUES

**Issue 1: Data collection, analysis, and management.** Characterization of the aquifer hydrology in the Ground Water Management Plan needs to be performed. Data collection and management is a vital part of this process. However, additional data collection and analysis is needed to refine the aquifer characterization and to facilitate long-term management of the resource.

**DCM-1A Data collection, management, and analysis program:** Develop and implement a data collection, management, and analysis program that:

Collects data needed according to Appendix 1.

Continues data entry into the database, manages data for quality control and applicability to analytical techniques, standardizes formats, shares data with other agencies, and ensures data compatibility with other data collection efforts.

Analyzes the data to:
•Refine a conceptual understanding of the ground water hydrology for

determination of the available resource.
•Assesses impacts of land use on the resource, and
•Determine if a single effective regional numerical model is needed or would be useful for ground water management.

**DCM-1B Data transfers with Ecology:** Ecology will input local ground water management area data into Ecology's ground water data base.

**Discussion:** The *Data Collection and Analysis Plan* would be adjusted according to the recommendations from consultants and Seattle-King County Health Department, Environmental Health Division staff following completion of data analysis. A modified monitoring program would include collection of data from existing network sites, plus collection of data from sites added to fill data gaps recognized during initial data analysis. Monitoring stations would be omitted where data is no longer needed. Data collected would include water quality monitoring for pesticide and fertilizer contamination, hazardous waste contamination, and sea water intrusion; the identification and location of wells by well ID tagging; and maps showing areas of high, medium, and low recharge. All data collected would be entered into the SKCHD database and regularly shared with other water agencies including the Department of Ecology (Ecology), Department of Health, King County, cities and utilities. The Aquifer Protection Fund could provide the means to keep the database current and to share the data with the affected agencies.

Data generated would not only result in an increased level of confidence in conclusions drawn from the data, but would also serve to generate additional information needed to fill data gaps and promote an increased conceptual understanding of ground water hydrology useful for future model development. A ground water flow model includes considerations for surface water linkages to ground water and the impacts to surface waters resulting from increased withdrawal. Model development is necessary to provide the technical information necessary to make informed management decisions relating to ground water and surface water resources.

The Ground Water Management Plan contract with Ecology requires King County to download the database to provide ground water quality and quality, precipitation, and stream flow data to Ecology. However, there is no mechanism for future data transfers to Ecology upon completion of the study. Ecology, King County, and the relevant city and utility data bases must all be kept current.

**Implementation plan for DCM-1A and DCM-1B:**

**Task 1:** Monitoring of water quality, water level, precipitation, and stream discharge parameters. (DCM-1A)

Where water level declines or ground water contamination is observed, appropriate action would be taken. Other activities listed in Appendix 1 would be conducted.

**Task 2:** Tag existing and new wells where found. (DCM-1A)

| | |
|---|---|
| Who: | Seattle King County Health Department (SKCHD), Environmental Health Division; Ecology; cities; utilities; well drillers; and volunteers. |
| When: | Ongoing. |
| Cost: | SKCHD: $52,200/yr. Cities and utilities: To be determined during concurrence process. |
| Source of funds: | Aquifer Protection Fund. |

**Task 3:** Enter data collected into SKCHD database. Maintain database and download data regularly to Ecology, affected cities, and water districts. Ecology to enter ground water management area data into Ecology's ground water data base. (DCM-1B)

| | |
|---|---|
| Who: | SKCHD and Ecology |
| When: | During concurrence and at predetermined intervals after concurrence. |
| Cost: | SKCHD: $104,400/yr. Ecology: $7,000/yr. |
| Source of funds: | Aquifer Protection Fund, General Agency Funds. |

**Task 4:** Development of a numerical or computerized ground water hydrology model

| | |
|---|---|
| Who: | SKCHD |
| Cost: | SKCHD: $104,400 yr. Ecology $7,000/yr. |
| Fund Source: | Aquifer Protection Fund, General Agency Funds. |

Redmond DCMP Data Collection List:

| GWAC Ranking | Task | Cost Estimate | 1st Year | Second Year |
|---|---|---|---|---|
| HIGH | An aquifer vulnerability assessment that integrates physical susceptibility and land use activities would be useful for long term ground water protection planning. Specific information that would be needed includes land use zoning, septic tank density, underground storage tanks, transportation corridors, beneficial use of ground water, and known contamination risks. | 2088 hours<br>$55/hour | 114,840.00 | |
| HIGH | In order to develop an accurate water balance for the RBC GWMA, additional stream gauging, precipitation, evapotranspiration, and water use data must be collected.<br><br>Stream gauging needs to be accomplished at 2 locations (upper and lower reaches) of each continuous flowing stream, Bear, Evans and Cottage creeks. The gauging should be done hourly for 10 - 15 years, ideally permanently. Gauging should also be done monthly on Siedel, Daniels and Struve creeks.<br><br>Precipitation should be continued to be collected in Redmond, Woodinville, Sahallee, and Novelty Hill.<br><br>An evapotranspiration station should be established, probably in Redmond. | Streams: 9 locations.<br><br>Cost for a new station: $3000 + $440 labor to install = $3400 each.<br><br>Monitoring: 2 days every month = 16 hrs X $55/hr X 12 mo.s = 10,560<br><br>Precipitation: 8 hours X $55/hr X 12 mo.s = 5280<br><br>Evapotranspiration: $500 equipment cost.<br><br>Data entry: 1 day every month = 8 hrs X $55 hr X 12 = $5280 | 52,220.00 | 21,120.00 |
| HIGH | Ground water chemistry: A representative number of wells sampled for the RBC study should continue to be monitored at least annually. Effort should focus on the shallow, uppermost aquifer zones if there is insufficient resources to monitor all zones. | 15 wells<br>Labor: 5 days<br>Lab: $200 each<br><br>(5 days X 8 hours X $55/hr) + 200 = 2400 | 2,400.00 | 2,400.00 |

| GWAC Ranking | Task | Cost Estimate | 1st Year | Second Year |
|---|---|---|---|---|
| HIGH | Long term water level data needs to be collected throughout the study area in all aquifer zones. Water levels should be collected twice a year (summer and winter) to evaluate fluctuations and trends. New monitoring wells should be surveyed for altitude. | 30 wells needs<br>3 days, twice a year, X $55/hr<br><br>Survey: 5 days, $55/hr = 2200 | 4,840.00 | 4,840.00 |
| SUBTOTAL HIGH | | | 174,301.00 | 28,360.00 |
| MEDIUM | The number and distribution of domestic wells should be determined. | 80 hours<br>$55/hr | 4,400.00 | |
| MEDIUM/LOW | To better estimate future ground water use potential and to supply input into any numerical model, aquifer parameters such as hydraulic conductivity and transmissivity should be estimated for the various aquifer zones. This should be accomplished through pump testing of existing and new test wells. Pumping tests should be done for a minimum of 24 to 72 hours if possible. | Existing wells: 20<br>New wells: 10<br>Pump test each: $1000 for existing, $2500 for new. | 45,000.00 | |
| SUBTOTAL MEDIUM | | | 49,400.00 | 0.00 |
| LOW | Hydrostratigraphic information is very limited for the northern parts of the basin, particularly along Avondale Road and Cottage Lake. An additional 5 - 10 test wells should be drilled in these areas to evaluate geologic and ground water conditions. Since all of the area is served by septic system, an understanding of the subsurface conditions is critical to evaluate aquifer vulnerability | 10 wells<br>$10,000 each | | 100,000.00 |
| LOW | Geophysical work, such a seismic refraction, should be done along the same transects as the electrical resistivity soundings. This effort should be done prior to any additional test well drilling so that is can be used to select future drilling locations. | $75,000 | $75,000 | |

| GWAC Ranking | Task | Cost Estimate | 1st Year | Second Year |
|---|---|---|---|---|
| SUBTOTAL LOW | | | 75,000.00 | 100,000.00 |
| TOTAL | | | 298,701.00 | 128,360.00 |

(This page left blank intentionally)

### 3.2.3. Ground Water Quality and Quantity Issues Associated with Stormwater Management

Stormwater is water which runs off impervious surfaces when it rains. Past and present stormwater management practices have often caused ground water quantity and quality problems. Ground water quality may be impacted if stormwater containing contaminants is recharged intentionally or inadvertently. From a public health standpoint, the most serious concern over recharge of stormwater is possible effects on the quality of drinking water. Also, precipitation that, under natural conditions, would be recharged to ground water is diverted to surface water. As a result, there is a decrease in the quantity of recharge to ground water.

The continuity of surface and ground water is an important concept in understanding the effects of surface water contamination on ground water. It is also important in making decisions regarding the most efficient way to protect both surface and ground water. Ground water and surface water cannot be considered two separate hydrologic systems because they are inextricably entwined.

King County has experienced the effects of urbanization and deforestation. Growth of King County's urban area has resulted in more impervious surfaces, more runoff, stream damage, and a reduction of recharge to ground water. Deforestation, the removal of vegetation and the subsequent compaction of soil, may also increase runoff and reduce ground water recharge.

Stormwater management facilities can be designed to maximize infiltration into the ground, thereby increasing recharge to aquifers. However, an obvious concern is the potential to contaminate ground water with pollutants carried in stormwater. In the past, stormwater management emphasized flood control and was not particularly concerned with water quality. More recently, however, concern has shifted to the quality of stormwater and how it can impact receiving waters, including ground water. Stormwater management practices include source control and treatment facilities.

Stormwater management facilities vary in the degree to which flow control and treatment mechanisms occur. The most common methods used for both flow control and water quality improvement are detention basins, infiltration facilities, biofilters, and coalescing plate oil/water separators.

**Stormwater Management Programs and Regulations**

Numerous federal, state, and local programs and regulations govern the management of stormwater and the control of point and non-point pollution. However, there are no programs or regulations which solely relate to the issue of impacts of stormwater management practices upon ground water resources.

State Programs. The Puget Sound Water Quality Authority adopted the Puget Sound Water Quality Management Plan which forms the foundation of the stormwater program at the Department of Ecology (Ecology). That program affects cities, counties, and the Washington State Department of Transportation. The Puget Sound Water Quality Management Plan focuses on protection of surface waters which are tributary to the sound as well as Puget Sound itself. Little attention is paid to the continuity of surface and ground waters. The protection of ground water afforded through the many activities fostered by the Puget Sound plan is often noted but is secondary to protection of surface waters.

Coordination of surface and ground water management is included in two Ecology programs: the Local Planning and Management of Non-point Source Pollution program and the Ground Water Management Program. The Local Planning and Management of Non-point Source Pollution program requires affected counties to convene watershed ranking committees to establish priorities among watersheds that are in need of protection. It also encourages coordination and integration of local ground and surface water protection planning efforts by stating that:

> "To reduce duplication of effort, Ecology shall also be responsible for coordinating the activities of the watershed management committee with other existing water management programs (e.g. ground water). Coordination and integration of local efforts related to ground and surface water is strongly encouraged. If a joint ground water and watershed management program is established, the county shall be the lead agency for the joint program."

The law creating Ground Water Management Programs contains less specific language, but does encourage coordination. However, there are several reasons for why this integration at the local level seldom occurs. Those reasons are listed below.

- The state treats surface and ground water quality protection programs as separate. The programs are administered by different sections within Ecology. Grants are also managed differently.

- Centennial Clean Water Funds are categorized in a way which discourages integrated plans. Because of intense competition in the non-point category, a proposal which emphasizes ground water protection will be placed in the ground water category. This practice discourages joint watershed/ground water non-point source pollution control plans.

- Ground water planning is usually seen as a public health issue and local public health departments usually serve as lead agencies for Ground Water Management Programs. Watershed planning is usually seen as a surface water issue and is usually addressed by a branch of a local public works or planning department.

- Local lead agencies, faced with short timelines and limited resources, are answering to different programs at Ecology and responding to different regulations which guide their planning processes. The magnitude of the problem of trying to coordinate in the face of the confusion generated at the state level proves daunting. Lack of coordination between agencies is often the unfortunate result.

It is possible that budget cuts at Ecology and declines in the amount of money available through the Centennial Clean Water Fund will force a resolution of inefficiencies in water quality planning at the state level. Despite staff recommendations favoring consolidation, there has not yet been concrete progress in this direction.

Another state program which relates to stormwater is the Stormwater and Combined Sewer Overflows Program. The goal of that program is to protect shellfish beds, fish habitat, and other resources; to prevent the contamination of sediments from urban runoff and combined sewer overflows; and to achieve standards for water and sediment quality by reducing pollutant discharges from stormwater and combined sewer overflows. Ecology is developing model ordinances, a technical manual, and numerous other guidance documents to assist cities and counties.

Ecology is also directed under the Stormwater and Combined Sewer Overflows Program to

- Work with Washington State Department of Transportation on a program to control runoff from state highways in the Puget Sound basin, and

- Develop a technical manual which establishes best management practices for stormwater for use by local governments.

In response Ecology developed the Stormwater Management Manual for the Puget Sound Basin (1992) to provide assistance local governments in meeting the stormwater management rules. This manual addresses erosion and sedimentation control, runoff control, and control of pollution from urban land uses. The manual addresses impacts on ground water in the following manner.

- Infiltration is the preferred method of (runoff) volume control and other methods are allowable only after infiltration has been ruled out for technical reasons.

- The Ecology manual requires that a certain volume of runoff be infiltrated or detained. This is in contrast to the King County manual which requires only that peak runoff rates not be altered by the development. This is of major significance when considering volume of water to be potentially recharged to ground water.

Local Programs. King County Surface Water Management Division of the Department of Public Works has broad responsibility for management of stormwater in King County. King

County Surface Water Management conducts routine maintenance of drainage and pollution control facilities; constructs facilities to control runoff and protect natural drainage systems; conducts needed engineering and habitat analyses; and responds to both complaints and emergencies involving flooding, erosion, and water quality. The program's goal is to minimize the personal, financial, and environmental costs associated with flooding and erosion by providing a comprehensive approach to surface water management. King County Surface Water Management has presented the King County Council with the *King County Surface Water Management Strategic Plan*. The Strategic Plan emphasizes an acceleration of the current program along with new emphasis in water quality and "off road" stormwater facilities. King County Surface Water Management also addresses ground water quality and quantity in its planning processes.

An important feature of the King County Surface Water Management program is its design manual completed in 1990. The *King County Surface Water Design Manual* (Design Manual) contains requirements and standards for designing surface and stormwater management systems within King County. King County requires that impacts on existing artificial and natural drainage systems be mitigated prior to permit approval for certain developments. While the Design Manual requires water quality treatment best management practices comparable to the Ecology Manual, King County's Design Manual does not require infiltration as the method of choice for volume control. Rather, infiltration is allowed in certain soil types. It is generally not allowed in soils that would be considered moderately permeable. Additionally, the King County manual does not require infiltration or detention of a certain volume of water. It requires that peak runoff not be altered by new development. (King County is currently revising its Design Manual to meet the requirements of the Ecology Manual, with a target completion date of December 1995.)

King County Surface Water Management and Seattle-King County Department of Public Health (SKCHD) Environmental Health Division coordinate to some extent on planning activities, but not as much as is needed to effectively avoid redundancy or conflicts. Coordination between King County Surface Water Management and SKCHD Environmental Health Division is far from comprehensive, and the potential for conflicting goals and policies exists. A thorough analysis of the existing degree of consistency between the planning processes undertaken by the two agencies has not been carried out.

The Building and Land Development Division of the Parks, Planning, and Resources Department implements King County Code Title 21 Zoning (the zoning code) which, to some extent, regulates the degree of impervious cover allowed for developments. Proposed changes in the zoning code would establish, for the first time, limitations on impervious cover for development. A draft of the modified code is now being reviewed by a technical review committee established by the King County Council.

Cities in King County have developed stormwater management programs that vary substantially in their comprehensiveness. The King County Department of Metropolitan

Services (Metro) is currently providing technical information about surface water quality to jurisdictions in King County to assist them in establishing surface water utilities.

**Land Use in Critical Aquifer Recharge Areas**

Research has shown that nearly all land uses associated with human activity significantly affect ground water quality due to the effects of non-point sources of pollution. It has also been shown that the degree of contamination increases with the intensity of development. It becomes a public policy question as to how to balance land use development demands with the need to protect ground water.

Studies demonstrate that land uses vary in their potential to contribute contaminants to ground water from non-point sources. Land uses that were shown to result in the highest concentrations or detection frequencies of chemical contaminants are generally agriculture, residential (especially high density residential), and industrial/commercial. It is difficult to extrapolate the findings of these studies to another geographical area. However, perhaps the most meaningful conclusion that can be drawn is that evidence suggests that all land uses compromises ground water quality, and that contamination increases with intensity of land use.

In order to address the potential impacts to ground water quality from stormwater practices associated with land use activities in Aquifer Recharge Areas, a greater level of understanding concerning the effectiveness of stormwater source controls, treatment, and infiltration is needed. Additional studies including modeling and field testing of best management practices (e.g., lined wet ponds, lined bioswales, and infiltration basins in series) is needed. The studies should test the efficiency of various facilities in removing contaminants from stormwaters that are representative of a variety of land uses from a contaminant loading perspective. Results of such studies could help identify the most appropriate treatment technology for a given land use and could help identify compatible land uses to assist elected officials in making land use decisions.

The Ground Water Management Plan should address the question of appropriate land use for high potential aquifer recharge areas. In particular, it is important to make recommendations regarding appropriate residential densities and commercial and industrial uses. Answers to these questions are not fully available. Research into the effectiveness of stormwater treatment is at an incipient stage. Practical problems associated with the application of this technology on a wide scale are yet to be determined. Many studies of this technology are planned or underway, some of them in King County. Infiltration technology is fraught with problems but, given Ecology's emphasis on infiltration, there is substantial impetus to continue to research the effectiveness of this technology in the Puget Sound region. Thus, the question of appropriate density and land use in high potential aquifer recharge areas should be answered with some degree of validity in the not too distant future. Until such time, the best policy may be to maintain low densities in aquifer recharge areas to avoid irreversible adverse ground water quality impacts. It is possible that water quality and source controls will prove to be inadequate to address concerns over ground water quality. In this case low density and limited land uses may be the only feasible alternative.

## GOAL

To promote ground water recharge using stormwater management practices which prevent the degradation and/or depletion of ground water.

## ISSUES

**Issue 1 - Runoff Versus Recharge.** The King County Surface Water Design Manual does not promote infiltration as the preferred method of stormwater management or limit runoff volumes. Rather, the Manual requires that there be no increase in peak runoff rates. Potential ground water recharge is lost to surface runoff resulting in depletion of aquifers. Many cities in Ground Water Management Areas have adopted or use the King County Manual for reference in their stormwater management programs and, therefore, are likely following the same policy towards infiltration.

> **ST-1A Runoff Versus Recharge:** King County and cities will amend/adopt surface water design manuals to require that runoff be infiltrated in high and moderate potential recharge areas where site conditions permit, except where potential ground water contamination cannot be prevented by pollution source controls and stormwater pretreatment. The Department of Ecology's Stormwater Management Manual for the Puget Sound Basin provides the preferred guidance.

**Discussion:** Development impacts on ground water can be partially mitigated by infiltrating stormwater rather than discharging it to surface water bodies. This practice partially compensates for the loss of natural recharge caused by impermeable surfaces. Some areas of King County with glacial outwash soils are particularly suited to infiltration. In these areas, infiltration should be used to mimic the natural recharge patterns present prior to development as closely as possible. While infiltration is encouraged in King County and, presumably, in some cities, taking a stronger position in favor of infiltration should result in greater use of this technique.

Infiltration of stormwater presents a threat to ground water quality. stormwater should not be infiltrated where the risk of ground water contamination cannot be mitigated by pollution source controls and stormwater pretreatment. Ecology provides guidance in regard to adequate source control and pretreatment in regard to specific development types in the *Stormwater Management Manual for the Puget Sound Basin*. Some local jurisdictions are developing similar manuals that are at least as stringent as the Ecology manual. Ground water quality concerns associated with the infiltration of stormwater are addressed further in Issue 2.

Infiltration of roof runoff, while allowed in King County and presumably in cities, could be used more extensively or required in appropriate settings including single-family residential developments. Consideration should be given to water quality before adopting requirements to infiltrate roof runoff. Certain roofing materials and associated treatments to retard moss growth could result in the introduction of hazardous substances to ground water. Additionally, in highly urbanized areas subject to relatively heavy air pollution, roof runoff may be too contaminated to infiltrate without treatment. These issues should be more thoroughly explored by King County and the cities as they develop specific requirements for infiltration. The King County manual does not currently contain any restrictions on infiltration of untreated roof runoff other than limiting the soils in which infiltration is allowed.

Without this action, it is probable that King County and cities will gradually increase the use of infiltration technology because of the emphasis placed on it by the *Stormwater Management Manual for the Puget Sound Basin* (the Ecology Manual). Development is, however, proceeding rapidly and many opportunities to implement infiltration technology may be lost. It may result in more rapid implementation of the Ecology Manual's provisions if the Ground Water Advisory Committees request early action in favor of the use of infiltration whenever possible in all jurisdictions in the Ground Water Management Areas.

**Implementation:**

**Task 1. Amend/adopt surface water design manuals.**

| | |
|---|---|
| Who: | King County and cities. |
| When: | Year __, or when agencies would normally amend/adopt surface water design manuals. |
| Cost: | To be determined during concurrence. City of Redmond: $40,960. |
| Funding Source: | Cities and King County general funds. |

**Issue 2 - Ground Water Quality Concerns.** It has been demonstrated by numerous studies that non-point source pollution is a major contributor to ground water degradation. Water quality controls and infiltration of stormwater will increasingly be used to reduce non-point source pollution effects upon both surface and ground water resources. Technology associated with these practices is in early stages and long term effects on ground water quality are unknown. While water quality controls will improve the quality of the water discharged to the ground, the increasing emphasis on infiltration poses risks. Infiltration will be employed most often in areas with glacial and alluvial soils associated with high potential aquifer recharge areas. Regardless of the comprehensiveness of new requirements, treatment systems will sometimes fail for a variety of reasons and they cannot be expected to function optimally at all times. Additionally, non-point source pollution that is not borne by stormwater will infiltrate and reach ground water regardless of stormwater management techniques.

The Redmond-Bear Creek Valley Ground Water Advisory Committee (GWAC) adopted these management strategies to ensure that high potential aquifer recharge areas are protected from non-point source pollution to the greatest extent feasible, that stormwater infiltration best management practices are used, and that further information is sought on the long-term effects of this practice upon ground water quality.

> **ST-2A Ground Water Quality Concerns - Zoning:** King County and cities within Ground Water Management Areas will maintain rural and low density, urban residential zoning and open space in high potential aquifer recharge areas where more intensive land uses have not already been zoned. King County and cities will change zoning for more intensive land uses in these areas to the rural and low density, urban residential zoning whenever possible during land use plan updates.
>
> **ST-2B Ground Water Quality Concerns - Facility Requirements:** King County and cities within Ground Water Management Areas will require that all types of stormwater facilities in high potential aquifer recharge areas be designed to protect ground water quality using Best Available Technology (BAT).
>
> **ST-2C Ground Water Quality Concerns - Study:** King County and cities will jointly sponsor study of the effectiveness of the current BAT facility, which is a wet pond, bioswale, infiltration basin in series (treatment components and conveyance are lined to preclude infiltration). As part of this study, King County will monitor discharges from these facilities in actual use and prepare a report of findings. The report will recommend whether this type of facility is effective in preventing ground water quality degradation and if it should be used to retrofit existing stormwater quality facilities with documented water quality impacts. Based upon this report, King County and cities will give high potential aquifer recharge areas and Wellhead Protection Areas high priority for water quality facility retrofit as warranted.

**Discussion:** ST-2A is proposed because of the sensitivity of high potential aquifer recharge areas to contamination, the increasing importance of protecting drinking water aquifers, and the difficulty, if not impossibility, of cleaning up contaminated aquifers. For a variety of reasons, including promoting recharge and protection against hazardous material spills, land use controls should be considered in high potential aquifer recharge areas.

Management of stormwater, even if done according to best management practices, will not be perfect. Indeed, considerable difficulty has been experienced with stormwater infiltration facilities. It should be expected that systems will sometimes fail for structural, maintenance, or weather-related reasons. King County already requires lined treatment facilities in excessively permeable soils, but does not require conveyance systems that preclude infiltration. It is expected that cities in King County, some of which have adopted all or part of the King County Manual, have similar requirements. Adoption of ST-2B will stimulate discussion during the concurrence process and enable the Ground Water Advisory Committees to understand the cities' existing stormwater management requirements. It will also provide an opportunity to seek concurrence with Ground Water Advisory Committee proposals to improve existing programs where appropriate.

Even as new requirements are instituted, stormwater managers do not have adequate information to determine long term effects of new requirements on ground water quality. Additional studies, including monitoring the treatment efficiency of new facilities, will facilitate determinations of whether long-term effects of stormwater facilities utilizing best management practices are acceptable.

The Center for Urban Water Resources Management at the University of Washington or Metro could possibly serve as a coordinator of a multi-jurisdictional study. The Center was formed, in part, to address questions regarding appropriate management of stormwater. Numerous local jurisdictions are financial contributors to the Center's operations, including King County.

The Center has expressed interest in conducting the type of study described in ST-2C and concurs with the need for such a study. The Center serves as a facilitator for local governments interested in finding solutions to common problems. If, for example, King County were to propose such a study, the Center would then contact its members to determine if they would support it.

A study should be designed that will benefit all Puget Sound jurisdictions which are both responsible for protecting ground water under the Growth Management Act (Chapter 36.70A RCW) and the Ground Water Quality Standards (Chapter 173-200 WAC) and for requiring infiltration of stormwater per the Ecology Manual. The study should determine whether certain land uses make stormwater infiltration particularly threatening to ground water quality. For example, the study should compare rural and urban uses of land in regards to the potential for safe recharge stormwater. Residential and commercial uses of land should also be compared.

**Implementation Plan:**

Task 1: Maintain rural and low density zoning in high potential aquifer recharge areas (ST-2A).

Task 2: Change zoning in high potential aquifer recharge areas during land use plan update (ST-2A).

Task 3: Require stormwater facilities incorporate Best Available Technology (ST-2B).

Task 4: Sponsor study (ST-2C).

Task 5: Monitor facilities and report (ST-2C).

| | |
|---|---|
| Who: | Tasks 1-5: King County, Tasks 1-4: Cities. |
| When: | Year __. |
| Cost: | Task 1 (ST-2A) none.<br>Task 2 (ST-2A) minimal, but may need money to compensate land owners.<br><br>Task 3 (ST-2B) costs for regulation change to be provided by cities during concurrence; City of Redmond: $35,840.<br><br>Task 4 (ST-2C) unknown, the program needs to be developed to determine costs; City of Redmond: $20,480.<br><br>Task 5 (ST-2C) King County Surface Water Management to provide information during concurrence, but is expected to be done under existing budget. |
| Funding Source: | Addressed in following text. |

There is no cost associated with King County and cities maintaining specific zoning designations in high potential aquifer recharge areas. The cost of using the best management practice described in ST-2B will be borne by developers and, ultimately, consumers. Funding for ST-2C should come from the Aquifer Protection Fund. Alternatively, ST-2C could be funded by a Centennial Clean Water Fund grant if the Aquifer Protection Fund is not approved. If that is the case, King County, cities, and the Center for Urban Water Resource Management or Metro should make a strong bid for a Centennial Clean Water Fund grant to carry out a study. Local governments should emphasize in the grant application that local ground water resources may be at risk due to the new emphasis by Ecology on infiltration of stormwater. Local governments should be supported in their effort to study the effects of the Ecology requirements. King County and cities would need to pool financial resources to provide local match for a grant. Other grant sources besides Centennial Clean Water Fund could also be considered. If no grant monies are available, the county and cities would have to pool resources to fund the full cost of the study.

The SKCHD Environmental Health Division will seek support from King County Surface Water Management to monitor stormwater infiltration facilities. It is anticipated that the monitoring can be done under existing budgets because King County Surface Water Management's recently adopted Strategic Plan indicates that a certain amount of utility fees are dedicated to monitoring the effectiveness of stormwater management facilities. The

SKCHD Environmental Health Division will seek an agreement with King County Surface Water Management to monitor a minimum number of facilities and provide reports on facility effectiveness.

**Issue 3 - Education.** Considerable effort is underway to educate the public regarding the prevention of non-point pollution and improper disposal of hazardous materials. Agencies or jurisdictions involved include King County, cities, the Puget Sound Water Quality Authority, Ecology, Metro, the King County Conservation District, the Soil Conservation Service, public and private schools, and others. We do not know if existing educational materials stress the interrelationship between surface and ground water pollution. Nor do we know if educational materials address the manner in which the public can encourage recharge of precipitation rather than contribute to problems associated with excess runoff.

**ST-3 Education.** The RBC-GWAC recommends that King County and cities will jointly carry out a ground water education program. In regards to stormwater management, this effort will ensure that educational activities are adequate to communicate to the public:

- How ground water may become contaminated via surface water pollution, and
- Ways in which ground water recharge may be encouraged.

NOTE: The Education Section contains the complete Education Program. Please refer to that section for more information.

**Issue 4 - Coordination Between Surface and Ground Water Planning Efforts.** Surface and ground water planning efforts should be effectively coordinated in order to make the best use of limited resources.

The RBC-GWAC adopted a series of actions that promote optimal coordination between surface and ground water resource planning efforts.

**ST-4A Coordination Between Surface and Ground Water Planning Efforts - Ecology Programs:** Ecology will assess its surface and ground water quality planning programs to determine how they could be combined or coordinated in a way which is both scientifically justified and which provides for greater efficiency.

**ST-4B Coordination Between Surface and Ground Water Planning Efforts - Puget Sound Water Quality Authority:** The Puget Sound Water Quality Authority recognizes that surface and ground water form a continuous and dynamic system which must be comprehensively protected. The Puget Sound Water Quality Management Plan will be revised to address all water quality issues in the Puget Sound drainage basin, including ground water.

**ST-4C Coordination Between Surface and Ground Water Planning Efforts - King County:** King County will assess its water resource planning efforts to determine how to effectively coordinate them to provide the best possible protection of water resources.

**Discussion:** State law encourages coordination of non-point and ground water protection plans. In reality, effective coordination has been difficult for local governments to achieve. There are many underlying reasons why this consolidation of planning efforts at the local level often doesn't occur. Reasons include:

- Administration of surface and ground water protection grants by different sections at Ecology;
- Separate state regulations guiding the planning processes;
- More favorable funding rules under the Centennial Clean Water Fund for planning processes that do not address water quantity issues, a crucial element of a Ground Water Management Plans;
- Lack of recognition of the need to protect surface and ground water concurrently as part of a continuous dynamic system;
- Planning processes carried out by different lead agencies at the local level; and
- Lack of a proactive program to coordinate at the local level.

By adopting these management strategies, the RBC-GWAC expresses its concerns regarding this issue to the three major entities involved in multi-jurisdictional surface and ground water planning: Ecology, the Puget Sound Water Quality Authority, and King County.

Legislation is not needed to make administrative changes at Ecology. Relevant regulations addressing ground and surface water planning already encourage coordinated or joint efforts. How the regulations are implemented will be one determining factor in whether water resource protection planning processes continue to diverge on somewhat separate tracks.

The Puget Sound Water Quality Authority's priorities should continue to be those issues which have the greatest impact upon the quality of Puget Sound waters. However, the Authority should explore the importance of ground water contributions to Puget Sound. Changes at the state level would necessitate close cooperation with local governments currently involved in planning activities. Innovation should be encouraged in implementing water resource plans in order to alleviate redundancies which may exist between surface and ground water planning efforts.

On the local level, coordination will result in more efficient use of scarce resources for environmental protection. Conflicting planning documents that could serve to interfere with the implementation of one or both can be avoided. More importantly, integrated approaches that could result in better protection and more efficient use of resources can be developed.

County staff, developers, and the public have difficulty determining county policy when there are several incomplete planning processes addressing the same issues in the same geographic area. Coordination, if successful, will help everyone to understand both existing policy and policy in the developmental stages.

While a coordinating process will initially be time consuming, it will save resources in the long run. It will also help local lead agencies to meet more closely the coordination provisions of state regulations.

King County agencies responsible for planning could jointly evaluate existing water resource planning efforts to determine how they might be streamlined and made more effective. Agencies involved should include, at a minimum, King County Surface Water Management, the SKCHD Environmental Health Division, the King County Environmental Division, and the Community Planning Section of the Planning and Community Development Division.

**Implementation:**

**Task 1:** Assess programs.

| | |
|---|---|
| Who: | Ecology. |
| When: | |
| Cost: | $70,000 over two years. |
| Funding Source: | General agency funds. |

**Task 2:** Revise Puget Sound Water Quality Authority Plan.

| | |
|---|---|
| Who: | Puget Sound Water Quality Authority. |
| When: | |
| Cost: | No additional costs. |

**Task 3:** Assess planning efforts.

| | |
|---|---|
| Who: | King County. |
| When: | |
| Cost: | King County: $26,000. |
| Funding Source: | King County would need to undertake and fund the effort to streamline its water quality planning activities. SKCHD will discuss this issue with King County Surface Water Management and will seek the input |

from other county divisions. General funds should be used to cover staff time spent in this effort.

**Issue 5 - Roadway Runoff.** The State Highway Runoff Program provides for improved water quality and quantity controls for stormwater runoff from new and existing state highways. The *King County Surface Water Design Manual* requires water quality and quantity controls for new roadways in King County. It is believed that many cities have similar requirements. However, state and local programs may not address ground water quality and quantity problems associated with existing roadways. Existing contamination problems may be identified via Basin Plans developed by King County Surface Water Management in cooperation with cities and via other processes to identify needed capital improvements. King County and cities then address the problems identified as funding allows.

**ST-5A Roadway Runoff:** King County and cities will:

- Direct their public works departments to give high priority to high potential aquifer recharge areas and Wellhead Protection Areas when identifying and correcting water quality problems associated with existing roadways, and

- Require stormwater quality and quantity controls comparable to new regulations when conducting major renovation or widening of roads.

**Discussion:** This action could influence local stormwater management jurisdictions within the Ground Water Management Areas to give a higher priority to high potential aquifer recharge areas and Wellhead Protection Areas when addressing stormwater quality and quantity problems. The benefits of corrective actions would be increased by focusing them in the areas that are most susceptible to ground water contamination or are important because they are located within the zone of contribution to a public water supply well or wellfield.

County and city public works departments have a tremendous task ahead to meet all of the requirements posed by new and upcoming stormwater management regulations. Many will be addressing existing water quality problems as a result of new requirements depending on the degree of comprehensiveness of the stormwater management program required or opted for. Cities will be establishing stormwater utilities and setting priorities for expenditures of fees collected from residents and businesses. It is important at this time to bring concerns regarding the need for ground water protection to the attention of local jurisdictions and to request that these concerns receive high priority.

**Implementation:**

**Task 1:** Public Works Departments assign high priority to high potential aquifer recharge areas and Wellhead Protection Areas.

**Task 2:** Require new regulatory controls.

| | |
|---|---|
| <u>Who</u>: | King County and cities. |
| <u>When</u>: | Year__. |
| <u>Cost</u>: | Task 1, Minor costs associated with a policy.<br><br>Task 2: Minor costs associated with regulation development. Increased costs for implementing the regulation to be determined during concurrence. |
| <u>Funding Source</u>: | No additional funds are needed to request prioritization of high potential aquifer recharge areas for water quality and quantity improvements. Stormwater utility fees or development impact fees allowed under the Growth Management Act may be used to fund improvements made during road renovation or widening. |

**Issue 6 - Soil Amendment.** Glacial till soils are common in the Ground Water Management Areas. These soils are characterized by a shallow layer of permeable material, which was derived from the weathering of parent materials left by glaciers. Since the underlying parent materials were compressed by the weight of the glaciers, those materials, called glacial till, are impermeable and form an effective barrier to downward movement of recharging precipitation. The shallow layer of soil overlying the glacial till often contains a seasonal aquifer or water table aquifer which can act as a storage reservoir, absorbing precipitation and releasing it to surface water (wetlands and streams) over a period of time. If this shallow layer is removed during clearing or landscape operations, this "sponge effect" is lost. Without the absorbent top layers of soil, cleared land produces more surface runoff and, additionally, cannot attenuate pesticides and fertilizers. If it encounters a recharge area downslope, surface runoff carrying pesticides and fertilizers can contaminate ground water.

Soil amendment (such as adding composted biosolids or wood products) can reduce surface runoff, retain pesticides and fertilizers, and reduce the amount of water needed for landscaping. However, the benefits of soil amendment to ground water are not fully known.

> **ST-6A Soil Amendment:** King County and cities will jointly evaluate the ground water quality and quantity benefits of soil amendment. Soil amendment requirements shall be implemented if the proposed research proves to be a practical method of improving water quality, increasing infiltration, and reducing stormwater runoff.

**Discussion:** Soil amendment in this context refers to the process of adding materials to the soil to increase moisture and nutrient retention. Soil amendments which could be used include composted yard waste, commercial topsoil, and sand. The benefit of soil amendment is that nutrients, pesticides, and other pollutants from generalized sources would be less likely to run off of a site, or move rapidly through excessively permeable soils to reach shallow, unprotected aquifers typical of high potential aquifer recharge areas.

Soil amendment may be a valuable means to protect both ground and surface water. Additional information is needed about this topic in order to determine whether the benefits warrant further action.

The City of Redmond studied various soil amendments for their ability to increase soil moisture and nutrient holding capacity. The city was not awarded a Centennial Clean Water Fund grant to field test the findings of the study for which it applied.

A study of this type might logically be coordinated by the Center for Urban Water Resources Management with the cooperation of King County and cities. Any additional study should build upon work completed by the City of Redmond.

**Implementation:**

**Task:** Develop a new soil amendment program.

| | |
|---|---|
| Who: | King County; cities; and Center for Urban Water Resources, University of Washington. |
| When: | As per GWAC ranking, Implementation Table, Year __. |
| Cost: | To be determined during concurrence with input from the Center for Urban Water Resources Management. |
| Funding Source: | Aquifer Protection.Funds should be used to support this action. A Centennial Clean Water Fund should be sought if the Aquifer Protection Fund is not approved. Local governments would need to pool resources for matching funds. Other grant sources may also need to be explored. Alternatively, local governments could pool their resources to fund the study. |

3.2.4. Ground Water Education Program

Providing citizens with information on ground water resource management and protection may be a particularly effective protection method. Understanding, caring, and commitment are needed to protect a resource that is found almost everywhere and is affected by a wide variety of land and water use activities. Although regulations may help, groups of informed citizens actively caring for their own backyard may be more effective. Providing technical assistance will not address all concerns but will empower some community members to take individual action.

Currently there are a number of education programs focused on individual sources of contamination. However, there is no existing, comprehensive ground water education program.

A comprehensive approach is needed to:

Help engender understanding and concern to facilitate protection of the resource;

Aid in developing resource protection messages that are consistent regardless of the specific educational program;

Coordinate with other resource protection programs that focus on a specific issue, such as solid waste, hazardous waste, or stormwater management; and

Develop specific education activities and materials for point and non-point sources of contamination that do not have their own individual educational programs.

A comprehensive program would coordinate existing environmental education programs to develop compatible messages about ground water resources and ground water protection. This component would be accomplished by briefing environmental educators about King County's ground water system and supporting joint programs. The program would respond to local ground water quality and quantity concerns that are not already covered by other programs. This program would provide assistance for individual drinking water supplies, local planning efforts, and/or other ground water protection projects.

Providing information to citizens involved in community planning projects would be another aspect of this program. Increasingly, citizens are taking an active part in neighborhood planning efforts and are concerned about resource protection. As they develop these plans, whether addressing school siting, transportation routes, or zoning; citizens may need information about the ground water system in their community. This knowledge will assist them in addressing ground water protection measures within the context of their planning processes.

Educational programs have been shown to be an effective method to protect natural resources. The development of the Ground Water Management Program included a public education component. During the Redmond-Bear Creek Valley Ground Water Advisory Committee's consideration of the potential threats to ground water, several specific educational program elements were adopted. These elements need to be consolidated into one comprehensive program.

## GOAL

To increase individual participation in protecting the ground water resource by educating citizens concerning the Ground Water Management Plan, the threats to ground water quantity and quality, and means by which those threats can be reduced.

## ISSUES

**Issue 1 - Existing education.** Considerable effort is underway to educate the public regarding the prevention of non-point pollution, conservation, well construction, and improper disposal of hazardous materials. Agencies or jurisdictions involved include King County Surface Water Management, Seattle-King County Department of Public Health (SKCHD) Environmental Health Division, King County Cooperative Extension, King County Department of Development and Environmental Services, cities, Puget Sound Water Quality Authority, Department of Ecology, Metro, King County Conservation District, Soil Conservation Service, public and private schools, and others. These agencies have developed a variety of educational materials; however, it has not been determined if these existing educational materials contain ground water resource protection information.

> **ED-1 Existing education:** King County and cities will jointly perform a ground water education program which will review existing education activities and make use of these programs when applicable. SKCHD Environmental Health Division will review applicable educational efforts in progress to determine whether the protection of ground water is emphasized. SKCHD Environmental Health Division will seek the cooperation of the parties involved to include ground water information and concerns in the educational programs (From ST-3 Education).

Elements of the program from other issues are:

- Existing educational program content will be reviewed for agreement with Ground Water Management Plan policies and goals. SKCHD Environmental Health Division will review the current educational programs of Soil Conservation Service, Cooperative Extension, and others to ensure that the Ground Water Management Plan goals and policies are reflected (From PF-3B Education and Proposed Programs);

- King County will emphasize the risks to ground water associated with the disposal of household hazardous wastes to on-site sewage systems when conducting household hazardous waste educational activities as part of the Local Hazardous Waste Management Plan (From OS-3A Household Hazardous Wastes);

- King County, cities, and water utilities will work with local nurseries, King County Cooperative Extension Service, and King County Conservation Districts to promote the availability of appropriate seed stocks, plants, and materials to facilitate implementation of xeriscaping (use of low-water use plants) (From WQ-4B1 Education);

- The Education Program will support conservation education efforts in the schools and for the general public as described in the Conservation Planning Requirements (Washington Water Utilities Council, Department of Health, Department of Ecology, March 1994). These would include, but not be limited to, the items listed under Public Education on page 24 of the Conservation Planning Requirements (From WQ-4B2 Education);

- King County will educate residents about landscaping practices that promote aquifer recharge through an informational brochure prepared by Cooperative Extension and SKCHD Environmental Health Division (From WQ-4B3 Education) ;

- There is a lack of general public knowledge about the public health significance of the requirements for well construction, operation, maintenance, and abandonment. The Ground Water Management Plan Education Program will coordinate with and support the Department of Ecology's well identification, well construction, proper well maintenance, contamination sources, and well abandonment projects (From WC-4 Education).

**Discussion:** Prevention of pollution is the best approach from the standpoint of cost and environmental impact. Education represents the best prevention tool because it creates an awareness and concern in individuals which influences their decisions and actions. Developing a comprehensive independent educational program to address ground water protection would probably be redundant. Scarce resources can be used efficiently by building upon existing programs.

SKCHD Environmental Health Division will seek the cooperation of applicable parties to include ground water information and concerns in their educational programs. This review will ensure that the Ground Water Management Plan goals and policies are reflected. Cooperative Extension and other agencies have a number of educational efforts underway. They integrate ground water protection information where possible and are agreeable to including more. Cooperative Extension, Soil Conservation Service and other agencies could address Ground Water Management Plan concerns in their educational materials. Those concerns could be addressed through the following actions.

SKCHD Environmental Health Division will undertake measures to increase public awareness concerning the potential impacts of discharging household chemical products to an on-site sewage system. Such measures will be an extension of activities scheduled as part of the Local Hazardous Waste Management Plan. (From OS-3A Household Hazardous Wastes)

Educational efforts would complement and combine with current efforts of SKCHD Environmental Health Division, Cooperative Extension, and the Conservation District. This information could be disseminated through the Master Gardener and other programs of Cooperative Extension. Awareness of the problem of reduced aquifer recharge may increase responsibility and concern for aquifer recharge areas in the community. Educational programs concerning the effect of landscaping practices on aquifer recharge could be coupled with education on the impacts of pesticide and herbicide use on ground water quality. A discussion of proper disposal of household hazardous wastes could be included. Landscaping tips should include a discussion of native vegetation and its role in facilitating infiltration of moisture. (From WQ-4A1 Conservation)

Informed well owners and other community members are probably more likely to comply with the well construction and abandonment regulations. Methods of informing well owners might include distributing a questionnaire about wells to homes in the community, developing and distributing an educational brochure for homeowners, and supplementing the brochure with community educational programs. The questionnaire should be designed to ascertain the number of wells on each property, the construction methods used, and the number of wells that require abandonment. The brochure should include recommended practices and legal requirements for well construction and abandonment. It should also include the reasons why practices such as sealing the well are both advisable and required by law so that homeowners are knowledgeable before they make plans to construct or abandon a well. The education program should cover the same information, and provide the public with an opportunity to ask individual questions. (From WC-4 Education)

**Implementation:**

Implementation for ED-1 will be described under Issue 2.

**Issue 2 - New educational elements.** There are several issues and contaminant sources that are not addressed by any existing education program upon which to build. These have been identified through the Redmond Bear Creek Valley Ground Water Advisory Committee (RBC-GWAC) consideration of ground water protection issues. These issues and contaminant sources need to be addressed as part of the educational program.

> **ED-2 New educational elements:** King County and cities will jointly carry out a ground water educational program which will develop specific educational activities and materials for sources of contamination. SKCHD Environmental Health Division will report to the Ground Water Management Plan Management Committee (Management Committee) on the adequacy of existing educational programs to address ground water concerns. This report will include proposed changes as a result of review and discussions carried out in the implementation of ED-1. SKCHD Environmental Health Division will then develop a supplemental educational program to address deficiencies identified above, if necessary, and present the program to the Management Committee for review and adoption.

New educational programs will be developed and implemented per the adopted RBC-GWAC actions below (this is a partial list, more elements are expected to be developed as the program progresses):

- King County will develop and carry out a public education program intended to increase awareness concerning proper on-site sewage system operation and maintenance, including the risks associated with disposal of hazardous wastes in such systems (From OS-3B Household Hazardous Wastes); and

- King County and cities will jointly educate homeowners and owners of exempt underground storage tanks regarding tank abandonment requirements of the Uniform Fire Code through the Ground Water Management Plan Education Program. (From UST-3E Heating Oil Tanks: Education).

The public may not be aware of the relationship between landfilling solid waste and the resultant potential threat to ground water quality. Recycling (removal of usable components from the waste stream) reduces the amount of solid waste that must be landfilled. Information about the relationship between solid waste disposal and ground water will be included in the education program (From SW-8 Education).

**Discussion:** During the development and consideration of the issues that affect ground water quantity and quality, the GWAC found that several issues could be addressed through educational efforts. However, the necessary level of education was not being conducted by any other agency. Therefore, the adopted actions contained new educational elements. These are:

- The existing public information pamphlet concerning on-site sewage system maintenance and operation will be amended to provide instructions concerning proper household hazardous waste disposal practices prior to any scheduled reprinting (From OS-3B Household Hazardous Waste);

- Including home heating oil tanks in the overall Ground Water Management Plan Education Program will help address the low level of compliance with the requirements for home heating oil tank abandonment. Many homeowners are unaware of their responsibilities under the Uniform Fire Code, probably because there are no programs on proper maintenance and abandonment. By providing educational material to tank owners, community knowledge about the problem will increase, and, hopefully, an the number of tank owners that comply with the regulations will increase as a result. Also, by increasing community awareness, it is expected that home purchasers would require information on tank status be disclosed (UST-3E Heating Oil Tanks); and

- Providing information about recycling and educating residents about reducing the waste stream may reduce the amount of waste going into landfills and the amount of hazardous products that people buy (SW-4 Education).

Other new program elements may be developed under direction from the Management Committee. Some possible tasks are:

- Support schools or individual teachers with an interest in ground water protection. Such support could include providing education materials or developing school skits.

- Work with neighborhood groups on neighborhood ground water protection efforts. This could include developing and installing interpretive signs, for example, signs explaining well Wellhead Protection Areas.

- Develop a video on water resources for cable television and distribution to local video outlets.

- Sponsor informational booths at local fairs and displays at local libraries or bank lobbies.

**Implementation:**

**Task 1:** Review applicable educational efforts.

**Task 2:** Foster cooperation of other environmental education efforts.

**Task 3:** Report to Ground Water Management Plan Management Committee on the adequacy of existing educational programs to address ground water concerns. This report will include proposed changes as a result of the above review and discussions.

**Task 4:** Develop a supplemental educational program to address deficiencies identified above and present it to the Management Committee for review and adoption.

**Task 5:** Coordinate implementation of the program.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division under direction of the Management Committee. |
| When: | Year 1 and ongoing. |
| Cost: | 3.0 FTE per year ($312,000). Funding for staff at SKCHD Environmental Health Division is necessary to carry out the review, coordination, report preparation, and development of a supplemental program, if needed. It is possible that enhancing existing programs will require that funds be provided to the relevant agency or jurisdiction. |
| Funding Source: | Aquifer Protection Fund. |

## 3.3. PROGRAMS TO PROTECT GROUND WATER QUALITY

### 3.3.1. Ground Water Protection Issues Associated with Hazardous Materials Management

Substances that are hazardous to public health and the environment are a by-product of industrialization. As society becomes more industrialized, materials become more prevalent and hazardous. There are myriad industrial and commercial processes that produce and use these substances. However, the use of hazardous materials is not limited to industries and businesses. These materials are widely available and used by almost everyone to some degree. The impact of these substances on our environment, particularly ground water, is determined by the management practices of the businesses and individuals who use them.

Ground water contamination can occur when hazardous materials, either liquids or those dissolved in water, migrate through the soil. Ground water contamination can also occur when hazardous materials are spilled into surface water features that are in hydraulic continuity with ground water. Human health threats occur when contaminated ground water reaches aquifers used for drinking water supplies. The clean up of contaminated aquifers is difficult, costly, time-consuming, and may not be successful.

The threat of ground water contamination by hazardous materials is currently being addressed by a number of federal, state, and local statutes. These laws address particular activities associated with hazardous materials. The remainder of this discussion will be divided into three sections corresponding with the manner in which hazardous materials are regulated. The three sections are:

- Hazardous waste management,
- Hazardous waste contamination sites, and
- Hazardous material spill prevention and emergency response.

**Hazardous Waste Management**

Hazardous wastes are discarded hazardous materials. The *Uniform Fire Code* of 1988 defines hazardous materials as those chemicals or substances which are physical hazards or health hazards as defined in Article 80 of the code whether the materials are in usable or waste condition.

The statutes addressing the protection of ground water from hazardous waste are described as follows.

<u>Resource Conservation and Recovery Act</u>. This act requires the Environmental Protection Agency (EPA) to regulate generators that produce more than 220 pounds of hazardous waste per month. Smaller quantities of hazardous waste are subject to state law.

<u>Hazardous Waste Management Act (Chapter 70.105 RCW)</u>. This act designates the Department of Ecology (Ecology) as the state agency to implement the Resource Conservation and Recovery Act. Chapter 70.105 RCW describes many key features of Ecology's Resource Conservation and Recovery Act-based hazardous waste management program including:

- Establishing a permit system for land based treatment, storage, and disposal facilities;
- Developing standards for the safe transportation, treatment, storage, and disposal of hazardous wastes;

- Establishing a manifest system to track hazardous waste;
- Establishing reporting, monitoring, records keeping labeling, and sampling requirements; and
- Inspecting, monitoring, and sampling.

The Hazardous Waste Management Act requires the development of a statewide Hazardous Waste Plan that is to be updated every 5 years. The plan must include but not be limited to:

- State inventory and assessment of capacity of existing facilities to treat, store, dispose, or otherwise manage hazardous waste;
- Forecast of future hazardous waste generation;
- A description of Ecology studies to determine appropriate waste management methods; and
- A public information and education plan coordinated with local government efforts; and
- Public involvement.

The current plan contains seventy separate issues and recommendations. Some of the most important or relevant are:

- Ecology lacks adequate staff to carry out inspection and enforcement activities;
- Staff turnover rate within the permit section was near sixty percent over the last several years, severely limiting Ecology's ability to process applications;
- Penalties for violations are based on environmental or human health risk, economic gain by the violator may be sufficient to offset the penalty;
- Issuance of land based treatment, storage, and disposal facilities permits is extremely resource intensive; and
- The existing permit application guidance is very general and non-technical, there is no standardized permit application format.

The Hazardous Waste Management Act declares that local government is the appropriate level for planning and implementing programs to manage moderate risk waste with Ecology's assistance.

In 1991 jurisdictions in King County developed and adopted the *Local Hazardous Waste Management Plan* (Plan) for Seattle-King County with support from a state grant. The goal of the plan is to protect public health and the environment from the adverse effects of improper handling and disposal of hazardous wastes by Small Quantity Generators and households. Small quantity generators are those businesses that produce moderate risk waste, defined as less than 220 pounds of hazardous waste and/or less than 2.2 pounds of extremely hazardous waste per month.

Ground water protection is discussed as a component of educational and enforcement activities to implemented as part of the plan. Of particular concern is the risk of ground water contamination associated with the disposal of hazardous wastes in on-site sewage disposal systems. The plan intends to emphasize this concern in its education activities.

<u>Dangerous Waste Regulations Chapter 173-303 WAC</u>. These regulations were adopted by Ecology as authorized under the Hazardous Waste Management Act for the purpose of implementing the provisions of that act. The purpose of the regulations are:

- Designation of dangerous and extremely hazardous wastes;
- Surveillance and monitoring of those wastes;
- Provision of forms and rules to establish a system for manifesting, tracking, reporting, monitoring, record keeping, sampling, and labelling hazardous wastes;
- Establishment of siting, design, permitting, operation, closure, post-closure, financial, and monitoring requirements for hazardous waste transfer and land based treatment, storage, and disposal facilities; and
- Encouragement of recycling, reuse, reclamation and recovery to the maximum extent possible;

<u>Hazardous Waste Reduction Act</u>. Under this act, Ecology adopted the federal Pollution Prevention Planning Regulations where generators and users of more than threshold quantities of hazardous waste must prepare Pollution Prevention Plans for reducing use of hazardous waste. Regulated facility operators must submit annual implementation progress reports to Ecology.

## GOAL

To ensure that ground water is not contaminated due to improper management of hazardous wastes.

## ISSUES

**Issue 1 - State Hazardous Waste Plan.** The Washington State Hazardous Waste Plan has identified many deficiencies in the existing state program to regulate hazardous waste. These deficiencies were identified by an Ecology-sponsored advisory committee made up of business leaders, government agency staff, elected officials, environmentalists, consulting firms, and educators over a period of two years. Ecology has stated in the plan that it is committed to carrying out the recommendations developed by the committee. Implementation of the recommended strategies is necessary in order for the state to manage hazardous wastes in a manner that will protect ground water.

> **HM-1 State Hazardous Waste Plan - Implementation:** The Redmond-Bear Creek Valley Ground Water Advisory Committee (RBC-GWAC) adopts the following resolution: "The RBC-GWAC supports the findings and recommendations of the Washington State Hazardous Waste Plan. The RBC-GWAC requests that Ecology and the Washington State Legislature fund and carry out the provisions of the Plan with a sense of urgency in recognition of the threat posed to ground water from hazardous wastes." The RBC-GWAC will communicate this resolution to the Director of Ecology, the Assistant Director for Waste Management, and the Washington State Legislature.

**Discussion:** The Washington State Hazardous Waste Plan identifies problems and recommends solutions for hazardous waste management. The RBC-GWAC can effectively communicate its concerns for ground water protection from hazardous waste to Ecology and the legislature by supporting the plan. The RBC-GWAC's resolution will be communicated to Ecology via the Ground Water Management Plan review and certification process. Letters could also be sent to Ecology and the appropriate legislative committee chairs.

**Implementation:**

The request to effect the solutions recommended by the Washington State Hazardous Waste Plan will be communicated to Ecology during the review and certification process for the Ground Water Management Plan. Additional letters will need to be written.

**Task:** Write letters to the Director of Ecology, the Assistant Director for Waste Management, and the Washington State Legislature.

| | |
|---|---|
| Who: | Seattle-King County Department of Public Health (SKCHD) Environmental Health Division. |
| When: | Year 1. |
| Hours/Costs: | SKCHD: 1 day, $400. |
| Funding Source: | Aquifer Protection Fund. |

**Issue 2 - Hazardous Waste Facilities Zones.** King County has not designated zoning categories in which hazardous waste storage and treatment facilities may be considered for siting. Failure to designate such zones will result in preemption by Ecology of local government jurisdiction over interpretation of zoning codes for facility siting. This preemption would not be permanent since jurisdiction would be returned to local government upon designation of hazardous waste facility zones.

> **HM-2 Hazardous Waste Facilities Zones - Local designation:** King County and cities will designate zones for hazardous waste storage and treatment in recognition of:
>
> - The benefits associated with on-site hazardous waste management;
> - The opportunity for local governments to interpret their own zoning codes; and
> - The collective responsibility for some of the risks associated with the existence of vital industrial and commercial establishments that produce hazardous wastes.

**Discussion:** The designation of hazardous waste facility zones will result in improved waste management practices. It will recognize and facilitate the state "Close to Home" policy aimed at encouraging on-site hazardous waste management, including waste reduction and recycling. This policy also encourages communities which benefit directly from businesses that generate hazardous wastes to accept some of the associated risk. On-site hazardous waste management also reduces the risks involved in transporting wastes. Cost savings may be realized for the waste generator, thereby providing incentive to pursue more favorable waste reduction and waste management alternatives.

Given that the state legislature determined that local government land use authority would be preempted to a large degree, it is probably better for King County to designate the zones in which, by its own interpretation, hazardous substances may be used rather than relinquishing that responsibility to the state. It is not known whether all of the cities in the King County Ground Water Management Areas have designated hazardous waste facility zones. The Ground Water Advisory Committees can raise this issue with their jurisdictional cities during the Ground Water Management Plan concurrence process.

**Implementation:**

The request that King County and cities designate zones will be communicated during the Ground Water Management Plan concurrence process. King County and cities will respond to the request by concurring/not concurring with that portion of the plan. The county and cities should designate zones within 2 years of concurrence. No further action is needed beyond any negotiations that are necessary to gain concurrence.

## Hazardous Waste Contamination Sites

Hazardous waste contamination sites are sites where hazardous waste has been spilled, leaked, or disposed of into the ground. The statutes which regulate hazardous waste contamination sites include the following.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This federal act established a trust fund commonly referred to as "Superfund" for the clean up of abandoned or uncontrolled waste sites. The act assigns primary responsibility for undertaking remedial and enforcement actions to the Environmental Protection Agency.

The 1986 amendments to the Comprehensive Environmental Response, Compensation, and Liability Act established a new agency within the U.S. Public Health Service called the Agency for Toxic Substances and Disease Registry. This agency is responsible for carrying out health related authorities of the act. The Agency for Toxic Substances and Disease Registry is primarily concerned with health effects of toxic substances in the environment. The agency conducts "human health assessments" at hazardous waste sites listed on EPA's National Priority List of the most significant hazardous waste sites in the nation.

Washington Model Toxics Control Act (Chapter 70.105D RCW). The Model Toxics Control Act, passed as an Initiative by Washington voters, supplements the federal Comprehensive Environmental Response, Compensation, and Liability Act. The stated purpose of Model Toxics Control Act is to raise sufficient funds to clean up all hazardous waste sites in the state and to prevent future hazards associated with improper hazardous waste disposal (RCW 70.105.010.). Toxic Control Accounts, both state and local, have been created to implement the provisions Model Toxics Control Act. The act also establishes a program for Ecology to identify, investigate, and undertake remedial actions at sites where hazardous substances have been released into the environment.

The Washington Department of Health Office of Toxic Substances has a role in hazardous waste site management which corresponds to that of the Agency for Toxic Substances and Disease Registry on the federal level. The Office of Toxic Substances has a contractual arrangement with the Environmental Protection Agency to conduct health assessments at National Priority List sites in Washington State for which the responsible parties are not part of the federal government.

The Office of Toxic Substances is also involved in identifying sites that are not on the National Priority List or the state Hazardous Site List and informing the Environmental Protection Agency and Ecology of their presence. The Office of Toxic Substances has sought the assistance of local health departments in site identification both by letter and newsletter but, to date, the response state-wide has been minimal. The importance of local participation is emphasized by the Office of Toxic Substances because there are often sites of possible concern that are only known to local health officials. Both federal and state officials indicate that more involvement by local health departments in site discovery and public outreach is needed.

Local governments are not subject to any legal requirement to regulate hazardous waste sites. They are involved in hazardous waste site cleanup, primarily as a either a responsible or an affected party. The SKCHD Environmental Health Division is involved in cleanup actions that are related to its regulatory programs. Landfill closure is the cleanup action that most frequently requires SKCHD Environmental Health Division involvement.

Model Toxic Control Act Cleanup Regulations (Chapter 173-340 WAC). Under authority of the Model Toxics Control Act, Ecology adopted the Model Toxic Control Act Cleanup Regulations yo support program activities required to implement the Act.

**ISSUES**

The RBC-GWAC decided that no action was needed for this topic.

**Hazardous Material Spill Prevention and Emergency Response**

Spill Prevention at Facilities. Fire protection agencies in King County play a major role in prevention of hazardous material spills from fixed facilities. This role derives from the fire protection agencies' responsibility to implement the *Uniform Fire Code.*

Each city in King County has its own fire department which operates in accordance with its jurisdictional ordinances. Fire protection in King County is accomplished both by the King County Fire Marshal and individual fire districts. The County Fire Marshal's Office is the regulatory agency that implements the Uniform Fire Code including hazardous materials provisions. Fire districts, on the other hand, have responsibility for fire fighting and other emergency response activities including hazardous material spills. Fire districts do not have authority to adopt or enforce fire codes.

The Uniform Fire Code is developed by the International Conference of Building Officials (ICBO). The intent of the Uniform Fire Code is to prescribe requirements consistent with nationally recognized best management practices for safeguarding life and property from the hazards of fire and explosion associated with various practices. One of those practices is the storage, handling, and use of hazardous materials.

There is no federally adopted version of the Uniform Fire Code. States are free to adopt any version of the Uniform Fire Code, adopt the code in an amended form, or choose not adopt it; although, in practice, all states have adopted some version of the Uniform Fire Code.

Article 80 of the Uniform Fire Code includes requirements for the prevention, control, and mitigation of dangerous conditions related to hazardous materials and provides for availability of information concerning hazardous materials that might be needed by emergency response personnel.

The Uniform Fire Code prohibits persons and businesses from using, storing, dispensing, or handling hazardous materials in quantities over a specified amount without a permit. Inspections are performed by fire protection agencies to ensure compliance. Storage areas must be constructed according to requirements in the Uniform Fire Code, including secondary containment facilities for some chemicals. Modifications to and closures of hazardous materials storage facilities must be done under permit.

With few exceptions, such as the use of approved pesticides in accordance with label directions, the Uniform Fire Code prohibits release of any hazardous material to sewers, storm drains, surface waters, the ground, or to the air except under permit from appropriate agencies. Fire chiefs have discretionary authority to require commercial or industrial facility operators to prepare Hazardous Materials Management Plans and Hazardous Materials Inventory Statements prior to issuance of an operating permit. These documents are important tools that assist the fire protection agencies in implementing Article 80.

In Washington State, the Uniform Fire Code is incorporated by reference into the State Building Code, Chapter 19.27 RCW. The State Building Code establishes the state Building Code Council with authority to adopt and revise the State Building Code. The Building Code Council has adopted an amended version of the Uniform Fire Code. Two amendments that tend to weaken the Uniform Fire Code in Washington may be of concern to the RBC-GWAC:

- Hazardous Materials Management Plans and Hazardous Materials Inventory Statements are not required from businesses regulated under the federal Emergency Planning and Community Right To Know Act (Chapter 51-24-80103 WAC); and

- An entire category of hazardous materials has been exempted from storage regulations under the Uniform Fire Code. This category is denoted in the 1991 Uniform Fire Code as "Carcinogens, irritants, sensitizers, and other health hazard solids, liquids, and gases" (WAC 51-24-80315).

The Building Code Council concluded that the Hazardous Materials Management Plans and Hazardous Materials Inventory Statements duplicate planning requirements under the Emergency Planning and Community Right to Know Act. Some hazardous materials experts disagree with the council and contend that fire protection agencies were left with less than adequate information concerning facilities to which they must respond in an emergency.

The exemption of a category of hazardous materials from storage regulations is of concern for several reasons. The exempted category contains some of the substances that are of greatest concern from a ground water quality perspective. The section from which an exemption is granted includes a requirement for secondary containment for both indoor and outdoor storage of the materials included in the hazard class. No other agency has the broad authority that the Uniform Fire Code grants to fire protection agencies, nor do other agencies conduct on-site inspections as frequently. The lack of regulation of storage practices for this hazard class at local businesses could substantially weaken the effort to prevent the release of these materials to the environment and, ultimately, to ground water.

Local governments may adopt the Uniform Fire Code as embraced by the state, or may adopt a more stringent version. The version of the Uniform Fire Code adopted by local governments is important to ground water protection in that weaknesses inherent in the state version can be compensated.

While the Uniform Fire Code prescribes the issuance of hazardous materials permits and periodic inspections, local governments establish the level at which the Uniform Fire Code is implemented. Staffing and level of effort in hazardous materials regulation varies. Some fire departments lack expertise in hazardous materials regulation and are staffed insufficiently staffed to conduct a credible hazardous materials program. This is, in part, because Article 80 is a relatively new portion of the Uniform Fire Code.

While there is some overlap in regulatory authority, each of the agencies involved in hazardous materials management has a different emphasis. In many cases, the agencies can help each other to gain compliance or to maintain contact with businesses. Regulatory requirements added together may provide better protection of both the environment and public safety than a single regulation. While fire protection agencies have made great strides in implementing Article 80 of the Uniform Fire Code, the related programs of local governments are not yet fully developed.

Hazardous Material Spills During Transport. The risk of ground water contamination posed by truck or rail transport of hazardous materials is determined by many factors including the nature and quantity of the materials transported; precautions taken in packaging and transport; safety factors including speed limits, congestion, highway, or railway design and maintenance; and sensitivity of the area in which a spill occurs.

Many highways and roads in King County that are frequented by trucks carrying hazardous materials traverse areas which are geologically susceptible to ground water contamination or near municipal wells. In general, risk assessments for transportation spills have not been conducted for King County; although, individuals may have completed such assessments as part of special studies such as State Environmental Policy Act review. Public water system purveyors will, in the near future, be developing their Wellhead Protection Programs as required under federal law and state regulations. Assessment of risk associated with transportation spills will likely be included in contaminant source inventories required under the Wellhead Protection Program.

Numerous federal and state agencies are responsible for the enforcement of the laws that are designed to prevent spills of hazardous materials from commercial carriers. The U.S. Department of Transportation, Federal Highway Administration, Office of Motor Carriers enforces regulations for interstate motor carriers contained in the Code of Federal Regulations Parts 100 - 199. Parts 171 - 180 are commonly referred to as the Hazardous Materials Regulations.

The Federal Railroad Administration and the Washington State Department of Transportation regulates rail construction and safety as well as shipment of hazardous materials by rail.

The Washington Utilities and Transportation Commission, the Washington State Patrol, the Washington Department of Transportation, and Ecology are all involved in preventing spills of hazardous materials from commercial motor carriers at the state level. Ecology has a role in regulation of hazardous waste transport under Chapter 173-303 WAC, the state Dangerous Waste Regulations; regulations which are more stringent than Washington State Department of Transportation hazardous materials rules.

The consensus of those interviewed for the issue paper on transportation spill prevention is that the system is working well and getting better. Regulations and programs governing packaging and transportation of hazardous materials are generally felt to be adequate and will become more effective with recent updates.

Emergency Response to Hazardous Material Spills. Emergency response to hazardous material spills that threaten the environment is the responsibility of many agencies. This section will discuss spill reporting, spill response, and emergency planning. Spill reporting is required under the state Dangerous Waste Regulations, the federal Emergency Planning and Community Right to Know Act, the Department of Transportation's Hazardous Materials Regulations, Washington's Underground Storage Tank Regulations, and the Uniform Fire Code.

The approach to spill response is unique to each spill. First responders to hazardous materials spills threatening life and property are usually the Hazardous Materials Units of local fire protection agencies.

The Emergency Planning and Community Right to Know Act (42 U.S. Code Section 11045) was enacted by Congress in 1986. It was contained within the Superfund Amendments and Reauthorization Act, Title 3, and its provisions are often referred to informally as "SARA Title 3 requirements;" although it is codified separately. The Emergency Planning and Community Right to Know Act requires federal, state, and local government to engage in emergency response planning with the participation of industry. The act includes "right-to-know" stipulations that provide communities with access to information concerning hazardous material use or storage at facilities in their locales. The Emergency Planning and Community Right to Know Act also requires emergency and toxic release reporting.

Emergency planning provisions of the Emergency Planning and Community Right to Know Act require states to establish a State Emergency Response Commission, Emergency Planning Districts, and Local Emergency Planning Committees. Local Emergency Planning Committees must develop and facilitate the implementation of Local Emergency Management Plans in cooperation with the facilities who use, produce, or store "extremely hazardous substances."

King County has a basic Local Emergency Management Plan in place. Those industries that are subject to Emergency Planning and Community Right to Know Act regulations are required to participate in the preparation of the Local Emergency Management Plan. Participation by an industry often involves preparation emergency response plans for their own facilities. These plans are incorporated into the overall Local Emergency Management Plan. To date protection of people and property has been the primary emphasis of the King County Local Emergency Management Plan.

Several problems with the Local Emergency Management Plan have been observed. Most industries subject to Emergency Planning and Community Right to Know Act reporting requirements have not provided their emergency response plans to King County for incorporation into the Local Emergency Management Plan. Additionally, King County should be collecting information regarding hazardous materials facilities from all fire protection agencies within the planning area and entering it into a database compatible with databases used by other jurisdictions within the county. King County has a database system but is not receiving information for entry into the database.

It is generally recognized by all persons interviewed for this paper that the King County Local Emergency Management Plan needs significant improvement. There is also guarded optimism that the situation is about to improve.

A map of areas susceptible to ground water contamination from transportation spills of hazardous materials could be the basis for the Local Emergency Planning Committees to consider such issues as the routing and timing of extremely hazardous materials shipments through the community, particularly in Aquifer Protection Areas. Highway design factors and speed limits could also be considered.

Another matter that may be of concern to the RBC-GWAC could be addressed through the Local Emergency Management Plan. In other areas of the nation, it has been found that fire fighting techniques in sensitive areas should be considered in advance of an emergency.

## GOAL

**Hazardous material spills:** To ensure that spills of hazardous materials are prevented. To be adequately prepared to respond to spills of hazardous materials so ground water contamination is minimized.

## ISSUES

**Issue 3 - Implementation of the Uniform Fire Code.** Article 80 of the Uniform Fire Code is a valuable tool to prevent hazardous material spills in business, industrial, and institutional settings. There are two major obstacles to comprehensive implementation of Article 80. Many jurisdictions within the Ground Water Management Areas have not fully developed their hazardous materials programs. They lack adequate staff, training, and enforcement tools to implement Article 80.

Additionally, the State Building Code Council has adopted a less stringent version of Article 80 that exempts important hazardous materials from full regulation by fire protection agencies. In addition, some businesses and industries have been exempted from the requirement for Hazardous Materials Management Plans and Hazardous Materials Inventory Statements. Some local jurisdictions within Ground Water Management Areas have not passed ordinances to retain the original scope of Article 80.

> **HM-3 Implementation of the Uniform Fire Code:** King County and cities within the Ground Water Management Areas will:
>
> - Commit staff and funding to comprehensive implementation of Article 80 in both new and existing facilities using both educational and regulatory approaches;
> - Propose ordinances for adoption, if they have not already done so, that provide adequate enforcement tools to ensure compliance with Article 80 and that restore the requirements for:
> - Hazardous Materials Management Plans,
> - Hazardous Materials Inventory Statements, and
> - Storage requirements for "Carcinogens, irritants, sensitizers, and other health hazard solids, liquids, and gases" found in Uniform Fire Code 80.315; and
> - Emphasize regulatory attention and educational activity in high infiltration potential areas.

**Discussion:** The Uniform Fire Code does not prescribe penalties. Rather, it contains an ordinance format that may be adapted by local governments for the purpose of establishing a schedule of penalties. King County has a cumbersome civil penalty procedure that can be used to gain compliance. Only by commitment to an active program to implement Article 80 will its benefits be realized. Some jurisdictions contacted in preparation of this issue paper have not yet staffed their programs with trained individuals. The RBC-GWAC, by requesting a commitment to program development, will achieve two ground water protection accomplishments:

- They will bring to the attention of local jurisdictions the importance of effective hazardous materials management programs on the local level; and

- If successful in obtaining concurrence, will improve existing programs.

Because aquifers cross jurisdictional boundaries, less vigorous spill prevention in one jurisdiction can have a deleterious effect on an underlying aquifer used by an adjacent jurisdiction. It is important, therefore, to seek consensus among all of the jurisdictions in the Ground Water Management Areas regarding the importance of hazardous materials spill prevention.

As originally written, Article 80 does not incorporate an enforcement program. Each jurisdiction adopting the Uniform Fire Code must develop and adopt its own enforcement program. Many jurisdictions do not have authority to issue citations for violations of the Uniform Fire Code. The RBC-GWAC can express both its support for educational approaches and request better enforcement tools in the interest of improved hazardous materials management.

Several key sections of Article 80 were altered or deleted by the State Building Code Council. Certain chemicals were exempted from storage requirements, and some businesses were exempted from the requirements for Hazardous Materials Management Plans and Hazardous Materials Inventory Statements. Restoration of the original wording is important for ground water protection.

It would be beneficial if fire services could focus attention on high infiltration potential areas since contamination introduced in these areas presents the greatest risk to drinking water wells.

**Implementation:**

Initially, this action will be implemented via the concurrence process. By concurring with the request, local governments will be committed to implementation of Article 80 of the Uniform Fire Code.

As lead agency for implementation of the Ground Water Management Plan, the SKCHD Environmental Health Division will develop criteria for evaluating the hazardous materials management programs of fire protection agencies and include an annual evaluation in its regular reports to the GWACs and the Ground Water Management Committee. (Please see Chapter 4 for a discussion of committees involved in Ground Water Management Plan implementation.) The SKCHD Environmental Health Division will continue to encourage program development and implementation on an ongoing basis.

During the concurrence process, the SKCHD Environmental Health Division will conduct discussions with the King County Fire Marshal and city fire departments concerning funding needed to implement this action. The goal of these discussions is to determine whether implementation can be funded by hazardous materials permit fees alone or whether aquifer protection fees should be considered to supplement fire protection agency activities.

Some local governments in King County have already instituted hazardous materials permit fees as a means to fund their programs. This is probably the best, long-term solution to hazardous materials regulation. Each jurisdiction will need to assess its existing program and determine the best mechanism to fund improvements, if needed.

**Tasks 1 and 2. Hazardous materials program development and implementation.**

| | |
|---|---|
| Who: | King County Fire Marshal and fire departments of cities within the Ground Water Management Plans. |
| When: | Starting in implementation year 1 and ongoing. |
| Costs: | To be determined by each participant. |
| Funding Source: | To be determined by each participant during concurrence process. Final Ground Water Management Plan will contain designated source of funds. |

**Task 3. Evaluation of hazardous materials programs.**

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Annual evaluation for implementation years 1, 2, and 3. |
| Costs: | 480 hours, $24,000 in second year; 160 hours, $8000 in year 3; Total 640 hours, $32,000. |
| Funding Source: | Aquifer Protection Fund. |

**Issue 4 - Implementation of the Emergency Planning and Community Right-to-Know Act.** Most experts have concluded that the King County Local Emergency Management Plan does not adequately address coordination issues essential for responding to regional disasters including large chemical spills. Most of the commercial and industrial facilities that maintain substantial quantities of extremely hazardous substances on-premises and are regulated under the Emergency Planning and Community Right to Know Act have not yet submitted emergency response plans for inclusion in the King County Local Emergency Management Plan. A centralized database has not been developed that would facilitate data sharing between jurisdictions who may need to jointly respond to large scale incidents. The Local Emergency Management Plan has not, to date, considered the locations of sensitive areas such as Aquifer Protection Areas in developing emergency response measures, in part, because that information has not been available. The Environmental Protection Agency has enforcement authority and could use it to assist the County in achieving compliance with the

Emergency Planning and Community Right to Know Act, but because of the lack of a centralized database and referral system, the Environmental Protection Agency is not receiving referrals for enforcement.

**HM-4 Implementation of the Emergency Planning and Community Right-to-Know Act:** King County, as lead agency for the Local Emergency Management Plan, and cities will seek a permanent source of funding to provide staff and resources necessary to complete a comprehensive Local Emergency Management Plan that includes the following:

- Emergency response plans for all industries that have more than threshold quantities of extremely hazardous substances on premises;
- A centralized, current, database with 24-hour access containing information regarding the locations and amounts of hazardous materials in King County including both Emergency Planning and Community Right to Know Act-regulated facilities and those that are regulated only under the Uniform Fire Code;
- Provisions for adequate coordination between agencies and jurisdictions that might be involved in responding to a major chemical spill;
- Provisions for community outreach so that new businesses are brought into the system;
- A hazard analysis that takes into consideration the locations of Critical Aquifer Recharge Areas, Wellhead Protection Areas, Sole Source Aquifers, and public water systems utilizing ground water sources;
- Fire-fighting techniques and emergency response techniques that favor ground water protection in high infiltration potential areas;
- Referral of facilities that fail to meet Emergency Planning and Community Right to Know Act requirements to the Environmental Protection Agency for enforcement; and
- Provisions for regular testing of the emergency response plan.

**Discussion:** All persons consulted in preparation of this issue paper agreed that the Local Emergency Management Plan needs significant improvement. The improvements requested above reflect the concerns that many of those individuals articulated as well as elements of a Local Emergency Management Plan as described by federal guidelines.

Maps of Aquifer Protection Areas prepared as part of the Ground Water Management Plan will provide emergency planners with the necessary information to design appropriate response protocols for spills in these areas. Fire fighting and emergency response techniques that maximize protection of ground water should be considered.

Referral of facilities that fail to meet Emergency Planning and Community Right to Know Act requirements to the Environmental Protection Agency for enforcement will serve as the measure of last resort in obtaining compliance from facilities that have not responded positively to educational approaches. This is necessary because local emergency response officials do not have enforcement authority under the Emergency Planning and Community Right to Know Act.

The Local Emergency Management Plan must be constantly updated and tested to be effective. Community outreach is needed so that new businesses are brought into the system. The database should be dynamic and capable of rapidly incorporating information taken from routine inspections conducted by local fire protection agencies. In this way, emergency planners, elected officials, and resource protection planners can assess threats to the environment and public health from hazardous materials in the community on an ongoing basis.

**Implementation:**

The SKCHD Environmental Health Division, as lead agency for implementation of the Ground Water Management Plan, will:

- Provide maps of high infiltration potential areas and well locations to the King County Emergency Management Division;

- Provide information regarding emergency response techniques necessary to protect aquifers and wells;

- Review existing literature and determine the need to contract for a consultant with emergency management expertise;

- Report the impacts to aquifer protection and the Minimum Wellhead Protection Program referred to in Chapter 4; and

- Develop recommendations for the Emergency Management Division, a determination will be made as to whether to share recommendations directly with emergency responders or to work through the Local Emergency Management Plan process.

During the concurrence process, The SKCHD Environmental Health Division will conduct discussions with the King County Emergency Manager and city fire departments concerning funding that may be necessary to implement this action. The goal of these discussions is to determine whether implementation can be funded by an industry supported program. Perhaps a portion of hazardous materials permit fees referred to in Action HM-5 could be dedicated to supporting the Local Emergency Management Plan. The possibility of supplementing hazardous materials permit fees with aquifer protection fees will also be considered.

**Task 1. Develop and implement an improved Local Emergency Management Plan.**

| | |
|---|---|
| Who: | King County Emergency Management Division in cooperation with cities and other members of the Local Emergency Planning Committees. |
| When: | Start in year 1 of implementation and ongoing. |
| Costs: | To be determined by King County Emergency Manager. |
| Funding Source: | To be determined during concurrence process. A source of funds will be designated in the final Ground Water Management Plan. |

**Task 2. Communicate the locations of high infiltration potential areas and wells to emergency responders.**

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Beginning in year 1 of implementation and ongoing as maps are continuously refined and wellhead protection areas are defined by public water system purveyors. |
| Costs: | Negligible. The work involved in preparing/obtaining maps is accounted for in the Data Collection and Management section. |

**Task 3. Prepare a report for the Emergency Management Division concerning fire fighting and emergency response techniques that are protective of ground water.**

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Year 2 of plan implementation. |
| Costs: | 480 hours, $24,000. Consultant contract: Amount to be determined. |
| Funding Source: | Aquifer Protection Funds. |

**Task 4. Develop recommendations for the King County Emergency Management Division regarding fire fighting and emergency response techniques for inclusion in the Local Emergency Management Plan; Ensure that this information is shared with emergency responders throughout King County.**

| | |
|---|---|
| Who: | Ground Water Management Committee. |
| When: | Year 3 of plan implementation. |
| Costs: | Costs are addressed in the implementation plan for Chapter 4. |

**Task 5. Report on the progress of development and implementation of the Local Emergency Management Plan in relation to GWAC concerns.**

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Year 3 of plan implementation. |
| Costs: Personnel: | 160 hours, $8000. |
| Funding Source: | Aquifer Protection Fund. |

**Issue 5. Prevention of aquifer contamination associated with transportation-related hazardous material spills.** An assessment of the risk of aquifer contamination from transportation-related hazardous material spills in King County could provide information regarding the significance and characteristics of this problem. The information obtained could be used to identify risk reduction strategies.

**HM-5A Transportation-Related Hazardous Materials Spills - Purveyor Assessment:** Purveyors of large public water systems (1000 connections or more) will:

- Assess the risk of transportation-related hazardous material spills in their Wellhead Protection Areas, and
- Develop and implement risk reduction strategies as needed.

**HM-5B Transportation-Related Hazardous Material Spills - Management Committee Evaluation:** The RBC-GWAC resolves that it will be the responsibility of the Ground Water Management Committee to evaluate the recommendations developed and actions taken by the Washington State Department of Health's Transportation Engineering Subcommittee in order to determine whether further actions should be taken on a county-wide basis to protect aquifers from transportation-related hazardous material spills.

**Discussion:** The state Wellhead Protection Program will require public water system purveyors to assess contamination risks in Wellhead Protection Areas. It is likely that assessing risks of transportation-related hazardous material spills will be one of the components. The RBC-GWAC can ensure that this matter is considered by addressing it during concurrence of the Ground Water Management Plan.

Public water system purveyors should address problems unique to their Wellhead Protection Areas in their Wellhead Protection Programs.

The Washington State Department of Health has initiated a process to identify methods in which hazardous material transportation spills could be more effectively prevented and acted upon. The Washington State Department of Health plans to pursue changes at a state level if appropriate. Participants include the Washington State Department of Health, Ecology, the Washington State Department of Transportation, the federal Department of Transportation, federal railroad officials, and chemical and transportation industry representatives. The RBC-GWAC could take advantage of this existing process and defer this matter to the Ground Water Management Committee for further resolution.

**Implementation:**

This will initially be implemented during the concurrence process. Purveyors will indicate whether they intend to address this concern via their wellhead protection programs. The SKCHD Environmental Health Division as lead agency, will report to the GWACs and Ground Water Management Committee on progress in implementation briefs. It is intended that a progress report will be provided in year 3 of plan implementation because Wellhead Protection Programs will be in full development at that point.

The Ground Water Management Committee will review this issue according to its priorities and will address it prior to the plan update.

**Task 1. Assess the risk of transportation-related hazardous material spills in Wellhead Protection Areas.**

| | |
|---|---|
| Who: | Public water system purveyors (1000 connections or more). |
| When: | When developing their Wellhead Protection Programs. Note: These programs will be phased in according to rules developed by the Washington State Department of Health. |
| Costs: | To be determined by purveyors. |
| Funding Source: | Purveyors operating budgets with some Aquifer Protection Fund support. |

**Task 2. Develop and implement risk reduction strategies as needed.**

| | |
|---|---|
| Who: | Public water system purveyors (1000 connections or more). |
| When: | In accordance with schedules prepared by purveyors in their Wellhead Protection Programs. |
| Costs: | To be determined by purveyors. |
| Funding Source: | To be determined by purveyors. Limited use of Aquifer Protection funds might be available. |

**Task 3. Evaluate recommendations/actions of the Department of Health's**

**Transportation Engineering Subcommittee and determine whether further action should be taken on a county-wide basis to protect aquifers from transportation-related hazardous material spills.**

| | |
|---|---|
| Who: | Ground Water Management Committee. |
| When: | Prior to update of the Ground Water Management Plan. |
| Costs: | Costs associated with the functions of the Management Committee are accounted for in Chapter 4. There are no further costs anticipated. |

**Task 4. Prepare a brief evaluation of progress made by purveyors in addressing this issue for the RBC-GWAC and the Ground Water Management Committee.**

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Year 3 of plan implementation. |
| Costs: | 160 hours, $8000. |
| Funding Source: | Aquifer Protection Fund. |

3.3.2. Ground Water Concerns Associated with Underground Storage Tank Management

**Commercial Underground Storage Tanks**

Commercial underground petroleum and chemical storage tanks represent perhaps the most significant potential threat to ground water quality in King County. Leakage from underground storage tanks and associated piping often occurs without detection and even relatively small amounts of certain compounds can have serious adverse impacts on ground water quality. Once released from an underground storage tank, some volatile organic compounds and petroleum products can rapidly migrate through the soil profile to ground water.

The precise number of underground storage tanks that are located in King County is not known. However, Ecology estimates that at least 6,550 such tanks are currently in operation, not including home heating oil tanks.

Underground storage tanks are regulated by federal, state, and local governments. Private sector insurance and lending institutions also bring pressure to bear upon owners and operators of underground storage tanks to install and maintain those systems in a manner which reduces liability risks through avoiding releases. A summary of each level of governmental regulation is provided below.

Federal Program. Federal regulations (Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks, 40 CFR 290 Part

280) were developed by the Environmental Protection Agency under Subtitle i of the Resource Conservation and Recovery Act. The Environmental Protection Agency regulations contain provisions for delegation of the federal Underground Storage Tank (UST) Program to the states.

State Program. The state Underground Storage Tank Management Act, Chapter 90.76 RCW, directed the Department of Ecology (Ecology) to develop an underground storage tank program designed, operated, and enforced in a manner that meets the requirements for delegation of the federal Underground Storage Tanks Program. RCW 90.76 provided Ecology with authority to adopt rules for management of all underground storage tanks that are subject to governance under the Environmental Protection Agency regulations. Accordingly, Ecology adopted the state Underground Storage Tank Regulations (Chapter 173-360 WAC) in November 1990. These comprehensive regulations incorporate the minimum requirements of the federal Underground Storage Tanks Program. Certain classes of underground storage tanks are exempt from regulation under both the Ecology and Environmental Protection Agency underground storage tank programs. These classes include home heating oil tanks and farm and residential motor fuel tanks of less than 1,100 gallons.

Local Programs Under Chapter 90.76 RCW. Under Chapter 90.76 RCW, Ecology is encouraged to delegate portions or all of the state Underground Storage Tank Management Program responsibilities to cities, towns, or counties. Annual tank fees collected by Ecology under legislative authority will be apportioned between Ecology and the city, town, or county assuming responsibility for the program or a portion of the program. However, local governments seeking delegation of the entire program would be undertaking a heavy commitment with the limited funding options available.

Local jurisdictions may establish underground storage tank programs that are more restrictive than the state program if they do so to protect an "Environmentally Sensitive Area." Environmentally Sensitive Areas are defined in Chapter 90.76 RCW as geographic areas that possess physical characteristics that make them especially vulnerable to releases from underground storage tanks. A city, town, or county can request Ecology to designate an area within its jurisdiction as an Environmentally Sensitive Area. If a single Environmentally Sensitive Area is located within more than one political jurisdiction, such as two different cities or one city and a county, the jurisdictions can jointly request that Ecology designate the area as sensitive.

An area can qualify as an Environmentally Sensitive Area in one of two ways:

- The area has already been granted special environmental status under another state or federal statute or regulation for the purpose of protecting ground water or surface water from pollution, or

- The local jurisdiction can demonstrate that ground water is vulnerable to pollution because of site specific hydrogeological characteristics (WAC 173-360-520).

An Environmentally Sensitive Area designation under authority of Chapter 90.76 RCW is not synonymous with an Environmentally Sensitive Area designation under Chapter 43.21C RCW, the State Environmental Policy Act (SEPA); although, a single area could be designated as an Environmentally Sensitive Area under both RCW's. Designation under Chapter 90.76 RCW affects only the construction and operation of underground storage tanks while designation under the State Environmental Policy Act affects a much broader range of land use activities.

Local Programs Under Uniform Fire Code. Local fire protection agencies posses authority to regulate underground storage tanks under the provisions of the Uniform Fire Code (Article 79 Uniform Fire Code). Chapter 51-16 WAC, State Building Code, incorporates the Uniform Fire Code by reference. Local governments must enforce the provisions of the Uniform Fire Code as adopted and modified by the state. Local jurisdictions may adopt more stringent requirements.

It should be noted that some cities in King County do not believe that the Uniform Fire Code authorizes them to regulate heating oil tanks. The King County Fire Marshal's Office, however, does regulate heating oil tanks under Article 79 of the Uniform Fire Code.

King County is legally responsible for permitting and inspecting the installation and removal of underground tanks within unincorporated areas regardless of whether the area is in a Fire District. Fire Districts are responsible for fire fighting function while the King County Fire Marshal's office is responsible for technical tasks such as construction plan review for compliance with fire safety and hazardous materials storage codes, including plan review for new underground storage tanks. The Fire Marshal's office is a division of the Department of Development and Environmental Services. City fire departments carry out both fire fighting and technical tasks.

Underground storage tanks of 10,000 gallons or larger in size must undergo environmental review under the State Environmental Policy Act. The State Environmental Policy Act section of the King County Environmental Division, Department of Development and Environmental Services routinely requires secondary containment for underground storage tanks of this size in Ground Water Management Areas upon review of permit applications referred by the Fire Marshal's office. It is not known whether city reviewers of State Environmental Policy Act documents are requiring secondary containment.

Leaking Underground Storage Tank Management Program. Section 205 of the Superfund Amendments and Reauthorization Act of 1986 created an Underground Storage Tank Trust Fund to pay for the cleanup of releases of hazardous substances, including petroleum products, from underground storage tanks. The fund is administered by the Environmental Protection Agency Office of Underground Storage Tanks. The fund is intended to support cleanup of leaking underground storage tanks in cases where no financially solvent owner/operator can be identified, where the owner/operator refuses or is unable to promptly

respond to the problem, or where an imminent hazard to public health or the environment exists.

The fund also provided financial assistance to state governments for development of state leaking underground storage tank response programs. Ecology developed this state's Leaking Underground Storage Tank Program through this fund. Releases of hazardous substances from underground storage tanks in this state are currently addressed by Ecology through oversight of voluntary cleanup actions by tank owners or through enforcement actions. Should Ecology need to undertake direct cleanup of a tank release, funding is obtained from the Model Toxics Control Act fund.

**Underground Home Heating Oil Tanks**

Leaking underground home heating oil tanks may present a threat to ground water quality. However, because of heating oil's chemical constituency and low potential for migration through the soil, both federal and state regulations adopt a less aggressive approach to regulation of underground heating oil tanks.

Potential problems associated with home heating oil tanks include leakage from operating tanks and releases from improperly abandoned tanks containing residual product. Many of the existing home heating oil tanks within King County are likely to be bare steel tanks without cathodic protection and, as such, a large percentage may be leaking or will leak in the future.

The number of underground home heating oil tanks in operation within King County is unknown, primarily because the number and locations of such tanks is considered proprietary information by the heating oil industry. The King County Department of Assessments has information regarding the heat source for residences excluding mobile homes. However, the information is not necessarily accurate because it is frequently not updated when oil to gas conversions occur. The frequency of underground home heating oil tank abandonment is estimated at 20 percent.

The Uniform Fire Code requires that tanks which have remained unused for a period of one year must be abandoned in a manner prescribed by Article 79, which generally involves removal and proper disposal of the tank. The tank may be abandoned in place at the discretion of the jurisdictional fire chief, or, in the case of King County, by the Fire Marshal. Whether removed or abandoned in place, remaining product must be withdrawn and disposed of properly. The tank must be filled with concrete or other approved substance if abandoned in place.

Compliance with the Uniform Fire Code requirements has historically been very low according to the King County Fire Marshal's Office. There are many home heating oil tank owners that are apparently unaware of their responsibilities under the Uniform Fire Code. Tank owners that are aware of their responsibilities are often reluctant to undertake proper tank abandonment because of the relatively high cost, about $2,000 per tank. Abandonment costs could double in amount or more, if soil sampling and removal of contaminated soil are required. Part of the expense in unincorporated King County includes the cost of a permit. The fee, presently set at $232.90, is the same as that paid by those who are removing a commercial tank. (These costs were current for 1991.)

## GOAL

To ensure that underground chemical and fuel storage tanks are managed adequately to prevent contamination of ground water in King County.

## ISSUES

**Issue 1 - Augment State Underground Storage Tanks Program.** The underground storage tank management program administered by Ecology does not posses resources necessary to field check and monitor for compliance with regulations.

> **UST-1A Augment State Underground Storage Tanks Program:** King County and cities will jointly petition Ecology to designate Ground Water Management Areas as Environmentally Sensitive Areas under Chapter 90.76 RCW, the state Underground Storage Tank Management Act.
>
> **UST-1B Augment State Underground Storage Tank Program:** King County and cities will enhance current inspection of underground storage tank installation and removal in Environmentally Sensitive Areas to include the relevant requirements of Chapter 173-360 WAC, the state Underground Storage Tank Regulations.

**Discussion:** Designation of Environmentally Sensitive Areas in King County by Ecology will give local jurisdictions an opportunity to build upon the Ecology program. Ecology has already indicated that their program will not involve field inspections of each individual underground storage tank. Many of the compliance activities associated with the Ecology rules will be conducted through the mail. Ecology anticipates that their underground storage tank program will stress a self policing approach. Preventing contamination of some of the more highly vulnerable aquifers in King County from the operation of underground storage tanks may require a more comprehensive management program than that currently envisioned by Ecology. An enhanced local program may be developed and implemented in consideration of the importance of the Environmentally Sensitive Areas as areas contributing recharge to public water supplies.

Designation of the all Ground Water Management Areas would create workable boundaries for administrative purposes and is supportable from a protection standpoint since Ground Water Management Area boundaries are based on ground water divides. WAC 173-360-510 provides that Ground Water Management Areas may be readily designated as Environmentally Sensitive Areas.

Funding sources for state and local activities are connected. Ecology charges an annual tank fee to all underground storage tank owners. Ecology may pass a portion of the proceeds from this fee through to local programs; however, Ecology must retain a sufficient portion of the fee to support operation of its state program. This may be the entire fee, since the fee set by the legislature is very low. Local jurisdictions are prohibited by Chapter 90.76 RCW from assessing additional annual tank fees unless an Environmentally Sensitive Area is designated. In that case, local programs may assess a supplemental permit fee within the Environmentally Sensitive Area to support local program activities. However, this supplemental fee cannot exceed 50% of the base fee charged by Ecology.

Thus, state and local governments are limited in their ability to assess industry for program costs. Local governments that are interested in developing enhanced underground storage tank programs should determine which aspects of the state program is in most need of enhancement and offer recommendations for adequate funding, given the prohibitions against increased annual tank fees contained in Chapter 90.76 RCW and the small possibility of a of pass-through of state collected fees to local programs.

Tank installation and removal are critical steps in the management of underground storage tanks. Removal is particularly important because of the opportunity to detect and clean up previous spills. These activities are already inspected for compliance with the Uniform Fire Code. This action offers the possibility of expanding the existing inspection program to include relevant requirements of the state Underground Storage Tank Regulations. Increased permit fees to offset inspection costs would not violate the prohibition against raising the annual tank fee. Staff training is an aspect of the program that could be funded by pass-through monies collected by Ecology contingent upon designation of the Ground Water Management Areas as Environmentally Sensitive Areas.

Feasibility of an enhanced inspection program will rest upon resolution of the following issues by state and local government.

- Each of the existing Ground Water Management Areas, except Vashon Island, includes one or more incorporated communities.
- Decisions regarding the nature of an enhanced local program must be jointly made by all of the affected jurisdictions.
- Local governments will need to develop a proposal and submit it to Ecology.

Ecology will determine whether the proposal meets legal and regulatory requirements governing designation of Environmentally Sensitive Areas and provisions for stricter local programs. The amount of money collected by Ecology and available for passing through to the local program will need to be negotiated.

- A key local decision involves delegation of the new responsibility. Both fire protection agencies and the Seattle-King County Department of Public Health (SKCHD) Environmental Health Division could logically administer the program. Fire protection agencies offer the advantage of current involvement in an existing inspection program. On the other hand, the SKCHD Environmental Health Division may be the most appropriate agency to implement the program because it has legal standing in all incorporated and unincorporated communities in King County and has been identified as the lead agency for ground water protection and management activities. It may be much simpler and offer consistency if a King County Board of Health rule were to establish a county-wide program such as that in existence for on-site sewage disposal. It is not known whether a King County Board of Health rule could be implemented by the fire protection agencies, but that possibility should be explored. At least one neighboring county has a joint program for tank removal inspection. The Tacoma-Pierce County Health Department inspects for environmental concerns while the fire protection agencies continue to inspect for fire code requirements. This arrangement is reported to be working well with good cooperation between the two entities involved. The joint program offers the benefit that fewer personnel must be trained to do inspections.

- Staff must be trained in the installation and removal requirements of the state Underground Storage Tank Regulations. Funds are needed to pay for this activity. A possible source is the supplementary annual tank fee Ecology collects in Environmentally Sensitive Areas. It is anticipated that this money will be turned over to local governments for the purpose of carrying out enhanced local programs in Environmentally Sensitive Areas.
- A fee for the installation of new underground storage tanks will be needed to offset the costs incurred by the agency responsible for plan review and on-site inspections associated with the design and installation of new underground storage tanks. Plan review and on-site inspection costs can be quite high. Experiences in a neighboring county suggest that, on a time and material basis, an average of about $300 to $350 per underground storage tank is expended by the agency responsible for plan review and on-site inspection. The King County Fire Marshal's Office currently charges $125 for the first tank and $39 for each additional tank for plan review and inspection under the Uniform Fire Code. For aggregate storage at one site of over 10,000 gallons the proposal is referred to the county's State Environmental Policy Act section which requires an additional $600 fee. (These fees were current as of 1991.)

- Expansion of the enhanced program to other cities or unincorporated areas of the county should be considered. However, supplemental annual tank fees would not be available to train staff. It is possible that training could be provided to all jurisdictions in the County for the same cost as to those in Ground Water Management Areas. This possibility should be considered.

**Implementation:**

**Task 1:** Prepare and submit petition to designate Ground Water Management Areas as Environmentally Sensitive Areas. After Environmentally Sensitive Area designations, there may be additional work, such as publicity, mapping, and notifying affected agencies.

**Task 2:** To enhance current inspection program of underground storage tank installation and removal in Environmentally Sensitive Areas to include the relevant requirements of Chapter 173-360 WAC, the state Underground Storage Tank Regulations, the following steps must be undertaken:

- Determine local regulatory authority;
- Develop elements of an enhanced program, including training and evaluation;
- Determine role of local agencies in implementation; for example, the King County Fire Marshal's office and local fire service jurisdictions could assume responsibility for underground storage tank management, provided that they have the capacity and interest; and
- Amend ordinances as necessary to implement program.

**Task 3:** Develop and implement a training program for inspectors regarding requirements of the Underground Storage Tank Regulations in order to carry out the inspections referred to in Task 2. The Management Committee must decide who is to provide this training. This program includes determining the additional training needed, identifying inspectors in need of training, and training all inspectors within a given time frame.

**Task 4:** Determine how to modify local program based upon:

- Ecology's annual reports evaluating the state underground storage tank program, and
- Annually reviewing effectiveness of local programs and developing evaluation methods.

Who: Tasks 1, 2, 3, 4: SKCHD Environmental Health Division under Management Committee direction.

| | |
|---|---|
| | Task 3: Management Committee to determine. |
| When: | As per implementation schedule. |
| Cost: | Minimum SKCHD Environmental Health Division staff: 0.5 FTE for three years, $52,200/yr. Other costs will be determined during development of program by the Management Committee. |
| Funding Source: | The enhanced local program would be funded by industry in the form of increases in current inspection fees and supplementary annual tank fees. The latter may be used to pay for training of inspection staff. Other tasks could be funded through the Aquifer Protection Fund. |

**UST-1C Augment State Underground Storage Tank Program:** The Seattle-King County Health Department Environmental Health Division will prepare an ordinance for King County Board of Health consideration regarding underground tanks containing the following requirements:

- Disclosure at the time of sale of any real property in King County of the number, location, and legal status of existing underground chemical storage tanks; and

- Secondary containment for all new tanks.

**Discussion:** Requiring disclosure of underground storage tanks on a piece of property would provide a source of information for the database on tank location. This would enable King County to provide information on a specific property to anyone in need of the information. This would also provide the Fire Marshal's Office information on heating oil tanks. The education program could target these properties for direct mail or other educational activities.

Requiring secondary containment for new tanks would close a gap in the current federal and state regulations. Federal and state regulations do not require secondary containment of underground storage tanks. This measure would help prevent ground water from becoming contaminated. Current regulations only require leak detection, which may not alert tank operators until after ground water is contaminated. Secondary containment is where the primary tank is enclosed within a second impermeable barrier, with capacity for containment of all or part of the tank volume. Combining secondary containment with interstitial monitoring can detect leaks before they escape into the environment.

**Implementation:**

**Task 1:** Draft ordinance preparation, presentation to King County Board of Health's for its consideration.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Year ___. |

| | |
|---|---|
| Cost: | 160 hours, $8000. |
| Funding Source: | Aquifer Protection Fund will be needed for staffing the effort to draft the ordinance and process it through public hearings and King County Board of Health review. |

**Issue 2 - Exempt Tanks.** Chapter 173-360 WAC, the state Underground Storage Tank Regulations, are reactive in some respects. The regulations focus on monitoring and post-leak detection rather than prevention of leaks. Construction and monitoring requirements still allow leaks and consequently contamination of the environment. Additionally, certain classes of underground storage tanks are partially or completely exempt from federal and state regulation.

> **UST-2A Exempt Tanks:** Seattle-King County Health Department Environmental Health Division will prepare an ordinance for King County Board of Health consideration requiring secondary containment for underground chemical storage tanks as defined by WAC 173-360-120 and for the following exempt or deferred tanks: heating oil tanks of all sizes and motor fuel tanks of 1,100 gallons or less.

**Discussion:** Current state regulations focus on monitoring and post-leak detection rather than prevention of leaks. They provide for leak detection methods which may not alert tank operators until ground water is already contaminated.

Requiring secondary containment would enhance current regulations by providing a method to prevent leaks. Secondary containment offers the best protection from leaks from underground storage tanks that could contaminate soil and ground water. It is the only method that detects the potential for spill before the spill is introduced into the environment. The industry widely recognizes the advisability of secondary containment and most commercial installations now incorporate it. It is both economically and technically feasible.

Secondary containment refers to the practice of enclosing the primary tank with a second impermeable barrier. The secondary vessel may be a separate container or it may be an integral component of the primary tank. Leak detection monitoring is provided in the space between the tanks. The King County Board of Health could significantly reduce the possibility of future contamination of ground water by requiring that this precaution be taken.

The smaller, exempt tanks could also benefit from secondary containment. Most existing exempt tanks lack corrosion protection and many are probably leaking. Exempt tanks are home and farm tanks of 1,100 gallons or less that store motor fuel for consumptive use on the premises and heating oil tanks of 1,100 gallons or less; also, heating oil tanks over 1,100 gallons in size are exempt from some of the requirements of federal and state regulations. Secondary containment equipment is available for small tanks as well as large and is economically feasible.

Fire protection agencies already have programs to review plans for above and underground tanks that are fee supported. A requirement for secondary containment of above ground storage would have major impact on the existing inspection programs.

**Implementation:**

**Task 1:** The Management Committee needs to determine who would enforce this ordinance. It may not be feasible to have the King County Board of Health pass an ordinance that the Fire Marshal enforces.

**Task 2:** Prepare an ordinance for King County Board of Health (or other appropriate body) consideration requiring secondary containment for underground storage tanks (as in WAC 173-360-120) and for exempt tanks.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division under Management Committee advisement. |
| When: | As per implementation schedule. |
| Cost: | SKCHD: 160 hours minimum ($8,000). |
| Funding Source: | Aquifer Protection Fund will be needed for staffing the effort to draft the ordinance and carry it through public hearings and King County Board of Health review. Plan review by fire protection agencies would be fee supported. |

**UST-2B Exempt Tanks:** The Seattle-King County Department of Public Health Environmental Health Division will prepare an ordinance for the King County Board of Health's consideration regarding underground tanks containing the following provisions:

- Require that all underground chemical storage tanks without secondary containment that are in use and exempt from the state Underground Storage Tank Regulations must be tested at regular intervals for integrity by qualified personnel and tagged to either allow or prohibit future product delivery.

**Discussion:** Requiring testing and tagging of exempt tanks would ensure that leaking tanks won't receive more product. This would also help address the question as to whether ground water is being contaminated by these tanks. These location of these tanks could be added to the database for analysis. This is a stringent requirement that would provide a considerable amount of information. Questions that would need to be addressed in the future are: what would be use would be made of the information? and would there be any follow-up?

**Implementation:**

**Task 1:** Draft proposed ordinance, present for King County Board of Health's consideration.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Year ___. |
| Cost: | 160 hours, $8,000. |
| Funding Source: | Aquifer Protection Fund will be needed for staffing the effort to draft the ordinance and carry it through public hearings and King County Board of Health review. |

**Issue 3 - Heating Oil Tanks.** There is some disagreement whether Article 79 of the Uniform Fire Code contains clear authority for the local Fire Marshall to regulate heating oil tanks. This should be determined at the state level.

Home heating oil tanks may not be maintained or abandoned properly. Homeowners are often unaware of requirements for the proper operation and abandonment of underground heating oil tanks. There are currently no programs in place to educate citizens or provide incentives for proper operation and abandonment. Also, homeowners are reluctant to abandon tanks properly and under permit due to fears over the possible expense associated with remediating a site with contaminated soil.

Also, the extent of the threat to ground water associated with underground heating oil tanks, including those serving single family residences, is unknown. Locating these tanks would help in determining the potential threat. It is unknown how many of these tanks are in the Ground Water Management Areas or where they are located.

> **UST-3A Heating Oil Tanks - Local Legal Authority:** The Washington State Department of Ecology will seek a state Attorney General's opinion regarding the authority of the King County Fire Marshal and city fire chiefs to regulate the installation and removal of underground heating oil tanks through Uniform Fire Code provisions.

**Discussion:** It is clear to King County that there is regulatory authority under Article 79 of the Uniform Fire Code for the regulation of underground heating oil tanks. However, due to discrepancies in interpretation among the cities, this should be clarified at the state level. This needs to be resolved so that the activities under 3C and 3D can be assigned.

**Implementation:**

**Task 1:** Review problem and ordinances.

**Task 2:** Prepare question(s) for state Attorney Generals Office.

**Task 3:** Submit to State Attorney Generals Office.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division under the Management Committee, through Ecology. |
| When: | Year 1. |
| Cost: | SKCHD: 320 hours, $16,000; Ecology: $1,750. |
| Funding Source: | Aquifer Protection Fund. |

**UST-3B Heating Oil Tanks - State Code Amendment:** The Department of Ecology will seek an amendment to the State Building Code (Chapter 51-16 WAC) to make underground heating oil tanks subject to the provisions of Article 79 of the Uniform Fire Code if the Attorney General's opinion indicates that such tanks are not now regulated.

**Discussion:** If the state Attorney Generals Office finds that the Article 79 does not give local governments the authority, then the State Building Code will need to be revised.

**Implementation:**

**Task 1:** Prepare revision with appropriate staff at State Building Code Council, propose revision, implement revision process and public hearings, etc.

| | |
|---|---|
| Who: | Ecology. |
| When: | Year 1. |
| Cost: | $5,000. |
| Funding Source: | |

**UST-3C Heating Oil Tanks - Abandonment and Maintenance:** The Seattle-King County Department of Public Health Environmental Health Division will prepare an ordinance for the King County Board of Health's consideration regarding underground tanks containing the following provisions for home heating oil tanks:

- Prior to release of any permits associated with energy conversions (gas piping, electrical, etc.), proof must be provided to the permitting department from the Fire Marshal or jurisdictional fire chief that the underground heating oil tank was abandoned in accordance with regulations; and

- Underground heating oil tanks that are abandoned in place must be filled with a material that precludes further storage of any chemical in the tank.

**Discussion:** Requiring proof that the underground heating oil tank was properly abandoned before any permits associated with energy conversions (gas piping, electrical, etc.) are issued will provide a method to ensure that fewer tanks are improperly abandoned upon energy conversion. This would require additional reviewed by the permitting agency, but a standard form could be developed to provide this information.

There is a potential problem with the current requirement for material used to fill tanks. If for some reason the tank cannot be removed, the tank must be filled with inert material, generally interpreted to mean concrete or another approved substance. However, sand and other porous material is allowed. This type of material would allow storage of some liquid product, which could be another contamination source for ground water. The local regulation governing abandonment of tanks in place could require that the material used to fill tanks be concrete or other material that would prevent storage of any other material in the tank.

**Implementation:**

**Task 1:** Draft ordinance wording, present for King County Board of Health's consideration.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | |
| Cost: | 160 hours, $8,000. |
| Funding Source: | Aquifer Protection Funds will be needed for staffing the effort to draft the ordinance and carry it through public hearings and King County Board of Health review. |

**UST-3D Heating Oil Tanks - Location:** King County and cities will develop a database describing and locating these tanks.

**Discussion:** A database of underground storage tank locations could be used to help analyze the threat to ground water from tanks and to provide a client list for educational activities. The database could include information gathered from all of the above activities and other sources. This information could be compared to sensitive areas and leaking tank reports from Ecology and analyzed by the SKCHD Environmental Health Division/Management Committee to determine if the current program meets the ground water protection goal. This information could also be used to help deliver information from the Education Program to tank owners.

**Implementation:**

**Task 1:** Develop a database on tank location by collecting and entering information (existing and new).

**Task 2:** Maintain database.

**Task 3:** Analyze periodically.

**Task 4:** Provide location information to Education Program and other users such as Ecology.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division under Management Committee direction. |
| When: | As per implementation schedule. |
| Cost: | SKCHD: 0.25 FTE, $26,100.<br>City of Redmond: No additional cost. |
| Funding Source: | Aquifer Protection Fund. |

**UST-3E Heating Oil Tanks - Education:** King County and cities will jointly educate homeowners and exempt tank owners regarding tank abandonment requirements of the Uniform Fire Code through the Ground Water Management Plan Education Program.

**Discussion:** Including home heating oil tanks in the overall Ground Water Management Plan Education Program will help address the low level of compliance with the requirements for home heating oil tank abandonment. Homeowners are unaware of their responsibilities under the Uniform Fire Code, probably because there are no programs on proper maintenance and abandonment. By providing educational material to tank owners, an increase in the community knowledge about the problem and, hopefully, an increase in the numbers of tank owners that comply with the regulations would result. Also, by increasing community awareness, it is expected that home purchasers would require information on tank status be disclosed.

**Implementation:** This will be included in the Education Program, Chapter 3.

### 3.3.3. Ground Water Quality Issues Relating to On-Site Sewage Disposal System Use

Ground water contamination associated with domestic on-site sewage system effluent can involve a number of contaminants including nitrate, bacteria, viruses, and trace organic chemical compounds. Nitrate is often considered the most significant contaminant associated with domestic wastewater since it is highly resistant to removal from treatment mechanisms present in the soil profile. Bacteria and viruses can be attenuated during migration through a few feet of fine to medium textured soils provided unsaturated flow conditions can be maintained. However, coarse textured, excessively permeable soils are ineffective in removing bacteria and viruses. Also, domestic effluent often contains very low levels of volatile and semi-volatile organic compounds. These organic compounds are generally residues from household cleaning and paint products and are known as household hazardous wastes. If on-site sewage systems are improperly designed or constructed, installed in inadequate soils, used at too high of a development density, or used to dispose of non-domestic wastewater, they can adversely impact surface and ground water quality as well as public health.

There is an extensive regulatory system currently in place at the state and local level to prevent adverse environmental impacts from the use of on-site sewage disposal systems.

That regulatory system is undergoing modifications at the state level that will further strengthen the ground water protection provisions of applicable on-site sewage system regulations and standards.

Controls on system density and improved design criteria appear to have minimized the threat to ground water quality posed by new individual residential on-site systems. However, within the various Ground Water Management Areas, there may be existing high density developments served by conventional on-site sewage systems. To date, water quality problems associated with such developments have been not been documented. However, extensive ground water monitoring efforts to identify problems associated with on-site sewage systems have not been undertaken.

## GOAL

To promote on-site sewage disposal planning and practices that are effective in protecting ground water resources from possible adverse impacts.

## ISSUES

**Issue 1 - Nitrate Concerns.** The designs of most on-site sewage disposal systems installed in Type 1 soils prior to April 1987, the implementation date of King County Board of Health Title 13, did not incorporate enhanced treatment technology. These systems often support development densities that exceed one residential unit, or equivalent, per acre. The poor treatment efficiency of conventional on-site sewage systems installed in coarse textured soils suggests a potential for nitrate contamination of underlying ground water, especially in areas where the density of on-site sewage systems is relatively high. Nitrate concentrations may build up in the zones of contribution to public water system wells to unacceptable levels, potentially resulting in irreversible loss of drinking water supplies.

> **OS-1 Nitrate Concerns:** The Redmond-Bear Creek Valley Ground Water Advisory Committee (RBC-GWAC) requests that the following be considered by the Management Committee:
>
> - Develop requirements that Wellhead Protection Programs for systems serving over 1,000 connections incorporate nitrate loading analysis in determining the level of risk to public water supplies associated with on-site sewage disposal systems and other sources of nitrate;
> - Collaborate with land use authorities to require alternative methods of development and/or revised land use for tracts of undeveloped land overlying ground water aquifers with unacceptable levels of nitrate (greater than 5 mg/l); and

- Collaborate with the King County Board of Health to require alternative methods of sewage disposal in areas where nitrogen levels in underlying ground water are unacceptable (more than 5 mg/l).

**Discussion:** Taking no action would continue to expose the public to potential loss of its drinking water supplies. The extent of that risk, however, would remain unknown if nitrate loads are not measured, modeled, and predicted. It is possible because of lag time in the travel of nitrate to wells that by the time the problem is detected it would be too late to remedy the situation.

Public water system purveyors are required to delineate Wellhead Protection Areas and develop Wellhead Protection Programs. Wellhead Protection Areas are defined as the surface and subsurface area surrounding a well or wellfield that supplies a public water system through which contaminants are likely to pass and eventually reach the well(s). Wellhead Protection Areas must be managed by a community in order to protect ground water based drinking water supplies. Research has shown that, when median nitrogen levels are 6 mg/l or greater, 10 percent of nitrate samples will be greater than the 10 mg/l maximum contaminant level. Other communities in the nation have set a limit of 5 mg/l to provide a margin of error and safety.

An analysis of current and future loading will enable planners and public officials to make informed decisions regarding land use and water use. Where current nitrate levels threaten public water supplies, decisions regarding future water supply will need to be made. Such alternatives as development of new drinking water sources or extension of public sewers to a community can be considered. The nitrate loading analysis will also enable planners and public officials to make decisions regarding future land use in a Wellhead Protection Area.

**Implementation:**

**Task 1:** Require that Wellhead Protection Programs for systems serving over 1,000 connections incorporate nitrate loading analysis in determining the level of risk to public water supplies associated with on-site sewage disposal systems and other sources of nitrate.

| | |
|---|---|
| Who: | Management Committee. |
| When: | As per implementation schedule during development of the Well Head Protection Program. |
| Cost: | To be determined. |
| Funding Source: | Aquifer Protection Fund. |

**Task 2:** Collaborate with land use authorities to require alternative methods of sewage disposal where nitrogen levels are found to be unacceptable (more than 5 mg/l).

| | |
|---|---|
| Who: | Management Committee. |

| | |
|---|---|
| When: | After analysis. |
| Cost: | To be determined. |
| Fund Source: | Aquifer Protection Fund. |

**Issue 2 - Hazardous Materials.** Because some types of commercial, industrial, and institutional facilities use or store hazardous materials in their day to day operations or dispose of unregulated, small quantities of hazardous wastes, there may be an opportunity for hazardous materials or wastes to be inadvertently or intentionally discharged to on-site sewage disposal systems serving those types of facilities.

**OS-2A Hazardous Materials:** Seattle-King County Department of Public Health (SKCHD) Environmental Health Division will:

- Inventory commercial, industrial, and institutional facilities served by on-site sewage disposal systems which potentially use, store, or dispose of hazardous materials;
- Educate operators regarding hazardous materials management, and;
- Selectively monitor those facilities that appear to represent a significant risk to ground water quality.

**Discussion:** A number of important programs are being implemented as a result of the Local Hazardous Waste Management Plan for King County. However, those activities are not currently designed to emphasize the unique risks associated with hazardous materials introduced into on-site sewage systems.

Once released to the soil column, hazardous materials or hazardous wastes can potentially migrate to underlying ground water. Since low levels of some hazardous materials in drinking water can pose a high level of risk to human health, even releases of small quantities of hazardous materials to an on-site sewage system can have a profound impact on underlying ground water quality.

The proposed inventory will enable the SKCHD Environmental Health Division to identify facilities that have types and quantities of hazardous substances on premises which would suggest a relatively high risk of their release to an on-site sewage system. Those high risk facilities will be targeted for earliest possible field audits and educational activities under the Local Hazardous Waste Management Plan. The educational activities will provide facility owners and operators with information concerning alternative products, proper hazardous substance storage, handling, recycling, disposal, and spill containment. Should the field audit reveal any facilities where wastewater other than that of residential/domestic quality is being generated, the owner/operator will be referred to the Department of Ecology for possible regulation under the State Waste Discharge Program.

Changes in occupancy of commercial, industrial, and institutional facilities will be carefully monitored by the SKCHD Environmental Health Division and the inventory periodically updated. The SKCHD Environmental Health Division will develop and implement this program within the context of the Local Hazardous Waste Management Plan.

This action should prove moderately effective in limiting the release of hazardous substances to on-site sewage systems serving commercial, industrial, and institutional facilities.

**Implementation:**

**Task 1:** Prepare inventory.

**Task 2:** Educate operators.

**Task 3:** Implement monitoring program.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. Some education of operators is conducted through the Local Hazardous Waste Management Program. |
| When: | As per implementation schedule. |
| Cost: | To be determined. |
| Funding Source: | The costs incurred by the SKCHD Environmental Health Division will be offset by fees collected under the Local Hazardous Waste Management Plan and the Aquifer Protection Fund. |

**OS-2B Hazardous Materials:** The SKCHD Environmental Health Division will:

- Explore legal mechanisms for prohibiting the use and/or sale of products marketed as on-site sewage system additives which are intended to dissolve grease accumulations or to reduce the frequency of sludge removal from the septic tank and

- Prepare regulations for consideration by the King County Board of Health which would prohibit the sale and/or use of such products within the cities and unincorporated areas of King County.

**Discussion:** The SKCHD Environmental Health Division will conduct an assessment of the feasibility of prohibiting the use or sale of septic tank additives that contain chemicals or substances capable of contaminating ground water. Such additives may not only be harmful to underlying ground water but may adversely affect on-site sewage system operation. The feasibility assessment will explore legal mechanisms for such a prohibition, evaluate the potential for adequate enforcement, and identify all associated costs. The potential effectiveness of prohibiting septic tank additives cannot be determined until the feasibility assessment is completed. If it is found to be feasible, SKCHD Environmental Health Division will prepare amendments to Title 13 of the Code of the King County Board of Health.

Implementation:

**Task 1:** Assess feasibility.

**Task 2.** Prepare amendments to Title 13 of the Code of the King County Board of Health.

**Task 3.** Adopt amendments.

| | |
|---|---|
| <u>Who</u>: | Task 1, 2: SKCHD Environmental Health Division is responsible for Tasks 1 and 2; the King County Board of Health is responsible for Task 3. |
| <u>When</u>: | As per implementation schedule. |
| <u>Cost</u>: | 80 hours (SKCHD), $4000. |
| <u>Funding Source</u>: | Aquifer Protection Fund. |

**OS-2C Hazardous Materials:** The SKCHD Environmental Health Division will prepare amendments to Title 13 of the Code of the King County Board of Health to expressly prohibit the use of on-site sewage systems for disposal of any materials or substances other than domestic sewage as defined in WAC 246-272-010 for King County Board of Health consideration.

**Discussion:** Under this action, the SKCHD Environmental Health Division would be requested to prepare amendments to Title 13 to prohibit the discharge of non-domestic wastewater to on-site sewage systems and submit the amendments to King County Board of Health for approval. The primary intent of the alternative is to strengthen SKCHD Environmental Health Division's existing authority to prevent the discharge of non-domestic wastes to on-site sewage systems, particularly wastes containing hazardous materials.

Enforcement of this provision will require careful review of site applications for on-site sewage disposal by the SKCHD Health Environmental Health Division staff. The SKCHD Environmental Health Division should consider requiring discharge monitoring reports from operators of commercial or institutional establishments. Strengthening the regulatory authority for preventing discharges of non-domestic wastewater may assist in enforcement actions.

**Implementation:**

**Task 1:** Prepare amendments to Title 13.

**Task 2:** Adopt amendments.

| | |
|---|---|
| Who: | The SKCHD Environmental Health Division is responsible for Task 1; the King County Board of Health is responsible for Task 2. |
| When: | As per implementation schedule. |
| Cost: | 80 hours (SKCHD), $4000. |
| Funding Source: | Aquifer Protection Fund. |

**Issue 3 - Household hazardous wastes.** Household hazardous wastes can enter the wastewater stream when residues from cleaning and paint products or quantities of unwanted chemical substances are poured into a sink or toilet for disposal. When discharged to an on-site sewage system, household hazardous wastes may pass through the system and migrate to underlying ground water. While wastes from any single residence are not likely to have detectable impacts on underlying ground water, the cumulative effects of many residences may be significant. Many people are unaware that common household products often contain chemical compounds that can represent an environmental or even public health hazard if improperly handled.

> **OS-3A Household Hazardous Wastes:** The SKCHD Environmental Health Division will emphasize the risks to ground water associated with the disposal of household hazardous wastes to on-site sewage systems when conducting household hazardous waste educational activities as part of the Local Hazardous Waste Management Plan.

**Discussion:** Seattle-King County Department of Public Health Environmental Health Division will undertake measures to increase public awareness concerning the potential impacts of discharging household chemical products to an on-site sewage system. Such measures will be an extension of activities scheduled as part of the Local Hazardous Waste Management Plan.

**Implementation:**

**Task 1:** Conduct educational activities

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | As part of ongoing Local Hazardous Waste Management Program. |
| Cost: | To be determined. |
| Funding Source: | Local Hazardous Waste Management Program fees. |

> **OS-3B Household Hazardous Waste:** The SKCHD Health Environmental Health Division will develop and carry out a public education program intended to increase the awareness of proper on-site sewage system operation and maintenance, including

the risks associated with disposal of hazardous wastes in such systems.

**Discussion:** This will be included in the overall Ground Water Management Plan education program. One item that has been identified to be done for this action is that prior to any scheduled reprinting, the existing public information pamphlet concerning on-site sewage system maintenance and operation will be amended to provide instructions concerning proper household hazardous waste disposal practices.

**Implementation:** Discussed in Education Section.

**Issue 4 - Operation and Maintenance.** Homeowners may not be aware of the location and proper operation and maintenance of on-site sewage disposal systems.

> **OS-4A Operation and Maintenance:** The SKCHD Environmental Health Division will prepare amendments to Title 13 of the Code of the King County Board of Health for consideration by the King County Board of Health to require that the as-built on-site sewage disposal system plan be recorded with the property deed in order that it be transferred with the title at the time of property purchase. In addition, information concerning the relationship between on-site system maintenance and operation practices and ground water protection should be added to the standard as-built plan form.

**Discussion:** Under this action, the SKCHD Environmental Health Division will prepare amendments to Title 13 concerning recording of as-built plans and will submit the amendments to the King County Board of Health for approval. An as-built plan is a scale drawing of an on-site sewage disposal system as it is actually installed at a construction site. It is submitted to the SKCHD Environmental Health Division by the designer after construction is completed.

The as-built plan serves the important function of providing a detailed record of the location and configuration of the on-site sewage system at a site. The standard as-built form of the SKCHD Environmental Health Division also provides information concerning general maintenance and operation of the system, such as recommended frequency of septic tank pumping. That information could be expanded to include information concerning household hazardous waste disposal practices.

Currently, there is no requirement for the home builder or first owner to provide the as-built plan to subsequent owners of a home. By requiring the as-built to be recorded with the deed, the as-built would be provided automatically to subsequent owners with the title report.

This action should be highly effective in ensuring that critical information concerning the location and configuration of the on-site sewage system is transferred to a home purchaser. It also affords an opportunity to transmit information concerning proper on-site sewage system maintenance and operation. Recording of the as-built will result in nominal cost to the initial homeowner. No significant obstacles to implementation are anticipated.

**Implementation:**

**Task 1:** Prepare amendments to King County Board of Health Title 13.

**Task 2:** Adopt amendments.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division is responsible for Task 1; King County Board of Health is responsible for Task 2. |
| When: | As per implementation schedule. |
| Cost: | 80 hours (SKCHD), $4000. |
| Funding Source: | Aquifer Protection Fund. |

**OS-4B Operation and Maintenance:** The SKCHD Environmental Health Division will evaluate a county-wide on-site sewage system management program to determine its potential effectiveness in protecting ground water.

**Discussion:** The SKCHD Environmental Health Division will conduct a feasibility assessment concerning the effectiveness of a county-wide on-site sewage system management program in protecting ground water quality. The purpose of an on-site sewage system management program is to help ensure proper operation and maintenance of on-site sewage systems. Historically, a was considered to have failed if sewage backed up into the house, or sewage surfaced on the ground. These types of failures usually affected human health (by direct contact) and surface water quality. Systems that affect ground water quality do so by subsurface infiltration of poorly treated wastewater to underlying ground water, in essence, a failure in treatment efficiency. This type of impact should be minimized by the on-site sewage regulations which require enhanced treatment in those soils that do not provide adequate contaminant attenuation (Type 1 soils). It is unclear as to how an on-site system management program could help prevent or remedy subsurface, treatment efficiency failures; consequently, it will be important to addressed this issue.

**Implementation:**

**Task 1:** Conduct a feasibility assessment concerning the effectiveness of a county-wide on-site sewage system management program on ground water quality.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | As per implementation schedule. |
| Cost: | 0.5 FTE, $52,200/yr. |
| Funding Source: | Aquifer Protection Fund. |

**Issue 5 - On-Site Regulations.** The adoption of the Water Quality Standards for Ground Waters of the State of Washington, Chapter 173-200 WAC, by the Department of Ecology in October of 1990 has created concerns over whether the existing Regulations of the State Board of Health for On-Site Sewage Disposal (Chapter 246-272 WAC) and Title 13 are consistent with the provisions of those new standards.

**OS-5 On-Site Regulations:** Encourage efforts by Ecology and the Department of Health to:

- Evaluate the effects of on-site sewage disposal systems on ground water, and
- Determine best available technology for on-site sewage disposal which meets the intent of the Water Quality Standards for Ground Waters of the State of Washington, WAC 173-200.

**Discussion:** In regulating on-site sewage system use, state and local health agencies have attempted to ensure that contamination associated with the use of those systems will not result in contamination levels that will adversely affect either the beneficial use of underlying ground water or public health. With the passage of the Ground Water Quality Standards, the traditional approach of the health agencies must now be reconciled with the Ecology focus of preventing any significant deviation of ground water quality from natural quality.

The specific effects of on-site sewage systems on underlying ground water should be carefully studied and explicit guidelines developed concerning the best reasonable available technology.

Guidance concerning the interpretation of the Ground Water Quality Standards will help ensure that application of on-site sewage disposal system technology is consistent with the State's Anti-degradation Policy.

Costs associated with this alternative are primarily limited to Ecology and Washington State Department of Health staff time. However, special field studies of on-site sewage system performance may need to be conducted to provide reliable data on which to base the guidance.

**Implementation:**

Task 1: Develop a funding plan to support preparation of the guidelines and conducting field studies of on-site sewage system performance.

<u>Who</u>: Ecology and Washington State Department of Health.
<u>When</u>:
<u>Cost</u>: TBD

Fund Source: General Agency Funds.

### 3.3.4. Ground Water Quality Issues Related to the Use of Pesticide and Fertilizer

Pesticides and fertilizers are used for the control of plant and animal pests and promotion of plant growth. Pesticides are a large and varied group of substances that are specifically designed to kill biological organisms including weeds, insects, and rodents. Fertilizer is used to promote plant growth. Pesticides and fertilizers are in widespread, everyday use. The major categories of use are home, right-of-way (ROW) maintenance, agriculture, and forestry. Pesticides and fertilizer have the potential to contaminate ground water when they are used improperly.

Home use accounts for approximately 20 percent of pesticide use in the Puget Sound region. Unlike licensed pesticide users, homeowners are not trained in proper application procedures or to diagnose whether a particular pesticide is needed; thus, they are more likely to use them improperly. The use of fertilizer and pesticides by non-agricultural users will likely increase as the population of King County continues to grow.

A variety of entities use herbicides for right-of-way maintenance. These include county public works, electric companies, Washington State Department of Natural Resources, railroads, natural gas companies, and oil pipeline companies. Right-of-way maintenance typically involves a combination of herbicide use and physical vegetation control methods such as mowing. For example, Puget Power maintains low-growing plant communities under their power lines by using a combination of chemical and physical plant maintenance techniques. The King County Department of Public Works practices chemical weed control on road shoulders.

In rural areas, agricultural activities are likely to represent the greatest threat to ground water quality. Past agricultural activities, before current federal and state pesticide regulations were in place, may have contaminated ground water. In addition, current agricultural practices, especially by small farms, may not adequately protect ground water.

The current regulations, programs, and practices may be adequate to protect ground water. There has not been a reported incident of ground water contamination related to pesticide or fertilizer practices in King County. However, in depth monitoring of ground water quality in King County has not yet been accomplished. Ground water contamination related to pesticide and fertilizer use may not have been reported because, in the past, monitoring efforts were not oriented towards collecting samples from locations most likely to be affected by pesticides and fertilizers, the expense for this analysis was prohibitive, and laboratories did not have the capability to analyze for many of the pesticide compounds.

Monitoring and research programs are difficult to design because there is little accurate information about the types of compounds used in the region and the patterns of use. The

Ground Water Management Plan included pesticide and fertilizer components in the ground water quality sampling program to characterize the aquifer(s). Additional work through an ongoing program is needed to evaluate the effect of pesticides and fertilizer on ground water quality.

Small farms may need assistance to ensure that their practices do not contaminate ground water. National and local programs which have looked at agricultural related water quality problems have found that a cooperative effort between agriculture, educators, and regulators is the best approach. The primary local cooperative effort is through the King County Conservation District. The District's goal is to lend technical assistance and education to the agriculturalist. The District:

- Trains landowners regarding best management practices to improve water quality and to increase productivity;

- Provides technical assistance to landowners who are developing farm management plans on their own initiative or who have been required to develop a plan by Department of Ecology (Ecology) in lieu of an enforcement action; and

- Develops local education and information programs on soil and water conservation.

The District boundaries include all of unincorporated King County as well as any incorporated areas that have been annexed into the District. The Conservation District depends on funding from outside sources such as King County, Ecology, Washington Conservation Commission, and private groups.

While primary focus is placed on large, commercial farms, the Conservation District also helps part-time farmers manage small acreage operations. Management practices can be implemented individually or as components of integrated farming systems, known as Farm Conservation Plans. A Farm Conservation Plan is a comprehensive plan for managing farm resources to protect the quality of the environment and maintain economic viability of the farm. Farm Plans integrate best management practices to protect ground water quality into a comprehensive resource protection plan designed for the individual farm. Each plan is adapted to the individual farm by the person who runs the farm with the assistance of a soil conservationist from the Conservation District. Alternative methods of overcoming problems and making better use of soil, water, and plant resources are addressed in the farm conservation plan. The landowner is allowed to make all of the implementation decisions. Since farm conservation plans are developed with the farmers input, this is primarily a voluntary educational approach and is currently not mandatory.

However, the Puget Sound Water Quality Management Plan Non-Point Source Pollution Program (see below) favors the use of farm conservation plans is the preferred approach to controlling pollution from both commercial and noncommercial farms.

The Washington State Department of Agriculture. The Washington State Department of Agriculture is the state agency with primary authority over pesticide and fertilizer sale and use through Chapter 15.54 RCW, Chapter 15.58 RCW, and Chapter 16-228 WAC.

Chapter 15.54 RCW, the Washington Commercial Fertilizer Act, requires that commercial fertilizer distributors report twice yearly to the Washington State Department of Agriculture regarding the net tons of fertilizer they distribute in Washington. Chapter 15.58 RCW, the Washington Pesticide Control Act, requires that pesticide dealers and private and public pest control consultants must be licensed. Licensees must demonstrate knowledge of pesticide laws and hazards, and their safe distribution, use, application, and disposal. Additionally, licensees may be required to keep records including quantity of pesticides, dates of shipments and receipt, name of consignor and consignee, and any other information requested by Washington State Department of Agriculture.

Chapter 16-228 WAC, the Rules Relating to General Pesticide Use, require record keeping by pesticide dealers regarding the sale of restricted use pesticides; the distribution of pesticides, except those labeled for home and garden use only; and the distribution of state restricted use pesticides. Certified applicators must keep records of application sites. These records must be provided to the Director of the Department of Agriculture upon request.

The Department of Agriculture conducted the Record Database Pilot Project to explore the feasibility of using pesticide application records in a state geographic information system. That project approximated requesting and cataloguing the information that commercial fertilizer dealers, pesticide dealers, and certified applicators are required to keep. Because the data request was voluntary, the data received did not represent a complete summary of all pesticides applied. Several major applicators, such as railroad, right-of-way, and a few commercial farms did not submit records. Most homeowner use in urban areas also was not part of the database as record keeping is not required. In general, the Department of Agriculture found that a general application data request was very expensive and time consuming. Those individuals and businesses that have been required to maintain records for a number of years were able to complete the information required in a reasonably accurately manner. Hobby farmers and individuals who have not been required to keep records in the past had difficulty. Most records submitted required staff analysis before the data could be entered. Only about six or seven records per hour could be entered into the computer data base. Since record requests can involve thousands of applications, current staff could not effectively handle the data. Use of the geographic information system was shown to be feasible if the initial data request is limited to specific sites or specific pesticides.

Washington State University Cooperative Extension Service. The Cooperative Extension Service is part of the state higher education system. It develops and implements a broad range of educational programs and resource materials. Specific programs have been developed relating to pest and nutrient management for homeowners, recreational areas, and crop and livestock production. The Cooperative Extension Service provides technical assistance in selecting and implementing "Best Management Practices" and integrated pest management systems for specific sites and circumstances. It also provide training to private and commercial pesticide applicators to prepare them for licensing and recertification exams.

The Pesticide Reduction Program is a grant project administered by the Cooperative Extension Service. This prevention education program emphasizes proper diagnosis of plant problems and advocates alternatives to the use of pesticides. The program is targeting residents and businesses in the Green-Duwamish and Cedar River watersheds during the period January 1992 to December 1994. This project could be applied to Ground Water Management Areas, if it is found to be effective in reducing pesticide and fertilizer impacts on ground water.

Washington State Department of Ecology. The Washington State Department of Ecology (Ecology) has coordinated a multi-jurisdictional effort to address impacts on ground water from pesticide and fertilizer use. This effort has produced the *Protecting Ground Water: A Strategy for Managing Agricultural Pesticides and Nutrients* (April 1992) which is referred to as the "State Strategy." The state strategy is intended to provide support and direction to agencies and the agricultural community in their efforts to protect and preserve ground water quality in rural areas. The focus of the state strategy is on protection of ground water rather than remediation. It identifies and supports activities and programs to prevent contamination and will allow both the agricultural community and involved agencies to make best use of resources.

Puget Sound Water Quality Authority. The Puget Sound Water Quality Authority created the comprehensive Puget Sound Water Quality Management Plan. The 1991 plan update proposed that pesticide surveys be conducted in the Puget Sound Basin and that an pesticide use educational program be developed targeting urban and suburban residents. These proposed actions were included as two new elements in the non-point source pollution section addressing water quality impacts from pesticides.

- **Pesticide Usage Surveys in Selected Watersheds (NP-16)**: Cooperative Extension will be the lead to design pilot pesticide usage survey for selected watersheds in the Puget Sound Basin. Cooperative Extension shall include appropriate agencies, scientists and local governments in designing and conducting the surveys. The surveys should define spatial and temporal use patterns; focus specifically on pesticides of concern in the watershed; include information from all major users, including homeowners; and identify storage and disposal practices.

- **Puget Sound Pest Management Information Program (NP-17)**: Cooperative Extension will be the lead to establish this program by designing and implementing program activities with an advisory group. The program will work through existing programs and groups to conduct research and education on integrated and targeted pest management and to promote conservative use of pesticides, particularly by local governments and homeowners.

Educational activities, although currently extensive, may not fully reflect the threats to ground water from the use of pesticides and fertilizer, or the means by which those threats can be reduce. A variety of education programs are currently underway which could be evaluated and augmented with information on the relationship between pesticide and fertilizer use and ground water quality. Those programs include the extensive activities of the Cooperative Extension Service.

The 1991 plan update described two educational programs operated by the Cooperative Extension Service relating to pesticide use:

- **Information and Education on Less-Toxic Alternatives for Household Products**: Cooperative Extension will work with others to make information and training available to promote targeted and proper use and disposal of pesticides as part of the implementation of the local hazardous waste plans. Cooperative Extension will consult with other groups on the type of information and program needed.

- **Puget Sound Pest Management Information Program**: Cooperative Extension will act as the lead to establish a Puget Sound Pest Management Information Program. Cooperative Extension will design and implement program activities with an advisory group. The program will work through existing programs and groups, including the King County Roads Division program on integrated pest management, to conduct research and education on integrated and targeted pest management, and to promote conservative use of pesticides, particularly by local governments and homeowners.

In summary, more control over pesticide and fertilizer impacts on ground water is possible. This would involve utilizing current technology to target the areas that could benefit most from increased education or regulation. Technology is available in King County to determine ground water susceptibility and vulnerability to pollution. Susceptibility depends upon the overlying soil characteristics. Vulnerability depends on the presence of contaminants at the surface. It is also possible to match the chemical characteristics of pesticides and fertilizers to the soil's capability to absorb and/or degrade them. Ground water monitoring efforts could then be designed to target predicted pesticides and fertilizers in specific, vulnerable portions of aquifer systems.

## GOAL

To prevent ground water contamination from the use of pesticide and fertilizer.

## ISSUES

**Issue 1 - Pesticide and Fertilizer Use.** Use of pesticides and fertilizer may pose a threat to ground water quality.

> **PF-1A Pesticide and Fertilizer Use:** King County and cities will fund the King County Conservation District to develop Farm Plans for any agricultural user (including small hobby or homeowner farms) of pesticide and fertilizer in aquifer protection areas.

**Discussion:** The cumulative impact from large numbers of small farms can be substantial. As more land is developed on the border between urban and rural zones, more small hobby farms are being created. Various agencies provide training on best management practices and integrated pest management, but hobby farmers are not required to participate. They often do not have the time, or do not know about opportunities to learn about best management practices and integrated pest management. Farm plans include best management practices and integrated pest management for a variety of farming activities, including pesticide and fertilizer use. Farm plans would provide a mechanism for direct education of the hard-to-reach pesticide and fertilizer users, particularly the hobby farmer.

After the aquifer recharge areas are identified, King Conservation District would follow-up by identifying and contacting all of the small farms that would be affected. The district would then work with owners and operators of those farms to develop conservation plans. The King Conservation District has an administrative framework in-place for this program; however, they do not have assigned funding. This effort would require additional funding from their outside sources, such as King County and cities.

**Implementation:**

**Task 1:** Estimate how many farm plans are needed and how much funding is necessary.

**Task 2:** Include funding for this program in the King Conservation District budget.

**Task 3:** Contact farms and prepare farm plans.

| | |
|---|---|
| Who: | King Conservation District would be responsible for Tasks 1 and 3. |
| When: | As per implementation plan. |
| Cost: | To be determined during concurrence. |
| Funding Source: | Aquifer Protection Fund. |

| | |
|---|---|
| Who: | King County and cities that support the King Conservation District would be responsible for Task 2. |
| When: | As per implementation plan. |
| Cost: | To be determined during concurrence. |

Funding Source: Special Assessment fee.

**PF-1B Pesticide and Fertilizer Use:** King County and cities will evaluate the Cooperative Extension Pesticide Reduction Program for effectiveness for protecting ground water and applicability to the Ground Water Management Areas.

**Discussion:** The Cooperative Extension Pesticide Reduction Program emphasizes proper diagnosis of plant problems and advocates reduced pesticide use. It is targeting homeowners, commercial pesticide applicators, and nursery operators in the Green-Duwamish and Cedar River watersheds during the period January 1992 to December 1994. King County and cities (the Management Committee) would evaluate its effectiveness and possible applicability for implementation in other areas of the county, particularly Ground Water Management Areas. This evaluation would be conducted with the Cooperative Extension Service. The Management Committee must also determine funding needs and sources. A potential funding source would be from development fees assessed as mitigation for non-point source pollution.

**Implementation:**

**Task 1:** Evaluate Program.

**Task 2:** Determine if program is applicable to Ground Water Management Areas.

**Task 3:** Determine funding sources.

**Task 4:** Design and implement program in Ground Water Management Areas.

Who: Task 1 will be conducted by Cooperative Extension.
When: At end of program.
Cost: No additional cost, the evaluation is included in the program.
Funding Source: No funding is necessary.

Who: Task 2 - 4 will be conducted by Management Committee (SKCHD staff).
When: At end of program.
Cost: $8000.
Fund Source: Aquifer Protection Fund.

**PF-1C Pesticide and Fertilizer Use:** For road and utility rights-or-way in sensitive aquifer recharge areas, King County and cities will use non-chemical vegetation maintenance practices or will use only chemicals which, when approved application methods are used, do not pose a threat to ground water quality. King County and cities will determine if maintenance practices by other parties for roads and utility rights-or-way in sensitive aquifer recharge areas need to be restricted to non-chemical methods or non-leaching chemicals. King County and cities will encourage similar practices in non-critical aquifer recharge areas.

**Discussion:** The improper use of vegetation management chemicals could have a detrimental effect on ground water. Some public and private agencies and utilities are decreasing or eliminating use of leachable chemicals and are actively researching alternative vegetation control methods. However, some agencies and utilities have not followed this trend. These agencies and utilities are not easily reached through existing educational programs. This would be a preventative, not remedial, action as there has been no documented case of ground water pollution from chemical management of vegetation.

Research into alternatives to chemical use would involve a variety of agencies and utilities including the Washington State Department of Transportation, Washington State Parks and Recreation Commission, Burlington Northern, Weyerhauser and other forest owners, and public and private utilities.

**Implementation:**

**Task 1:** Adopt ordinance/policy that only non-chemical vegetation maintenance or non-leaching chemicals be used for Rights-of-Way maintenance.

**Task 2:** Research practices by other organizations.

**Task 3:** Determine if prohibition is needed based upon research.

| | |
|---|---|
| Who: | Task 1 would be conducted by King County and cities. |
| When: | As per implementation plan. |
| Cost: | 320 hours (SKCHD), $16,000. Cities would have personnel costs associated with adoption of an ordinance or policy. There may be increased costs associated with these methods. |
| Funding Source: | Aquifer Protection Fund. |

| | |
|---|---|
| Who: | Task 2 and 3 would be conducted by King County and cities (Management Committee). |
| When: | As per implementation plan. |
| Cost: | To be determined during concurrence. |
| Funding Source: | Aquifer Protection Fund. |

**Issue 2 - Education and Proposed Programs.** Many issues concerning the use of fertilizers and pesticides are best addressed by Ecology's State Strategy and the *Puget Sound Water Quality Management Plan* and various associated educational efforts. Implementation of many of the programs outlined in the State Strategy and the Puget Sound Water Quality

Management Plan depend upon funding from the Washington State Legislature and other sources. Existing educational efforts may not stress the need for ground water protection or reflect the goals of the Ground Water Management Plan.

> **PF-2A Education and Proposed Programs:** The Redmond-Bear Creek Valley Ground Water Advisory Committee supports the strategies enumerated in Ecology's *Protecting Ground Water: A Strategy for Managing Agricultural Pesticides and Nutrients* (April 1992) and the 1991 *Puget Sound Water Quality Management Plan* (HHW-2: Information and Education on Less Toxic Alternatives for Household Products and NP-17: Puget Sound Pest Management Information Program) to help insure that operators of small farms and homeowners receive more information about pesticide and fertilizer use.

**Discussion:** The State Strategy and the *Puget Sound Water Quality Management Plan* address use of pesticide and fertilizer on a statewide basis. Since they are statewide strategies, they are not specific to King County, but they do attempt to attain similar ground water protection goals as the Ground Water Management Plan. They provide an overall back-drop to development of local programs and provide guidance to developers of local non-point pollution control plans, Wellhead Protection Programs, and Ground Water Management Plans. These strategies would benefit from recognition and support in the Ground Water Management Plan.

**Implementation:**

**Task 1:** The Ground Water Management Plan states that the State Strategy and the 1991 *Puget Sound Water Quality Management Plan* will be supported.

| | |
|---|---|
| Who: | The Redmond-Bear Creek Valley Ground Water Advisory Committee. |
| When: | During preparation of the Draft Ground Water Management Plan. |
| Cost: | There is no additional cost associated with this action. |
| Funding Source: | A funding source will not be necessary. |

> **PF-2B Education and Proposed Programs:** The content of existing educational programs will be reviewed for agreement with Ground Water Management Plan policies and goals. The Seattle-King County Department of Public Health (SKCHD) Environmental Health Division will review the current educational programs of the Soil Conservation Service, the Cooperative Extension Service, and others to ensure that the Ground Water Management Plan goals and policies are reflected. This will be conducted as part of the Ground Water Management Plan Education Section.

**Discussion:** Prevention of pollution is the best approach from the standpoint of cost and environmental impact. Education is the best method of prevention because it creates an awareness and concern in individuals which influences their decisions. The SKCHD

Environmental Health Division will seek the cooperation of the parties involved to include ground water information and concerns in the existing educational programs. This review will ensure that the Ground Water Management Plan goals and policies are reflected. The Cooperative Extension Service has several educational efforts underway. They integrate ground water protection information where possible and are agreeable to including more information relating to ground water protection. The Cooperative Extension Service, Soil Conservation Service, and other involved agencies could reflect Ground Water Management Plan concerns in their educational material.

Developing an independent educational program to address this issue would probably be largely redundant. It would not likely be supported financially by elected officials in a time of limited budgets. We can use scarce resources more efficiently by reviewing and updating existing programs. Funding for staff at the SKCHD Environmental Health Division is necessary to carry out the review, coordination, report preparation, and development of a supplemental program, if needed. It is possible that enhancing existing programs will require that funds be provided to the relevant agency or jurisdiction responsible for administering the program.

**Implementation:** As per the Education Section, Chapter 3.

3.3.5. Ground Water Quality Issues Related to Well Construction and Abandonment

Wells provide a link between an aquifer and the earth's surface. Modern wells consist of a well casing that extends downward from the ground surface to the aquifer within a cylindrical bore hole. The Minimum Standards for Construction and Maintenance of Wells, Chapter 173-160 WAC, requires that the space between the casing and the wall of the bore hole be sealed to prevent vertical movement of water along the outside of the casing. If this space is not adequately sealed, it may serve as a conduit by which contaminated surface or subsurface water may travel into an aquifer.

Under WAC 173-160, any well that is unusable, whose use has been permanently discontinued, which is in such disrepair that its continued use is impractical, or is an environmental, safety, or public health hazard, must be abandoned. The principal objective of proper abandonment procedures is to restore, as far as possible, the original hydrogeologic conditions at the well site. Proper abandonment procedures entail sealing the well in such a way that water is excluded from the well and no vertical movement of water is possible. An improperly abandoned well may serve as a conduit for contaminated ground or surface water, permit continued flow of water to the surface from an artesian aquifer, alter the pressure conditions within a confined aquifer, or present a physical hazard at the surface.

Resolving the issue of potential aquifer contamination by improper well construction and abandonment involves ensuring that existing regulations pertaining to construction and abandonment are followed. The Department of Ecology (Ecology) is the agency responsible for regulating well construction and abandonment by administering the state's minimum standards. However, Ecology has sufficient work force and budget to inspect only a fraction of the wells constructed and abandoned each year. Because of Ecology's budgetary limitations, well construction and abandonment is largely self-policed by well owners and contractors. Also, prior to 1973, Ecology did not require well contractors or owners to submit well logs. As a result, an unknown number of wells exist in the state without any record and, therefore, cannot be evaluated for compliance with current regulations.

In response to these and other concerns, in 1992, the State Legislature passed Substitute House Bill (SHB) 2792 which authorized Ecology to delegate authority to administer and enforce the well sealing and decommissioning portions of the water well construction program to local health districts or counties. Utilizing the expertise and work force of the local health jurisdictions may assist in ensuring that wells are constructed and abandoned properly.

## GOAL

To protect the ground water resource in King County by ensuring that proper well construction and abandonment procedures are followed.

## ISSUES

**Issue 1 - State Program.** Existing regulations for well construction and abandonment are not adequately enforced. Ecology does not receive enough funding to inspect more than a small percentage of wells during construction or abandonment.

> **WC-1A State Program:** Ecology, King County, and cities will continue to pursue sufficient funding for a complete well construction and abandonment program.

**Discussion:** Ecology is not focusing on well construction and has been operating the program at a minimal level due to lack of funding. Ecology tried to obtain the needed funding by proposing legislation to provide funding from increased fees for licensing, start cards, water right applications, and enforcement penalties. This proposed legislation was not approved.

Ecology will continue its efforts to increase funding for these programs, including presenting legislation. Ecology will call upon the Ground Water Advisory Committees, including King County and cities, for support for the legislation. This could include phone calls, letters ,and/or testimony to the state legislators. If legislation is passed, Ecology could then hire staff to adequately implement the well program.

**Implementation:**

**Task 1:** Develop and submit legislation, with input from affected parties.

Who: Ecology.
When: Year __.
Cost: $70,000.
Funding Source: Agency General Funds.

**Task 2:** Support proposed legislation.

Who: King County and cities.
When: After legislation is presented.
Cost: Probably minimal, to be determined during concurrence. No additional cost to City of Redmond.
Funding Source: Agency General Funds.

**WC-1B State Program:** King County and Ecology will develop a local health department program for implementation of the delegated portion of the well construction and abandonment program in King County.

**Discussion:** Delegation of portions of a state program to the local health department has been demonstrated to be a dynamic method of ensuring that public health concerns are safeguarded, as demonstrated by the local health department/Washington State Department of Health programs for on-site sewage disposal and small public water systems. A partnership between local and state government could provide a greater degree of protection for public health than the current state program, because local health departments are closer to the public and see more problems on a day-to-day basis than does Ecology.

Seattle-King County Department of Public Health (SKCHD) Environmental Health Division would work with Ecology to develop a joint program. This will include demonstrating that King County possesses the necessary expertise to undertake the program and adding the program to the SKCHD Environmental Health Division budget. The local program would include well identification tagging. Ecology would continue to perform the administrative aspects of the program, such as well driller licensing and instruction, well log review and record-keeping, providing technical information and training to the local health department, and undertaking enforcement procedures, when necessary.

**Implementation:**

**Task 1:** Develop and implement program.

Who: Ecology and SKCHD Environmental Health Division.
When: Year __.
Cost: SKCHD: $52,200. Ecology: $70,000.

Funding Source: Aquifer Protection Fund.

**Issue 2 - Well Identification.** Wells need to be identified so that Ecology may implement their programs to protect the ground water resource. There is no method to systematically identify wells. Wells that were drilled before 1973 were not required to submit well logs to Ecology, and there is no program to identify wells that should be abandoned.

> **WC-2A Well Identification:** King County and cities will require sellers to disclose to buyers the existence of used or unused wells on their property. Ecology will prepare draft legislation to require sellers to disclose to buyers the existence of used or unused wells on their property.

**Discussion:** King County Planning estimates that, on the average, a residence is sold every five years. This disclosure requirement could identify a significant number of unknown wells. Buyers will be notified using a coordinated disclosure form which could encompass other environmental, health, and safety concerns in addition to well abandonment and identification. The form will notify buyers that unused or unusable wells, or wells presenting an environmental, safety, or public health hazard are required to be abandoned according to procedures outlined in Chapter 173-160 WAC. It will also state that wells are legally required to be tagged with a well identification number. The disclosure form will indicate whether abandonment has been performed according to requirements. Identification numbers for wells on the property, if available, will be provided on the form. The cost for this evaluation would be borne by the parties to the transaction.

Submittal of the disclosure form would result possible response from Ecology, the Washington State Department of Health, and/or the SKCHD Environmental Health Division; however, response could be slow, given the current funding of their programs. Ecology would oversee the abandonment of wells or delegate this to the SKCHD Environmental Health Division. The Washington State Department of Health and SKCHD Environmental Health Division would enforce existing regulations on any unapproved public water supply wells that are found.

Ecology would develop similar legislation. Upon approval of the legislation, Ecology will draft rules providing a state-wide disclosure form. In drafting these rules, Ecology will invite broad-based participation of appropriate agencies and affected parties. It is also requested that, in carrying out this task, Ecology and the Department of Health consider the possibility of enforcement techniques, such as withholding conveyance of title until compliance with the disclosure requirements.

**Implementation:**

**Task 1:** Prepare and pass an ordinance or policy which will require sellers to disclose to buyers the existence of used or unused wells on their property.

| | |
|---|---|
| Who: | King County and cities. |
| When: | Year __. |
| Cost: | King County 160 hours, $8000; City of Redmond will not incur additional expense; final costs to be determined during concurrence. |
| Funding Source: | Aquifer Protection Fund. |

**Task 2:** Prepare legislation

| | |
|---|---|
| Who: | Ecology. |
| When: | Year __. |
| Cost: | To be determined. |
| Funding Source: | General Agency Funds. |

**WC-2B Well Identification:** King County and cities will require that applicants establish the location and status of wells present on their property when that property is the subject of State Environmental Policy Act review, rezone applications, and/or land use permit applications. King County and cities will provide this information to Ecology.

**Discussion:** One reason that well identification is needed is to determine if a well should be abandoned. Proper abandonment procedures entail sealing the well in such a way that water is excluded from the well and no vertical movement of water is possible. By having applicants provide information as to status, more wells could be evaluated. Status is defined by whether the well is currently in use, what it is used for, and the apparent construction method.

King County involvement in identifying wells in need of proper abandonment is already in effect on an informal basis. This alternative would formalize the county's involvement while also encouraging community involvement and education. The discovery of unused wells during land development activities is fairly common. Granting of a rezone or permit would be contingent upon unused wells being properly abandoned and active wells being tagged with an identification number and entered into Ecology's well inventory. By requiring that applicants for rezones and land use permits demonstrate that the property has been examined for wells and that existing wells are in compliance with the standards specified in Chapter 173-160 WAC, King County and cities could help narrow a regulatory gap. The cost of these requirements would be passed on to the applicants for rezones and permits. Follow-up on the status report would be accomplished by the SKCHD Environmental Health Division delegation program.

**Implementation:**

**Task 1:** Develop ordinance or policy/procedure change as needed for each application type.

**Task 2:** Implement policy/procedure and new regulations.

**Task 3:** Provide information to Ecology.

| | |
|---|---|
| Who: | King County and cities. |
| When: | Year __. |
| Cost: | King County 160 hours, $8000; City of Redmond will not incur additional expense; final costs to be determined during concurrence. |
| Funding Source: | Aquifer Protection Fund. |

**Task 4:** Enter new information into records

| | |
|---|---|
| Who: | Ecology. |
| When: | Year __ (to be determined during concurrence). |
| Cost: | Year 1, $17,000; Year 2, $35,000. |
| Funding Source: | Agency general funds. |

**Issue 3 - Abandonment cost.** Improperly abandoned wells may become a conduit for contamination to an underlying aquifer. Abandonment costs may discourage property owners from disclosing improperly abandoned wells.

> **WC-3A Abandonment cost:** King County will explore the possibility of creating a funding mechanism for abandonment of wells identified through the property owner disclosure program.

**Discussion:** The Management Committee will decide if the Aquifer Protection Fund could be used for this purpose and whether to include this proposed action in the work program. The SKCHD Environmental Health Division will provide a report to the Management Committee on feasibility and cost. The SKCHD Environmental Health Division report will be based on the information disclosed through other actions.

**Implementation:**

**Task 1:** Report to Management Committee on feasibility of providing money for well abandonment.

**Task 2:** Determine if Aquifer Protection Fund could support this, and to what extent.

**Task 3:** Revise Ground Water Management Plan if necessary.

| | |
|---|---|
| Who: | Task 1, SKCHD Environmental Health Division. |
| When: | Year __. |
| Cost: | To be included in SKCHD Environmental Health Division work |

| | |
|---|---|
| | program, 0.125 FTE, $13,050. |
| Funding Source: | Aquifer Protection Fund. |

| | |
|---|---|
| Who: | Task 2 and 3, Management Committee. |
| When: | Year __. |
| Cost: | This will be part of Management Committee tasks. |
| Funding Source: | Aquifer Protection Fund. |

**WC-3B Abandonment cost:** During revision of Chapter 173-160 WAC, Ecology will consider alternatives to present requirements for well abandonment procedures that are cost effective, appropriate to the well's hydrogeology, and would protect public health.

**Discussion:** There is interest within Ecology to consider alternatives to the current regulations for well abandonment which may be costly for some well owners. Ecology may consider alternatives during revision of Chapter 173-160 WAC, which details the required abandonment methods.

**Implementation:**

**Task 1:** Consider alternatives to current abandonment procedure.

| | |
|---|---|
| Who: | Ecology. |
| When: | During next revision of Chapter 173-160 WAC. |
| Cost: | $15,000 over two years. |
| Funding Source: | Agency general funds. |

**Issue 4 - Education.** There is a lack of general public knowledge about the public health significance of the requirements for well construction, operation, maintenance, and abandonment.

**WC-4 Education:** The Ground Water Management Plan Education Program will coordinate with and support Ecology's efforts in well identification, well construction, well maintenance, contamination sources, and proper well abandonment.

**Discussion:** Informed and involved well owners and other community members are probably more likely to comply with the well construction and abandonment regulations than they would be otherwise. Ways to inform and involve well owners might include distribution of a questionnaire about wells to homes in the community; developing and distributing an educational brochure for homeowners; and supplementing the brochure with community educational programs. The questionnaire should be designed to elicit information regarding the number of wells on each property, the construction methods used, and the number of wells that require abandonment. The brochure should include recommended practices and legal requirements for well construction and abandonment. It should also include the reasons why practices such as sealing the well are both advisable and required by law so that homeowners are knowledgeable before they make plans to construct or abandon a well. The education program should cover the same information and provide the public with an opportunity to ask individual questions.

**Implementation:** This will be included in the Education Section, Chapter 3.

3.3.6. Ground Water Concerns Associated with Sewer Pipes

Sewage collection and treatment in King County is provided by the King County Department of Metropolitan Services (Metro), cities, and water and sewer districts. Wastewater is carried from homes and businesses through side sewers which are connected to a system of tributary sewers (or "trunk sewers") within the drainage area. Trunk sewers are connected to interceptors which transport the wastewater to treatment plants. In King County, there are approximately 3,000 miles of sewer pipe with approximately 150 million gallons of wastewater received at wastewater plants throughout the county each day.

Currently, all sewer pipes in King County are fabricated from polyvinyl chloride (PVC), a strong, durable material that is virtually leak-free. However, prior to the use of polyvinyl chloride, sewer pipes were made from materials such as concrete, brick, clay, and ductile iron, materials which are much more susceptible to leakage. Many of these older pipes are still in use today.

Infiltration is defined as ground water entering sewer pipes, both as runoff during storm events or as base flow from other sources. Inflow refers to direct flows of stormwater into sewer pipes through hookups such as roof and footing drains. Because sewer authorities cannot easily differentiate between sources of infiltration and inflow, they are commonly grouped together under the single heading, "I and I."

Infiltration into sewer systems also represent potential export losses of ground water. Export loss means that ground water is transported out of the basin by sanitary sewer reducing the total amount of available ground water.

If ground water infiltrates sewer pipes during periods when the water table is high, then it is conceivable that wastewater is discharged to ground water when the water table drops below the level of the sewer pipes. However, exfiltration (waste water leaking from sewer pipes) is not considered a problem by the sewer utilities contacted in King County.

Numerous utility officials consider side sewers on private property more of a threat to ground water quality than the sewer mains themselves. For example, in the City of Kent, side sewers were determined to contribute 75 percent of the infiltration to Kent sewers.

Infiltration sources were detected by Metro using smoke tests. Metro bore the expense of replacing the leaking side sewers.

In 1987, Metro completed an infiltration study for the Renton Treatment Plant. The conclusion of the study was that it was cheaper to treat the waste water at the plant than repair the leaking pipes. However, with new technologies which subsequently became available for pipe repair, it now appears to be less costly to correct infiltration and inflow problems than to enlarge the plant. Metro's Renton plant treats approximately 60 million gallons of wastewater per day during the summer. A study conducted at the plant in 1989/90 concluded that approximately 33 percent of that amount, or 20 million gallons per day, was from infiltration. To date, data on the extent and magnitude of this potential problem is unavailable.

There have been no studies conducted on exfiltration of wastes from sewer lines in King County and their impacts on ground water quality.

## GOAL

- To prevent the degradation of ground water which may be caused by wastewater leaking from gravity sewer pipes and side sewers, and

- To prevent the loss of water through infiltration to gravity sewer pipes and side sewers.

## ISSUES

**Issue 1 - Infiltration and Exfiltration.** Infiltration of ground water into gravity sewer pipes may be causing significant export losses of ground water from the Ground Water Management Areas. Exfiltration of sewage from leaking sewer pipes may be causing contamination of ground water.

**SP-1A Infiltration and Exfiltration - Studies:** King County will:

- Review and analyze existing studies and on going pilot programs by Metro and local sewer districts to determine if infiltration and exfiltration are problems in Ground Water Management Areas; and

- Analyze conclusions and determine appropriate follow up action, if any.

**Discussion:** Metro and other sewer utilities in King County systematically replace aging sewer pipes. This is reducing the extent of exfiltration from sewer pipes and infiltration of ground water into the sewer pipes. However, this is a long term project and is only in effect in some portions of the Ground Water Management Areas. Also, it is difficult to analyze whether the existing replacement programs are effective in reducing or preventing ground water depletion or contamination. A local one-time study will have significant costs, but if properly designed, should meet all informational needs. The cost associated with the study will vary according to scope and design.

The study site(s) should consist of an area with a high ground water table and relatively old sewer pipes carrying high quantities of industrial waste. The study should include the use of dye tests to confirm exfiltration and flow meters to quantify the exfiltration. Directionally drilled bore holes or shallow excavated holes would be used to extract of contaminated soil and water. The extracted soil and water would be sampled for coliform bacteria, BOD, metals, inorganics, and priority pollutants.

A study of exfiltration was conducted by Brown and Caldwell. In their research they determined that, historically, exfiltration has not been a problem in King County, but that comprehensive information on exfiltration is not currently available (1989). Exfiltration tests conducted in Lexington and one other location in Maryland determined that exfiltration exceeded infiltration by a ratio of 1.5 and 14.2 to 1 respectively.

**Implementation:**

**Task 1:** Prepare a grant application for the Centennial Clean Water Funds for the sewer exfiltration study.

**Task 2:** Carry out appropriate actions schedule as determined by study findings.

| | |
|---|---|
| Who: | Task 1 - Seattle-King County Department of Public Health (SKCHD) Environmental Health Division.<br>Task 2 - SKCHD Environmental Health Division and sewer agencies. |
| When: | Task 1 - Within 1 year of adoption of Ground Water Management Plan by the Department of Ecology.<br>Task 2 - Depending on study findings. |
| Cost: | To be determined by cities/sewer agencies during concurrence.<br>City of Redmond: $15,360. |
| Funding Source: | |

**SP-1B Infiltration and Exfiltration - Programs:** Encourage Metro, cities and sewer utilities to continue existing or implement new regularly scheduled leak detection and repair programs to protect ground water aquifers in the Ground Water Management Area.

**Discussion:** Metro and the utilities are conducting maintenance and pilot programs in King County to replace leaking sewer pipes for reduction of infiltration and inflow at wastewater treatment plants. This is reducing exfiltration of wastewater from sewer pipes and infiltration of ground water into sewer pipes. For ground water protection from contamination and depletion, Metro and the utilities should be encouraged to replace leaking sewer pipes in Ground Water Management Areas and to educate homeowners in properly maintaining their side sewers. Projects such as that sponsored by Metro to replace side sewers in the City of Kent should be encouraged.

**Implementation:**

**Task 1:** Draft letter to Metro, cities, and sewer utilities concerning the need for leak proof sewer pipes in Ground Water Management Areas.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Upon approval by GWACs. |
| Cost: | Additional funding is not required. SKCHD Environmental Health Division costs included as part of Ground Water Management Plan administration tasks. |
| Funding Source: | Not applicable. |

**SP-1C Infiltration and Exfiltration - Leakproof Piping:** King County will amend the Comprehensive Land Use Plans and King County Code Chapter 13.24 to require the following:

- New sewer piping installed in Aquifer Protection Areas be leakproof, and
- Existing leaking sewer pipes, including side sewers, will be replaced as soon as possible with leakproof piping in Aquifer Protection Areas according to schedules provided in comprehensive plans developed by sewer utilities.

**Discussion:** The King County Comprehensive Plan is currently being updated. By amending the comprehensive plan, King County can require leak-proof piping for new installations or replacement of leaking sewer pipes in areas with high infiltration potential when reviewing sewer utility plans. King County Code 13.24 states that utility plans must be consistent with the King County Comprehensive Plan. By requiring leak-proof sewer piping in areas with high infiltration potential, ground water in those areas will be protected from depletion and contamination. (NOTE: leak-proof is as defined in the Renton Aquifer Protection Ordinance.)

**Implementation:**

**Task 1:** Draft letter to King County Planning and Policy Division requesting inclusion of new and existing leakproof sewer piping provisions in the King County Comprehensive Plan.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Upon approval by GWACs. |

| | |
|---|---|
| Cost: | $400. |
| Funding Source: | |

**Issue 2 - Ground water Depletion.** Granular backfill around sewer pipes could provide a conduit for the migration of ground water, depleting valuable ground water reserves from a specific area.

> **SP-2 Ground water depletion - Backfill:** Ecology should consider amendments to sewer construction specifications to prevent the transmission of ground water along pipe alignments in high ground water transmissivity areas. Such transmissions take place in the granular backfill required for proper pipe support. These amendments shall include best management practices for backfill materials and/or the use of impermeable seals at appropriate intervals.

**Discussion:** The use of granular sand as backfill for pipe support in new sewer construction or repair facilitates the transmission of ground water along pipe alignments. This may cause a depletion in ground water levels, or a depletion in the quantity of ground water available for drinking water purposes in a specific area. Backfill materials used in pipe construction and repair need to be constructed of materials that do not permit this ground water transmission. The Department of Ecology needs to develop best management practices for construction of sewer trenches on sloping ground with gravel based bedding or similar materials, possibly including the use of impermeable seals at appropriate intervals to stop ground water transmission and loss.

**Implementation:**

**Task 1:** Draft letter to the Department of Ecology requesting development of best management practices for bedding materials and/or impermeable seals at appropriate intervals for sewer trenches on sloping ground in high infiltration potential areas.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | Upon approval by GWACs. |
| Cost: | $200. |
| Funding Source: | Aquifer Protection Fund. |

3.3.7. Ground Water Quality Issues Related to Solid Waste Landfills

A landfill is a disposal facility at which solid waste is permanently placed in or on land. A landfill can accept all waste except hazardous wastes as defined in federal and state regulations. There are environmental impacts associated with landfills, including leachate and gas production. Leachate is water or other liquid that has been contaminated by dissolved or suspended materials due to contact with solid waste or gases from the solid waste. Landfills may pose a threat to ground water quality due to leachate production. Ground water that has been contaminated by leachate may affect public health. Ground water that is not currently being used for drinking water also needs to be protected from leachate contamination, as it may become a drinking water source in the future.

Solid waste landfills must be permitted annually by the Seattle-King County Department of Public Health (SKCHD) Environmental Health Division. The permit includes specific conditions for facility operations, including closure requirements, and requires compliance or consistency with a number of state and local regulations. The most significant of those state and local regulations are described below.

**Water Quality Standards for Ground Water of the State of Washington (Chapter 173-200 WAC)**

The Ground Water Quality Standards establish requirements for the protection of existing and future beneficial uses of ground water. The standards reflect the state's Antidegradation Policy and seek to protect ground water from both environment quality and human health perspectives. These regulations are administered by the Washington State Department of Ecology (Ecology). Ecology reviews all proposed state regulation changes and applications for consistency with the Ground Water Quality Standards.

**Minimum Functional Standards for Solid Waste Handling (Chapter 173-304 WAC)**

The Minimum Functional Standards contain solid waste disposal facility standards for leachate collection and treatment, ground and surface water monitoring, facility siting, and other factors important to ground water management. All active landfills in Washington State are required to comply with the Minimum Functional Standards or obtain a variance from Ecology. The Minimum Functional Standards contain a provision that the bottom of a landfill must be 10 feet above ground water. However, this provision may not provide adequate protection for ground water in all situations.

Code of the King County Board of Health, Title 10, "King County Solid Waste Regulations." The King County Board of Health has adopted the Minimum Functional Standards as the local regulation for governing design, construction, operation, and closure of solid waste facilities in King County. The SKCHD Environmental Health Division enforces Title 10. The SKCHD Environmental Health Division revised Title 10 during 1992. Among other changes, demolition disposal sites now must meet siting criteria for mixed waste landfills.

These regulations help ensure that ground water will not be contaminated by leachate. There are some gaps in the current regulations which can be closed by ensuring consistency with the state Ground Water Quality Standards and revising state and local regulations. These changes will help ensure that existing landfills are operated in a manner that will afford maximum protection to ground water.

Abandoned landfills may also pose a threat to ground water quality. An abandoned landfill is any disposal site closed prior to the requirement for obtaining a closure permit. Not enough is known about abandoned landfills in King County to determine their possible impact on ground water quality. King County has identified a number of abandoned landfills and has proposed a program to investigate and propose remedial action for these sites.

Recycling reduces the amount of waste that must be landfilled by reusing waste materials and extracting valuable materials from the waste stream. Thus, encouraging King County's recycling efforts may help protect ground water quality.

## GOAL

To prevent the occurrence of ground water contamination problems associated with the operation of solid waste disposal facilities in King County.

## ISSUES

**Issue 1 - Standards.** Solid waste management standards can be improved to provide better ground water protection. The areas where changes may be made include:

- Compliance with the state Ground Water Quality Standards (WAC 173-200),
- Aquifer Protection Areas, and
- Cell expansion at existing facilities.

**SW-1A Standards:** Ecology will determine whether the existing Minimum Functional Standards for Solid Waste Handling are consistent with the state Ground Water Quality Standards and revise as necessary.

**SW-1B Standards:** The SKCHD Environmental Health Division will prepare amendments to Title 10 to prohibit siting or expansion of landfills in high potential recharge areas (Aquifer Protection Areas) for consideration by the King County Board of Health.

**SW-1C Standards:** Ecology (Minimum Functional Standards) and the SKCHD Environmental Health Division (Title 10) will prepare amendments to their regulations to clearly state that cell expansion is subject to current standards, including location, for King County Board of Health's consideration.

**Discussion:** Including a statement in these regulations that cell expansion must meet current design and construction standards would serve to codify that requirement. That is, cell construction should and, in practice, does comply with the standards.

The proposed regulatory changes may have some economic ramifications. For example, expenses associated with compliance with the regulatory changes may result in an increase in landfill development costs and higher tipping fees. If a landfill is planned in the future, the Aquifer Protection Area exclusion would reduce the number of possible sites and perhaps make it more costly. The agencies would have related administrative costs for these revisions.

**Implementation:**

**Task 1:** Amend regulation for cell expansion.

**Task 2:** Amend Title 10 to prohibit siting/expansion in high potential recharge areas.

**Task 3:** Amend regulations for liner standards.

| | |
|---|---|
| Who: | Task 1,3: Ecology. |
| When: | During Minimum Functional Standards revision. |
| Cost: | To be determined during concurrence.<br>Ecology: $105,000 over two years + $17,500. |
| Funding Source: | General agency funds. |

| | |
|---|---|
| Who: | Task 1,2,3,: The SKCHD Environmental Health Division would propose that the King County Board of Health amend Title 10. This includes preparing the revision, advertising the hearing, briefing the King County Board of Health, and having a majority vote in favor. Also, revision of the Minimum Functional Standards will be reviewed by the SKCHD Environmental Health Division. Consistency with WAC 173-200 and other recommendations would be verified during regulation revision. |
| When: | During regulation revision, as per implementation schedule, Chapter 4. |
| Cost: | To be determined during concurrence. SKCHD: $4,000. |
| Funding Source: | General agency funds. |

**Issue 2 - Waste Screening.** Unauthorized hazardous waste may be entering landfills which increases the potential for contamination to ground water.

> **SW-2 Waste Screening:** The SKCHD Environmental Health Division and the King County Solid Waste Division will evaluate the effectiveness of the King County Solid Waste Division Waste Clearance and Screening Program and provide a report to the Ground Water Management Committee and King County Council within two years.

**Discussion:** King County Solid Waste Division's (SWD) new Waste Clearance and Screening Program is designed to reduce the amount of unauthorized waste that is accepted at county landfills. This type of program is required under federal law. The first phase of the program is to review and evaluate current procedures. Also, three other major elements of the program have been initiated:

- Perform random load checks,
- Respond to landfill/transfer station incidents with suspect waste, and
- Train employees on how to spot suspect waste.

So far, all of the transfer station employee have been trained. By October, the Solid Waste Division expects to have all other staff (landfill, drivers) trained. Funding for the program is part of the current budget.

The results of the program, as determined by evaluation, should be considered by the Management Committee for possible future action.

**Implementation:**

**Task 1:** Evaluate Waste Clearance and Screening Program.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division and King County Solid Waste Division. |
| When: | At end of pilot project, and after two years of full program. |
| Cost: | SKCHD Environmental Health Division costs to be determined during concurrence. Solid Waste Division costs are already included in the program budget. |
| Funding Source: | Aquifer Protection Fund. |

**Issue 3 - Abandoned Sites.** Abandoned solid waste disposal sites may pose a threat to ground water.

> **SW-3 Abandoned Sites:** King County will proceed with investigation and remediation of the abandoned sites in a timely manner. The SKCHD Environmental Health Division will evaluate progress of the investigation and remediation efforts and report yearly to the Management Committee and the King County Council.

**Discussion:** The SKCHD Environmental Health Division prioritized abandoned landfill sites based on the potential for ground water contamination as indicated in the Abandoned Landfill Survey. The Solid Waste Division's investigation program assesses the existence of contamination in ground water. If potential for contamination is found, the site may be referred to Ecology for their follow-up in accordance with the Model Toxics Control Act.

This alternative is feasible because the Solid Waste Division is proceeding with this program. Funding for the Solid Waste Division's program has been identified. Implementation would not require additional resources. However, a timely investigation of these sites is requested to demonstrate to the Solid Waste Division that this issue is important to the Redmond Bear Creek Valley Ground Water Advisory Committee and to protection of ground water quality.

**Implementation:**

**Task 1:** Continue investigation of the abandoned sites.

| | |
|---|---|
| Who: | Solid Waste Division. |
| When: | As per the implementation schedule. |
| Cost: | Costs for this have been identified and a funding source secured. No additional costs are anticipated. |

**Task 2:** Evaluate and report on progress.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | |
| Cost: | 160 hrs., $8000. |
| Funding Source: | Aquifer Protection Plan. |

**Issue 4 - Education.** The public may not be aware of the relationship between landfilling solid waste and the threat to ground water quality. Recycling (removal of usable components from the waste stream) reduces the amount of solid waste that must be landfilled.

> **SW-4 Education:** Include information about the relationship between solid waste disposal and ground water in the education program. (This will be included in the Education Program. Please see Chapter 3).

**Discussion:** Providing information about recycling and educating residents about waste reduction may reduce the amount of waste going into the landfills and the amount of hazardous products that people buy.

**Implementation:** See Education Program Chapter 3.

### 3.3.8 Ground Water Concerns Associated with Burial of Human Remains

Cemeteries are found throughout King County, and it is possible that, under certain hydrogeologic conditions, burial practices have affected or are affecting local ground water quality. About 40 percent of King County residents rely on ground water for their potable water source. Currently, there are 70 cemeteries in King County ranging in size from 20 burial sites to 140,000 burial sites. Nothing is known about the existing or potential effect of decomposing corpses and caskets on ground water.

Potential threats to ground water from decomposing corpses and caskets include chemicals, bacteria, viruses, and metals. The embalming process uses formalin, composed of formaldehyde, methanol, glycerin, borax, and water. Approximately 1/2 gallon of formalin is used to embalm each body. Bacteria and viruses are not a concern since nutrients and oxygen are not present for the bacteria to survive and multiply. Viruses in both embalmed and non-embalmed bodies will eventually die out because they require a viable host to reproduce.

Similar to body decomposition, the rate of a casket's decomposition depends on construction materials used and soil conditions. Construction materials include hardwood, softwood, metals, and a magnesium bar placed along the middle of the casket to prevent hydrolysis of the metals. It is unknown if these metals have leached into and are contaminating ground water.

Ground water may be in contact with corpses and caskets. Concrete burial liners and vaults are not waterproof. Embalming fluids and other materials may infiltrate ground water depending on such factors as soil type, topography, the geology encountered as water travels to an aquifer, and the depth to the water table. Soils and geologic materials vary in their ability to attenuate or remove contamination by chemical, biological, and physical processes. Generally, the deeper the water table, the more opportunity exists for contaminant removal by soil and geologic deposits.

In King County, there is ample opportunity for cemetery graves to come in contact with water. Many cemeteries are located in areas where the water table is believed to be very shallow, within 10 feet of land surface. Rainfall ranges from 20 to 50 inches per year throughout the Puget Sound lowlands, with an average value of approximately 35 inches per year. Additionally, the grounds of most operational cemeteries are heavily irrigated in the summer months. In instances where vaults are not used, or do not keep water out, either ground water or recharge water could come into contact with the grave, hastening decomposition and transporting decomposition and embalming products to the ground water system.

Attempts to gather information pertaining to ground water contamination have produced no useful citations. Considerable information does exist on the transitional and end products of decomposing human bodies, residual body wastes, and chemicals that are used in the process of embalming bodies. Data are also available on the composition of residues of disintegrating caskets and associated materials. However, little is known about the effects of these products on ground water.

## GOAL

To prevent the degradation of ground water from embalming fluids, disintegrating metal caskets, decaying human remains, and other materials associated with processing bodies for funeral burial or cremation.

## ISSUES

**Issue 1 - Lack of information.** Information is insufficient to determine ground water impairments from embalming fluids, decaying human remains, and other materials associated with the burial of human remains in King County.

> **B-1 Information - Studies**: The Seattle-King County Department of Public Health (SKCHD) Environmental Health Division will continue to search for and evaluate existing information on cemeteries, including the results of the Woodlawn (New York) Cemetery investigation when made available. The SKCHD Environmental Health Division will also conduct a study within the county to determine if cemeteries are contaminating ground water. Findings of this study can be critically reviewed and compared with findings from other studies nationwide. Information gathered can be used to establish siting criteria for new and existing cemeteries undergoing expansion or to take other appropriate follow-up actions, if required.

**Discussion:** A thorough search, to date, of national and international databases concluded that there was no information available on impacts on ground water from cemeteries. The results of the Woodlawn Cemetery study should provide some information on impacts to ground water. However, given the unique geology of this region, the findings of the Woodlawn study may not be applicable to the Redmond-Bear Creek Valley Ground Water Management Area. The goals and objectives of the Woodlawn study and various factors (such as depth to ground water) may be quite different. Correspondence dated August 18, 1992, from the President of the Woodlawn Cemetery indicated that the company originally contracted to conduct the study had canceled, and, as of yet, a suitable replacement has not been found.

A study of the potential for cemeteries to contaminate underlying ground water aquifers would make an important contribution to the assessment of ground water quality. Such a study could provide King County with regionally specific answers to this issue and allow the county to determine if further action is warranted.

A local study would have significant costs, but would directly meet all information needs. The U.S. Geological Survey (USGS) has proposed a two year study of the impacts of cemeteries on ground water with an estimated cost of $228,000. Such a study would provide specific information on local ground water impacts.

Under a Centennial Clean Water Fund grant, King County and the USGS are conducting a two year study of cemetery waste impacts on ground water quality which was scheduled to commence in April 1993. Although the Redmond-Bear Creek Valley Ground Water Advisory Committee may consider this study low priority, the USGS considered it to be of local and national scientific significance, and the Department of Ecology rated it high on their Centennial Clean Water Fund list.

**Implementation:**

**Task 1:** Grant Application approved by the Department of Ecology in 1992 (King County unable to fund).

**Task 2:** If studies conclude that cemeteries are contaminating ground water, act upon the study recommendations through development of pertinent state and local legislation regarding siting, criteria, etc.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | To be determined. |
| Cost: | Grant project estimated at $228,000. Other literature research: 80 hrs., $16,000. |
| Funding Source: | Centennial Clean Water Fund by Ecology, by USGS, and the SKCHD Environmental Health Division or Aquifer Protection Fund. |

3.3.9. Ground Water Quality Issues Related to Sand and Gravel Mining

It is not unusual for productive sand and gravel mines to be located over vulnerable aquifers. Mining activities in these areas can increase ground water vulnerability to contamination both from the extraction process and from site reclamation.

The primary "effluent" discharged at a gravel site is turbid rinse water. Generally, operators are required to collect the wastewater on-site in retention and settling ponds where the fine sediment settles out. The collected water is then allowed to infiltrate back to the water table.

Often the excavation pit is also a component of the treatment system. Any chemical contaminants that are allowed to enter the excavation pit via the wash water or spills in the area would have increased access to the aquifer. Possible contaminants found at a mining site include lubricants and fuels which may be directly associated with the mining operation or from road and work area runoff.

Beyond the risks associated with active mining, one of the largest threats to ground water appears to be the excavation pit itself. Excavation pits have been used both legally and illegally as dump sites for a variety of wastes. In many cases, materials used to fill the pits would today be classified as a dangerous waste.

Sand and gravel mining operations are subject to permitting at both the local and state level. One of two land use permits must be obtained in King County to mine sand and gravel, a conditional use permit or an unclassified use permit. A conditional use permit is required to mine in a mining zone. As implied by the title, conditions are attached to the permit. The conditions are established during environmental review under Chapter 43.21 RCW, the State Environmental Policy Act. An unclassified use permit is required to mine in areas not zoned for mining. This is a temporary permit lasting for five years and is also subject to conditions established during environmental review.

Applications for the above permits incorporate the reclamation plan for the site and provide information showing how provisions of Chapter 21.42 Q-M, Quarrying and Mining Classifications, will be met.

King County also requires a grading permit for excavations of sand and gravel exceeding 500 cubic yards in volume. The applicant must demonstrate that the conditions regarding operation and reclamation of the site are met. Grading permits are renewed annually allowing the Department of Development and Environmental Services to institute new conditions as regulations change. Protection of ground water is one of the conditions of the permit. The King County Council is currently revising the zoning code including a chapter on reclaimed lands. This portion of the zoning code is very general and does not address ground water concerns. The source of fill being used in reclamation is specified in the initial permit and in annual permit updates. Applicants must utilize fill approved by the Department of Ecology (Ecology) if the fill comes from a previously developed site. Soil must be tested for contamination in order to obtain Ecology approval. Approval is not required if fill comes from an undeveloped site.

The King County Comprehensive Plan includes a section on mineral resources which identifies the following three major issues:

- Designation of mineral extraction sites,
- Review of operating procedures at existing sites, and
- Reduction of environmental effects of extractive operations.

Currently, the Regional Planning and Policy Division of Parks Planning and Resources Department is reviewing the 1985 King County Comprehensive Plan and preparing amendments for the King County Council in order to meet the requirements of the Growth Management Act regarding resource lands.

State permits for sand and gravel mining are required from both the Washington State Department of Natural Resources and Ecology. Applicants generally apply for the Department of Natural Resources permit concurrently with the King County grading permit. The Department of Natural Resources regulates and permits sand and gravel mines over 3 acres in size. King County works closely with the Department of Natural Resources to ensure that each is approving the same set of operating plans.

SB 5502 "Surface Mining" passed by the 1993 Legislature, places a high priority on ground water protection. Specific contents of the bill include provisions for the Washington State Department of Natural Resources to regulate mine reclamation with the county reviewing applications with Washington State Department of Natural Resources considering the county comments. Washington State Department of Natural Resources cannot approve fill for reclamation of site without county health department approval of fill first. This does not correlate with Ecology's general permit requirements where Ecology approves of fill material. The minimum reclamation standards discuss how Washington State Department of Natural Resources will protect ground water and surface water during reclamation. Washington State Department of Natural Resources will regulate to protect ground water and surface water resources after reclamation is complete.

Washington State Department of Natural Resources has more concern with possible contamination of water sources from adjacent operation pollutants. Department of Development and Environmental Services will need to regulate all pollutant sources near mines. Washington State Department of Natural Resources suggested Seattle-King County Health Department (SKCHD) Environmental Health Division follow up status in 1-3 months. It is unknown how this will impact the King County Zoning Code, Chapter 21.A.22 at this time.

In 1991, Ecology, the Department of Natural Resources, and several local authorities identified a series of best management practices for sand and gravel operations. Originally, Ecology planned to adopt these best management practices as either guidelines or formal rules for industry to follow in order to comply with the requirements of Chapter 173-200 WAC, the Water Quality Standards for Ground Waters of Washington State. After further evaluation, Ecology elected to protect both surface and ground water quality through a general permit titled: "General Permit for Processed Water and Stormwater Associated with Sand and Gravel Operations, Rock Quarries, and Similar Mining Operations, Including Stockpiles of Mined Materials, Concrete Batch Operations and Asphalt Batch Operations." (July, 1994) This general permit issued by Ecology supersedes surface and ground water permits that Ecology requires.

The goal of the general permit is to enforce state and federal standards that apply to the quality of water discharged to either surface water or ground water from certain types of mines. All discharges from sand and gravel mines must meet the Ground water Quality Standards (Chapter 173-200 WAC) and the Surface Water Standards (Chapter 173-201A WAC). Both surface water discharge, regulated under the National Pollutant Discharge Elimination System permit program, and discharge to ground water, regulated under the State Waste Discharge permit program, are governed by the general permit.

The method of compliance with the general permit may include the implementation of recently developed best management practices and wastewater treatment facilities design criteria. Permittees will be required to monitor discharges to both surface water and ground water. All facilities covered under the general permit will collect and report their monitoring data annually to Ecology. Ecology will use the monitoring data obtained in the first three years to determine permit effluent limits for potential contaminants and to establish the scope of monitoring which will be required in the re-issued general permit (after 5 years).

## GOAL

To ensure that regulatory programs are adequate to prevent adverse effects on ground water quality attributed to sand and gravel mining operations, including reclamation.

## ISSUES

**Issue 1 - Regulatory modifications.** Sand and gravel mining operations can cause changes in a site or include activities which increase the potential for contamination of important aquifers. Significant changes in sand and gravel mining permit process are occurring at the state level.

> **SG - 1. Regulatory Modifications.** King County and cities will include a comprehensive list of best management practices in grading permits issued for gravel pits. King County and cities should comply with the NPDES and Ecology's "General Permit" requirements.

**Discussion.** For the general permit drafted by Ecology, sand and gravel facilities are required to manage, treat and discharge their wastewater in a manner consistent with the Ground Water Quality Standards and NPDES. This general permit includes the implementation of best management practices and monitoring of discharges to ground water with annual reporting of the monitoring data to Ecology. The General Permit provides positive controls to protect both surface water and ground water from contamination.

**Implementation**:

Task 1: Develop (or use Ecology's) a list of best management practices.
Task 2: Include the list in the requirements for grading permits.
Task 3: Meet General Permit and NPDES requirements for King County or city owned sand and gravel sites.

| | |
|---|---|
| Who: | King County, City of Redmond |
| When: | As per Ecology's requirements |
| Cost: | To be determined |

**Issue 2 - Land use of inactive or reclaimed mines.** Permissible subsequent use of reclaimed sand and gravel mining sites should be reflective of the increased susceptibility of aquifers to contamination. Currently, there is no formal requirement that permitted uses be given special consideration.

> **SG-2A Reclaimed sand and gravel mines:** King County and cities will amend their

comprehensive plans to include a policy which stipulates that land use of reclaimed sand and gravel mines be carefully evaluated in light of the increased susceptibility of underlying aquifers to contamination due removal of overlying protective geologic materials during past mining operations.

**Discussion**: Land use is generally a matter of local control. The comprehensive plans provide overall guidance for land use decisions. It would be appropriate for the comprehensive plans to address subsequent land use of reclaimed sand and gravel sites. The King County Regional Planning and Policy Division is currently reviewing the King County Comprehensive Plan for the King County Council in relation to the requirements of the Growth Management Act and is seeking input from the King County GWACs regarding amendments to that plan.

The King County Council would probably be receptive to this recommendation because it does not preclude particular land uses; it simply requires special consideration for gravel mining sites. This alternative is consistent with the aforementioned goal in that it would help to ensure that regulatory agencies adequately protect ground water quality. The alternative is also timely and requires no funding. Concurrence with the Ground Water Management Plan by the King County Council and effected cities would constitute agreement to implement this alternative. For the King County Comprehensive Plan, a separate petition could be prepared by the SKCHD Environmental Health Division on behalf of the RBC-GWAC if the need for input precedes the concurrence process. The SKCHD Environmental Health Division will monitor the progress of the King County Comprehensive Plan revisions in order to facilitate timely input by the GWAC.

**Implementation**:

<u>Who</u>: King County has commenced and the cities will commence amending their comprehensive plans once they concur with the Ground Water Management Plan. For King County, the Planning and Policy Division and the SKCHD Environmental Health Division will prepare comprehensive plan amendments. The King County Council will adopt comprehensive plan amendments depending upon their schedule and approval of the work plan which provides for all plan amendments including this one.

<u>Funding Source</u>: There is no funding necessary for this action.

**SG-2B Fill Testing:** King County and the cities may require testing of any fill in sand and gravel mining sites undergoing reclamation in critical recharge areas.

**Discussion**: The nature of material used as fill in reclaimed sand and gravel sites is currently undocumented. Material considered hazardous waste may have been used as fill at these sites. Hazardous materials could migrate to and contaminate ground water used as a drinking water source, especially where soils consists of coarse sand or gravel/rocks. Sand and gravel fill in reclaimed sites particularly in critical recharge areas, needs to be tested to determine if it could potentially be contaminating ground water.

**Implementation:**

| | |
|---|---|
| Who: | King County and affected cities will commence testing of sand and gravel fill at reclaimed sites. |
| When: | Within 90 days of concurrence with the Ground Water Management Plan. |
| Cost: | City of Redmond: $25,600. |
| Funding Source: | Funding for this activity could come from general funds, permit fees, etc. |

**SG-3C Zoning Code - Reclamation Plans:** King County and the cities will require that reclamation plans for mineral extraction sites include measures to protect ground water quality and quantity.

**Discussion:** The King County Zoning Code is currently being revised. Chapter 21.A.22 (Developed Standards, Mineral Extraction, Section 446 Reclamation) requires that a reclamation plan be submitted for each rezone application. The reclamation plan must identify the subsequent land use of the reclaimed lands, indicate how reclamation will be accomplished, and propose a time schedule indicating when reclamation will occur. This chapter of the zoning code is general and does not address ground water quality and quantity impacts from post-operational land uses proposed in the reclamation plan. Generally, these sites are underlain by gravelly soil which could allow contaminants to migrate to underlying ground water from the excavation pit prior to site reclamation.

**Implementation:**

**Task 1:** Revise zoning code to protect ground water underlying reclaimed sand and gravel mining operations.

| | |
|---|---|
| Who: | King County and cities. |
| When: | Through concurrence, King County and cities will agree to amend section accordingly when zoning codes are revised. |
| Costs: | None. |
| Funding Source: | No additional funding is necessary. |

**Task 2:** Review SB5502 and the Washington State Department of Natural Resources's role in protecting ground water during and after mine reclamation. Depending on findings, draft letter to the Department of Natural Resources concerning ground water protection (if needed). Assess SB5502 in relation to Chapter 21.A.22. Take appropriate action.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | During first year after concurrence. |
| Costs: | 10 hours, $500. |

Funding Source: Aquifer Protection Fund.

3.3.10. Ground Water Concerns Associated with Land Application of Municipal Waste Treatment Plant Products: Biosolids and Sewage Effluent

Biosolids are settled sewage solids generated from wastewater treatment plants (formerly referred to as "sludge"). Biosolids can be solid or semi-solid, usually combined with varying amounts of water and dissolved materials. The primary means of biosolids disposal in Washington State are landfilling and incineration. However, biosolids may be utilized for various beneficial uses including composting, land application (including agriculture and silvicultural application), land reclamation, land cover, construction material, and soil amendment (composted mixtures). Land application is gaining in popularity and provides potential for direct benefit to crops (including forest areas) or top soil development prior to planting.

Utilization of biosolids for beneficial purposes is the environmentally preferred method of handling a difficult problem. Currently, nearly all the biosolids generated and disposed of in King County are utilized for silviculture, composting, soil improvement, or agricultural purposes through land application. Potential contaminants in raw biosolids include nitrogen, phosphorous, heavy metals, hydrocarbons, microorganisms, and radionuclides. Based on present technology, properly managed land application of biosolids poses little threat to health or the environment. Additionally, it is not known to have caused any degradation of underlying ground water resources. However, with the increased interest in land application, the potential impacts on the ground water resources associated with that practice may need to be considered.

Biosolids are considered to be solid waste. They are regulated under the Minimum Functional Standards for Solid Waste Handling (Minimum Functional Standards), Chapter 173-304 WAC. These standards require land utilization facilities for sewage sludge and woodwaste sludge (at agricultural and silvicultural sites only) to meet utilization guidelines, or to meet the landspreading disposal standards. The utilization guidelines are contained in *Municipal and Domestic Sludge Utilization Guidelines, Ecology Report 82-11* (October, 1982). The *Best Management Practices for the Use of Municipal Sewage Sludge, Ecology 82-12* (September, 1982) are also referred to in the Minimum Functional Standards.

The Seattle-King County Department of Public Health (SKCHD) Environmental Health Division has approximately 1/4 full-time equivalent (FTE) assigned to the permitting and monitoring of land application of biosolids projects. The SKCHD Environmental Health Division has found that this level of staffing is not sufficient to allow carefully review of each new application to ensure the permits meet proper conditions, to monitor permitted projects, to field check "permit-by-rule" projects, and to maintain technical and scientific knowledge relating to biosolids management.

**GOAL**

To provide assurance that the ground water resources in King County will not be contaminated by the land application of biosolids.

**ISSUES**

**Issue 1 - Regulatory Program Staffing.** The SKCHD Environmental Health Division does not have adequate staff to:

- Carefully review new applications to ensure that permits meet proper conditions,
- Monitor permitted projects,
- Field check "permit-by-rule" projects, and
- Keep their technical and scientific knowledge relating to biosolids management current.

> **BSE-1 Regulatory Program Staffing:** The SKCHD Environmental Health Division will adequately staff the biosolids program.

**Discussion:** According to the supervisor for the Environmental Health Division's solid waste program, the addition of 3/4 FTE to the program, at a cost of about $78,300 per year, would enhance present management and partially accommodate the projected increases in the number of land application of biosolids projects. Increased staff would be consistent with the intent of current programs and guidelines which current staff cannot adequately administer. This alternative would result in cost increases for biosolids generators and, ultimately, the public. Short- and long-term benefits would be provided by this alternative. There would be an immediate improvement in oversight and long term benefit to the environment. This alternative is feasible, provided it met with King County Board of Health approval.

**Implementation:**

**Task 1:** Determine appropriate level of staffing for the biosolids program.

**Task 2:** Revise Title 10 to of the Code of the King County Board of Health to increase fees to support position, prepare a budget request for adoption.

**Task 3:** Present Title 10 revision to King County Board of Health for adoption.

**Task 4:** Present Seattle-King County Department of Public Health Environmental Health Division budget revision to King County Council.

**Task 5:** Position description written and advertised, position filled.

| | |
|---|---|
| Who: | SKCHD Environmental Health Division. |
| When: | As per implementation schedule, after King County Board of Health approves regulation and King County Council approves budget. |
| Cost: | It is estimated that this position would be 3/4 FTE costing about $78,300 annually. |
| Funding Source: | An increased permit fee or some type of annual operation fee based on tonnage to provide funding for the position. |

**Sewage Effluent**

Sewage effluent is the liquid portion of wastewater which remains after solids removal or settlement. This liquid may be untreated, or it may be further settled, filtered, and disinfected, depending on final use.

Reuse of effluent is regulated by the State Water Pollution Control Act, Chapter 90.48 RCW, administered by the Department of Ecology (Ecology) and by the *Guidelines for Land Disposal of Treated Domestic Sewage Effluent in Washington State* (February, 1976). The guidelines were prepared jointly by the Department of Ecology (Ecology) and the Department of Social and Health Services (now Department of Health). These guidelines are considered to be outdated, and have been replaced with the *Wastewater Reclamation and Reuse Interim Standards.*

Currently, reuse of sewage effluent by land application is not widely practiced in King County because precipitation limits the length of the application period. However, interest in effluent reuse increased during the 1992 drought period. During that period, METRO, the Seattle Water Department, Ecology, the Washington State Department of Health, and the Seattle-King County Department of Public Health (SKCHD) Environmental Health Division discussed possible uses for treated sewage effluent. The City of Seattle, with concurrence from the Washington State Department of Health, used treated effluent for a variety of non-public contact uses, such as street washing and sewer line flushing. Also, other utilities and industries are proposing projects such as irrigation and energy recovery.

In response to concerns over outdated guidelines and to the increased interest in effluent reuse, the Washington State Legislature passed Substitute House Bill (SHB) 2833 on April 2, 1992. This bill required Ecology to adopt standards, procedures, and guidelines by August 1, 1993 for industrial and commercial use of reclaimed water. Ecology, the Washington State Department of Health, and the Washington State Department of Agriculture are to provide technical assistance in the development of the standards, procedures, and guidelines. The standards must include provisions for permits, fees, monitoring, and inspections. In February 1993, the Washington State Department of Health, in conjunction with the Department of Ecology, released the Wastewater Reclamation and Reuse Interim Standards. These standards are intended to implement the requirements of SHB 2833.

**GOAL**

To provide assurance that the ground water in King County will not be contaminated by the reuse of wastewater effluent.

## ISSUES

**Issue 2 - Guideline Revision.** Recently, an increased need for conservation of water resources has focused interest on reuse of treated effluent. The effluent guidelines are being revised and will need to comply with the state Ground Water Quality Standards. However, it is not known if special protection for high potential aquifer recharge areas will be considered.

> **BSE-2 Guideline Revision:** The Redmond-Bear Creek Valley Ground Water Advisory Committee encourages Ecology to include ground water protection in the revised guidelines for reuse of effluent. The guidelines may need to include constraints on reuse of effluent in high potential aquifer recharge areas.

**Discussion:** The potential for effluent reuse by a variety of organizations appears to be increasing. Some effluent reuse applications sites may be in high potential aquifer recharge areas. The revision to the guidelines should anticipate this and address this potential problem.

**Implementation:**

**Task 1:** Revise effluent reuse guidelines, include aquifer recharge protection concerns.

| | |
|---|---|
| Who: | Washington State Department of Health and Ecology. |
| When: | As per legislative mandate. |
| Cost: | No additional cost is anticipated. |

## 3.4. GROUND WATER QUANTITY ISSUES

Ground water resources are the result of geology and climate. The geology of King County allows for water to be contained in a variety of soils. The climate provides fairly dependable rainfall and recharge to the ground water. Natural recharge occurs only through relatively undisturbed permeable soils. Aquifer and surface water levels are maintained by preserving recharge.

Impetus for ground water resource management comes from a variety of sources. Population growth creates an increasing demand on limited natural resources, including ground water. State law dictates how water may be appropriated. The State of Washington has attempted to balance the needs of the citizens with maintaining the water resource. The Department of Ecology (Ecology) administers laws dealing with water appropriations and allocations. Allocation to new users must not conflict with existing use, however, the information needed to make allocation decisions is deficient. Some areas have experienced the effects of unwise use of aquifers, such as water level decline and sea water intrusion. Parties involved in water use are developing and using innovative techniques to decrease water use and increase water availability, such as conservation and artificial recharge. Recent interest in maintaining surface water resources has highlighted the interaction of ground water and surface water. Future ground water resource management must include consideration of this interaction.

**State**

The Washington State Department of Ecology (Ecology) must make decisions on water rights, water level declines, ground water reservations, sea water intrusion and artificial recharge. These decision are difficult because of the lack of adequate data upon which to make decisions.

To evaluate water right applications, Ecology must determine how much water an aquifer system is capable of yielding on a sustained basis. This is difficult to do because of the lack of accurate withdrawal figures. Ecology has issued water rights in the past using standard, but informal, water usage rates for various land uses when precise information was not available. Technically and legally, water use should approximate water right totals. This is seldom the case, due in part, to the lack of a state-wide systematic water usage data management program and outdated water rights records. Staffing limitations and inefficient reporting frequently restrict staff efforts in areas experiencing significant problems. Consequently, estimates based on field inventory, random sampling, or personal contacts are frequently the best available figures. Ecology possesses the statutory authority to require an actual use accounting from the various appropriators of ground water.

It has been the general position of Ecology that aquifer systems could be fully utilized to the capacity of the aquifer to yield water on a sustained basis as long as the water table did not decline below a reasonable or feasible pumping rate, known as a decline limit. In order for Ecology to determine if a water table is declining, a long record of water level data is required. Sufficient water level data is unavailable for most of King County to make confident statements about the regional response to withdrawal of ground water.

Ecology also evaluates ground water reservation petitions. As part of an acceptable petition, Ecology must make a finding of general availability of unappropriated water to reserve. This finding depends upon known appropriation, which may not reflect actual use.

The threat to ground water from seawater intrusion (migration of salt water into fresh water aquifers due to pumping of ground water) is an emerging concern along the coast. When ground water is pumped from aquifers that are in hydraulic connection with Puget Sound, the gradients that are set up may induce a flow of salt water from Puget Sound toward the wells. The lack of information on the extent of ground water resources and ground water use compounds the problem of determining where seawater intrusion could exist. In response to these concerns, Ecology and the Washington State Department of Health produced the Draft Seawater Intrusion

Policy. The goal of the policy is to prevent seawater intrusion in areas where it has not occurred and to control seawater intrusion where the problem already exists.

Artificial recharge is an innovative method to augment the ground water resource. The main function of artificial recharge is to replenish aquifers during winter months when stream flows exceed minimum instream flow requirements. Replenished aquifers could be pumped during summer periods to meet local peak demands. This would reduce seasonal demands placed on aquifer systems during the summer and late fall months.

Currently, Ecology does not have the comprehensive ground water database necessary to evaluate water right applications, water level decline, and sea water intrusion. Washington State Department of Health and Ecology are responsible for water usage and water rights data.

The problem of lack of accurate data is being addressed by the Water Resource Data Management Task Force through the Five Year Water Resource Water Management Plan. The plan is to provide the information necessary for effective statewide and regional planning and management of the state's water resources. The plan will utilize data developed through the Ground Water Management Plan and other sources.

The Washington State Department of Health requires that larger water systems prepare conservation plans and has developed guidelines for these plans (Water Use Efficiency Act of 1989 RCW 43.20.230 and *Guidelines for Public Water Systems Regarding Water Use* Reporting, Demand Forecasting Methodology, and Conservation Programs). In addition to these requirements, the adopted Coordinated Water System plans include specific conservation program elements. Source and service meters, common conservation methods, are routinely installed by the larger public water systems. However, the smaller water systems with 2 - 9 connections do not currently have this requirements. These systems are regulated by the King County Board of Health Title 12 and administered by Seattle-King County Department of Public Health Environmental Health Division.

Drought, aquifer depletion and population growth is renewing attention on **water reuse.** Sewage effluent may be "re-used" for a variety of purposes, including water for toilet flushing, industrial use, irrigation, and aquifer recharge. The 1992 legislative session passed Substitute House Bill (SHB) 2833, which provided for the use of "reclaimed water." This bill set out the procedure for Ecology, the Washington State Department of Agriculture, and the Washington State Department of Health to follow to update the guidelines for sewage effluent reuse. By August 1, 1993, Washington State Department of Health was to adopt a single set of standards, procedures, and guidelines for the industrial and commercial use of reclaimed water. Interim guidelines were released by the Department of Health in February 1993.

### King County

In King County, high potential aquifer recharge areas are primarily protected through policies in the King County Comprehensive Plan, individual community plans and ordinances in the Zoning Code. Basin plans may also direct that development occur in a manner which protects recharge. King County relies on community plans to implement and augment through zoning the aquifer protection policies outlined in the King County Comprehensive Plan (Comprehensive Plan). The Comprehensive Plan is currently being revised, and the SKCHD Environmental Health Division is recommending that high potential aquifer recharge considerations be included.

Currently, the Comprehensive Plan contains several policies that relate to ground water protection, either directly or indirectly:

Policy E-337: "Ground water recharge areas should be identified and protected to ensure that ground water resources are protected from potential pollution." (Emphasizes ground water quality rather than quantity; this is proposed to be changed during the comprehensive plan update required by the Growth Management Act.)

Policy E-328: "Wetlands important for flood control, drainage, water quality, aquifer recharge, visual or cultural values or habitat functions should be preserved or enhanced."

Policy E-302: "When environmentally sensitive features are discovered through technical review of a development proposal, the need to protect the sensitive feature should be factored into site planning. Development plans should ensure that structures located on unconstrained portions of the site, and that clustering, if approved, is compatible with surrounding land uses. *These considerations may result in a reduction in density from that otherwise allowed by the zoning."* (Emphasis added. This means that if a development may impact recharge, density could be reduced from that allowed by the area zoning.)

The Comprehensive Plan policies are implemented specifically in community plans. For example, the Tahoma-Raven Heights Community Plan states that "the demand from surrounding land uses and densities should not exceed the capacity of the area's ground water resources nor otherwise cause deterioration of its quality" and "critical ground water recharge areas and watersheds should be identified and maintained in low density residential or similar non-intensive uses."

Recently, several policies were proposed that would enhance recharge in the county through community plans, basin plans, and changes to the zoning code. The Northshore Community Plan included policies for land clearing which may benefit aquifer recharge:

- "King County should adopt a county wide clearing ordinance with guidelines for clearing on lands outside of sensitive areas and specific performance standards including phasing and seasonality of clearing activities, retention requirements, and coverage. The ordinance should include the clarification of a clearing permit process."

- "Until such time that a county wide clearing ordinance is adopted, interim development standards should be implemented whereby clearing is limited on subdivision, short subdivision, and new residential and commercial building projects to protect water quality, limit surface water runoff and erosion, and maintain wildlife habitat and visual buffers."

Another proposed policy which may benefit ground water recharge is in the Executive Proposed Basin Plan for Hylebos Creek and Lower Puget Sound. This policy on vegetation retention states that significant trees should be identified during the platting process and retained, that significant natural vegetation should be retained, and the retained vegetation areas should be clearly and permanently marked on the site identified on all maps, and have legally binding restrictions. It also states that long-term monitoring for water quality trends should be performed to assess trends associated with increased urbanization.

King County Code Title 21, Zoning, regulates the degree of impervious cover allowed for developments and, therefore, affects the amount of recharge. The existing code contains maximum lot coverage by building. Proposed changes establish, for the first time, limitations on impervious cover for development. These limitations were established to provide for accurate sizing of stormwater facilities to manage future runoff. They also would prevent extreme cases of total lot coverage by impermeable surfaces. They are considered a clarification of the existing code and are representative of existing coverage with impermeable surface in King County. Therefore, it should not be interpreted that these revisions to the zoning code provide a significant reduction in the amount of impermeable surfaces allowed.

Another method to protect ground water recharge is through evaluations required under the State Environmental Policy Act. A number of proposed land uses require completion of a checklist that indicates potential environmental impacts prior to permitting by King County. If the proposed activities are judged to represent a significant environmental impact, an Environmental Impact Statement (EIS) must be completed. The review process is implemented by the King County Environmental Division, State Environmental Policy Act Section. The checklist includes sections on surface, ground, and stormwater, but does not ask specifically whether the proposed activities will be conducted in an Aquifer Recharge Area, whether they are likely to affect the quantity of recharge on-site, or to what degree the quantity of recharge is likely to be affected. In recharge related questions, however, the applicant is asked how much dredging or filling of wetlands is planned, whether water will be discharged to ground water, and how runoff will be generated and handled. Additional information may be requested by the State Environmental Policy Act Section if reviewers decide that the information provided in the checklist is not sufficient, or if another agency or group has indicated that the proposed site of the proposed land use action is an area that requires extra attention. The State Environmental Policy Act law allows exemption of certain activities from environmental review. The State Environmental Policy Act ordinance at the county level may be amended to include these activities if it is found that they could contribute environmental effects.

NOTE: Chapter 173-100 WAC Ground Water Areas Management and Program contains guidelines on program content which were to be adapted to the particular needs of an Ground Water Management Plan. Included in the program content was a section on alternatives, which was to outline various land and water use management strategies that address each of the ground water problems discussed in the problem definition section. It states that the alternative management strategies would address water conservation, conflicts with existing water rights and minimum instream flow requirements, programs to resolve such conflicts, and long-term policies and construction practices necessary to protect existing water rights and subsequent facilities installed in accordance with the Ground Water Management Plan program and/or other water right procedures. This issue section does not address these topics directly, except for conservation. Several new state programs have begun since the WAC was written which provide programs to resolve conflicts with existing water rights and minimum instream flow requirements, and long-term policies and construction practices necessary to protect existing water rights and subsequent facilities. (Generally, under the Water Resources Forum and the Chelan Agreement). The GWAC determined that the best way to address these issues and to support the new programs is to develop and implement a long-term monitoring and data collection program to provide the decision makers with information necessary to make better decisions. This is addressed in this issue paper and in the data collection and management issue paper.

## GOAL

To manage the ground water resources of King County to optimize current and long-term benefits.

## ISSUES

**Issue 1 - Policies and Ordinances.** Several policies and ordinances are proposed which may provide broad protection for aquifer recharge areas. The revisions to the King County Comprehensive Plan, the clearing ordinance, and the interim clearing standards may not be adopted by King County.

### WQ-1A Policies and Ordinances:

- King County will amend Comprehensive Plan Policy E-337 to include aquifer recharge.

- King County and cities will consider adopting a clearing ordinance with guidelines for clearing on lands outside of sensitive areas and specific performance standards including phasing and seasonality of clearing activities, retention requirements, and coverage. The ordinance should include the clarification of the clearing permit process.

- King County and cities will implement interim development standards whereby clearing is limited on subdivisions, short subdivisions, and new residential and commercial building projects to protect water quality, limit surface water runoff and erosion, and maintain wildlife habitat and visual buffers until such time that a clearing ordinance is adopted.

- King County will adopt the Executive Proposed Basin Plan for Hylebos Creek and the lower Puget Sound policy on vegetation retention which states that significant trees should be identified during the platting process and retained, that significant natural vegetation should be retained, and the retained vegetation areas should be clearly and permanently marked on the site, identified on all maps, and have legally binding restrictions. Long term monitoring for water quality trends should be performed to assess trends associated with increased urbanization.

**Discussion**: The community plan and zoning are primary tools for protection of aquifer recharge areas. Largely as a result of the 1990 Growth Management Act, changes are underway in the manner in which aquifer recharge areas are treated in King County. For example, recommendations have been made to the King County Comprehensive Plan review committee that the sections of the Comprehensive Plan pertaining to aquifer recharge be revised. These revisions have been requested to help preserve aquifer recharge.

**Implementation:**

**Task 1:** Amend Comprehensive Plan Policy E-337.

**Task 2:** Consider adopting a clearing ordinance.

**Task 3:** Adopt interim development standards.

**Task 4:** Adopt Hylebos Basin Plan as written.

| | |
|---|---|
| Who: | Tasks 1, 2, 3, 4: King County |
| When: | Task 1 during comprehensive plan update. |
| | Task 2 and 3 per implementation schedule. |
| | Task 4 when County review is accomplished. |
| Costs: | No additional costs are anticipated for these tasks. |

| | |
|---|---|
| Who: | Tasks 2 and 3: cities. |
| When: | As per implementation schedule. |
| Costs: | No additional costs are anticipated. |

> **WQ-1B Policies and Ordinances:** Petition the Department of Ecology to amend the State Environmental Policy Act checklist to include analysis of impacts on the quantity of aquifer recharge. Until the change by Ecology can be formally made, the cities, King County, and other reviewing agencies will consider impacts on the quantity of aquifer recharge during State Environmental Policy Act checklist review.

**Discussion:** Revising the State Environmental Policy Act checklist would reflect a growing concern for protection of ground water resources in general and, particularly, in critical recharge areas. The cost of addressing the expanded checklist would be carried primarily by project proponents. Additional costs could arise associated with increased work loads of checklist reviewers at King County and the cities, possibly necessitating addition of staff for State Environmental Policy Act document review. These costs would be offset by related increases in review fees.

**Implementation:**

**Task 1:** Revise State Environmental Policy Act checklist.

| | |
|---|---|
| Who: | Ecology, through rule revision. |
| When: | As per implementation plan. |
| Cost: | $3,500 per year. |
| Funding Source: | General Agency funds. |

**Task 2:** Impacts on the quantity of aquifer recharge during State Environmental Policy Act checklist review will be considered.

| | |
|---|---|
| Who: | Cities, King County, and other reviewing agencies. |
| When: | As per implementation plan. |
| Cost: | King County $4,000; Redmond $2,048. |
| Funding Source: | General Agency Funds. |

**Issue 2 - Data Needs.** There is a significant level of need for a complete characterization of aquifer resources. This information is needed by Ecology for water rights application analysis, surface water/ground water interaction determinations, possible ground water reservation, and other resource management decision making processes and concerns. To date, this has not been completed.

> **WQ-2A Data Needs:** Design and implement a ground water data collection management program which would enable Ecology and others who make land and water use decisions (such as purveyors, land use planners, and public officials) to make water resource decision based on more complete information.

**Discussion:** The Ground Water Management Plan started the development of data necessary for ground water resource characterization, including resource capability. However, a two to three year study is not long enough to collect all of the data necessary upon which to base sound resource decisions. Ecology, King County, and utilities need this information for a variety of ground water resource management purposes. If this information is not obtained, then decisions will be based on incomplete or inaccurate data. Specific descriptions of needed data will be in the Data Collection and Management Program, and will be based upon recommendations of the state Data Management Task Force.

**Implementation:**

**Task 1:** Ground water data collection management program will be designed and implemented.

| | |
|---|---|
| Who: | King County and cities through the Management Committee. |
| When: | As per implementation schedule. |
| Cost: | To be determined. (See Data Collection and Management section.) |
| Funding Source: | Aquifer Protection Fund. |

**WQ-2B Policies and Ordinances:** The Redmond-Bear Creek Ground Water Advisory Committee supports the Department of Ecology's Sea Water Intrusion Policy.

**Discussion:** Sea water intrusion may be a problem, or may become a problem, in the coastal areas of King County. Support for the Sea Water Intrusion Policy and collecting chloride data in the Data Collection and Management Program will help in implementing the policy in King County in the future.

**Implementation:**

**Task 1:** Include a statement of support in the Final Ground Water Management Plan. There is no additional cost for this action.

**Issue 3 - Water Rights.** Water rights records do not necessarily accurately reflect actual pumpage rates and current use of ground water resource.

**WQ-3A Water rights:** Utilities will update their water right records and submit them to the Department of Ecology as per the recommended program in the "Five Year Water Resource Data Management Plan."

**Discussion:** Water right records could be a much better tool in ground water management if the individual water rights more clearly reflected actual use and if unused rights were voluntarily or involuntarily relinquished and eliminated from the records. Utility records of water rights need to be updated and reported to Ecology to help influence policy decision. The Five Year Water Resource Data Management Plan's "Activity 10.2, Standardize Water Use Reporting," will provide for a standard method for organizations that report water use to use. This activity will specify the data to be collected, acceptable methods of data collection, and frequency of collection. This plan is designed to address the needs of Ecology, King County, and utilities for a variety of ground water resource management purposes. If this information is not obtained, then decisions will be based on incomplete or inaccurate data.

**Implementation:**

**Task 1:** Water use records will be updated and reported to Ecology as per the Five Year Water Resource Data Management Plan.

| | |
|---|---|
| Who: | Water users. |
| When: | As per the Plan. |
| Cost: | To be determined during concurrence. City of Redmond: $10,240. |
| Funding Source: | General agency funds. |

**Issue 4A - Conservation.** Conservation has been shown to have a positive impact on ground water resources. There are some conservation methods that could be implemented to enhance current programs. The draft King County landscaping ordinances have been proposed, but they may not be adopted. King County Board of Health regulations for small water systems do not include conservation elements.

Ground water may be conserved through implementation of effective demand reduction techniques. Conservation of water supplies is essential to the proper management of ground water resources.

> **WQ-4A1 Conservation:** King County will adopt the proposed landscaping ordinances to encourage conservation for new development. Landscaping plans should incorporate native growth areas, use of plant species which are drought tolerant, water efficient irrigation technologies, soil amendments, and limitations on the amount of allowable turf. Cities will consider adopting similar ordinances.

**Discussion:** Including conservation measures in the landscaping ordinance will ensure that water conservation is considered during the planning of a development. Otherwise, subsequent owners may have to retrofit conservation measures.

> **WQ-4A2 Conservation:** Seattle-King County Department of Public Health Environmental Health Division will propose a revision to regulations for existing, new, or expanded Group B Public Water Systems to address water conservation goals and measures for King County Board of Health consideration.

**Discussion:** The proposed regulations would address a gap in the conservation planning requirements. A system that is not in a Coordinated Water Supply Plan Area (Critical Water Supply Service Area), with less than 1,000 connections, and not under Utilities Technical

Review Committee review is not required to prepare a conservation element in a comprehensive plan. The proposed regulations would address this type of system.

Revising the Small Public Water System Regulations would include requiring water source meters, individual meters, and other items listed under the *Guidelines for Public Water Systems Regarding Water Use Reporting, Demand Forecasting Methodology and Conservation Programs* (March 1994). Existing Group B Public Water Systems could be required to retrofit with meters (source and individual) within 5 years of regulation adoption. New and Expanding Group B systems could be required to comply with requirements upon initiation or completion of expansion.

> **WQ-4A3 Conservation:** Seattle-King County Department of Public Health Environmental Health Division will propose regulations for new and existing individual wells incorporating conservation measures, including source meters, for King County Board of Health consideration.

**Discussion:** New regulations for individual wells would incorporate conservation measures. These would include requiring individual wells to retrofit with a source meter at the time of property sale and title transfer. New individual wells will have a source meter installed at time of initial well completion and approval. Meters provide a method to monitor and record water use.

**Implementation:**

**Task 1:** Adopt/consider landscaping ordinance. (WQ-4A1)

**Task 2:** Propose and consider changes to Title 12. (WQ-4A2)

**Task 3:** Propose and consider individual water system regulations. (WQ-4A3)

| | |
|---|---|
| Who: | Task 1: King County and cities. |
| When: | As per implementation schedule. |
| Cost: | To be determined. King County $8,160. |
| Funding Source: | General Agency funds. |

| | |
|---|---|
| Who: | Task 2, 3: SKCHD Environmental Health Division and King County Board of Health. |
| When: | As per implementation schedule. |
| Cost: | 160 hours, $8,160. |
| Funding Source: | Aquifer Protection Fund. |

**Issue 4B Education.** Education has also been shown to have a positive impact on ground water resources. The following educational activities need to be included in the Education Section.

**WQ-4B1 Education:** King County, the cities, and water utilities will work with local nurseries, Washington State University Cooperative Extension Service, and the Conservation District to promote the availability of appropriate seed stocks, plants, and materials to implement xeriscaping (use of low-water use plants).

**WQ-4B2 Education:** Support conservation education efforts in the schools and for the general public as described in the Guidelines (*Guidelines for Public Water Systems Regarding Water Use Reporting, Demand Forecasting Methodology, and Conservation Programs*). These would include, but not be limited to, the items listed on page 24 of the Guidelines.

**WQ-4B3 Education:** King County will educate residents about landscaping practices that promote aquifer recharge through an informational brochure prepared by Cooperative Extension and Seattle-King County Department of Public Health Environmental Health Division.

**Discussion for WQ-4B1, WQ-4B2, and WQ-4B3:** Educational efforts would complement and combine with current efforts of the SKCHD Environmental Health Division, Cooperative Extension, and the Conservation District. This information could be disseminated through the Master Gardener and other programs of Cooperative Extension. Awareness of the problem of reduced aquifer recharge may increase responsibility and concern for aquifer recharge areas in the community. Educational programs on how landscaping practices can affect aquifer recharge could be coupled with education on the effects of pesticide and herbicide use on ground water quality. A discussion of proper disposal of household hazardous wastes could be included. Landscaping tips should include a discussion of native vegetation and its role in facilitating infiltration of moisture.

**Implementation:**

WQ-4B1, WQ-4B2, and WQ-4B3 to be implemented as per Education section.

**Issue 4C Artificial recharge.** Artificial recharge is a new technique that is being tried in this area. However, not enough is known about the possible benefits of long-term artificial recharge.

**WQ-4C1 Artificial recharge:** Purveyors should investigate artificial recharge programs.

**Discussion:** The main function of artificial recharge is to replenish aquifers during winter months when stream flows exceed minimum instream flow requirements. Replenished aquifers could be pumped during summer periods to meet local peak demands. This would reduce seasonal demands placed on a ground water system during the summer and late fall months. The South King County Grant No. 1 identified potential recharge sites in Federal Way, Auburn, and the Covington Upland. Site specific investigations are required before suitability is established. The Seattle Water Department's Highline Project may serve as a model for other programs.

**Implementation:**

**Task 1:** Investigate Artificial Recharge.

| | |
|---|---|
| Who: | Public water systems. |
| When: | Per their needs and timeframes. |
| Cost: | To be determined. City of Redmond: $10,240. |
| Funding Source: | General Agency/utility funds. |

**Issue 4D - Decline Limits.** Water level decline limits are set by Ecology and can be an effective tool for managing the resource. Ecology needs long-term information in order to set decline limits.

> **WQ-4D1 Decline Limits:** The Department of Ecology shall review the information collected through the Data Collection and Management Program and make recommendations for the purpose of preventing further declines, or restoring predecline levels, and maintaining safe sustainable yields. All jurisdictions shall then follow the appropriate mitigation actions as recommended by Ecology.

**Discussion:** State-wide activities, such as the Water Resources Forum, are addressing this and other water resource issues. Ecology will be guided by the Forum for its future actions regarding the establishment of decline limits. Ecology has the authority to set allowed decline limits. However, it requires dependable data upon which to base such a decision. The Data Collection and Management Program will collect data on water levels which Ecology can use in evaluating decline limits.

**Implementation:**

**Task 1:** Review water level information collected through the Data Collection and Management Program to determine if decline limits are necessary.

| | |
|---|---|
| Who: | Ecology. |
| When: | As per implementation schedule. |
| Cost: | $280,000 over two years. |
| Funding Source: | General agency funds. |

Chapter 4. Recommended Implementation Process

# CHAPTER 4 - RECOMMENDED IMPLEMENTATION PROCESS FOR THE GROUND WATER MANAGEMENT PROGRAM

## 4.1. INTRODUCTION

The ground water management planning process has been funded by Centennial Clean Water Fund grants administered by the Washington State Department of Ecology (Ecology) and contributions from King County, cities, and water utilities. However, implementation of the Ground Water Management Plan (GWMP) depends upon long term funding and appropriate assignment of responsibility. Executive and legislative branches of government and other public and private interests have important roles in the implementation of the GWMPs to protect ground water quality and quantity. The recommended implementation process described in this chapter assigns roles and tasks and proposes a source of funding. Topics addressed include: Legislative Authority; Funding; Washington Department of Ecology; Ground Water Management Committee; Ground Water Advisory Committee; Lead Agency; Implementation Plan; Process to Consolidate GWMPs in King County; and Process for Evaluation and Revision of the GWMP.

Summary tables (Section 4.8) list actions to be taken during plan implementation. These tables also list priorities, who is responsible for implementation, cost, source of funds, and an approximate schedule for commencing and completing the work.

Two significant developments occurred during the planning process that had a profound influence upon the GWMPs. Both occurred after scopes of work for the GWMPs were adopted, and both necessitated major shifts in policy development.

The first is the Growth Management Act which was passed by the Washington legislature in 1990. This act requires local governments to identify and protect areas that are critical for aquifer recharge.

The second is wellhead protection requirements mandated by the 1986 amendments to the Safe Drinking Water Act. The amendments require states to develop Wellhead Protection Programs. The Wellhead Protection Program has been developed in Washington by the Department of Health. The draft program requires public water system purveyors to delineate wellhead protection areas for each public water system and develop programs to protect ground water in those areas.

Both the Growth Management Act and the Wellhead Protection Program include specific provisions that must be carried out at the local level. The Ground Water Advisory Committees (GWACs) have tried to accommodate and, where appropriate, incorporate the provisions of the Growth Management Act and the Wellhead Protection Program into the GWMPs. For example, some GWMP recommendations are county wide in applicability rather than limited to specific Ground Water Management Areas (GWMAs). This is in keeping with the directive of the Growth Management Act to local governments to cooperatively protect aquifer resources on a county or regional basis. The GWMPs are designed to accommodate other ground water protection activities in King County that are expected to occur in response to both the Growth Management Act and the Wellhead Protection Program.

## 4.2. LEGISLATIVE AUTHORITY

Legislative authority is needed to adopt both the GWMPs and the ordinances that may be necessary to implement them. The legislative authorities for implementation are the Metropolitan King County Council, the King County Board of Health, affected city councils and others.

### 4.2.1. Metropolitan King County Council

As of January 1994, the Metropolitan King County Council consists of 13 members. The Metropolitan King County Council is the policy determining body of the county and has all legislative powers of the county. The Metropolitan County Council exercises its legislative power by adoption and enactment of ordinances; by levying taxes, appropriating revenue and adopting budgets; and other powers as described in the King County Charter Section 220.20 (King County Charter, Sections 220 - 270).

### 4.2.2. Seattle-King County Board of Health

The Seattle-King County Board of Health was established based upon RCW 70.07.030, which authorizes the board of county commissioners to be the local board of health for the county. Also, King County Ordinance # 11178 (December 20, 1993) established the Metropolitan King County Council as the Board of Health for King County. The director of the department of public health is designated as the administrative officer for the board, and provides staff support to the Board for carrying out its duties and responsibilities. The board has supervision over all matters pertaining to the preservation of life and health of the people of the county. This includes:

- Supervising the maintenance of all health and sanitary measures for the protection of the public health of the county;
- Enacting such county rules and regulations as are necessary in order to preserve, promote, and improve public health, and provide for the enforcement thereof; and
- Establishing fee schedules for issuing or renewing permits or for such other services as are authorized, provided that such fees or services shall not exceed that actual cost of providing any such services. Fee schedules shall be established by board rules and regulations.

### 4.2.3. Affected City Councils and Others

City councils, elected by the citizens within the city boundaries, are the legislative body for the incorporated cities. They have similar powers and authority as the county council; most importantly, they are the land use and policy bodies for the incorporated cities. Other administrative bodies include the Board of Commissioners for Water Districts, Sewer Districts, and Water Associations. These Boards set policies and rates for the provision of water and sewer service within their service areas.

**Recommendation:** The GWACs recommend that legislative authority for adoption and implementation of the GWMPs be shared between the Metropolitan King County Council, the King County Board of Health (King County Board of Health), and affected city councils. These legislative bodies are needed to implement the plans because they encompass actions that are typically under the purview of one but not the others. King County Board of Health authority is particularly important because it allows for the adoption of ordinances that are effective in both the unincorporated areas and in the cities of King County. (The City of Seattle is an exception. It has its own Board of Health.) Roles of each legislative authority are recommended as outlined below:

Metropolitan King County Council:

- Review and prepare findings on the Draft GWMPs;
- Recommend a final Draft GWMP to the Washington Department of Ecology (Ecology) upon concurrence by the King County Board of Health, affected governments, and agencies;
- Adopt the GWMP after it has been certified by Ecology;
- Appoint members to a the Ground Water Management Committee (Management Committee) from nominees provided by entities represented (see note i.);
- Adopt revisions to the GWMP, subject to concurrence by the Management Committee, the King County Board of Health, and affected governments and agencies;
- Allocate aquifer protection funds subject to concurrence by the Management Committee, the King County Board of Health, and affected governments and agencies; and
- Adopt ordinances necessary for the implementation of the GWMP (generally addressing such matters as land use, zoning, and regulations governing the activities of county agencies).

King County Board of Health:

- Adopt an ordinance providing long term funding for the implementation of the GWMP; and
- Adopt ordinances necessary for the implementation of the GWMPs (generally addressing activities regulated by the Seattle-King County Health Department, Environmental Health Division, (e.g., on-site sewage disposal, small public and private drinking water systems, wellhead protection, and solid waste disposal).

City Councils:
- Review and prepare findings on the Draft GWMP;
- Adopt the GWMP after it has been certified by Ecology;
- Adopt ordinances as needed to implement the GWMP within city limits; and
- Adopt revisions to the GWMP.

Others:
- Adopt the GWMP after it has been certified by Ecology;
- Adopt measures as needed to implement the GWMP within their jurisdiction; and
- Adopt revisions to the GWMP.

## 4.3. FUNDING

A major source of long-term funding must be developed in order to implement the GWMPs. This source of funding would be augmented by grants and any specific use or service fees. Tables 4.8.1. and 4.8.2. in section 4.8. indicate actions for which grants and specific use/service fees are appropriate.

There are a variety of methods to provide funding source, including establishing an Aquifer Protection Area (RCW 36.36), King County Board of Health adopting a Rule and Regulation, Metropolitan King County Council adopting an ordinance, or establishing surface water utility agency fees.

Part of deciding what method will provide the funding source includes determining who the funds will be collected from. This could include ground water users, contamination source owners, or all parcels in the GWMA. Another decision is how to physically collect the funds.

**Recommendations**: The GWAC recommends that users that benefit should support the GWMP. Users of the ground water resource are water utilities, water districts, water associations, small water systems, individual water systems, industries, irrigators, and (perhaps) surface water utilities.

The GWAC recommends that funds should be collected from these users based upon an allocation of the cost of implementing the Plan over the Equivalent Residential Units (ERU) of water each uses. Plan implementers that have fee collection systems in place (water utilities, districts, some associations) should collect the allocated amount from their customers. It needs to be determined if surface water utilities should be included. If they are, they should collect their portion as do water utilities. Other ground water users, that do not have fee collection systems, (some associations, small water systems, individual systems, industrial and irrigation) should be identified and their allocation be included in the property tax statement.

The GWAC recommends that King County establish a fund for collection and disbursement of the money. Plan implementers should contract with the County using interlocal agreements as to the amount of money to be collected and what their activities will be.

The GWACs recommend that the King County Board of Health adopt an ordinance providing for long term funding of the GWMPs incorporating the following features:

- Funding should be adequate to implement the adopted GWMPs;
- The source of funds should be aquifer protection fees paid by persons who use ground water withdrawn from a GWMA;
- The aquifer protection fee should be related to how much water is used;
- Aquifer protection fees should be deposited in a dedicated aquifer protection fund established by King County;
- A fixed percentage of aquifer protection funds should be set aside for public water system purveyors to implement elements of an approved Wellhead Protection Program that are not already implemented by inclusion in the GWMPs;
- The fee structure should be flexible to account for fluctuations in water use that might produce budget shortfalls;
- The amount of the fee should be subject to amendment when the GWMPs are revised; and
- The fee should be collected by public water system purveyors in routine customer billings whenever possible.

Determination of the aquifer protection fee involves several steps. First, the costs of program elements are carefully estimated. Then, the costs of the implementation of all GWMPs in King County are added together. Finally, the costs that can be funded by grants or special use/service fees are deducted. The resulting amount is the total that is supported by Aquifer Protection Funds.

The aquifer protection fee will be based on equivalent residential units (ERU). ERUs are a unit of water that water utilities often use in setting rates. A typical residence uses and is billed for one ERU. A small business might be billed for anywhere from one to several ERUs. An aquifer protection fee per ERU would automatically provide cost distribution according to the amount used.

Cost estimates for GWMP elements are shown in Tables 4.8.1. and 4.8.2. It is estimated that the aquifer protection fee to support implementation of the GWMP per single family residence in the affected cities and in King County will be $__ [to be included in the Final GWMPs, after concurrence]. The cost for businesses is estimated to be $__ per ERU [to be included in the Final GWMPs, after concurrence]. Cost estimates will be refined to enable the King County Board of Health to establish the aquifer protection fee.

## 4.4. WASHINGTON DEPARTMENT OF ECOLOGY ROLE

The certified GWMPs will be codified in the Washington Administrative Code (WAC). As such, it is a regulation that Ecology is responsible for administering. Ecology will rely on local government cooperation to implement the Plans but may assist the lead agency, if needed, to gain compliance with provisions of the adopted Plans.

## 4.5. GROUND WATER MANAGEMENT COMMITTEE

The GWACs recommend the formation of a Ground Water Management Committee (Management Committee) that will coordinate ground water protection activities in the GWMAs. The Management Committee will be advised by the GWAC, at it's discretion, for a period of three years after certification of the GWMP by Ecology.

The Management Committee will carry out the following tasks:

Allocation of Aquifer Protection Funds:
- Review, amend as necessary, adopt, and recommend to the King County Board of Health an annual allocation of Aquifer Protection Funds based upon the adopted implementation plans for the GWMPs.

Monitor the implementation of the GWMPs:
- Review annual reports on implementation prepared by the lead agency; and
- Determine whether implementation is adequate and whether changes are needed in priorities, monitoring, reporting, etc., during the implementation period.

Update the GWMP:
- Act as a forum to consider new or ongoing ground water protection issues of significance to all GWMAs;
- Determine whether revisions are needed to the GWMP; and
- Review, amend as necessary, adopt, and recommend for adoption by the Metropolitan King County Council, King County Board of Health, and city councils an updated GWMP three years after certification of the original GWMP by Ecology.

Perform tasks as assigned in the GWMPs, such as: facilitating wellhead protection in King County; determining categorical exemptions to State Environmental Policy Act (SEPA) that should be eliminated in Aquifer Protection Areas; and development of guidance documents to assist environmental reviewers in King County and cities.

The Management Committee should consist of a core committee of 5 - 7 members for each GWMA, including a representative from the GWAC, the Seattle-King County Health Department (SKCHD), a suburban city in the planning area, a tribal nation in the planning area, a water purveyor, and a private citizen. These core committees should meet regularly to provide oversight to the implementation, to ensure that the budget process is performed in a fair and equitable manner, and to address the topics as assigned in the GWMP (referred to as the Management Committee in the management strategies). The members should be representative of the implementers (agencies that have interlocal agreements with King County). The core committees should work independently on some topics, but may join together for county-wide programs. They should solicit information and participation from experts and interested parties as necessary.

**Public Involvement**: Interested public groups and individuals should be kept informed of the core committee work and implementation progress by inclusion on a notification list. Those on the list should receive core committee meeting agenda and minutes and routine updates on the GWMP progress. The core committee meetings should be open to the public, if they wish to attend. Also, if the core committee is aware of an agency or individual that has an interest in a topic under discussion, they should be invited to attend. Elected officials should also be included on the notification list. Elected officials may also have the opportunity to have presentations on the GWMP progress.

**Dispute Resolution**: There should be a process for dispute resolution, either for implementers or for interested agency/individuals. The first step in dispute resolution should be with the core committee. If the aggrieved party wishes, then the Dispute Resolution Group should meet with the party. The Dispute Resolution Group should consist of the chair of each of the core committees.

**Bylaws**: Decisions of the Management Committee will be by consensus whenever possible. Procedures for resolving lack of consensus should be adopted by the committee for inclusion in its bylaws. Management Committee bylaws should include a provision stating that GWAC recommendations will be carefully and promptly considered and followed by a written response.

Individual members of the Management Committee will have the responsibility to coordinate internally with the entity represented. For example, a representative of a city needs to communicate and coordinate with their council, and public works, planning, building departments, and other affected departments regarding ground water management issues.

The Management Committee may make use of subcommittees to accomplish some tasks due to its size. For example, a subcommittee might address the topic of hazardous materials transport through aquifer protection areas. Federal and state agencies will be asked to serve in a technical capacity, as appropriate, on the subcommittees.

Water purveyors relying on a ground water source are asked to contribute to technical subcommittees formed to advise the Management Committee regardless of whether the system is located in a GWMA. The reason is that subcommittees will be deliberating upon issues that will affect all ground water purveyors, not just those in GWMAs. An example of such an issue is minimum wellhead protection for public water systems in King County. The existing GWMP will fulfill many wellhead protection needs. Minimum wellhead protection strategies developed by the Management Committee will add to what is already contained in the GWMP. It is also expected that individual purveyors will have system specific needs that they will want to include in their own wellhead protection programs. The funding proposal outlined in Section 4.3. includes financial support for those programs. Further discussion regarding wellhead protection is contained in Chapter 3, Special Areas.

## 4.6. GROUND WATER ADVISORY COMMITTEE

The GWACs were established to develop the GWMPs. After a Plan is certified by Ecology, the GWAC's duties, as described in WAC 173-100, are complete. However, successful implementation of a GWMP depends upon support by the affected agencies and the community.

The GWACs recommend that the GWAC will continue to meet at its discretion for up to three years from the date that the GWMP is certified by Ecology. The role of the GWAC is to monitor implementation of the GWMP and to make recommendations to the Management Committee via its representative. The GWAC will also review and comment upon the first GWMP update.

## 4.7. LEAD AGENCY

Implementation of the GWMP will require staff to perform day-to-day tasks. The staff should be familiar with the GWMP, data base management, GWMA concerns, budget process, and be technically capable. The staff should provide administrative functions to the satisfaction of the Management Committee and the legislative authorities.

The GWAC recommends that the SKCHD serve as lead agency for the implementation of the GWMPs.

In fulfilling its role as lead agency, SKCHD will:

- Refine cost estimates of the GWMPs in consultation with implementing governments and agencies;
- Assist the King County Board of Health in determining the amount of the aquifer protection fee;
- Prepare an annual proposed allocation of the Aquifer Protection Fund, based upon the

adopted GWMP implementation plans, for review and adoption by the Management Committee, King County Board of Health, affected governments and agencies, and the Metropolitan King County Council;

- Ensure that funds are disbursed per the adopted allocation plan to implementing agencies and governments;
- Provide staff support to the Management Committee and the GWACs;
- Monitor the implementation of the GWMPs;
- Prepare annual implementation reports for the review of the Management Committee and GWACs;
- Implementation of elements of the GWMPs as assigned to the lead agency by adopted implementation plans;
- Coordination of implementation of multi-jurisdictional program efforts such as data collection and Aquifer Protection Area mapping;
- Bring issues to the attention of the Management Committee;
- Coordinate implementation with the King County Surface Water Management Division Basin and Non-point Pollution Planning Program in order to optimize use of resources in achieving program goals; Coordinate with other King County planning processes;
- Coordinate with federal, state, and local agencies regarding ground water protection;
- Coordinate the process for revision of the GWMPs:

    Prepare draft update of the GWMPs for review, amendment as necessary, and approval of the Management Committee;

    Hold public hearings;

    Submit draft updates of the GWMPs to the Metropolitan King County Council and carry out the process of obtaining concurrence from affected governments and agencies; and

- Carry out other tasks that are determined to be appropriate.

## 4.8. IMPLEMENTATION PLAN

GWAC implementation priorities are listed in the Implementation Plan included as Tables 4.8.1. and 4.8.2. Prioritization enables the GWACs to ensure that ground water protection is maximized in the near term. The schedule contained in the Implementation Plan provides a framework within which all governments and agencies can plan their GWMP implementation activities.

Tables 4.8.1 and 4.8.2 are designed to conveniently communicate important facts about the implementation process. Each table lists, in relation to a specific action, its priority, who will be responsible for carrying it out, how much it will cost, what the source of funding will be, and approximately when it will be accomplished. The first table is organized by GWAC - determined priority. The second is organized by the agency or government that will be responsible for implementing the action.

## 4.9. PROCESS TO CONSOLIDATE GWMPs IN KING COUNTY

It is recommended that GWMPs in King County be consolidated into one program at the time that individual GWMPs come due for evaluation and revision. This will occur three years from the date that Ecology certifies each GWMP. GWMPs will be phased into the county-wide plan since certification dates may vary. The current GWMPs have provided a strong basis for extending the program into the rest of the county. The existing plans have been developed with interagency coordination and by a broad spectrum of community interests.

Reasons for consolidation include:

> The emergence of the federal/state Wellhead Protection Program that requires each public water system purveyor to delineate a Wellhead Protection Area and develop an individual Wellhead Protection Program;
>
> The emergence of the Growth Management Act of 1990 that requires coordinated protection of aquifer resources on a county wide basis; and
>
> A preponderance of similar basic ground water protection needs in the separate GWMAs.

It is envisioned that the county-wide plan would primarily serve as a tool to coordinate ground water protection activities, the bulk of which are common to all GWMAs.

Wellhead protection programs, in conjunction with GWMP programs and regulations, will become the basin-specific ground water protection activity. It is seen as redundant and confusing to continue basin-specific GWMPs in light of the wellhead protection requirements.

To facilitate development of county-wide ground water program elements, such as the well head protection program, a ground water Management Council, consisting of each GWMAs Management Committees, will be formed.

County-wide wellhead protection strategies will be developed by the Management Council for inclusion in the county-wide GWMP. Public water system purveyors will play a strong role in developing these strategies. Inclusion of wellhead protection strategies in the GWMP will make them eligible for funding under the aquifer protection fee. It is expected that individual purveyors may still have a need for water system specific measures that are not included in the county-wide GWMP. They will be responsible for implementation of such measures although the county-wide funding mechanism would provide financial support. Refer to Chapter 3 for a detailed discussion of the Wellhead Protection Program.

The county-wide plan, containing wellhead protection strategies, would meet the Growth Management Act requirement for a coordinated effort among local governments to protect aquifer resources. The lead agency will draft the county wide GWMP for the review, amendment, and adoption by the Management Council, affected local governments, and the Metropolitan King County Council.

Citizens will have the opportunity to provide input to ground water protection decisions through:

- input at GWAC meetings;
- water utilities (public input is required in the development of wellhead protection programs); and
- public hearings for plan adoption, revision, and implementation ordinances.

## 4.10. PROCESS FOR EVALUATION AND REVISION OF THE GWMP

A process for periodic evaluation and revision of the GWMP is established in order to ensure that the goals of the GWMP are achieved efficiently under changing conditions.

The Management Committee, the GWACs, SKCHD, and governments and agencies affected by the GWMP will be involved in the evaluation and revision of the GWMP. The first revision will be considered three years from the date of GWMP certification by Ecology. Subsequent revisions will be considered on five year intervals unless the Management Committee determines that more frequent updates are needed.

The concurrence process will be initiated by SKCHD following adoption of revisions by the Management Committee. Public hearings will be held as required by law. The draft update will be submitted to the Metropolitan King County Council for review, amendment, and adoption when all affected governments and agencies have concurred.

GWMP updates at time intervals smaller than three years should be avoided due to the lengthy process of review, public hearings, concurrence, and adoption. Other mechanisms may be used to implement short term changes either in substance or priority. For example, a grant could be sought to carry out a specific new task that the Management Committee feels is urgent but which is not included in the current GWMP. Alternatively, GWMP priorities could be changed in order to step up activity related to an issue that the Management Committee determines is more urgent than others.

SKCHD will assist the Management Committee in its evaluation of the GWMP by preparing annual implementation reports. These reports will cover such topics as:

- Progress in implementing plan elements in comparison with established priorities and schedule;

- Problems encountered in implementation of specific program elements;

- Proposed revisions or priority adjustments to address problems encountered in implementation; and

- Changes in federal, state, or local laws impacting the GWMP.

The Management Committee will use the reports, as well as its own deliberations and the recommendations of the GWAC, to determine whether and how GWMP should be modified when it is updated. SKCHD will incorporate proposed revisions into the draft county-wide GWMP.

## TABLE 4.8.1 - IMPLEMENTATION PLAN ORGANIZED BY PRIORITY[1]

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 new prog | WQ - 4A1 Conservation | King County | TBD | | | | General Funds | 1 |
| 1 new prog | WQ - 4A1 Conservation | City of Redmond | 10,240 | | | | Redmond General Funds | 1995 |
| 1 form agree | WQ - 3A Water rights | NE Sammamish | | 500 | | | General Agency Funds | 1, ongoing |
| 1 new prog | WQ - 4A2 Conservation | SKCHD | 8160 | | | | General Funds | As per schedule |
| 1 res | WQ - 2A Data Needs | SKCHD in DCMP (See DCM-1) | | | | Aquifer Protection Fund | | 1 |
| 1 support | WQ - 2B Policies and Ordinances | GWAC | N/A - support is stated in GWMP | | | | N/A | 1 |
| 1 form agree | WQ - 3A Water rights | City of Redmond | 2,048 | | | | General Agency Funds | 1 |
| 1 new prog | WQ - 4A3 Conservation | SKCHD | 8160 | | | Aquifer Protection Fund | | 1 |
| 1 reg | WQ - 1B Policies and Ordinances | King County | | | 4,000 | | General Funds | 1 |
| 1 reg | WQ - 1B Policies and Ordinances | Ecology | 3,500 | 3,500 | 3,500 | | General Funds | 1 |

[1] All costs are estimates.

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | WQ - 1A Policies and Ordinances | City of Redmond | N/A, to be done as part of update or adoption | | | | Redmond general funds | 1 |
| 1 support | WQ - 4C1 Artificial recharge | NE Sammamish | No additional costs: possible future project | | | | Agency Funds | Purveyors time frame |
| 1 support | WQ - 4C1 Artificial recharge | Union Hill | No additional cost[2] | | | | Agency Funds | Purveyors time frame |
| 1 support | WQ - 4C1 Artificial recharge | City of Redmond | 10,240 | | | | Agency Funds | Purveyors time frame |
| 1 form agree | WQ - 3A Water rights | Union Hill | 500 | | | | General Agency Funds | 1, ongoing |
| 1 support | WQ - 1A Policies and Ordinances | King County | N/A, to be done as part of update or adoption | | | | | 1 |
| 1 reg | WQ - 1B Policies and Ordinances | City of Redmond | 2,048 | | | | Redmond General Funds | 1 |
| 1 new prog | DCM - 2 Data Collection, Analysis and Management | Ecology | 7,000 | 7,000 | 7,000 | | General Agency Fund | 1+ ongoing |

[2]The MPD progess will influence when and how this is done.

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | Education<br>PF - 2A Education and Proposed Programs<br><br>PF - 2B Education and Proposed Programs<br><br>ST - 3 Education<br><br>OS - 3B Household Hazardous Wastes<br><br>SW - 4 Education<br><br>UST - 3E Heating Oil Tanks<br><br>WC - 4 Education<br><br>WQ - 4B1 Xeriscaping<br><br>WQ - 4B2 Conservation<br><br>WQ - 4B3 Landscaping | SKCHD | 325,728 | 330,000 | 335,000 | Aquifer Protection Fund | | 1+ ongoing |
| 1 support | Education | GWAC | N/A - stated in GWMP | | | | | 1+ ongoing |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 new prog | DCM - 1 Data Collection, Analysis and Management | King County: SKCHD Task 1 & 2: 24,000 Task 3: 104,400 Task 4: 104,400 | 261,000 | 261,000 | 261,000 | Aquifer Protection Fund | | 1+ ongoing |
| 1 new prog | WQ - 4D1 Decline Limits | Ecology | | 140,000 | 140,000 | | General Agency Funds | 1 |
| 1 new prog | WQ - 4D1 Decline Limits | NE Sammamish | No additional cost* | | | | $4800/yr. from General Agency Funds | 1 + ongoing |
| 1 new prog | WQ - 4D1 Decline Limits | Union Hill | 8000 | 8000 | 8000 | | General Agency Funds | 1 + ongoing |
| 1 support | Education | City of Redmond | 51,200 | | | | Redmond General Fund | 1+ ongoing |
| 1 support | Education | Woodinville | 26,000 - 49,000 | | | | Woodinville General Fund | 1+ ongoing |
| 1 support | Education | Union Hill | 2400 500 400 1500 | | | | General Agency Fund | 1+ ongoing |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | Education | NE Sammamish[3] | 3500<br>200<br>600 | 3500<br>200<br>600 | 3500<br>200<br>600 | | General Agency Fund | 1+ ongoing |
| 1 support | Education | Conservation District | No additional costs | | | | | 1+ ongoing |
| 1 support | Education | WSU Cooperative Extension Service | No additional costs | | | | | 1+ ongoing |
| 15 comp prog | SA - 1C Adoption of general aquifer protection policies | King County<br><br>Task 4: | N/A , done by concurring with GWMP | | | | General Agency Funds | 1 |
| 15 comp prog | SA - 1B Elimination of categorical exemptions to SEPA | City of Redmond Task 2: | 204,800 | | | Aquifer Protection Fund | | 1996 |
| 15 comp prog | SA - 1A Designation of Environmentally Sensitive Areas | King County | Task 1: N/A, done by Concurring with GWMP | | | Aquifer Protection Fund | | 1 |
| 15 comp prog | SA - 1A Designation of Environmentally Sensitive Areas | City of Redmond | Task 1: N/A, done by Concurring with GWMP | | | | | |

[3]NE Sammamish costs are estimates, with all costs combined into the estimate. These estimates have not been approved by the Board of Commissioners.

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 15 comp prog | SA - 1C Adoption of general aquifer protection policies | City of Redmond | 10,240 | | | | General Agency Funds | 1995 |
| 15 comp prog | SA - 1B Elimination of categorical exemptions to SEPA | King County | 52,200 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 2 Minimum Wellhead Protection | City of Redmond (Management Committee) | 10,240 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1D Enhanced environmental review to protect aquifers | King County Task 5: | 52,200 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 2 Minimum Wellhead Protection | Management Committee | TBD | | | Aquifer Protection Fund | | 1997 |
| 15 comp prog | SA - 1E Ground water recharge areas | City of Redmond | N/A: done by concurring with GWMP | | | | | |
| 15 comp prog | SA - 1D Enhanced environmental review to protect aquifers | City of Redmond | 51,200 | | | Aquifer Protection Fund | | 1996 |
| 15 comp prog | SA - 1E Ground water recharge areas | King County | N/A: done by concurring with GWMP | | | | | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | ST - 2C Ground Water Quality Concerns - Study | City of Redmond | | | 20,480 | Aquifer Protection Fund (or grant) | | 1997 |
| 2 res | ST - 2C Ground Water Quality Concerns - Study | SKCHD | | TBD | | Aquifer Protection Fund (or grant) | | |
| 2 reg | ST - 4A Coordination Between Surface and Ground Water Planning Efforts: Ecology Programs | Ecology | | 35,000 | 35,000 | | General funds | |
| 2 res | ST - 2B Ground Water Quality Concerns - Facility Requirements | City of Redmond | | | 35,840 | Aquifer Protection Fund | | 1997 |
| 2 res | ST - 2C Ground Water Quality Concerns - Study | King County (SKCHD) | | TBD | | Aquifer Protection Fund (or grant) | | |
| 2 reg | ST - 5A Roadway Runoff | City of Redmond | | No additional cost | | | General Agency Funds | |
| 2 reg | ST - 6A Soil Amendment | King County | | TBD | | Aquifer Protection Fund (or grant, other sources) | | |
| 2 reg | ST - 5A Roadway Runoff | King County | | TBD | | | General Agency Funds | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | ST - 4C Coordination Between Surface and Ground Water Planning Efforts: King County | King County (SKCHD) | | 26,000 | | Aquifer Protection Fund | | |
| 2 reg | ST - 4B Coordination Between Surface and Ground Water Planning Efforts: Puget Sound Water Quality Authority | Puget Sound Water Quality Authority | No additional costs | | | | General Agency Funds | |
| 2 res | ST - 2B Ground Water Quality Concerns - Facility Requirements | King County | | TBD | | Aquifer Protection Fund | | 2 |
| 2 form agree | WC - 1A State Program | King County | | N/A | | | N/A | |
| 2 form agree | WC - 1A State Program | Ecology | | 70,000 | | | General funds | |
| 2 res | UST - 3D Heating Oil Tanks: Location | City of Redmond through Management Committee | | No additional cost | | Aquifer Protection Fund | | |
| 2 res | UST - 3D Heating Oil Tanks: Location | SKCHD | | 26,000 | | Aquifer Protection Fund | | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 form agree | WC - 1A State Program | City of Redmond | | N/A | | | N/A | |
| 2 new prog | WC - 1B State Program | SKCHD | | 52,200 | | Aquifer Protection Fund | | |
| 2 reg | WC - 2A Well Identification | Ecology | | TBD | | | General funds | |
| 2 reg | WC - 2A Well Identification | City of Redmond through the Management Committee | | No additional cost | | | General funds | |
| 2 reg | WC - 2A Well Identification | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 new prog | WC - 1B State Program | Ecology | | 70,000 | 70,000 | | General Agency Funds | |
| 2 res | UST - 3C Heating Oil Tanks: Abandonment and Maintenance | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 res | UST - 3A Heating Oil Tanks: Local Legal Authority UST - 3B Heating Oil Tanks: State Code Amendment | Ecology | | 1,750<br>5,000 | 100,000 | Aquifer Protection Fund | | TBD |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | WC - 2B Well Identification | City of Redmond | | No additional cost | | | General funds | |
| 2 reg | WC - 2B Well Identification | Ecology | | 17,500 | 35,000 | | General funds | |
| 2 res | WC - 3A Abandonment cost | SKCHD, through Management Committee | | | 13,080 | Aquifer Protection Fund | | |
| 2 res | WC - 3B Abandonment cost | Ecology | | 5,000 | 10,000 | | Agency funds | Next WAC revision |
| 2 pol | UST - 1A, 1B Augment State UST Program | SKCHD | 53,244 | 53,244 | 53,244 | Aquifer Protection Plan | Fees | 1,2,3 |
| 2 pol | UST - 1A, 1B Augment State UST Program | City of Redmond, through Management Committee | | No additional cost | | | Fees | 1,2,3 |
| 2 res | UST - 3A Heating Oil Tanks: Local Legal Authority UST - 3B Heating Oil Tanks: State Code Amendment | SKCHD, through Management Committee | | 16,000 | | Aquifer Protection Fund | | TBD |
| 2 reg | UST - 2B Exempt Tanks | SKCHD | | 8000 | | Aquifer Protection Fund | | TBD |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | UST - 2A Exempt Tanks | SKCHD, through Management Committee | | 8000 | | Aquifer Protection Fund | | As per schedule |
| 2 reg | UST - 1C Augment State UST Program | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 reg | ST - 6A Soil Amendment | City of Redmond | | No additional cost | | Aquifer Protection Fund (or grant, other sources) | | |
| 2 reg | WC - 2B Well Identification | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | City of Redmond (Task 1,2) | 25,600 | | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | Purveyors (Task 1,2) | | TBD | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | 1996 |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 5) | | | 8,000 | Aquifer Protection Fund | | 3 |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | Union Hill (Task 1,2) | | 1500 | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | NE Sammamish (Task 1,2) | 2000 | | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 2 new prog | OS - 1 Nitrate Concerns | Management Committee (Task 1,2) | | TBD | | Aquifer Protection Fund | | As per WHPP schedule |
| 2 res | HM - 5B Transportation-Related Hazardous Material Spills-Management Committee Evaluation | SKCHD (Task 4) | | | 8000 | Aquifer Protection Fund | | 3 |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | HM - 5B Transportation-Related Hazardous Material Spills-Management Committee Evaluation | Management Committee (Task 3) | | | No additional | Aquifer Protection Fund | | 3 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | Management Committee (Task 4) | | Incl in Chapter 4 | | Aquifer Protection Fund | | 3 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 3) | | 24,000 | | Aquifer Protection Fund | | 2 |
| 2 reg | HM - 2 Hazardous Waste Facilities Zones - Local designation | City of Redmond | N/A: accomplished by concurring with GWMP | | | | General Agency Funds | |
| 2 reg | HM - 2 Hazardous Waste Facilities Zones - Local designation | King County | N/A: accomplished by concurring with GWMP | | | | General Agency Funds | |
| 2 support | HM - 1 State Hazardous Waste Plan-Implementation | SKCHD | | 400 | | | | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | SKCHD (Task 3) | | 24,000 | 8,000 | Aquifer Protection Fund | | 1-3 |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | City of Redmond (Task 1,2) | | 30,720 | | | TBD | 1-3 1995 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 2) | | Included in data manage ment costs | | Aquifer Protection Fund | | Ongoing |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | King County: Emergency Management Div (Task 1) | | TBD | | | TBD | Ongoing |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | KC Fire Marshal (Task 1,2) | | TBD | | | TBD | 1-3 |
| 2 new prog | OS - 1 Nitrate Concerns | City of Redmond (Management Committee) | | | 25,600 | | Redmond General Funds | 1997 |
| 2 res | OS - 2A Hazardous Materials | SKCHD | | TBD | | Aquifer Protection Fund | Local Hazardous Waste Plan | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | King County (Task 1) | | N/A: done during code revision | | | General Agency Funds | |
| 2 reg | SG - 3 Fill Testing | City of Redmond | 25,600 | | | | Permit fees, general agency fund | 1995 |
| 2 reg | SG - 3 Fill Testing | King County | | TBD | | | Permit fees, general agency fund | 1 |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | City of Redmond (Task 1) | | N/A | | | | |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | SKCHD (Task 2) | | 500 | | Aquifer Protection Fund | | |
| 2 reg | ST - 2A Ground Water Quality Concerns - Zoning | King County | | TBD | | | General Agency Funds | |
| 2 reg | ST - 1A Runoff Versus Recharge | City of Redmond | 40,960 | TBD | | | General Agency Funds (SWM Utility) | 1995 |
| 2 reg | ST - 1A Runoff Versus Recharge | King County | | TBD | | | General Agency Funds | |
| 2 form agree | SG - 2 Reclaimed Sand and Gravel Mines: Comprehensive Plans | City of Redmond | N/A; included in Comprehensive Plan update work program | | | | General Agency Funds | 1996 |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 form agree | SG - 2 Reclaimed Sand and Gravel Mines: Comprehensive Plans | King County | N/A; included in Comprehensive Plan update work program | | | | General Agency Funds | |
| 2 educ | OS - 3A Household Hazardous Wastes | SKCHD (LHWMP) | | TBD | | | LHWMP fees | ongoing LHWMP |
| 2 reg | OS - 2C Hazardous Materials | SKCHD | | 4000 | | Aquifer Protection Fund | | 1 |
| 2 new prog | OS - 2B Hazardous Materials | SKCHD | | 4000 | | Aquifer Protection Fund | | |
| 2 reg | OS - 4A Operation and Maintenance | SKCHD | | 4000 | | Aquifer Protection Fund | | as per schedule |
| 2 new prog | OS - 4B Operation and Maintenance | SKCHD | | 52,200 | | Aquifer Protection Fund | | As per schedule |
| 2 new prog | OS - 5 Regulations | State Department of Health | | TBD | | | General funds | |
| 2 new prog | OS - 5 Regulations | Ecology | | TBD | | | General funds | |
| 2 reg | ST - 2A Ground Water Quality Concerns - Zoning | City of Redmond | | No additional cost | | | General Agency Funds | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 3 res | SP - 1A Infiltration and Exfiltration: Studies | Sewer Agencies: City of Redmond | | 15,360 | TBD | | General Agency Funds | 1996 |
| 3 other | SP - 1C Infiltration and Exfiltration: Leakproof Piping | SKCHD | | | 400 | Aquifer Protection Fund | | |
| 3 other | SP - 2 Groundwater depletion - Backfill | SKCHD | | | 200 | | | |
| 3 form agree | SP - 1B Infiltration and Exfiltration: Programs | SKCHD | | | N/A: stated in GWMP | | | Upon approval |
| 3 res | SP - 1A Infiltration and Exfiltration: Studies | SKCHD | | | TBD | | Grant | |
| 3 reg | PF - 1C Pesticide and Fertilizer Use | City of Redmond | | | 15,360 | Aquifer Protection Fund | | 1996 |
| 3 res | PF - 1B Pesticide and Fertilizer Use | Cooperative Extension | | | No additional cost | | Included in present program | Upon Completion of the Program |
| 3 res | PF - 1B Pesticide and Fertilizer Use | City of Redmond through Management Committee | | | No additional cost | | | Upon Completion of the Program |
| 3 res | PF - 1B Pesticide and Fertilizer Use | King County | | | 8,000 | Aquifer Protection Fund | | Upon Completion of the Program |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | King County | | | TBD | Aquifer Protection Fund | | As per Implementatio n Plan |
| 3 reg | PF - 1C Pesticide and Fertilizer Use | King County | | | 16000 | Aquifer Protection Fund | | |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | City of Redmond | | | No additional cost | | | As per Implementatio n Plan |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | Conservation District | | | 94,900 | Aquifer Protection Fund | | As per Implementatio n Plan |
| 4 new prog | BSE - 1 Regulatory Program Staffing | SKCHD | 78,300 | 78,300 | 78,300 | | Permit fee | 1,2,3,4 As per schedule pending BOH approval |
| 4 support | BSE - 2 Guideline Revision | GWAC | | | N/A: stated in GWMP | | N/A | As per legislation |
| 4 reg | C - 1 Information - Studies | SKCHD | | | 16,000 | Aquifer Protection Fund | Grant (228,000) | 3 |
| 4 reg | SW - 2 Waste Screening | SKCHD | | | TBD | Aquifer Protection Fund | | 2 yrs after end of project |
| 4 reg | SW - 2 Waste Screening | King County Solid Waste Division | | | Included in program | | Included in program | 2 yrs after end of project |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 4 new prog | SW - 3 Abandoned sites | SKCHD | | 8000 | | Aquifer Protection Fund | | on-going |
| 4 reg | SW - 1C Standards | SKCHD | | | 4,000 | | Agency funds/general funds | |
| 4 reg | SW - 1C Standards | Ecology | | | 17,500 | | Agency funds/general funds | |
| 4 reg | SW - 1A Standards | Ecology | | 5,000 | 100,000 | | Agency funds | During MFS revision |
| 4 reg | SW - 1B Standards | SKCHD | | | 4,000 | | General funds | |
| 4 new prog | SW - 3 Abandoned sites | King County Solid Waste Division | | | In SWD work plan | | General funds | on-going |
| not ranked | SG - 1 BMP for Grading Permits | King County | TBD | | | Aquifer Protection Fund | | |

Table 4.8.2. Implementation by jurisdiction or agency

## TABLE 4.8.2. IMPLEMENTATION PLAN ORGANIZED BY AGENCY OR GOVERNMENT[1]

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | Education | City of Redmond | 51,200 | | | | Redmond General Fund | 1+ ongoing |
| 2 reg | HM - 2 Hazardous Waste Facilities Zones - Local designation | City of Redmond | N/A: accomplished by concurring with GWMP | | | | General Agency Funds | |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | City of Redmond (Task 1,2) | | 30,720 | | | TBD | 1-3<br>1995 |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | City of Redmond (Task 1,2) | 25,600 | | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 2 new prog | OS - 1 Nitrate Concerns | City of Redmond (Management Committee) | | | 25,600 | | Redmond General Funds | 1997 |
| 3 reg | PF - 1C Pesticide and Fertilizer Use | City of Redmond | | | 15,360 | Aquifer Protection Fund | | 1996 |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | City of Redmond | | | No additional cost | | | As per Implementa-tion Plan |
| 3 res | PF - 1B Pesticide and Fertilizer Use | City of Redmond through Management Committee | | | No additional cost | | | Upon Completion of the Program |
| 15 comp prog | SA - 1B Elimination of categorical exemptions to SEPA | City of Redmond Task 2: | 204,800 | | | Aquifer Protection Fund | | 1996 |

[1] All costs are estimates.

**TABLE 4.8.2 (continued)**

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 15 comp prog | SA - 1D Enhanced environmental review to protect aquifers | City of Redmond | 51,200 | | | Aquifer Protection Fund | | 1996 |
| 15 comp prog | SA - 2 Minimum Wellhead Protection | City of Redmond (Management Committee) | 10,240 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1C Adoption of general aquifer protection policies | City of Redmond | 10,240 | | | | General Agency Funds | 1995 |
| 15 comp prog | SA - 1E Ground water recharge areas | City of Redmond | N/A: done by concurring with GWMP | | | | | |
| 15 comp prog | SA - 1A Designation of Environmentally Sensitive Areas | City of Redmond | Task 1: N/A, done by Concurring with GWMP | | | | | |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | City of Redmond (Task 1) | | N/A | | | | |
| 2 reg | SG - 3 Fill Testing | City of Redmond | 25,600 | | | | Permit fees, general agency fund | 1995 |
| 2 form agree | SG - 2 Reclaimed Sand and Gravel Mines: Comprehensive Plans | City of Redmond | N/A; included in Comprehensive Plan update work program | | | | General Agency Funds | 1996 |
| 2 reg | ST - 5A Roadway Runoff | City of Redmond | | No additional cost | | | General Agency Funds | |
| 2 reg | ST - 6A Soil Amendment | City of Redmond | | No additional cost | | Aquifer Protection Fund (or grant, other sources) | | |
| 2 reg | ST - 2A Ground Water Quality Concerns - Zoning | City of Redmond | | No additional cost | | | General Agency Funds | |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | ST - 1A Runoff Versus Recharge | City of Redmond | 40,960 | TBD | | | General Agency Funds (SWM Utility) | 1995 |
| 2 res | ST - 2C Ground Water Quality Concerns - Study | City of Redmond | | | 20,480 | Aquifer Protection Fund (or grant) | | 1997 |
| 2 res | ST - 2B Ground Water Quality Concerns - Facility Requirements | City of Redmond | | | 35,840 | Aquifer Protection Fund | | 1997 |
| 2 pol | UST - 1A, 1B Augment State UST Program | City of Redmond, through Management Committee | | No additional cost | | | Fees | 1,2,3 |
| 2 res | UST - 3D Heating Oil Tanks: Location | City of Redmond through Management Committee | | No additional cost | | Aquifer Protection Fund | | |
| 2 reg | WC - 2A Well Identification | City of Redmond through the Management Committee | | No additional cost | | | General funds | |
| 2 reg | WC - 2B Well Identification | City of Redmond | | No additional cost | | | General funds | |
| 2 form agree | WC - 1A State Program | City of Redmond | | N/A | | | N/A | |
| 1 reg | WQ - 1B Policies and Ordinances | City of Redmond | 2,048 | | | | Redmond General Funds | 1 |
| 1 new prog | WQ - 4A1 Conservation | City of Redmond | 10,240 | | | | Redmond General Funds | 1995 |
| 1 support | WQ - 4C1 Artificial recharge | City of Redmond | 10,240 | | | | Agency Funds | Purveyors time frame |

**TABLE 4.8.2 (continued)**

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | WQ - 1A Policies and Ordinances | City of Redmond | N/A, to be done as part of update or adoption | | | | Redmond general funds | 1 |
| 1 form agree | WQ - 3A Water rights | City of Redmond | 2,048 | | | | General Agency Funds | 1 |
| 1 support | Education | Conservation District | No additional costs | | | | | 1+ ongoing |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | Conservation District | | | 94,900 | Aquifer Protection Fund | | As per Implementation Plan |
| 3 res | PF - 1B Pesticide and Fertilizer Use | Cooperative Extension | | | No additional cost | | Included in present program | Upon Completion of the Program |
| 1 new prog | DCM - 2 Data Collection, Analysis and Management | Ecology | 7,000 | 7,000 | 7,000 | | General Agency Fund | 1+ ongoing |
| 2 new prog | OS - 5 Regulations | Ecology | | TBD | | | General funds | |
| 2 reg | ST - 4A Coordination Between Surface and Ground Water Planning Efforts: Ecology Programs | Ecology | | 35,000 | 35,000 | | General funds | |
| 4 reg | SW - 1A Standards | Ecology | | 5,000 | 100,000 | | Agency funds | During MFS revision |
| 4 reg | SW - 1C Standards | Ecology | | | 17,500 | | Agency funds/general funds | |
| 2 res | UST - 3A Heating Oil Tanks: Local Legal Authority<br>UST - 3B Heating Oil Tanks: State Code Amendment | Ecology | | 1,750<br>5,000 | 100,000 | Aquifer Protection Fund | | TBD |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | WC - 3B Abandonment cost | Ecology | | 5,000 | 10,000 | | Agency funds | Next WAC revision |
| 2 form agree | WC - 1A State Program | Ecology | | 70,000 | | | General funds | |
| 2 reg | WC - 2B Well Identification | Ecology | | 17,500 | 35,000 | | General funds | |
| 2 reg | WC - 2A Well Identification | Ecology | | TBD | | | General funds | |
| 2 new prog | WC - 1B State Program | Ecology | | 70,000 | 70,000 | | General Agency Funds | |
| 1 new prog | WQ - 4D1 Decline Limits | Ecology | | 140,000 | 140,000 | | General Agency Funds | 1 |
| 1 reg | WQ - 1B Policies and Ordinances | Ecology | 3,500 | 3,500 | 3,500 | | General Funds | 1 |
| 4 support | BSE - 2 Guideline Revision | GWAC | | | N/A: stated in GWMP | | N/A | As per legislation |
| 1 support | Education | GWAC | N/A - stated in GWMP | | | | | 1+ ongoing |
| 1 support | WQ - 2B Policies and Ordinances | GWAC | N/A - support is stated in GWMP | | | | N/A | 1 |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | KC Fire Marshal (Task 1,2) | | TBD | | | TBD | 1-3 |
| 1 new prog | DCM - 1 Data Collection, Analysis and Management | King County: SKCHD<br>Task 1 & 2: 24,000<br>Task 3: 104,400<br>Task 4: 104,400 | 261,000 | 261,000 | 261,000 | Aquifer Protection Fund | | 1+ ongoing |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | HM - 2 Hazardous Waste Facilities Zones - Local designation | King County | N/A: accomplished by concurring with GWMP | | | | General Agency Funds | |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | King County: Emergency Management Div (Task 1) | | TBD | | | TBD | Ongoing |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | King County | | | TBD | Aquifer Protection Fund | | As per Implementation Plan |
| 3 res | PF - 1B Pesticide and Fertilizer Use | King County | | | 8,000 | Aquifer Protection Fund | | Upon Completion of the Program |
| 3 reg | PF - 1C Pesticide and Fertilizer Use | King County | | | 16000 | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1B Elimination of categorical exemptions to SEPA | King County | 52,200 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1D Enhanced environmental review to protect aquifers | King County Task 5: | 52,200 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1A Designation of Environmentally Sensitive Areas | King County | Task 1: N/A, done by Concurring with GWMP | | | Aquifer Protection Fund | | 1 |
| 15 comp prog | SA - 1C Adoption of general aquifer protection policies | King County Task 4: | N/A , done by concurring with GWMP | | | | General Agency Funds | 1 |
| 15 comp prog | SA - 1E Ground water recharge areas | King County | N/A: done by concurring with GWMP | | | | | |
| not ranked | SG - 1 BMP for Grading Permits | King County | TBD | | | Aquifer Protection Fund | | |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | SG - 3 Fill Testing | King County | | TBD | | | Permit fees, general agency fund | 1 |
| 2 form agree | SG - 2 Reclaimed Sand and Gravel Mines: Comprehensive Plans | King County | N/A; included in Comprehensive Plan update work program | | | | General Agency Funds | |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | King County (Task 1) | | N/A: done during code revision | | | General Agency Funds | |
| 2 res | ST - 2C Ground Water Quality Concerns - Study | King County (SKCHD) | | TBD | | Aquifer Protection Fund (or grant) | | |
| 2 reg | ST - 1A Runoff Versus Recharge | King County | | TBD | | | General Agency Funds | |
| 2 reg | ST - 2A Ground Water Quality Concerns - Zoning | King County | | TBD | | | General Agency Funds | |
| 2 res | ST - 2B Ground Water Quality Concerns - Facility Requirements | King County | | TBD | | Aquifer Protection Fund | | 2 |
| 2 reg | ST - 6A Soil Amendment | King County | | TBD | | Aquifer Protection Fund (or grant, other sources) | | |
| 2 reg | ST - 5A Roadway Runoff | King County | | TBD | | | General Agency Funds | |
| 2 reg | ST - 4C Coordination Between Surface and Ground Water Planning Efforts: King County | King County (SKCHD) | | 26,000 | | Aquifer Protection Fund | | |
| 4 new prog | SW - 3 Abandoned sites | King County Solid Waste Division | | | In SWD work plan | | General funds | on-going |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 4 reg | SW - 2 Waste Screening | King County Solid Waste Division | | | Included in program | | Included in program | 2 yrs after end of project |
| 2 form agree | WC - 1A State Program | King County | | N/A | | | N/A | |
| 1 reg | WQ - 1B Policies and Ordinances | King County | | | 4,000 | | General Funds | 1 |
| 1 support | WQ - 1A Policies and Ordinances | King County | N/A, to be done as part of update or adoption | | | | | 1 |
| 1 new prog | WQ - 4A1 Conservation | King County | TBD | | | | General Funds | 1 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | Management Committee (Task 4) | | Incl in Chapter 4 | | Aquifer Protection Fund | | 3 |
| 2 res | HM - 5B Transportation-Related Hazardous Material Spills-Management Committee Evaluation | Management Committee (Task 3) | | | No additional | Aquifer Protection Fund | | 3 |
| 2 new prog | OS - 1 Nitrate Concerns | Management Committee (Task 1,2) | | TBD | | Aquifer Protection Fund | | As per WHPP schedule |
| 15 comp prog | SA - 2 Minimum Wellhead Protection | Management Committee | TBD | | | Aquifer Protection Fund | | 1997 |
| 1 support | Education | NE Sammamish[2] | 3500<br>200<br>600 | 3500<br>200<br>600 | 3500<br>200<br>600 | | General Agency Fund | 1+ ongoing |

[2]NE Sammamish costs are estimates, with all costs combined into the estimate. These estimates have not been approved by the Board of Commissioners.

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | NE Sammamish (Task 1,2) | 2000 | | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 1 new prog | WQ - 4D1 Decline Limits | NE Sammamish | No additional cost* | | | | $4800/yr. from General Agency Funds | 1 + ongoing |
| 1 form agree | WQ - 3A Water rights | NE Sammamish | | 500 | | | General Agency Funds | 1, ongoing |
| 1 support | WQ - 4C1 Artificial recharge | NE Sammamish | No additional costs: possible future project | | | | Agency Funds | Purveyors time frame |
| 2 reg | ST - 4B Coordination Between Surface and Ground Water Planning Efforts: Puget Sound Water Quality Authority | Puget Sound Water Quality Authority | No additional costs | | | | General Agency Funds | |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | Purveyors (Task 1,2) | | TBD | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | 1996 |
| 3 res | SP - 1A Infiltration and Exfiltration: Studies | Sewer Agencies: City of Redmond | | 15,360 | TBD | | General Agency Funds | 1996 |
| 4 new prog | BSE - 1 Regulatory Program Staffing | SKCHD | 78,300 | 78,300 | 78,300 | | Permit fee | 1,2,3,4 As per schedule pending BOH approval |
| 4 reg | C - 1 Information - Studies | SKCHD | | | 16,000 | Aquifer Protection Fund | Grant (228,000) | 3 |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | Education<br>PF - 2A Education and Proposed Programs<br>PF - 2B Education and Proposed Programs<br>ST - 3 Education<br>OS - 3B Household Hazardous Wastes<br>SW - 4 Education<br>UST - 3E Heating Oil Tanks<br>WC - 4 Education<br>WQ - 4B1 Xeriscaping<br>WQ - 4B2 Conservation<br>WQ - 4B3 Landscaping | SKCHD | 325,728 | 330,000 | 335,000 | Aquifer Protection Fund | | 1+ ongoing |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 3) | | 24,000 | | Aquifer Protection Fund | | 2 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 2) | | Included in data management costs | | Aquifer Protection Fund | | Ongoing |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 5) | | | 8,000 | Aquifer Protection Fund | | 3 |
| 2 support | HM - 1 State Hazardous Waste Plan-Implementation | SKCHD | | 400 | | | | |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | SKCHD (Task 3) | | 24,000 | 8,000 | Aquifer Protection Fund | | 1-3 |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | HM - 5B Transportation-Related Hazardous Material Spills-Management Committee Evaluation | SKCHD (Task 4) | | | 8000 | Aquifer Protection Fund | | 3 |
| 2 reg | OS - 2C Hazardous Materials | SKCHD | | 4000 | | Aquifer Protection Fund | | 1 |
| 2 new prog | OS - 2B Hazardous Materials | SKCHD | | 4000 | | Aquifer Protection Fund | | |
| 2 reg | OS - 4A Operation and Maintenance | SKCHD | | 4000 | | Aquifer Protection Fund | | as per schedule |
| 2 educ | OS - 3A Household Hazardous Wastes | SKCHD (LHWMP) | | TBD | | | LHWMP fees | ongoing LHWMP |
| 2 new prog | OS - 4B Operation and Maintenance | SKCHD | | 52,200 | | Aquifer Protection Fund | | As per schedule |
| 2 res | OS - 2A Hazardous Materials | SKCHD | | TBD | | Aquifer Protection Fund | Local Hazardous Waste Plan | |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | SKCHD (Task 2) | | 500 | | Aquifer Protection Fund | | |
| 3 other | SP - 2 Groundwater depletion - Backfill | SKCHD | | | 200 | | | |
| 3 other | SP - 1C Infiltration and Exfiltration: Leakproof Piping | SKCHD | | | 400 | Aquifer Protection Fund | | |
| 3 form agree | SP - 1B Infiltration and Exfiltration: Programs | SKCHD | | | N/A: stated in GWMP | | | Upon approval |
| 3 res | SP - 1A Infiltration and Exfiltration: Studies | SKCHD | | | TBD | | Grant | |

## TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | ST - 2C Ground Water Quality Concerns - Study | SKCHD | | TBD | | Aquifer Protection Fund (or grant) | | |
| 4 reg | SW - 2 Waste Screening | SKCHD | | | TBD | Aquifer Protection Fund | | 2 yrs after end of project |
| 4 reg | SW - 1B Standards | SKCHD | | | 4,000 | | General funds | |
| 4 new prog | SW - 3 Abandoned sites | SKCHD | | 8000 | | Aquifer Protection Fund | | on-going |
| 4 reg | SW - 1C Standards | SKCHD | | | 4,000 | | Agency funds/general funds | |
| 2 res | UST - 3A Heating Oil Tanks: Local Legal Authority<br>UST - 3B Heating Oil Tanks: State Code Amendment | SKCHD, through Management Committee | | 16,000 | | Aquifer Protection Fund | | TBD |
| 2 reg | UST - 1C Augment State UST Program | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 reg | UST - 2B Exempt Tanks | SKCHD | | 8000 | | Aquifer Protection Fund | | TBD |
| 2 pol | UST - 1A, 1B Augment State UST Program | SKCHD | 53,244 | 53,244 | 53,244 | Aquifer Protection Plan | Fees | 1,2,3 |
| 2 reg | UST - 2A Exempt Tanks | SKCHD, through Management Committee | | 8000 | | Aquifer Protection Fund | | As per schedule |
| 2 res | UST - 3D Heating Oil Tanks: Location | SKCHD | | 26,000 | | Aquifer Protection Fund | | |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | UST - 3C Heating Oil Tanks: Abandonment and Maintenance | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 reg | WC - 2B Well Identification | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 new prog | WC - 1B State Program | SKCHD | | 52,200 | | Aquifer Protection Fund | | |
| 2 res | WC - 3A Abandonment cost | SKCHD, through Management Committee | | | 13,080 | Aquifer Protection Fund | | |
| 2 reg | WC - 2A Well Identification | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 1 res | WQ - 2A Data Needs | SKCHD in DCMP (See DCM-1) | | | | Aquifer Protection Fund | | 1 |
| 1 new prog | WQ - 4A2 Conservation | SKCHD | 8160 | | | | General Funds | As per schedule |
| 1 new prog | WQ - 4A3 Conservation | SKCHD | 8160 | | | Aquifer Protection Fund | | 1 |
| 2 new prog | OS - 5 Regulations | State Department of Health | | TBD | | | General funds | |
| 1 support | Education | Union Hill | 2400<br>500<br>400<br>1500 | | | | General Agency Fund | 1+ ongoing |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | Union Hill (Task 1,2) | | 1500 | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 1 new prog | WQ - 4D1 Decline Limits | Union Hill | 8000 | 8000 | 8000 | | General Agency Funds | 1 + ongoing |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | WQ - 4C1 Artificial recharge | Union Hill | No additional cost[3] | | | | Agency Funds | Purveyors time frame |
| 1 form agree | WQ - 3A Water rights | Union Hill | 500 | | | | General Agency Funds | 1, ongoing |
| 1 support | Education | Woodinville | 26,000 - 49,000 | | | | Woodinville General Fund | 1+ ongoing |
| 1 support | Education | WSU Cooperative Extension Service | No additional costs | | | | | 1+ ongoing |

[3]The MPD progess will influence when and how this is done.

Glossary

## GLOSSARY OF COMMON HYDROGEOLOGIC AND WATER-RESOURCE RELATED TERMS AND ACRONYMS

| | |
|---|---|
| **ALLUVIAL** | Pertaining to or composed of alluvium or deposited by a stream or running water. |
| **ALLUVIUM** | A general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semisorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope. |
| **AMMONIA** | A gas composed of $NH_3$, commonly used as fertilizer. |
| **AQUIFER** | A soil or geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield economical quantities of water to wells and springs. |
| **AQUIFER SYSTEM** | A body of permeable and relatively impermeable materials that functions regionally as a water-yielding unit. It comprises two or more permeable units separate at least locally by confining units that impede ground water movement but do not greatly affect the regional hydraulic continuity of the system. The permeable materials can include both saturated and unsaturated sections. |
| **AQUIFER TEST** | A test involving the withdrawal of measured quantities of water from or addition of water to a well, and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or addition, e.g., a bailer or pump test. (These are withdrawal tests.) |
| **AQUITARD** | An essentially impermeable geologic formation, group of formations, or part of a formation through which virtually no water moves. |
| **AREA OF INFLUENCE** | Area surrounding a pumping well within which the water table or potentiometric surface has been changed due to the well's pumping or recharge. |
| **ARTESIAN** | Refers to ground water under sufficient hydrostatic head to rise above the aquifer containing it. |
| **ARTESIAN WELL** | A well deriving its water from a confined aquifer in which the hydraulic water level stands above the ground surface; synonymous with flowing artesian well. |
| **ATTENUATION** | The general process of reducing the amount and concentration of contaminants in water. Includes physical, chemical, and biological processes as well as dilution. |
| **BASALT** | A general term for dark-colored iron- and magnesium-rich igneous rocks. It is the principal rock type making up the ocean floor and is easily seen in exposed cliffs in Eastern Washington. |
| **BASE FLOW** | That part of stream discharge not attributable to direct runoff from precipitation or snowmelt, usually sustained by ground water discharge. |

| | |
|---|---|
| **BEDROCK** | A term for the solid rock that underlies soil or uncompacted sediments. |
| **BENTONITE** | A colloidal clay, largely made up of the mineral sodium montmorillonite, [a hydrated aluminum silicate] used in sealing the annular space to create a surface or sanitary seal. |
| **CAPILLARY ACTION** | The movement of water within the interstices of a porous medium due to the forces of adhesion, cohesion, and surface tension acting in a liquid that is in contact with a solid. |
| **CAPILLARY FRINGE** | The zone at the bottom of the vadose zone where ground water is drawn upward by capillary force. |
| **CARBONATE** | A sediment formed by the precipitation from aqueous solution of carbonates of calcium, magnesium, or iron. |
| **CHLORIDE** | A compound of chlorine with one other positive element or radical. |
| **CLEAN WATER ACT** | Basic federal legislation regulating surface water quality. |
| **COLIFORM BACTERIA** | Bacteria (*E. coli*) associated with human and warm-blooded animal waste. |
| **COLLUVIUM** | Loose clastic material usually found at the base of a hill or cliff. |
| **CONE OF DEPRESSION** | A depression in the ground water table or potentiometric surface that has the shape of an inverted cone and develops around a well from which water is being withdrawn. It defines the area of influence of a well. |
| **CONFINED AQUIFER** | A condition of an aquifer bounded above and below by lower permeability rock or sediment layers. |
| **CONFINING BED** | A geologic unit with low permeability (hydraulic conductivity) which restricts movement of water into or out of the aquifer. See also aquitard. |
| **CONTAMINATION** | The degradation of natural water quality as a result of anthropogenic activities. |
| **CROSS-SECTION** | A schematic representation of geologic layers as seen in a side view. |
| **DISCHARGE** | Ground water that flows out of an aquifer into an adjacent aquifer or to the surface into a spring or river. |
| **DISCHARGE AREA** | An area in which there are upward components of hydraulic head in the aquifer. In the discharge area ground water flows toward the surface, and may escape as a spring, seep, or base flow, or by evaporation and transpiration. |
| **DISPERSION** | The spreading and mixing of chemical constituents in ground water caused by diffusion and mixing due to microscopic variations in velocities within and between pores. |
| **DRAINAGE BASIN** | The land area from which surface runoff drains into a stream channel or system of channels, or to a lake, reservoir, or other body of water. |

| | |
|---|---|
| **DRAWDOWN** | The distance between the static water level and the top surface of the cone of depression during pumping of a well. |
| **DRILLERS LOG** | A record of the geologic and aquifer conditions encountered by a driller during drilling of a water supply well. The State of Washington requires that a log be completed for each well. |
| **DRINKING WATER STANDARDS** | Federal or state water quality regulations that limit the contaminant levels of certain compounds for drinking water. |
| **DYNAMIC EQUILIBRIUM** | A condition of which the amount of recharge to an aquifer equals the amount of natural discharge. |
| **ECOLOGY** | Washington State Department of Ecology. |
| **EFFLUENT** | Liquid waste discharged from a manufacturing or treatment process, in its natural state or partially or completely treated, that discharges into the environment. |
| **EFFLUENT STREAM** | A stream or reach of a stream that receives water from the zone of saturation and provides base flow; its channel lies below the water table. Synonym: gaining stream. A stream whose flow is increased due to contributions from the zone of saturation or aquifer. |
| **EOLIAN** | Sediments transported by wind action. |
| **EROSION** | The physical and chemical processes that remove and transport natural materials at the surface. |
| **EVAPOTRANSPIRATION** | Loss of water from a land area through transpiration of plants and evaporation from the soil. |
| **FLOODPLAIN** | The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river and covered with water when the river overflows its banks. It is built of alluvium carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. |
| **FLOW LINES** | On a hydraulic gradient diagram, the lines indicating the direction followed by ground water toward points of discharge. Flow lines are perpendicular to equipotential lines. |
| **FLOW RATE** | The volume of flow per unit time (e.g., gallons per minute). |
| **FLOWING ARTESIAN WELLS** | Wells which tap confined aquifers which flow at ground surface without the necessity of pumping. |
| **FLUVIAL** | Deposits produced by river action. |
| **FOSSIL** | The remains or traces of animals or plants which have been preserved by natural processes. |
| **GEOLOGIC MAP** | A map showing the aerial distribution of geologic units and the altitude or structure of those units. |

| | |
|---|---|
| **GEOLOGY** | The study of earth materials, processes, and history. |
| **GLACIAL DRIFT** | A general term for unconsolidated sediment transported by glaciers and deposited directly on land or in the sea. |
| **GLACIOFLUVIAL** | Pertaining to the meltwater streams flowing from melting glacier ice and especially to the deposits and landforms produced by such streams. |
| **GLACIOLACUSTRINE** | Deposits created in glacial-lake environments from glacial silts and clays. |
| **GMA** | Growth Management Act. |
| **GMP** | Gallons per minute. |
| **GROUND WATER** | All water that is located below the surface; more specifically, subsurface water below the water table. |
| **GROUND WATER TABLE** | The surface between the zone of saturation and the zone of aeration; the surface of an unconfined aquifer. |
| **GROUND WATER DIVIDE** | A ridge in the water table, or potentiometric surface, from which ground water moves away at right angles in both directions. |
| **GROUND WATER MODEL** | A simplified conceptual or mathematical image of a ground water system, describing the feature essential to the purpose for which the model was developed and including various assumptions pertinent to the system. Mathematical ground water models can include numerical and analytical models. |
| **HARDNESS** | A property of water causing formation of an insoluble residue when the water is used with soap. It is primarily caused by calcium and magnesium ions. |
| **HAZARDOUS WASTE** | Federally regulated man-made waste that is ignitable, corrosive, reactive, or toxic. |
| **HYDRAULIC CONDUCTIVITY** | The rate of flow of water in gallons per day through a cross section of one square foot under a unit hydraulic gradient, at the prevailing temperature (gpd/ft). |
| **HYDRAULIC CONNECTION** | The condition in which two water-bearing layers or bodies may freely transmit water between them. |
| **HYDROGEOLOGIC** | Those factors that deal with subsurface waters and related geologic aspects of surface water. |
| **HYDROLOGIC CYCLE** | The cyclical movement of water from the oceans to atmosphere to the land and back to the oceans. |
| **HYDROSPHERE** | All waters of the Earth, as distinguished from the rocks (lithosphere), living things (biosphere), and the air (atmosphere). |
| **HYDROSTRATIGRAPHY** | The assemblage of layers of aquifers and aquitards. |
| **IGNEOUS** | A type of rock solidified from molten material. |

| | |
|---|---|
| **IMPERMEABLE** | An adjective used to describe rock, soils, or sediments that impede the flow of water. |
| **INFILTRATION** | The downward movement of rain water or surface water into soil. |
| **LACUSTRINE** | Referring to a lake environment. |
| **LAMINATED** | The layering or thin bedding in sedimentary rocks. |
| **LANDFILL** | A general term indicating a disposal site of refuse and dirt from excavations. |
| **LEACHATE** | The liquid that has percolated through solid waste and dissolved soluble components. |
| **LEUCOCRATIC** | A term applied to light-colored rocks. |
| **MAXIMUM CONTAMINANT LEVEL (MCL)** | The maximum permissible level, as required by the Safe Drinking Water Act regulations, of a contaminant in water that is delivered to the users of a public water system. |
| **MESOZOIC** | A broad period of earth's history estimated to be 225 to 65 million years ago. |
| **METAMORPHIC** | A rock that has been physically and/or chemically changed from an original texture and/or composition, usually by very high temperatures or pressures below the earth's surface. |
| **MG/L** | Milligrams per liter; a unit of concentration in water equivalent to one part per million or 0.0001 percent. |
| **MICROORGANISMS** | Microscopic organisms such as any of the bacteria, protozoans, or viruses. |
| **NITRATE** | A compound commonly associated with domestic and agricultural waste, and formed by nitrogen. |
| **OUTWASH** | Stratified sand and gravel removed or washed out from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of an active glacier. The coarser material is deposited nearer to the ice. |
| **OUTWASH PLAIN** | A broad, gently sloping sheet of outwash. |
| **PEAT** | A non-compacted deposit of organic material commonly developed from bogs or swamps. |
| **PERCOLATE** | The act of water seeping or filtering through soil without a defined channel. |
| **PERMEABILITY** | The property or capacity of a porous rock, sediment, or soil for transmitting a fluid; it is a measure of the relative ease of fluid flow under unequal pressure. |
| **pH** | A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. Originally stood for "potential of hydrogen". |

| | |
|---|---|
| **PLEISTOCENEA** | A period of earth's history estimated to be 2 million to 10,000 years ago. |
| **PLUME** | A contaminated portion of an aquifer extending from the original contaminant source. |
| **POLLUTION** | When the contamination concentration levels restrict the potential use of ground water. |
| **POROSITY** | The percentage of the bulk volume of a rock or soil that is occupied by interstices, whether isolated or connected. |
| **POTABILITY** | Ability to be used as drinking water. |
| **POTENTIOMETRIC SURFACE** | The surface to which water will rise in an aquifer under hydrostatic pressure. |
| **PPM** | Parts/per million. A unit of concentration equivalent to 0.0001 percent. |
| **RBC-GWMA** | Redmond-Bear Creek Valley Ground Water Management Area. |
| **RBC-GWMP** | Redmond-Bear Creek Valley Ground Water Management Plan. |
| **RECENT** | Less than 10,000 years ago in earth's history. |
| **RECHARGE** | The addition of water to the zone of saturation; also, the amount of water added. |
| **RECHARGE AREA** | Area in which water reaches the zone of saturation by surface infiltration. |
| **RUNOFF** | That part of precipitation flowing overland to surface streams. |
| **SANDSTONE** | A sedimentary rock composed of abundant rounded or angular fragments of sand set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material. |
| **SEAWATER INTRUSION** | The entry of seawater into a fresh water aquifer. |
| **SEDIMENTARY ROCKS** | Rocks resulting from the consolidation of loose sediment that has accumulated in layers. |
| **SHALE** | A fine-grained sedimentary rock, formed by the consolidation of clay, silt, or mud. It is characterized by finely laminated structure and will not fall apart on wetting. |
| **STORAGE COEFFICIENT** | The volume of water released from storage per unit-volume of porous medium per unit change in head. |
| **STRATIGRAPHIC** | Pertaining to the composition and position of layers of rock or sediment. |
| **TERTIARY** | A period of earth's history estimated to have occurred between 65 and 2 million years ago. |
| **TILL** | Predominantly unsorted and unstratified drift, generally unconsolidated, deposited directly by and underneath a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, |

gravel, and boulders ranging widely in size and shape.

| | |
|---|---|
| **TOPOGRAPHIC** | Pertaining to the general configuration of a land surface. |
| **TOTAL DISSOLVED SOLIDS (TDS)** | A term that expresses the quantity of dissolved material in a sample of water, either the residue on evaporation, dried at 356°F (180°C), or, for many waters that contain more than about 1,000 mg/l, the sum of the chemical constituents. |
| **TRANSMISSIVITY** | The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Transmissivity values are given in gallons per minute through a vertical section of an aquifer one foot wide and extending the full saturated height of an aquifer under a hydraulic gradient of 1 in the English Engineering system; in the International System, transmissivity is given in cubic meters per day through a vertical section of an aquifer one meter wide and extending the full saturated height of an aquifer under a hydraulic gradient of 1. |
| **TRANSPIRATION** | The process by which water absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface. |
| **TURBULENT FLOW** | Water flow in which the flow lines are confused and heterogeneously mixed. It is typical of flow in surface-water bodies. |
| **UNCONFINED AQUIFER** | Ground water in an aquifer that is not covered by an impermeable layer. |
| **UNSATURATED ZONE** | The subsurface zone containing both water and air. The lower part of the unsaturated zone (capillary fringe) does not actually contain air, but is saturated with water held by suction at less than atmospheric pressure. |
| **VADOSE ZONE** | The zone containing water under pressure less than that of the atmosphere, including soil water, intermediate vadose water, and capillary water. This zone is limited above by the land surface and below by the surface of the zone of saturation, that is, the water table. |
| **VISCOSITY** | The property of a substance to offer internal resistance to flow. Specifically, the ratio of the shear stress to the rate of shear strain. |
| **WATER TABLE** | The subsurface level between the zone of saturation (ground water) and the zone of aeration. |
| **WEATHERING** | The destructive process(es) by which the atmosphere and surface water chemically change the character of a rock. |
| **ZONE OF CONTRIBUTION** | The area surrounding a pumping well that encompasses all areas or features that supply ground water recharge to the well. |
| **ZONE OF INFLUENCE** | The area surrounding a pumping well within which the water table or potentiometric surfaces have been changed due to ground water withdrawal. |

Sources:

- **Ground water Wells, Driscoll, F. Johnson Division, 1986.**
- **Ground water Resource Protection, King County Planning Division/State of Washington/Department of Ecology.**
- **Redmond-Bear Creek Ground Water Management Program Draft Hydrogeologic Characterization Report by EMCON Northwest, Inc., November 1992.**
- **Northern Thurston County Ground Water Management Plan, February, 1992.**

Appendices

# APPENDIX A
# EAST SAMMAMISH COMMUNITY PLAN
# BEAR CREEK COMMUNITY PLAN POLICIES
# CITY OF REDMOND COMMUNITY DEVELOPMENT GUIDE

| | |
|---|---|
| GM-1 | King County should develop interlocal agreements with Issaquah, Redmond and the Muckleshoot Indian Tribe providing for timely agency notice, review and comment opportunity and staff consultation on proposed development within the impact area designated for each jurisdiction. The agreements should include, but not be limited to, review of:<br>a. Zoning reclassification;<br>b. Preliminary subdivisions;<br>c. Master planned developments;<br>d. Regional use and conditional use permits;<br>e. Shoreline substantial development permits; and<br>f. Threshold determinations under SEPA. |
| GM-2 | Urban Reserve Areas shall be designated in East Sammamish for the purpose of phasing, with a residential density of one house per five acres, and with tight clustering of lots required to preserve the maximum amount of land for future development at urban densities. Lands within the Reserve areas shown on the Plan Map shall not be reclassified at higher densities until adequate facilities and services are available. |
| GM-3 | Lands within the Urban Reserve Areas shall be given a potential zone, along with Growth Reserve zoning, consistent with the long-term land use policies for the East Sammamish planning area. Any subdivision development under Growth Reserve zoning shall disclose probable future road alignments, parks and open space, and build-out density consistent with the site's potential zoning. |
| GM-4 | Lands within the Urban Reserve Area should be reclassified to their potential zones, either through an amendment to the Area Zoning or an individual reclassification application, only when it can be demonstrated to King County and the County determines that area wide service deficiencies in water, roads, electrical service and parks are remedied or do not apply to a particular property or subarea. County approval of the reclassification should occur only when King County finds that by the time a development is ready to be occupied the following criteria will be met; notwithstanding the foregoing, the underlying potential zone shall be effective on June 30, 1996;<br>a. Domestic water supplies are adequate to support planned growth, by virtue of an intertie between the Plateau and the regional water supply in cooperation with Seattle, or the development of new ground water resources, or conservation measures sufficient to guarantee capacity, or the property is located in or can be served by the Northeast Sammamish Sewer and Water District; and<br>b. Updated road adequacy standards are adopted by the King County Council and access to I-90 for properties not located in Northeast Sammamish Sewer and Water District is determined to be adequate based upon those standards; and<br>c. The East Lake Sammamish, and Issaquah Creek Basin and Nonpoint plans are adopted, and those projects that are identified by the Council during adoption of those plans as necessary to accommodate future growth are operational; and<br>d. The serving utility can provide electrical service to new development consistent with its public service obligations; and<br>e. King County's Park, Recreation and Open Space functional Plan is adopted. |

| | |
|---|---|
| GM-5 | Lands within the Urban Reserve Area which have access to East Lake Sammamish Parkway, and which are designated for multifamily residential development and given a potential multifamily zone in the Area Zoning, should be reclassified to their potential zones, either through an amendment to the Area Zoning or an individual reclassification application, only when it can be demonstrated to King County and the County determines that area wide deficiencies in water, roads, electrical service and parks are remedied or do not apply to a particular property or subarea. County approval of the reclassification should occur only when King County finds that by the time a development is ready to be occupied, the following criteria will be met:<br>a. Domestic water supplies are adequate to support planned growth, by virtue of an intertie between the Plateau and the regional water supply in cooperation with Seattle, or the development of new ground water resources, or conservation measures sufficient to guarantee capacity; and<br>b. Updated road adequacy standards are adopted by the King County Council; and<br>c. The East Lake Sammamish Basin Plan and Nonpoint Action Plan are adopted, and those projects that are identified by the Council during adoption of those plans as necessary to accommodate future growth are operational; and<br>d. The serving utility can provide electrical service to new development consistent with its public service obligations; and<br>e. King County's Park, Recreation and Open Space Plan is adopted. |
| GM-6 | The East Sammamish Community Plan designates urban growth areas based on the following criteria. Urban Growth Areas should include only lands that:<br>a. Are within existing cities;<br>b. Exclude designated resource lands;<br>c. Are already characterized by urban development that can be efficiently and cost effectively served by roads, water, sanitary sewer storm drainage, schools and other urban services, within the next 20 years;<br>d. Are bounded by recognized natural boundaries, such as watersheds, that impede provision of urban services;<br>e. Utilize topographical features which form a natural edge such as rivers and ridge lines;<br>f. Are sufficiently free of environmental constraints as to be able to support urban growth without major environmental impacts unless such areas are designated as an urban separator; and<br>g. Promote orderly and contiguous growth and are needed to accommodate at least a 20 year growth projection. |
| GM-7 | Growth Reserve shall not be applied on lands where sewer Utility Local Improvement Districts (ULIDS) have been formed and the King County Council has approved the District's Comprehensive Utility Plan, and on properties surrounded on two or more sides by such ULIDS. |
| GM-8 | The urban growth areas, designated by the East Sammamish Community Plan are appropriate for annexation to Issaquah or Redmond or incorporation when they meet the criteria of ESCP policy GM-8. The western portion of Happy Valley (Section 18) which is west and south of the ridgeline shall be within the urban growth area. The remaining portion of Happy Valley shall remain outside of the UGA because its long term rural land use designation, its environmentally critical lands and its topography mean that it will not require urban services. |
| GM-9 | If the UGAs identified in this plan conflict with the urban growth areas as identified by Ordinance 10450, changes to the adopted UGA boundary shall be recommended to the Growth Management Planning Council by King County. |

| | |
|---|---|
| GM-10 | Lands within designated urban growth areas are appropriate for annexation or incorporation. King County should encourage and will support annexation or incorporation proposals that meet the following criteria:<br>a. Urban level public services, including police and fire protection, schools, parks, public transportation, an urban street network, a domestic water system, storm drainage and sewer systems, and general governmental services, can be provided to annexing or incorporating areas without a degradation in service levels to existing service areas or to the remainder of the community planning area;<br>b. Standards for and the ability to implement level of service requirements, mitigation of adverse land use impacts, and environmental protection that are equal to or better than King County's standards have been adopted by the annexing city or in the case of an incorporation the petition for incorporation should include an objective to meet such standards and such standards will be adopted by the new city;<br>c. The annexation or incorporation does not create islands or pockets of unincorporated King County or special service districts that are difficult or inefficient to serve;<br>d. A sub-area land use and service plan for the annexation area that is consistent with the current East Sammamish Community Plan (ESCP), the KCCP and the GMA and will provide a variety of urban densities, had been adopted or is to be adopted concurrently with the annexation by the annexing city. In the case of incorporation the petition for incorporation includes goals to plan for land uses that are consistent with the KCCP and the GMA including planning for urban densities and full urban services;<br>e. For annexations either (1) an interlocal agreement has been negotiated between the annexing city and the special districts that now provide services to the proposed annexation area to insure that the annexation will not cause a degradation in service levels to areas outside the proposed annexation area or (2) King County believes the annexation will not cause degradation of service levels; and<br>f. Urban separators designated by the ESCP are maintained and preserved. |
| GM-11 | King County will support the phased annexation of land that encourages urban growth to occur within cities. The County should encourage annexations or incorporations within UGA's of areas already characterized by urban growth or zoned for current urban growth that have existing public facility and service capacities to serve such development. |
| GM-12 | Pre-annexation planning agreements should be negotiated between the County, Issaquah and Redmond. These agreements can be for individual annexations or for all proposed annexations by a city. |
| GM-13 | Pre-annexation planning agreements should establish a process to address, at a minimum, the following issues in the proposed annexation area:<br>a. Land use planning, including consistent language and terminology;<br>b. Transportation planning and mitigation;<br>c. Development standards and development review;<br>d. Surface water drainage and flood control;<br>e. Utilities planning and service provision;<br>f. Housing, including affordable and fair share housing;<br>g. Historic preservation;<br>h. Parks, trails, wildlife corridors and open space;<br>i. Environmentally sensitive areas including but not limited to steep slopes, bodies of water, flood plains, and wetlands;<br>j. Identification of resource lands and critical areas;<br>k. Identification of lands for public purposes;<br>l. Urban separators;<br>m. Financing of regional facilities (such as parks and libraries) and local urban services;<br>n. Financing of projects for which impact fees have been collected;<br>o. Financing to lessen infrastructure deficiencies; and<br>p. Distribution of tax revenue among service providers. |
| GM-14 | A joint county-city team should be established to coordinate annexation and incorporation proposals that help a smooth transition from county to city jurisdiction. |

| | |
|---|---|
| GM-15 | The East Sammamish Community Plan designates urban separators based on the following criteria:<br>a. The land can serve as wildlife habitat, is designated as a sensitive area, serves to link sensitive areas, is a topographic feature such as a major elevation change, encompasses part of a historic trail, or is part of a public park or trail or open space; and<br>b. The land helps to define and provide a visual separation between neighborhoods or communities; and<br>c. The land is characterized by low density development. |
| GM-16 | The eastern portion of Grand Ridge shall retain its Rural designation and is not included within the UGA. Zoning for this eastern portion shall require rural clustering. The western portion of Grand Ridge that is less environmentally constrained shall also be retained in a Rural designation and is not within the urban growth area. Residential development within the western portion of Grand Ridge should require rural clustering. The western portion is substantially less constrained than the balance of Grand Ridge and redesignation to Urban may be considered through a plan amendment study, once the Issaquah Wellhead Protection Study is complete such plan amendment study also must comply with the Ground Water Management Plan when approved by the State Department of Ecology. Land use decisions should be compatible with the findings of the Wellhead Protection Study and the adopted Ground Water Management Plan. |
| GM-17 | All residential development, whether urban or rural in the Grand Ridge subarea that is located within the Issaquah Creek basin shall be subject to stringent drainage control and tree clearing standards, in order to reduce or eliminate increased flood damage in the lower part of the basin, including within the City of Issaquah. |
| NE-1 | For all new development, increased standards for retention/detention, water quality facilities, and monitoring shall be considered, adopted and implemented as appropriate within the areas identified in surface water management basin planning and reconnaissance study areas. |
| NE-2 | Clearing and grading shall be limited on all short plats, plats, and commercial projects to protect water quality, maintain hydrologic functions of wetlands, attenuate surface water runoff, limit erosion, and maintain fish and wildlife habitat and visual buffers. Seasonal limits should restrict clearing and grading in Urban Areas to the driest months. Rural Areas should be subject to both seasonal limits and permanent tree retention requirements. |
| NE-3 | As new roads are built and existing roads widened, special consideration shall be taken to create or retain the aesthetic character of the area through the use of vegetated buffers that utilize native vegetation. |
| NE-4 | The recommendations regarding runoff control and infiltration of storm water in the Bear Creek Basin Plan, and, upon adoption, the recommendations in the East Lake Sammamish Basin and Nonpoint Action Plan, the Issaquah Creek Basin and Nonpoint Action Plan the Pine Lake Management Plan and the Beaver Lake Management Plan should be implemented. |
| NE-5 | Where commercial and industrial uses and high levels of vehicular traffic are established, water quality should be protected and enhanced. Petroleum, solvents, and other potential water pollutants should be stored in such a way as to prevent entry into natural drainage systems or ground water. |
| NE-6 | Public sewers are the preferred method for wastewater treatment in Urban Areas, including Urban Reserve Areas. Within Rural Areas, and Urban Areas where sewers are not yet available, proper siting and maintenance of septic systems should continue to receive special attention for new and existing land development to preserve the valuable ecological functions and beneficial public uses of water resources. |
| NE-7 | Control mechanisms equal to or more effective than those adopted by Ordinance 9365 limiting or removing phosphorus and other nonpoint source pollutants from water bodies should be established and implemented as special requirements in area-specific basin plans to provide added protection to streams, lakes, and wetlands. The Lake Sammamish Water Quality Management Project Report and, upon their adoption, the Issaquah Creek and East Lake Sammamish Basin and Non-point Source Control Plan, the Pine Lake Management Plan and the Beaver Lake Management Plan recommendations should be implemented to protect water bodies from nonpoint source pollution. |
| NE-8 | Upon adoption the recommendations of the Issaquah Creek, Redmond-Bear Creek and East King County Groundwater Management Programs should be implemented through zoning and other mechanisms to protect ground water resources. |
| NE-9 | To protect wildlife resources in East Sammamish and the surrounding region, a network of wildlife habitats should be established. The network should be of sufficient width to protect habitat and dispersal zones for small mammals, amphibians, reptiles and birds. This network should be protected through incentives, low-density zoning, and other appropriate mechanisms. |
| NE-10 | Development shall protect wildlife through site design and landscaping. New development within or adjacent to the wildlife habitat network should incorporate design techniques that protect and enhance wildlife habitat values. |

| | |
|---|---|
| NE-11 | All golf course proposals shall be carefully evaluated for their impact on surface and ground water quality and quantity, sensitive areas, and fish and wildlife resources and habitat. |
| NE-12 | Water used for irrigating golf courses should come from non-potable water sources wherever possible. Use of natural surface water sources, such as streams should be avoided due to impacts on fish and other wildlife habitat. A water conservation plan shall be submitted with golf course applications which should address measures such as the use of drought tolerant plant species. |
| NEW POLICY | A water quality study should be conducted for Pine Lake and GR-5 zoning should be applied to the Pine Lake Watershed until a plan amendment study is completed to determine the appropriate density and development conditions for the area. The plan amendment study should be based upon the findings of the water quality study and the East Lake Sammamish Basin & Nonpoint Action Plan.<br><br>The Plan amendment study should be transmitted to the Council before June 1, 1994 and should provide a range of alternative densities based upon several levels of phosphorus control and several levels of impact upon Pine Lake water quality. |

| | |
|---|---|
| NEW POLICY | A study should be conducted of the Pine Lake Basin to produce a Pine Lake Management Plan, with the objective of specifying the controls, actions and management practices to be implemented:<br>i. to reduce surface water problems that threaten public health and safety;<br>ii. to protect the value of Pine Lake for recreation, fish and wildlife habitat, aesthetic enjoyment, and other hydrological and environmental functions;<br>iii. to reduce the contributions of nonpoint source pollution, particularly phosphorous, to the surface waters of Pine Lake basin. |
| NEW POLICY | King County shall require all known, available and reasonable methods of prevention, control and treatment for phosphorous control for all new development in the Beaver Lake Watershed. Unless it can be demonstrated that a method or combination of methods is effective to prevent, control and treat phosphorous, and is more feasible, the following shall be required in the Beaver Lake Watershed until the SWM Drainage Manual is revised to deal with phosphorous loading to small lakes, at which time the SWM Drainage Manual requirements shall apply. If soils are suitable, King County shall require infiltration to and including the 25 year event, for all new development, if soils are not suitable for infiltration, then King County shall require a grass swale or constructed wet-land, and together with sand filtration for all new development. When the Beaver Lake Management Plan is adopted then this would sunset. |
| NEW POLICY | The Patterson Creek Basin currently provides highly-productive aquatic habitat. Urban development within this basin should be conditioned to protect this resource by minimizing site disturbance, impervious surfaces and disturbances of wetlands and streams. |
| NEW POLICY | A Wetland Management Area should be established for Beaver Lake (Wetland #57) |
| R-1 | The East Sammamish planning area should provide for a variety of housing types and densities. This variety may be achieved through small and large lot urban single family development, town houses, duplexes, apartments, mixed business-residential developments in urban activity centers and community and neighborhood centers, mobile home parks, and rural residential development. |
| R-2 | Residential land use designations shall allow for development that will accommodate a range of incomes by providing for a range of housing types and prices, and households at different life cycle stages (e.g., elderly as well as families with children). |
| R-3 | Urban Growth Reserve Areas shall be permitted an interim residential density of one house per five acres. Lots shall be tightly clustered (on no more than 25 percent of the parcel being subdivided, not including any sensitive area or required buffers) to preserve maximum flexibility and capacity for later development at urban densities. When sewers are available, all lots created under the Growth Reserve designation shall comply with density provisions of the King County Code as applied to the site's potential zoning. Sewers shall be considered available when they extend to within the distances for required connection to public sewers prescribed by The Code of the King County Board of Health. Urban Reserve Areas shall include all parcels of 2 acres or more area within Urban Residential areas. |
| R-4 | Residential densities compatible with the prevailing development pattern shall be used in Urban Areas where the predominant subdivision pattern has already developed. Infill development compatible with surrounding residential neighborhoods should be encouraged on vacant or under-used parcels of land where urban services can be provided. For purposes of guiding area zoning decisions, a parcel of land should be considered suitable for compatible infill at a density higher than surrounding development if:<br>a. It contains enough area to accommodate development with a suitable buffer, (i.e. a minimum site area of 1.5 acres), such as landscaping or native vegetation, in addition to any open space required to be retained to protect environmentally sensitive areas, and<br>b. Urban services are available and off-site impacts as traffic can be mitigated. |

| | |
|---|---|
| R-5 | A 1-acre residential density designation shall be applied in the East Sammamish planning area based on the following location criteria:<br>a. Areas that are substantially developed with an established pattern of 1 acre lots;<br>b. Urban lands that are severely environmentally constrained (parcels of land with 25 percent or less buildable area, as defined by King County's environmental regulations, shall be considered "severely constrained" for purposes of this policy);<br>c. Areas with significant open space value that can function as a defining community separator between the urban growth areas adopted by this plan for the Cities of Redmond and Issaquah, or as a wildlife habitat network to link major wetlands and other environmentally constrained features with good habitat value; these areas shall be developed with clustered subdivisions to protect the open space;<br>d. Areas that can provide a buffer between higher density Urban development and Rural Areas, or<br>e. Areas where there are very long term, environmental, financial obstacles to the provision of urban services and infrastructure sufficient to support development at higher urban densities. |
| R-6 | A residential density of 2-3 homes per acre shall be designated in Urban Areas meeting the following criteria:<br>a. Areas already developed at density of 2-3 homes per acre without significant opportunities for higher density infill consistent with ESCP Policy R-4, and<br>b. Areas less environmentally constrained than those specified in ESCP Policy R-5, but where a density of 2-3 homes per acre would afford a substantially higher degree of environmental protection than could be attained at higher residential densities. |
| R-7 | A residential density of 4 homes per acre shall be designated in Urban Areas meeting the following criteria:<br>a. Public water and sewer are or can be made available at the time of subdivision;<br>b. The parcels have 26 to 59 percent buildable area, as defined by King County's environmental regulations, and<br>c. The parcels have convenient access to a current or planned neighborhood collector street. |

| | |
|---|---|
| R-8 | A residential density of 6 homes per acre shall be designated in Urban Areas meeting the following criteria:<br>a. Public water and sewer are or will be available at the time of subdivision;<br>b. The parcels have 60 percent or more buildable area, as defined by King County's environmental regulations;<br>c. The parcels have convenient access to a current or planned neighborhood collector street; and<br>d. If surrounded by existing lower-density development, the parcels are large enough to provide a buffer such as landscaping or permanently protected tree cover. |
| R-9 | A residential density of 8 homes per acre shall be designated in Urban Areas meeting the following criteria:<br>a. Public water and sewer are or will be available at the time of subdivision;<br>b. The parcels have 60 percent or more buildable area, as defined by King County's environmental regulations;<br>c. The parcels have convenient access to a current or planned neighborhood collector street and within one-half mile of a current or planned arterial; and<br>d. If surrounded by existing lower density development, are on parcels large enough to provide a buffer such as landscaping or permanently protected tree cover. |
| R-10 | New multifamily zoning in the East Sammamish planning area should be located on parcels with 60 percent or more buildable area, as defined by King County's environmental regulations, are within one-quarter mile of a current or planned arterial and that are:<br>a. Close to or in the cities of Issaquah and Redmond and the planning area's community and neighborhood centers; or<br>b. In master planned developments; or<br>c. On small, dispersed sites identified on the Plan Map:<br>1. within urban residential areas, and<br>2. where public sewer and water can be made available at the time of development.<br><br>Parcels of land about 2.5 acres in size or smaller, and separated from each other by a distance of about 660 feet if within two miles of the boundaries of Redmond or Issaquah, or 1320 feet if located elsewhere, should be considered "small, dispersed sites" for purposes of this policy. Sites adjacent to or within convenient walking distance of public parks should be considered especially suitable for multifamily development if they meet criteria a b or c set forth in this policy. |
| R-11 | New multifamily development located on small, dispersed sites in the Pine Lake, Beaver Lake and Sahalee sub-areas shall be at a zoned density of 12 units per acre. Sites in or adjacent to the Sammamish Highlands and Pine Lake Plaza business areas, and the Klahanie master planned development, are appropriate for densities of 18 or 24 units per acre. |
| R-12 | New multifamily development in the Lake Sammamish subarea shall be located on small, dispersed sites at a zoned density of up to 12 units per acre, except for sites close to the Cities of Redmond and Issaquah where higher densities may be appropriate when consistent with those cities' land use plans. Sites in or adjacent to the neighborhood business area at the intersection of East Sammamish Parkway SE and SE 33rd Street, should have base densities of 12 or 18 units per acre.<br><br>New multifamily developments at densities up to 24 units per acre, are appropriate in some portions of the area to the east of the Lake Sammamish Parkway at the intersection of SE 43rd St. Environmental constraints may substantially reduce the density that can be achieved in this area. Actual densities shall be determined through the development review process subject to adopted County policies and regulations and the recommendations of the East Lake Sammamish Basin and Non-point Action Plan when it is adopted. |
| R-13 | The Happy Valley subarea and portions of the Patterson Creek sub-basin, including lands adjacent to the Patterson Creek Agricultural Production District, meet KCCP criteria for rural levels of development and shall be redesignated Rural. |
| R-14 | Residential development in designated Rural Areas in the East Sammamish planning area shall be at a density of one house per 5 acres, when parcel size permits and the land is physically suitable. |

| | |
|---|---|
| R-15 | A residential density of one house per 10 acres shall be applied to Rural Areas where the predominant lot size is 10 acres or larger and where at least one of the following circumstances applies:<br>a. The lands are adjacent to a designated Agricultural Production District, Forest Production District or legally approved long-term Mineral Resource Extraction Site;<br>b. The lands include significant areas of 40 percent steep slopes, severe landslide hazards, number 1 and 2 wetlands or other severe development constraints; or<br>c. The lands are within the identified 100-year floodplains of Evans or Patterson Creeks or other streams in the East Sammamish planning area. |
| R-16 | A residential density of one house per 2.5 acres shall be applied to Rural Areas where the following circumstances apply:<br>a. The existing lot size pattern is predominantly 2.5 acres or smaller;<br>b. The lands are predominantly free of environmentally sensitive areas and wildlife habitat;<br>c. Soils on the lands are predominantly those rated by the U.S. Soil Conservation Service as having "none to slight" or "slight to moderate" limitations for septic tank drainfields;<br>d. Public water supply is available to serve the area. |
| R-17 | All urban residential developments, including multifamily developments, regardless of size, shall provide or contribute toward park sites that meet the park site and location criteria in the Open Space Plan and Ordinance 3813. For single family plats 20 acres in size or larger, at least 1 acre of land toward this requirement shall be provided on-site, within walking distance of all residents and with opportunities for active recreation. On-site parks shall be privately developed. At least fifty percent of the land set aside should be for active recreation and developed as tot-lots, playgrounds, open lawn area or with other active recreation facilities. Land set aside for active recreation should be well-drained, level, and suitable for the active uses specified in the site plan. Trail improvements to power line and pipeline rights-of-way also should be considered as a means of providing recreation opportunities. |
| R-18 | If no land within or adjacent to the development meets the Open Space Plan criteria for park sites, a fee-in-lieu of park dedication (equal to the value of land and facility development) shall be substituted. Resulting accumulated funds shall be applied to purchase lands as close as possible to the contributing development site. |
| R-19 | Wherever possible, land dedicated for park sites shall be linked with park sites in adjacent developments and with nearby trail systems. |
| R-20 | Sidewalks, pathways, and trails shall link homes to recreation areas within the development and to park space outside the development. |
| R-21 | Homeowner associations shall maintain recreational park land and facilities not meeting criteria for public dedication. The County should require a recorded homeowner maintenance agreement to ensure park facilities are adequately maintained. |
| NEW POLICY | King County should consider a demonstration Transfer of Development Rights (TDR) program allowing transfers of density between parcels within the Grand Ridge subarea to meet public objectives. Sending areas should be specifically identified and their inclusion within the TDR program should result in the securing of additional public benefits such as public parks and open space or the protection of scenic corridors, wildlife habitat or water quality. Several receiving areas which focus residential development on the least environmentally sensitive areas, and those areas with optimum access and service availability, should also be identified within the Grand Ridge subarea. |
| CI-1 | The cities of Issaquah and Redmond are recognized as the Urban Activity Centers for the East Sammamish planning area. Industrial and major commercial activities shall be directed to these urban activity centers. |
| CI-2 | Commercial and industrial areas shall be compact rather than extending in strip developments along arterials. The boundaries of the commercial and industrial areas are defined by the land use planning map and area zoning. Rezoning nearby multifamily land for additional commercial or industrial uses is inconsistent with the intent of this plan. |
| CI-3 | All future commercial development in the East Sammamish planning area shall locate within the designated Urban Activity Centers and Community and Neighborhood Business Centers. |

| | |
|---|---|
| CI-4 | The Community Centers designated for serving the East Sammamish area are:<br>a. the Pine Lake Village shopping center, located at the intersection of 228th Avenue S.E. and the Issaquah Pine Lake Road;<br>b. the Sammamish Highland/Inglewood Plaza shopping center located at the intersection of Inglewood Hill Road (NE 8th) and 228th Ave. SE; and<br>c. the planned shopping center within the Klahanie development. |
| CI-5 | The Neighborhood Center for serving Plateau residents is the southeast quadrant of S.E. 32nd Street and East Lake Sammamish Parkway (Sammamish Plaza) intersection. |
| CI-6 | Criteria for additional Community and Neighborhood Centers on the plateau:<br>a. Documentation of need for the proposed center by demonstrating that population growth has exceeded what was anticipated by this plan, the market can support a new center, and existing centers will continue to be economically feasible;<br>b. Site shall be located adjacent to multifamily, commercial, or industrial uses;<br>c. Site shall not be located next to rural areas;<br>d. Site shall be served by transit by the time 50% of the site is developed;<br>e. Site shall not be within a 100-year flood plain, wetland, steep slopes, landslide and erosion hazard areas; and<br>f. Site does not result in any net loss in land designated and zoned for multifamily development. |
| CI-7 | Industrial/office park development shall be located within the Urban Activity Centers and at the Employment Center designated at the southern end of the plateau, near the I-90 corridor and north of the Front Street Interchange. |
| CI-8 | Support services such as restaurants, banks, grocery store, deli, cleaners, printing establishments, retail sales and consumer service establishments catering to the employees are encouraged to locate within the Employment Center. |
| CI-9 | Support services shall make-up no more than 35% of the total land area designated in the East Sammamish Plan for Employment Center development and shall be located in such a way that encourages safe pedestrian access from surrounding existing and planned industrial, office and retail development. Properties with existing retail uses at the intersection of E. Lake Sammamish Parkway and SE 56th Street should be designated for office, light industrial and retail uses. |

| | |
|---|---|
| CI-10 | Commercial and industrial development in the East Sammamish area shall include development requirements that:<br>a. Limit the commercial uses to those that provide community and neighborhood-scale convenience shopping and services to the surrounding area;<br>b. Limit industrial development to light, relatively non-polluting uses that can locate in an industrial/office park;<br>c. Require new commercial and industrial development to utilize clean air practices;<br>d. Enforce height and setback requirements when commercial and industrial development is adjacent to residential uses;<br>e. Provide open space (excluding parking) adequate buffers and screening through creative use and design of setbacks, berms, pathways, outdoor furniture and artwork and landscaping that help to reduce the visual impacts of impervious surfaces and maintain the character of the area;<br>f. Screen with suitable landscaping any portion of an exterior wall that is 30 feet or longer without windows that faces a street or residential lot;<br>g. Screen required off-street parking and loading bays with landscaping or buildings;<br>h. Ensure control of surface water run-off;<br>i. Ensure safe pedestrian, bicycle and vehicle access to and within all parts of the development;<br>j. Provide public access to on-site open space areas and recreational opportunities adjacent public park facilities, lakes and other environmental features where feasible;<br>k. Enforce sign and lighting requirements that reflect local character and reduce light and glare on the surrounding area;<br>l. Where appropriate, limit hours of operation in order to reduce noise and traffic impacts; and<br>m. Require predominantly drought resistant landscaping. |
| CI-11 | A transition area between the designated industrial/office park area south of Southeast 56th Street and the single family area to the north and east shall be provided. This shall include the provision of using natural constraints, buffers through setback requirements, landscaping, and designating land uses compatible with industrial/office park development and single family neighborhoods. |
| CI-12 | No additional commercial land shall be designated along the Redmond-Fall City Road. The Bear Creek Neighborhood Center on Redmond-Fall City Road provides adequate retail services for the immediate area. Future commercial development shall be focused at the Bear Creek commercial site. |
| CI-13 | The Northwest Pipeline office and maintenance shop is an existing use and is recognized by this plan as providing a needed service to the area. This 6.5 acre site may redevelop for pipeline utility and/or school bus base uses exclusive of major maintenance functions that are compatible with the surrounding rural development and agricultural uses. Redesignation of additional properties in the Happy Valley area for manufacturing park uses or other urban uses shall not be permitted. |
| RL-1 | Consistent with the covenants and restrictions attached to their deeds, lands with development rights purchased under the King County Farmlands Preservation Program shall have a zoning designation of at least one home per five acres. Development should be clustered to maximize the agricultural potential of the properties. |
| RL-2 | Lands located within the Agricultural Production District shall have an agricultural zoning designation of one home per 10 acres. |
| RL-3 | To minimize potential conflicts between rural residential land uses and agricultural activities, new development adjacent to Agricultural Production District boundaries and the Farmlands Program properties in Happy Valley shall be limited to residential land uses. Subdivisions in these areas shall be designed and sited to reduce potential conflicts between housing and agriculture, discourage trespass, and protect rural cultural resources. |
| RL-4 | To minimize potential conflicts between urban residential land uses and agricultural activities, where urban lands abut the Agricultural Production District or agriculturally zoned lands, clustering shall be mandatory. |
| RL-5 | Urban infrastructure expansion within the Agricultural Production District and Happy Valley should be limited to existing corridors. Exceptions may occur when such actions are consistent with agricultural policies, do not substantially disturb agricultural activities and are necessary to serve urban areas. |
| RL-6 | The East Sammamish area's active gravel pits should be encouraged to be mined to their full potential within the designated areas on the Land Use Map, and shall be restored and reused when extraction operations cease. Residential development at urban densities in conjunction with mixed commercial/residential uses or a master planned development (MPD) shall be the preferred reuse of the mineral sites in the vicinity of the City of Issaquah. Any MPD for these sites shall be reviewed in cooperation with the City of Issaquah. |

| | |
|---|---|
| RL-7 | Properties containing gravel pits shall not be subdivided until the area to be subdivided has been reclaimed in accordance with a reclamation plan for the entire site., so that grading, landscaping and other reclamation activities are coordinated for an entire site. |
| RL-8 | Extractive operations, including reclamation, shall be conditioned and monitored to protect Issaquah Creek and to help implement the Issaquah Creek Basin Plan. |
| RL-9 | Sites with existing and planned mineral extraction and processing operations should be annexed only when there are policies and regulations in place to assure long-term extraction and processing activities including environmental regulation and reclamation under city jurisdiction. When such sites are included within an incorporation, King County should pursue interlocal agreements to obtain the same assurances. |
| NEW POLICY | Parcels near or adjacent to the designated quarry mining area containing mineral resources should be mined to their maximum and feasible extent, consistent with environmental standards. Reclamation and restoration of the site should be done in such a way to facilitate access and development of the site consistent with the Plan's long term land use designation. |

| | |
|---|---|
| T-1 | Metropolitan King County Government should provide a balanced transportation system in the East Sammamish Planning Area by:<br>a. Applying demand management and operational management options to make more efficient use of existing vehicle capacity;<br>b. Providing non-motorized and high occupancy vehicle (HOV) facilities, including metro and services; and<br>c. Planning for and constructing capital improvements which ensure adequate roadway capacity. |
| T-2 | Metropolitan King County Government, Issaquah and WSDOT should enter into interlocal agreements transportation improvement projects to alleviate congestion at I-90 interchanges in the East Sammamish Planning Area. Recommendations from the Issaquah/I-90 Access Study, East Sammamish Access Improvement Study, Eastside Transportation Program and the East Sammamish Community Plan Update should be considered. |
| T-3 | Consistent with existing county-wide policies and in order to accommodate anticipated development and population growth in East Sammamish, transportation improvements in Metropolitan King County shall proceed in the following priority order:<br>a. Safety<br>b. Maintenance<br>c. Transit Support<br>d. Capacity increases for existing development<br>e. Capacity increases for future developments |
| T-4 | Safe equestrian access shall be preserved and/or enhanced within the road right-of-way within established equestrian communities in East Sammamish as identified on the Non-Motorized Improvement map. A widened gravel or dirt shoulder may be preserved or expanded as needed to enhance safe equestrian circulation within these communities. Such facilities and techniques should serve to maintain access to either the public or established private trails system in these areas. If right of way, traffic volumes/speed, and user demand indicate the need, a separated parallel facility in the road right-of-way may be constructed outside of the ditch line, or as a trail on an independent alignment. All roadside equestrian facilities should be coordinated with the off-street network to provide access and route continuity. Identified equestrian trails on private property shall be preserved through the development process through P-suffix conditions. |
| T-5 | All new development that contains an equestrian trail as identified on the map, East Sammamish Non-Motorized Improvement, or an historically used equestrian trail, shall provide the trail right-of-way as a condition of subdivision or other County permit approval. Trail right-of-way width shall be determined by King County at a width suitable to accommodate equestrian uses. The area within the trail right-of-way but not within any dedicated road right-of-way shall also be credited toward the lot area of any proposed development. |
| T-6 | If the need for a new transportation corridors is identified, Metropolitan King County Government shall move in a timely manner to identify and acquire the needed right-of-way. |
| T-7 | Metropolitan King County Government shall require a contribution for all new development in East Sammamish for transportation improvements to help mitigate traffic impacts as required by the Metropolitan King County Government Road Adequacy Standards and Mitigation Payments System. |
| T-8 | Commercial and industrial land uses in East Sammamish should be located and be served by the intersection of two principal arterials. Neighborhood centers should be located and served by at least a secondary arterial. |
| T-9 | New developments should be designed and constructed with an internal road system which includes a Neighborhood Collector linking with existing or planned adjacent developments, creating a complete Neighborhood Collector circulation system and such linkage should be designed to ensure sure safety of local streets. Through traffic on local access streets should be discouraged. |
| T-10 | New urban developments taking access via local access streets in existing residential neighborhoods should include connecting roads compatible in design with the existing neighborhood street while meeting safety standards of Metropolitan King County Government Road Standards. Development conditions may include improvements on existing streets in order to ensure safety standards. |
| T-11 | Metropolitan King County Government should work to increase fixed route transit service frequency, extend routes, and establish new routes and demand responsive services in order to connect the more developed portions of the East Sammamish Community Planning Area to downtown Redmond, Issaquah and area Park-and-Ride lots. |

| | |
|---|---|
| T-12 | Metropolitan King County Government should incorporate bus pullouts, bus shelters and other transit or HOV facilities, as needed, into roadway design and project recommendations. New subdivisions fronting streets with transit service should include provisions for transit support facilities as determined through the development review process. |
| T-13 | Metropolitan King County Government should establish Park and Ride facilities in the East Sammamish Community Planning area. Park and Ride facilities should be built along 228th Avenue and/or adjacent to I-90 and SR 202. The Park and Ride(s) lots should be sited adjacent to and connect with existing or proposed community or neighborhood centers or within the employment center located around the intersection of E. Lake Sammamish Parkway and SE 56th Street. Establishment of a site near, but to the north of, I-90 should be a high priority response to current and anticipated I-90 access problems. |
| T-14 | Small joint park and ride/park and pool lots should be established both publicly and privately in East Sammamish along principle or minor arterials near residential and commercial developments to facilitate transit use and car/van pooling. Preferably, these lots should be associated with existing uses, such as churches, where midweek parking capacity is under-utilized. |
| T-15 | HOV improvements shall be considered in all major widening and new construction road projects in East Sammamish. Consideration shall be given to HOV lanes, queue bypasses and transit pull-outs. HOV facilities should be a high priority on principal arterials. Metropolitan King County Government should also coordinate with the cities of Redmond and Issaquah and the Washington State Department of Transportation to include consideration of HOV facilities on roadways in their jurisdictions. |
| T-17 | Bicycle and pedestrian facilities should be incorporated into all East Sammamish road improvement projects. Special emphasis should be placed on pedestrian and bicycle safety improvements when developing project recommendations or when scheduling maintenance activities. |
| T-18 | All new residential developments in East Sammamish should have include a system of pathways including sidewalks which maximize internal pedestrian access and circulation. Pathways should provide the most direct access possible, thereby removing barriers and preventing unnecessary circuitous routes. This may include on or off street pedestrian routes. This may include providing pedestrian connections between abutting cul-de-sacs and coordinated off-site connections to adjacent existing and planned residential and commercial developments, institutions (including schools and libraries), transit stops, and regional trails. The residential developments should maintain on site pathway systems unless Metropolitan King County Government requires their dedication. |
| T-19 | New commercial, office, industrial, and multi family housing developments and public and private institutions (including schools and libraries) in East Sammamish should include pedestrian and bicycle access and circulation facilities. Facilities should be designed with special consideration for children, handicapped persons, and the elderly which allow convenient access to and within the site. The utmost attention should be given to safety in design of internal pedestrian walkways in an effort to reduce pedestrian/automobile conflict. The design of the development should not create barriers for bicycle access and should provide bicycle parking on the properties. Existing institutions are encouraged to remove existing bicycle barriers and to provide bicycle parking. |
| T-20 | Metropolitan King County Government should ensure adequate pedestrian and bicycle access to and support facilities at transit stops and include secure parking for at least one bicycle. |
| T-21 | Metropolitan King County Government should develop a pedestrian and bicycle circulation plan for all existing or planned community and neighborhood centers in East Sammamish during this planning cycle. |
| T-22 | Metropolitan King County Government should preserve existing equestrian access along streets relied upon by the equestrian community as identified in this plan for access to regional trails in East Sammamish. Such roads should preserve and/or enhance wide, soft surface shoulder conditions, or establish a parallel soft surfaced equestrian trail outside of the ditch line or curb of the road. |
| T-23 | Equestrian related improvements should be made on arterials only when no other safe and direct option for equestrian trail access exists on either non-arterial streets or dedicated off-street feeder trails. |
| T-24 | Metropolitan King County Government should develop Neighborhood Pathways within the road right-of-way along roads which have no existing pedestrian facilities and which has also been identified for equestrian need. Preferably, these multi-purpose pathways should be located outside the ditch line or curb and should be soft-surfaced. |

| | |
|---|---|
| T-25 | Establishment of a multipurpose separated trails system in East Sammamish shall be aggressively pursued, particularly if a proposed addition to the system would serve activity centers or destinations such as schools, commercial and industrial centers, recreational facilities, and residential developments. Access to the trail system shall be enhanced through the provision of increased parking at key access points be provided. |
| NEW POLICY | The Metropolitan King County Government shall address the transit needs of planning area residents. A jointly-funded study should be conducted in a currently developed area representative of the range of densities and housing types planned for the urban area of East Sammamish. The study should include a survey of residents' present commuting patterns as well as non-work related travel and preferences for transit improvements. Innovative transit solutions should be investigated to identify those that might best respond to the identified needs of area residents and a pilot project should be funded to implement the study's findings. |
| FS-1 | Installation of new water lines should be consistent with an adopted district's or municipal water comprehensive plan and is timed and coordinated, as required by K.C.C. 14.28 with other utility projects which utilize public right-of-ways and easements This will help to reduce overall public costs, noise and disruption to the local area during construction. |
| FS-2 | New development within the designated water service area should be required to be served by public water systems as defined by WAC 248.54 and provided for in the coordinated water system plan for the area. |
| FS-3 | Water conservation practices are encouraged for new building construction. |
| FS-4 | Long range water utility planning should support and be consistent with existing regulations and planned land use designations. Connection to the Seattle Tolt River Pipeline or a similar regional water source should be established as the long term solution for water needs in the Urban Area. |
| FS-5 | Conversion of Urban Reserve Areas to urban land uses should not be permitted until King County reviews and approves a water district comprehensive water plan amendment that identifies any required new source of water and until the criteria spelled out in GM-4 have been met. |
| FS-6 | Water service in Rural Areas may be provided by:<br>a. Direct connection to an approved public water system. If service from existing public water systems will not become available in a reasonable and timely manner at the time of development; then<br>b. A satellite water system should be established, managed by an approved Satellite System Manager; or<br>c. Formation of a new public water system, consistent with Coordinated Water System Plan guidelines. |
| FS-7 | Water mains extended into or through Rural Areas and Resource Production Districts should be sized according to the adopted CWSP to accommodate planned uses and rural densities. Existence of public water service for Rural areas or Resource Production Districts shall not result in or be justification for higher residential densities than anticipated by this community plan. Therefore, purveyor plans for systems in Rural Areas and Resource Production Districts must include a finding that increased density shall not be required to finance such systems. |
| FS-8 | Areas identified as recharge areas should be protected under the Issaquah Creek Valley and Redmond-Bear Creek Valley Ground Water Management plans. Methods to be considered should include use of clustered development, maintaining or redesignating the area for low density development conditions, amount of clearing and impervious area restrictions, and requiring stringent adherence to drainage and surface water runoff protection guidelines. |
| FS-9 | Metropolitan King County Government and affected jurisdictions should implement the adopted recommendations of the East Sammamish Basin Plan, Issaquah Creek Basin Plan, the East King County Critical Water Supply Study, the Issaquah Ground Water Management Plan and the Redmond-Bear Creek Valley Ground Water Management Plan when completed, as long term solutions for protecting water resources in the East Sammamish planning area. |
| FS-10 | Public sewers are the preferred method for wastewater treatment in Urban Areas, including Urban Reserve Areas. |
| FS-11 | Existing urban areas of one to two dwelling units per acre may continue to be served by on-site waste water treatment systems. Urban Reserve Areas may be served by on-site waste water treatment systems provided these systems function properly. |

| | |
|---|---|
| FS-12 | Metropolitan King County Government should oppose any extension of public sewer service into the Snoqualmie drainage basin except to serve Urban Areas, Urban Reserve Areas or existing development being served by a failing on-site system as determined by health department standards. Such extensions will not require, or be justification for, land uses or densities inconsistent with the adopted zoning and King County Comprehensive Plan. |
| FS-13 | Metropolitan King County Government encourages sewer districts to use latecomers agreements when they extend sewers into the urban reserve areas. |
| FS-14 | Within Rural Areas and Resource Production Districts, sewer service shall not be extended nor new sewer systems added. |
| FS-15 | Metropolitan King County Government should work with all local jurisdictions in addressing the need for additional sources of electric power. Interlocal agreements between Metropolitan King County Government, Redmond and Issaquah should include means of facilitating the siting, design and permitting process of transmission lines, distribution lines and substations. The integrity of the public involvement process of each jurisdiction should be maintained. |

| | |
|---|---|
| FS-16 | Land should be designated and set aside for future transmission line corridors and substations and the locations should be compatible with surrounding uses and supports existing and planned future land uses. Development within and adjacent to proposed corridors should be coordinated with and reviewed by King County, Redmond, Issaquah and Puget Power. |
| FS-17 | SEPA review of development permits should include a review of project specific as well as cumulative impacts on the electrical system. |
| FS-18 | King County and Puget Power should continue to work together to develop open space uses in Puget Power transmission line rights-of-way. |
| FS-19 | A "Notification of Electrical Service Needs", provided to Puget Power, should be required as part of a completed development application. This will serve to alert Puget Power of new developments in the area and the impacts of the proposed development on the electrical system. |
| FS-20 | New transmission lines and distribution stations should be developed to decrease the number of interruptions and duration of outages to Puget Power's existing electrical system. King County includes for informational purposes only, Puget Sound Power and Light Company's "King County GMA Electrical Facilities Plan", dated December 1992. |
| FS-21 | Developers proposing new subdivision developments within the planning area should notify local service providers in order to coordinate the provision of needed services in the area. |
| FS-22 | The installation of new natural gas lines should be timed and coordinated with other utility projects which utilize public right-of-ways and easements where possible. This will help to reduce overall public costs, noise and traffic impacts on the local area during construction. |
| FS-23 | Joint use of public safety facilities should be encouraged as future fire and police service needs are planned for and site plans are developed. |
| FS-24 | King County and the various school districts should identify future school needs based on land use densities, identify available and buildable future school sites and plan for needed infrastructure improvements. |
| FS-25 | King County should reevaluate the current mitigation process for new development on park and open space needs. King County Parks staff should work with the school districts to develop jointly funded, used and maintained playfields (including 90' baseball fields), community centers, gyms and swimming pools. |
| FS-26 | Prior to site preparation, an inventory of vegetation will be conducted to identify significant trees and vegetation. Site designs for new schools and other public facilities, should incorporate existing vegetation as much as possible. Retention of significant trees and vegetation along roadways is required in order to provide visual buffering of these facilities. |
| P-1 | Park and recreation facilities shall be provided which are designed and located to serve a broad spectrum of the East Sammamish population and which will preserve and protect cultural resources and unique natural features where possible. A variety of recreation opportunities should be available including natural areas, passive parks and active developed parks including athletic fields. A network of trail systems should be developed within the planning area. |
| P-2 | King County shall evaluate existing developed areas and areas designated for future growth, as well as county-owned property throughout the planning area, to identify future park sites. Suitable sites within developed and future growth areas should be given highest priority for new park acquisition and facility development. |
| P-3 | Prospective sites for active recreation parks, shall contain substantial areas of well-drained level ground suitable for athletic fields, tennis courts, and other similar facilities. Such facilities shall be located convenient to the population they are designed to serve. |
| P-4 | The trading of County property in the planning area for other private property for the purpose of obtaining better parklands or open space is encouraged. However, any land to be so acquired must be within the East Sammamish Planning area. Prior to any such land trade, community meetings shall be held to inform planning area residents and gather community input. |
| P-5 | In phased development, on-site recreation or park sites shall be designated during the initial phases; improvements (such as play equipment) should be completed proportionately as buildout occurs. |
| P-6 | Park and recreational facilities shall support the existing population as well as projected growth in the planning area consistent with county-wide park adequacy and concurrence requirements as they are adopted. |
| P-7 | King County shall provide a level of funding which shall at all times be sufficient to assure adequate maintenance of existing park and recreation facilities. |

| | |
|---|---|
| P-8 | King County shall give high priority in the allocation of resources to active recreation facilities to meet existing and projected recreation demand in the East Sammamish Community Planning Area. Facilities should include, but are not limited to, tot lots and athletic fields. |
| P-9 | The allocation of resources for active parks as well as open space and natural areas shall place heavy emphasis on early acquisition of land for these purposes while it is still available in the East Sammamish planning area. |
| P-10 | The East Sammamish Plan shall support the goals and recommended policies of the King County Open Space Plan as well as the protection of the open space sites proposed for acquisition by the Open Space Plan. Implementation techniques may include acquisition, establishment of development controls or provision of development incentives. |
| P-11 | Consistent with the King County Open Space Plan, the County shall encourage establishment of an open space system in East Sammamish and give priority to protecting recreational, cultural and natural and sensitive areas such as shorelines, aquifer recharge areas, wildlife habitat, historic properties, archaeological sites, scenic vistas and community separators or greenbelts. The County may require lot clustering within or adjacent to open space areas; linkages between open spaces and may provide density bonuses or incentives to developers who preserve significant open space or establish trails beyond usually applied mitigation. |
| P-12 | Existing vegetation buffers shall be maintained along all major thoroughfares within the planning area. These buffers should be as continuous as practicable. Where existing vegetation is not adequate to create a visual buffer additional landscaping shall be provided. |
| P-13 | King County should encourage retention of significant views. Scenic vistas should be protected by using a variety of residential development strategies such as clustering, unobtrusive siting of buildings, height restrictions and zoning. Properties with significant vistas should be considered for acquisition. |
| P-14 | King County should review and, where appropriate, implement the recommendations of the Mountains to Sound Greenway plan. |

| | |
|---|---|
| P-15 | Existing public access points to Lake Sammamish should be maintained and additional access points provided or acquired and developed to ensure public access to the lake. |
| P-16 | Sites providing shoreline access opportunities should be high priority for acquisition. Shoreline sites should incorporate facilities for picnic activities and other passive recreational uses. Where physical access would disrupt environmentally sensitive areas, the provision of viewpoints should be preferred over physical recreational uses. |
| P-17 | Urban separators should be established in the area designated on the community plan map to provide visual relief from continuous development, provide important linkages for wildlife habitat, and maintain a visual separation between distinct communities. The East Sammamish Area Zoning will implement the Urban Separators. |
| P-18 | There are areas within the Urban Separators that are especially suitable for trail connections for recreational use by present and anticipated population. King County should develop a trail and/or parks system utilizing the preserved open space within the Urban Separators. |
| P-19 | Trail opportunities shall be available to a wide range of users. Trails should avoid degradation of environmentally sensitive areas. King County shall put a high priority on the acquisition and development of the regional trail system linking the East Sammamish planning area to other parts of the County. |
| P-20 | A community wide trail system for pedestrians, equestrians, and bicyclists shall be developed. This trail system shall connect regional and city trails with local trails and walkways. |
| P-21 | The establishment and design of a community oriented local trail system should include: routes which connect residential and recreation areas; routes which provide access to public shoreline areas; routes which incorporate views and other special features of scenic, historic, architectural or other cultural interest; and routes which provide access to and connect schools and activity centers. |
| P-22 | Consistent with King County Open Space Plan rights-of-way or easements along utility corridors, abandoned railroads, and other former transportation corridors as potential trail corridors, within this planning area should be acquired. |
| P-23 | When the development of properties occurs in the East Sammamish planning area, public access or easements shall be required to complete the development of a local trail system for those properties where existing trails have historically been used by the public, or where the King County Open Space Plan identifies proposed trail alignment for regional and local trails. The Parks Division shall review the applications during the development review process. |
| P-24 | Adequate right-of-way shall be provided for trail use. Trails shall connect to existing and proposed schools, parks, riding stables, recreation areas and neighborhoods. Trail corridors shall be of adequate width to be screened from adjacent development. |
| P-25 | King County shall work closely with other jurisdictions, public agencies and user groups to seek appropriate trail links between elements of the open space system. |
| P-26 | Wildlife corridors may include trails wherever appropriate. The Environmental Division shall review and approve all trails proposed in wildlife habitat corridors. |
| P-27 | King County and other jurisdictions should implement a regional equestrian trails network. |
| P-28 | Off-Road-Vehicles (ORV) should be strictly prohibited from areas not specifically designated for ORV use. Separate ORV trails should be located where environmental impacts can be minimized. |
| ~~P-29~~ | ~~King County shall encourage private sector involvement in the provision of public recreation facilities.~~ |
| P-30 | King County shall encourage use of various mechanisms to provide and integrate parks, open spaces and trails into all existing and new development. Park and recreation facilities should be accessible to the general public. |
| P-31 | As a condition of development, park, open space and trail mitigation shall be required of all new residential development. Such mitigations should be identified and in place prior to, or concurrent with, development. |
| P-33 | King County, the state, the cities of Issaquah and Redmond, school and library districts and other agencies shall coordinate the development of park and recreation facilities and programs to maximize services and recreational opportunities at all levels. King County may seek to involve youth and adult sport organizations as partners in the selection, acquisition and development of park and recreation facilities serving their needs. |

| | |
|---|---|
| CR-1 | King County shall conduct a survey of existing cultural facilities on the East Sammamish plateau, to assess their condition, level of use, and the need for and feasibility of providing additional facilities. |
| CR-2 | Historic and archaeological resources not previously identified in East Sammamish shall be surveyed. These resources should be added to the Historic Resources Inventory and considered with other inventoried properties for acquisition and protection as open space or for other public use. |
| CR-3 | Most of the area's historic resources identified to date are found in two areas: west of 228th Avenue SE, and along the Paterson Creek/Redmond-Fall City Road. The Community Plan shall label all inventoried historic resources on the area zoning maps and attach special development conditions to them to assure land uses compatible with protecting their historic qualities. |
| CR-4 | Special effort shall be made to involve property owners when identifying and nominating historic resources for landmark status. |
| CR-5 | King County shall pursue interlocal agreements with all cities and appropriate Indian tribal organizations in the planning area. The cities of Issaquah and Redmond do not have historic preservation programs. This would make it possible for the Landmarks and Heritage Commission to identify and protect historic and cultural resources within the participating jurisdictions and their spheres of influence. |
| CR-6 | Historic resources which meet the criteria for County Landmark status should be nominated for designation. The King County Landmarks Commission, community groups and concerned individuals may initiate nominations. |
| CR-7 | The preservation, restoration and adaptive re-use of historic, archaeological and other cultural resources in the East Sammamish planning area is encouraged, in order to maintain the character of the community and to preserve tangible reminders of the area's history. |
| CR-8 | King County encourages local historical and arts organizations to work with the cities of Issaquah and Redmond and citizens in the unincorporated area of East Sammamish to interpret and preserve their heritage and to promote the arts and humanities in the community. |
| CR-9 | Additional property owner incentives and regulatory safeguards should be developed to protect and preserve County Landmarks and other identified historic resources. In addition to continuing current assistance efforts, incentives employed should include the use of existing grants and new grants from Hotel-Motel revenues to preserve eligible resources. Technical assistance from County staff and other sources should be expanded and made more widely available. |
| CR-10 | King County encourages the preservation of historic resources that meet the criteria for County Landmarks or for the State or National Registers of Historic Places. This can be accomplished through zoning, special conditions, development regulations, and other governmental regulation and action. |
| CR-11 | Development of properties in the vicinity of potential or designated historic sites shall preserve the aesthetic, visual and historic integrity of the historic resource through the use of landscape buffers, setbacks, and other means identified through the environmental review process. King County shall establish procedures to ensure that the impacts of nearby projects upon an historic resource are considered during development review of those projects. |
| CR-12 | Development of public facilities, particularly parks, open space lands and trails, shall be coordinated with and contribute to preservation, restoration, and use of heritage and cultural sites and the establishment of interpretative centers in East Sammamish area. |
| CR-13 | King County should continue to provide arts and culturally-based programming to the East Sammamish plateau through its existing programs, and should provide technical assistance for locally-generated arts programs. |
| CR-14 | Public awareness and appreciation of the benefits of historic preservation should be increased through outreach and educational programs. Use of interpretive signs, road side markers and other accessible public information on local history and historic resources should be encouraged. |
| CR-15 | Historic resources and arts and cultural programs should be incorporated into economic development and tourism activities in the East Sammamish area. Measures should include restoration and reuse of historic buildings, protection of scenic quality in historic farming areas, and historic mainstreet restoration in small communities. |

NEW POLICY

An Historic district designation for the West Beaver Lake Neighborhood (near the corner of SE 24th & West Beaver Lake Drive) should be pursued directly with the King County Office of Historic Preservation.

APPENDIX B
WELL LOGS FOR GEOLOGIC CROSS SECTIONS
[Available upon request]

APPENDIX C
ELECTRICAL RESISTIVITY SURVEY
[Available upon request]

APPENDIX D
NEW WELL CONSTRUCTION REPORTS
[Available upon request]

APPENDIX E
PUMP TESTING DATA
[Available upon request]

# APPENDIX F
# DAILY PRECIPITATION DATA
[Available upon request]

**APPENDIX G**
**STREAM FLOW MEASUREMENT DATA**
**[Available upon request]**

**APPENDIX H**
**WELL LOGS FOR WATER LEVEL MONITORING SITES**
**[Available upon request]**

**APPENDIX I**
**WATER LEVEL MEASUREMENT DATA**
**[Available upon request]**

APPENDIX J

LABORATORY WATER QUALITY TESTING DATA

[Available upon request]

**APPENDIX K**
**ENVIRONMENTAL CHECKLIST**

## ENVIRONMENTAL CHECKLIST

### A. BACKGROUND

1. **Name of the proposed project:**

   Redmond Bear-Creek Valley Ground Water Management Plan (RBC-GWMP)

2. **Name of Applicant:**

   Seattle-King County Health Department on behalf of the Redmond-Bear Creek Valley Ground Water Advisory Committee (RBC-GWAC)

3. **Address and telephone number of applicant and contact person:**

   Mr. Bill Lasby
   Seattle-King County Health Department
   918 Smith Tower
   506 Second Avenue
   Seattle, Washington 98104

   (206) 296-4795

4. **Date checklist prepared:**

   October 19, 1994

5. **Agency requesting checklist:**

   This checklist was prepared pursuant to Department of Ecology regulations (Section 110 Chapter 173-100 WAC) which state that proposed Ground Water Management Programs are subject to review under the State Environmental Policy Act (Chapter 43.21C RCW).

   The agency requesting the checklist is the Seattle-King County Health Department. Ms. Sharon Stewart Johnson, Acting Director of Public Health, and Mr. Carl Osaki, Chief of Environmental Health Division, are the Responsible Officials under SEPA for this project.

6. **Proposed timing or schedule (including phasing, if applicable):**

   The draft RBC-GWMP will be submitted to the Department of Ecology (Ecology) and affected agencies for review and concurrence in December 1994. Ecology will hold a public hearing for the purpose of taking public testimony on the Plan. Within 90 days following the public hearing, Ecology and each local government affected by the program must prepare findings. This period may be extended by Ecology for an additional 90 days. Local governments must either express concurrence or nonconcurrence with the draft RBC-GWMP within this specified time period.

   Statements of nonconcurrence must be resolved by the RBC-GWAC, possibly involving revision of the draft RBC-GWMP. The draft RBC-GWMP will then be resubmitted to Ecology for final certification.

   Once certification is granted, implementation of individual program elements will begin. Time necessary for implementation of the program elements is shown in Table 1 (located at the end of this document).

7. **Plans for future additions, expansion, or further activity related to or connected with this proposal:**

Routine, periodic updates of the RBC-GWMP will likely be necessary within five years after certification by the Department of Ecology. However, update of the RBC-GWMP may be needed within two to three years if adequate funding is not available for implementation of the individual program elements. Table 1 (located at the end of this document) outlines the implementation priority schedule for the next three years.

8. **Environmental information that has been prepared, or will be prepared, directly related to this project:**

All information is contained within the draft RBC-GWMP, technical reports, and technical appendices. Refer to those documents for a complete description of the plan elements.

9. **Applications that are pending for governmental approvals or other proposals directly affecting the property covered by the proposal:**

Pursuant to the requirements of the Growth Management Act (Chapter 36.70A RCW), comprehensive land use plans have been, or are being, developed or are being updated by King County and the City of Redmond. Such plans must consider the adequacy of public water supplies to support additional development and must contain provisions for protection of critical aquifer recharge areas.

10. **List of governmental approvals or permits that will be needed for the proposal:**

The draft RBC-GWMP must be submitted to the Washington State Department of Ecology (Ecology) for certification. Prior to certification, Seattle-=King County Health Department will circulate the draft RBC-GWMP to all affected local governments for their concurrence. The affected local governments within the RBC-GWMA include King County and the Cities of Redmond and Woodinville.

11. **Brief description of the proposal and project name:**

The RBC-GWMP was developed by the RBC-GWAC to meet the ground water protection needs of the area. The goal of the RBC-GWMP is to protect the quality and quantity of ground water within the area for present and future use, and to provide for effective and coordinated management of this essential resource. With expected increases in population and the populations' reliance on ground water it is clear that a comprehensive ground water plan tailored to the specific needs of the region is necessary to protect the ground water supply. Ground water provides most of the water used in the Redmond-Bear Creek Valley Ground Water Management Area (RBC-GWMA) for private, municipal, industrial, and agricultural needs.

This Ground Water Management Plan represents a community consensus on the most practical ground water protection measures to safeguard quality and ensure continued availability of this finite resource. The RBC-GWMP directs local and state agencies to develop regulations and programs necessary to protect ground water.

The Ground Water Management Plan is based on state law. In 1985, the state legislature recognized the need for greater ground water protection by adopting legislation which directed the Washington State Department of Ecology (Ecology) to establish a process for designating and developing plans for ground water management areas. (Chapter 90.44 RCW)

The RBC-GWMA was designated a Ground Water Management Area by Ecology on October 7, 1986. In accordance with guidelines in WAC 173-100, Ecology approved the membership of the RBC-GWMA Ground Water Advisory Committee, consisting of a broad cross section of interests with representatives from many groups. The Seattle-King County Health Department (SKCHD) was selected to be the lead agency by Ecology because it has jurisdiction throughout the RBC-GWMA and also has a regulatory role in water systems, on-site sewage systems, solid and hazardous waste, and general environmental health concerns.

Based upon careful study and deliberation about possible and effective ground water protection measures, the RBC-GWAC adopted the following recommendations for ground water management.

Special Area Designations to Enhance Ground Water Protection

The RBC-GWAC adopted the following goal: To use available special area designations in conjunction with local regulations and policies to enhance ground water protection efforts in the RBC-GWMA. The proposed management strategies include: designating Ground Water Management Areas as Environmentally Sensitive Areas; eliminating categorical exemptions to SEPA, and providing guidance to SEPA document reviewers so that they can identify proposed developments that may significantly impact ground water, recognize and require adequate information to assess impacts upon ground water, and recognize and propose effective mitigation; promoting King County and cities to adopt general aquifer protection policies including best management practices for development, preferring infiltration where feasible, and wellhead protection area policies; and promoting King County and cities will place a priority on implementation of the proposed Ground Water Management Plan management strategies in sensitive aquifer recharge areas and areas of unusual susceptibility to ground water contamination.

Data Collection and Management Program

Long-term collection of data on ground water quality and quantity, precipitation, and stream flow is necessary for management of the ground water resource and to continue developing a conceptual characterization of ground water hydrology within the ground water management area. Additional data collection and analysis is needed to refine characterization of the aquifer and to manage the resource.

The RBC-GWAC adopted the following goal: To protect ground water quantity and quality by developing and implementing a data collection and management program.

The proposed management strategy includes: developing and implementing a data collection and management program to collect the needed data, enter the data into the ground water management program database, and analyze the data to provide useful information to decision makers.

Stormwater Management

The most serious public health concern regarding stormwater is the possible impacts to ground water quality which is used as a drinking water source. Ground water quality may be impacted if stormwater containing contaminants recharges ground water intentionally or inadvertently. In addition, precipitation may be diverted to a surface water body that otherwise would naturally recharge ground water. This results in a decrease in the quantity of ground water recharge.

The RBC-GWAC adopted the following goal: To promote stormwater management practices that provide the greatest amount of recharge while protecting ground water quality.

The proposed management strategies include: requiring rural residential zoning and open space areas be maintained in high potential aquifer recharge zones to preserve recharge. To preserve ground water quality, require that runoff be infiltrated when site conditions permit, except where potential ground water contamination cannot be prevented by pollution source controls and stormwater pretreatment; and require that new construction and existing facilities retrofit a stormwater treatment facility in high potential aquifer recharge areas. The treatment components and conveyance system must be lined to preclude infiltration.

Education Program

Currently there are a number of education programs focused on individual sources of contamination. However, there is no comprehensive ground water education program. A comprehensive approach is needed to help engender understanding and concern in order to protect the resource; aid in developing resource protection messages that are consistent regardless of the specific education program; coordinate with other resource protection programs that focus on a specific issue (e.g., solid waste); and develop specific education activities and materials for point and non-point sources of contamination that do not have their own individual programs.

The RBC-GWAC adopted the following goal: To increase individual participation in protecting the groundwater resource by educating citizens in the Ground Water Management Plan about groundwater, the threats to quantity and quality, and ways they can reduce those threats.

The proposed management strategy is to develop and implement an education program that builds upon existing education efforts in the county and adds specific elements as identified in the various management programs.

Hazardous Materials Management

Ground water contamination can occur when hazardous materials migrate through the soil, or when hazardous materials are spilled into surface water features that are in hydraulic continuity with ground water. Human health threats occur when contaminated ground water reaches aquifers used for drinking water supplies. The clean up of contaminated aquifers is difficult, costly, time-consuming, and may not be successful.

The RBC-GWAC adopted this goal: To ensure that ground water is not contaminated due to improper management of hazardous wastes.

The proposed management strategies include supporting current state plans, the Washington State Hazardous Waste Plan, and to request that Ecology and the Washington Legislature fund and carry out the provisions of the Hazardous Waste Plan; to enhance existing regulations, Ecology will amend the Dangerous Waste Regulations (Chapter 173-303) to require setbacks from the seasonal high ground water level; King County and cities within the RBC-GWMA will implement Uniform Fire Code Article 80 in both new and existing facilities using both educational and regulatory approaches; and King County, and cities will seek a permanent source of funding to provide staff and resources necessary to complete a comprehensive Local Emergency Management Plan; and to provide future protection, purveyors of large public water systems will assess the risk of transportation-related hazardous material spills in their wellhead protection areas.

Underground Storage Tank Management

Commercial underground petroleum and chemical storage tanks represent perhaps the most significant potential threat to ground water quality in King County. Leakage from underground storage tanks and associated piping often occurs without detection. Once released from an underground storage tank, some volatile organic compounds and petroleum products can rapidly migrate through the soil profile to ground water. Leaking underground home heating oil tanks may also present a threat to ground water quality. Both federal and state regulations adopt a less aggressive approach to the regulation of heating oil tanks, however, because of the differences in the constituency and migration through the soil column.

The RBC-GWAC adopted this goal: To ensure that underground chemical and fuel storage tanks are managed adequately to prevent contamination of ground water in King County.

The proposed management strategies include enhancing existing regulations by designating Ground Water Management Areas as Environmentally Sensitive Areas under Chapter 90.76 RCW Underground Storage Tanks. King County and cities will enhance current inspections of underground storage tank installation and removal in Environmentally Sensitive Areas.

The Seattle-King County Health Department will prepare an ordinance for the King County Board of Health consideration requiring secondary containment for underground chemical storage tanks, and for exempt or deferred tanks such as heating oil tanks of all sizes, and motor fuel tanks of 1100 gallons or less; disclosure at the time of sale of any property in King County of the number, location, and legal status of existing underground chemical storage tanks for home heating oil tanks, proof from the Fire Marshall or fire chief that the underground heating oil tank was abandoned in accordance with regulations prior to release of any permits associated with energy conversions (gas piping, electrical, etc.); that underground heating oil tanks abandoned in place are filled with a material that precludes further storage of any chemical in the tank; and that all underground chemical storage tanks without secondary containment that are in use and exempt from the state Underground Storage Tank Regulations are tested at regular intervals for integrity by qualified personnel and tagged to either allow or prohibit future product delivery.

To provide education, King County and cities will jointly educate homeowners and exempt tank owners regarding tank abandonment requirements of the Uniform Fire Code through the Ground Water Management Plan Education Program.

On-site Sewage Disposal System Use

If on-site sewage systems are improperly designed or constructed, installed in inadequate soils, used at too high of a development density, or used to dispose of non-domestic wastewater, they can adversely impact surface and ground water quality as well as public health. Ground water contamination associated with domestic on-site sewage system effluent can involve a number of contaminants including nitrate, bacteria, viruses, and trace organic chemical compounds. Also, domestic effluent often contains volatile and semi-volatile organic compounds at very low levels. These organic chemicals are generally residues from household cleaning and paint products, (known as household hazardous wastes).

The RBC-GWAC adopted this goal: To promote on-site sewage disposal practices that are effective in protecting ground water resources from possible adverse impacts.

The proposed management strategies include: evaluating the effect of on-site systems on ground water and to propose residential densities that would keep nitrate concentrations at safe levels; King County will inventory facilities served by on-site sewage disposal systems which potentially use, store, or dispose of hazardous materials, educate operators regarding hazardous materials management, and selectively monitor those facilities that appear to represent a significant risk to ground water quality.

Seattle-King County Department of Public Health will explore the prohibition of use and/or sale of products marketed as on-site sewage system additives which are intended to dissolve grease accumulations or to reduce the frequency of sludge removal from the septic tank, and prepare an ordinance for King County Board of Health's consideration which would prohibit these products within the cities and unincorporated areas of King County.

SKCHD will prepare amendments to Title 13 of the King County Board of Health Code to expressly prohibit the use of on-site sewage systems for disposal of any materials or substances other than domestic sewage as defined WAC 246-272-010 for King County Board of Health consideration.

King County will emphasize the risks to ground water associated with the disposal of household hazardous wastes to on-site sewage systems when conducting household hazardous waste educational activities as part of the Local Hazardous Waste Management Plan, and will develop and carry out a public education program intended to increase the awareness of proper on-site sewage system operation and maintenance including the risks associated with disposal of hazardous wastes in such systems.

To inform households about their on-site sewage disposal system, the Seattle-King County Health Department will prepare amendments to Title 13 of the King County Board of Health Code for the Boards consideration to require that the as-built on-site sewage disposal system plan be recorded with the property deed in order that it be transferred with the title at the time of property purchase.

To ensure long-range functioning of on-site sewage disposal systems in the County, King County will explore the feasibility of a county-wide on-site sewage system management program effective for ground water protection.

Pesticides and Fertilizers

The major categories of pesticides and fertilizer use are agriculture, home, forestry, and right-of-way maintenance. Pesticides and fertilizers have the potential to contaminate ground water when they are used improperly.

The RBC-GWMA adopted this goal: To prevent ground water contamination from the use of pesticide and fertilizer.

The proposed management strategies include providing immediate protection for ground water by promoting King County and cities to use non-chemical vegetation maintenance practices or only non-leaching chemicals for roads and utility right-of-ways in Ground Water Management Areas.

To provide for future protection, King County and cities will evaluate the Cooperative Extension Pesticide Reduction Program for the effectiveness for protecting ground water, and the applicability to Ground Water Management Areas.

To provide education, King County and cities will fund the King County Conservation District to develop Farm Plans for any agricultural user of pesticides and fertilizers in aquifer protection areas.

Well Construction and Abandonment

Modern wells consist of a well casing that extends downward from the ground surface to the aquifer within a cylindrical bore hole. If this space is not adequately sealed, it may serve as a conduit by which contaminated surface or subsurface water may travel into an aquifer. Under state law any well that is unusable must be abandoned. An improperly abandoned well may also serve as a conduit for contaminated ground or surface water.
The RBC-GWAC adopted this goal: To protect the quality of ground water in the county by ensuring that proper well construction and abandonment procedures are followed.

The proposed management strategies include providing proper oversight and implementation of the existing regulations by pursuing sufficient funding for the well construction and abandonment program, and developing a local health department program for implementation of the delegated portion of Ecology's well construction and abandonment program.

To identify and catalog wells, King County and cities will require sellers to disclose the existence of used or unused wells on the property and require that applicants establish the location and status of wells present on the property in question during SEPA review, rezone, and land use permit applications. This information to will be provided to Ecology.

To ensure proper abandonment of wells, assistance will be provided to those needing to abandon wells, such as funding or alternative methods.

To provide education about well construction and abandonment, the Ground Water Management Plan Education Program will coordinate with and support Ecology's efforts in well identification, well construction, proper well maintenance, contamination sources, and well abandonment.

Sewer Pipes

Older sewer pipes, many of which are still in use, were made from materials such as concrete, brick, clay, and ductile iron. Joints were more susceptible to leaking with the use of these materials and may be contributing to infiltration, inflow, and exfiltration problems. Infiltration is ground water entering sewer pipes, both as runoff during storm events or as base flow from other sources. Inflow refers to direct flows of stormwater into sewer pipes through hookups such as roof and footing drains. Exfiltration is where the water table drops below the level of the sewer pipes, causing water in pipes to leak out into the surrounding substrate.

The RBC-GWAC adopted this goal: To prevent the degradation of ground water which may be caused by waste water leaking from sewer pipes, and to prevent the loss of water through infiltration to sewer pipes.

The proposed management strategies include providing research information. King County will review and analyze existing studies and on-going pilot programs by Metro and local sewer districts to determine if infiltration and exfiltration are problems in Ground Water Management Areas and determine appropriate follow up action.

To prevent impacts to ground water, Metro, cities, and sewer utilities are encouraged to continue, or to adopt, regularly scheduled leak detection and repair programs, as well as public education programs to protect ground water in the Ground Water Management Area. King County will amend the Comprehensive Land Use Plans and King County Code 13.24 to require that new sewer piping installed in Aquifer Protection Areas be leakproof. Ecology should consider amendments to sewer construction specifications which stop the transmission of ground water along pipe alignments in high infiltration potential areas.

Solid Waste Landfills

A landfill is a disposal facility at which solid waste is permanently placed in or on land. A landfill can accept all waste except hazardous wastes. There are environmental impacts associated with landfills, including leachate and gas production. Leachate is water or other liquid that has been contaminated by dissolved or suspended materials due to contact with solid waste or gases from the solid waste. Landfills may pose a threat to ground water quality due to leachate production.

The RBC-GWAC adopted this goal: To prevent the occurrence of ground water contamination problems associated with the operation of solid waste disposal facilities in King County.

The proposed management strategies include providing protection through regulations. Ecology will determine whether the existing regulations, known as the Minimum Functional Standards meet State Ground Water Quality standards and revise as necessary; and prohibit siting or expansion of landfills in high potential recharge areas.

To remediate existing problems, investigate and remediate any ground water impacts from abandoned landfills in a timely manner.

To provide education, include information about the relationship between solid waste disposal and ground water in the education program.

Burial of Human Remains

The threat to ground water from decomposing corpses and caskets includes chemicals, bacteria, viruses, and metals. For example, the embalming process uses approximately one-half gallon of formalin for each body. Bacteria and viruses are not usually a concern since nutrients and oxygen are not present for the bacteria to survive and multiply.

The RBC-GWAC adopted this goal: To prevent the degradation of ground water from embalming fluids, disintegrating metal caskets, decaying human remains, and other materials associated with processing bodies for funeral burial or cremation.

The proposed management strategy is to provide the needed information about this potential problem by evaluating existing information on cemeteries and conduct a study to determine if cemeteries are contaminating ground water. Information gathered can be used to establish siting criteria for new and existing cemeteries or to take other appropriate follow-up actions.

Sand and Gravel Mining

It is not unusual for productive sand and gravel mines to be located over vulnerable aquifers. Mining activities in these areas can increase ground water vulnerability to contamination both from the extraction process and from site reclamation.

The RBC-GWAC adopted this goal: To ensure that regulatory programs are adequate to prevent adverse effects upon ground water quality attributed to sand and gravel mining operations.

The proposed management strategies include providing future protection. King County and cities will require a comprehensive list of best management practices for general sand and gravel permits, amend their Comprehensive Plans to include a policy which provides that land use of reclaimed sand and gravel mines be carefully evaluated in light of the increased susceptibility of aquifers to contamination due to mining activities, and require that reclamation plans for mineral extraction sites include measures to protect ground water quality and quantity, including testing of fill materials.

Land Application of Biosolids and Effluent

Utilization of biosolids for beneficial purposes is the environmentally preferred method of handling and disposal. Currently, nearly all the biosolids generated and disposed of in King County are utilized for silviculture, composting, soil improvement, or agricultural purposes through land application. Potential contaminants in raw biosolids include nitrogen, phosphorous, heavy metals, hydrocarbons, microorganisms, and radionuclides. Based upon present technology, properly managed land application of biosolids pose little threat to public health or the environment, nor has it been known to have caused any degradation of the underlying ground water resources. However, with the increased interest in land application, the potential impacts on the ground water resources from land application need to be considered.

The RBC-GWAC adopted this goal: To provide assurance that the ground water resources in King County will not be contaminated by the land application of biosolids.

The proposed management strategies include ensuring regulatory compliance. To provide future protection, Ecology is encouraged to include ground water protection in the revised guidelines for reuse of effluent.

Programs To Protect Ground Water Quantity

Impetus for ground water resource management comes from a variety of sources. Population growth creates an increasing demand on limited natural resources, including ground water. State law dictates how water may be appropriated through the water rights program. The State of Washington has attempted to balance the needs of the citizens with maintaining the water resource.

Ecology administers laws dealing with water appropriations and allocations. Allocation to new users must not conflict with existing use, however, the information needed to make allocation decisions is incomplete. Water users are developing and using innovative techniques to decrease their water use and increase water availability, such as conservation and artificial recharge.

The RBC-GWAC adopted this goal: To manage the ground water resources of King County to optimize the current and long term benefits.

The proposed management strategies include providing policy direction. King County will amend the King County Comprehensive Plan to include aquifer recharge. In addition, the RBC-GWAC supports Ecology's Sea Water Intrusion Policy.

To maintain and enhance natural recharge, King County and cities will consider adopting a clearing ordinance with guidelines for clearing lands outside of sensitive areas, and specific performance standards. Until a clearing ordinance is adopted, King County and cities will implement interim development standards whereby clearing is limited on subdivision, short subdivision, and new residential and commercial building projects to protect water quality, limit surface water runoff and erosion, and to maintain wildlife habitat and visual buffers. In addition, King County will adopt the proposed landscaping ordinances to encourage conservation for new development. Cities will consider adopting similar ordinances.

To enhance existing regulations, Ecology will amend the SEPA checklist to include impacts on the quantity of aquifer recharge.

To provide for information collection and analysis, a ground water data collection management program will be designed and implemented which would enable land and water use decision makers to make water resource decisions based on complete information. Utilities will update their water right records and report to Ecology as per the recommended program in the "Five Year Water Resource Data Management Plan". Ecology will review the information collected through the Data Collection and Management Program and recommendations shall be made to prevent further declines, or restore pre-decline levels, and to maintain safe sustainable yields. All jurisdictions shall then follow the appropriate mitigation actions as recommended by Ecology.

To provide for conservation, the SKCHD will propose a revision to regulations for Group B Small Public Water Systems to cover water conservation goals and measures, and regulations for new and existing individual wells incorporating conservation measures, including source meters. The Education program will include elements to promote water conservation.

To explore new techniques for quantity enhancement, Purveyors should investigate artificial recharge programs.

12. **Location of the proposal, including street address, if any, and section, township, and range; legal description; site plan; vicinity map; and topographical map, if reasonably available:**

The RBC-GWMA is located in north central King County, approximately 20 miles northeast of Seattle, Washington (refer to Figure 1). The RBC-GWMA covers approximately 50 square miles. It is bounded on the west by the Sammamish River and on the north by the Snohomish-King County line. The eastern boundary follows the topographic divide between the Bear Creek and Snohomish River valleys. The southern boundary coincides with the topographic divide between the Evans Creek Valley, the Sahalee Plateau, and Lake Sammamish. The Bear Creek Valley bisects the study area north to south, and the Evans Creek Valley bisects the southern tip east to west.

## B. ENVIRONMENTAL ELEMENTS

### 1. Earth

a. **General description of the site (underline):**

<u>flat</u>, <u>rolling</u>, <u>hilly</u>, <u>steep slopes</u>, mountainous, other.

b. **What is the steepest slope on the site (approximate percent slope)?**

Elevations in the RBC-GWMA range from approximately 30 feet above mean sea level in downtown Redmond to over 600 feet near the Redmond watershed. Surface elevations rise steadily in a northerly direction from the City of Redmond up the Bear Creek Valley gaining approximately 450 feet in elevation.

c. **What general types of soils are found on the site (for example clay, sand, gravel, peat, muck)? Specify the classification of agricultural soils and note any prime farmland.**

The most dominant soil in the unsewered portion of the RBC-GWMA is a gravelly sandy loam referred to by the Soil Conservation Services as the Alderwood series (refer to Figure 2.5.7. in the Draft RBC-GWMP for the distribution). The Alderwood series is a moderately well drained soil that is formed in glacial till. Glacial till, also known as hardpan, is an unsorted, unstratified, compacted glacial drift consisting of a mixture of gravel, sand, silt, and clay.

The Everett series is another soil found sporadically within the RBC-GWMA. The Everett series is made up of somewhat excessively drained soils that are underlain by very gravelly sand.

d. **Are there any surface indications or a history of unstable soils in the immediate vicinity? If so, describe.**

Not applicable, this is a non-project action.

e. **Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate the source of the fill.**

Not applicable, this is a non-project action.

f. **Could erosion occur as a result of clearing, construction, or use?**

Not applicable, this is a non-project action.

g. **About what percent of the site will be covered with impervious surfaces after project construction (for example buildings or asphalt)?**

Not applicable, this is a non-project action.

h. **Describe the proposed measures to reduce or control erosion, or other impacts to the earth, if any.**

Not applicable, this is a non-project action.

2. Air

a. **What types of emissions to the air would result from the proposal (e.g. dust, automobile, odors, industrial, wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities, if known.**

Not applicable.

b. **Are there any off-site sources of emissions or odors that may affect your proposal? If so, generally describe.**

Not applicable.

c. **Describe proposed measures to reduce or control emissions or other impacts to air, if any.**

Not Applicable.

3. Water

a. Surface:

1. **Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, and wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.**

   The RBC-GWMA contains a number of lakes and streams. The primary streams include Cottage Creek, Daniels Creek, Seidel Creek, Bear Creek, and Evans Creek. The four largest lakes inside the RBC-GWMA boundary are Lake Leota, Cottage Lake, Welcome Lake, and Peterson Pond.

2. **Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.**

   Not applicable, this is a non-project action.

3. **Estimate the amount of fill and dredge material that could be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill materials.**

   Not applicable, this is a non-project action.

4. **Will the proposal require surface water withdrawals or diversion? Give general description, purpose, and approximate quantities, if known.**

   The proposal will not require withdrawal or diversion of surface water. The RBC-GWMP recommends that additional aquifer evaluations be conducted to quantify the extent of ground water resources and determine the relationship of such ground waters to surface water bodies within the area. Such information would be critical in preventing depletion of surface water instream resources which could potentially result from future ground water withdrawals.

5. **Does the proposal lie within a 100 year flood plain? If so, note location on the site plan.**

   Not applicable.

6. **Does the proposal involve discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.**

   The RBC-GWMP will not result in the discharge of waste materials to surface water. The plan does not recommend the construction of new public sewer systems or expansion of existing systems. The plan advocates substantial changes in stormwater disposal practices.

**b. Ground**

1. **Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.**

The RBC-GWMP will not result in withdrawals or discharges to ground water. The program recommends that ground water resources be accurately quantified to help in the development of long-term ground water management strategies.

2. **Describe waste material that will be discharged into the ground from septic tanks or other sources, if any. Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) is expected to serve.**

This is a non-project action which will not result in the generation of wastewater.

The RBC-GWMP recommends strengthening existing on-site sewage system regulations to improve the level of protection afforded to ground water.

c. **Water Runoff (including storm water)**

1. **Describe the source of runoff (including storm water) and method of collection and disposal, if any (including quantities if known). Where will this water flow? Will this water flow into other waters? If so, describe.**

Certain areas of the RBC-GWMA contain rapidly percolating soils, swales, retention ponds, and dry well systems which are used to manage stormwater runoff. Within the City of Redmond, approximately 122 dry wells are installed which discharge untreated stormwater directly into the underlying aquifer system. No dry wells are reported in the unincorporated portions of the county. Retention ponds are used widely throughout the rural county areas for control of drainage along rights-of-way.

2. **Could waste materials enter ground or surface waters? If so, generally describe.**

Implementation of the recommendations presented in the RBC-GWMP will not result in discharges of waste to surface or ground water.

d. **Describe proposed measures to reduce or control surface, ground, and runoff water impacts, if any.**

One of the primary purposes of the draft RBC-GWMP is to implement regulations, policies, and activities to control discharges of wastes, including stormwater runoff, to ground water.

4. **Plants**

a. **Types of vegetation found on site:**

**Deciduous trees:** red alder, black cottonwood, big-leaf maple, several willow tree species, cascara, and other less dominant species.

**Evergreen trees:** Douglas-fir, western hemlock, western red cedar, and western white pine.

**Shrubs:** vine maple, numerous willow species, evergreen huckleberry, salal, Oregon grape, evergreen blackberry, Himalayan blackberry, salmonberry, thimbleberry, red elderberry, and other less dominant species.

**Grass:** numerous species.

**Pasture:** numerous native and non-native grass and forb species.

**Wet Soil Plants:** red alder, western red cedar, numerous willow species, hardhack, salmonberry, cattail, soft rush, slough sedge and other sedge species, and other less dominant species.

**Water Plants:** Water-parsley, yellow water lily, and other species.

b. **What kind and amount of vegetation will be removed or altered?**

Not applicable, this is a non-project action.

c. **List threatened or endangered species or critical habitat known to be on or near the site.**

Not applicable, this is a non-project action.

d. **Describe proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on site.**

Not applicable, this is a non-project action.

5. **Animals**

a. **Underline any birds and animals which have been observed on or near the site or are known to be on or near the site:**

**Invertebrates:** shellfish, insects, other

**Fish:** bass, salmon, trout, herring, other

**Amphibians:** frogs, salamanders, other

**Reptiles:** lizards, snakes, turtles, other

**Birds:** hawks, heron, eagle, songbirds, ducks, other

**Mammals:** deer, bear, elk, beaver, other

b. **List any threatened or endangered species or critical habitat near the site.**

Bald eagles frequent the general area.

c. **Is the site part of a migratory route? If so, explain.**

The RBC-GWMA is part of the Pacific Flyway, as is the entire Puget Sound basin.

d. **Proposed measures to preserve or enhance wildlife, if any.**

The draft RBC-GWMP does not recommend any direct actions intended to preserve or enhance wildlife or wildlife habitat. However, the RBC-GWMP recommends ground water protection and management actions from which secondary benefits to surface water used for wildlife habitat may accrue.

6. **Energy and Natural Resources**

a. **What kinds of energy (electric, natural gas, oil, wood, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.**

Not applicable, this is a non-project action.

b. **Would the project affect the potential use of solar energy by adjacent properties? If so, explain.**

Not applicable, this is a non-project action.

c. **What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any.**

Not applicable.

7. **Environmental Health**

a. **Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spills, or hazardous waste that could occur as a result of this proposal? If so, describe.**

Implementation of the draft RBC-GWMP will not result in any environmental health hazards.

1. **Describe special emergency services that might be required.**

The draft RBC-GWMP will not result in the need for special emergency services.

2. **Describe proposed measures to reduce or control environmental health hazards.**

The draft RBC-GWMP recommends various actions to reduce or control environmental health hazards. These recommended actions include enhancing hazardous materials transportation spill response capabilities and implementing the Uniform Fire Code Article 80 in both new and existing facilities using both educational and regulatory approaches.

b. Noise

1. **What types of noise exist in the area which may affect your project (for example: traffic, equipment operation, other)?**

Not applicable.

2. **What types and levels of noise would be created by or associated with the project on a short-term or long-term basis (for example: traffic, construction, operation, other)?**

Not applicable, this is a non-project action.

3. **Describe proposed measures to reduce or control noise impacts, if any.**

Not applicable.

## 8. Land and Shoreline Use

a. **What is the current use of the site adjacent to the properties?**

The dominant land uses in the RBC-GWMA include low (approximately 1 home/acre) to moderate (2 to 3 homes/acre) density residential and undeveloped land. About 50 percent of the unincorporated RBC-GWMA is zoned for a minimum lot size of five acres. Higher density residential, commercial, and light industrial development are located within the City of Redmond.

b. **Has the site been used for agriculture? If so, describe.**

Agricultural activities within the RBC-GWMA are largely confined to hobby farming.

c. **Describe any structures on the site.**

Not applicable.

d. **Will any structures be demolished? If so, what?**

Not applicable.

e. **What is the current zoning classification of the site?**

The RBC-GWMA is comprised of three land-use jurisdictions, the Cities of Redmond and Woodinville, and King County. The RBC-GWMA is contained in all, or portions of, four community planning areas. These community planning areas including King County's Bear Creek, East Sammamish, and Northshore, and the City of Redmond's community development guide. Specific land uses and accompanying area-wide zoning, consistent with King County Comprehensive Plan policies, are established in the community plans. Refer to Figure 2.5.1. in the draft Redmond-Bear Creek Valley Ground Water Management Plan for a depiction of local community development plans within the RBC-GWMA.

f. **What is the current comprehensive plan designation of the site?**

See section 8.e. above.

g. **If applicable, what is the current shoreline master program designation of the site?**

Not applicable.

h. **Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.**

A number of areas within the RBC-GWMA are considered Critical Areas under the King County Critical Areas Ordinance and are categorically designated as environmentally sensitive areas under SEPA. These include wetlands, steep slopes, and stream and shoreline areas. The RBC-GWMP recommends designating Ground Water Management Areas as environmentally sensitive areas under SEPA.

i. **Approximately how many people would reside or work in the completed project?**

The RBC-GWMP will result in neither the creation nor loss of housing or employment opportunities within the RBC-GWMA. Aquifer capacity evaluations proposed under the draft RBC-GWMP may provide guidance to local governments in future land use decisions. However, aquifer capacity is one of a number of factors that must be considered in determining the spatial and temporal distribution of additional growth and development. Land use decisions must be made in the context of a wide variety of considerations such as the availability public services, adequacy of utility infrastructure, degree of environmental sensitivity, and aesthetic qualities of an area.

j. **Approximately how many people would the completed project displace?**

None.

k. **Describe proposed measures to avoid or reduce displacement impacts, if any.**

No impacts are anticipated; mitigation is not proposed.

l. **Describe proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any.**

The RBC-GWAC, the oversight organization for development of the draft RBC-GWMP, included representation from the City of Redmond and several King County Departments to help ensure that the draft RBC-GWMP is consistent with the existing land use plans of those jurisdictions.

The four community plans the govern the RBC-GWMA (Bear Creek, East Sammamish, Northshore, and the City of Redmond's community development guide) are all currently in the process of being revised or updated. As ground water management alternatives are developed for the RBC-GWMP, existing policies and regulations will be reviewed and incorporated into the individual plans if appropriate.

The Growth Management Act stipulates that critical aquifer recharge areas must be afforded special protection. The RBC-GWMP recommends that a number of actions be taken to protect against loss or impairment of the RBC-GWMA's ground water resources as a result of contaminant releases from sources in critical aquifer recharge areas. The proposed source control actions apply to on-site sewage systems, stormwater disposal systems, underground storage tanks, hazardous materials disposal, pesticide and fertilizer use, well construction and abandonment, education programs, special areas designations, sewer pipes, solid waste landfills, burial of human remains, sand and gravel mining operations, and land application of biosolids and effluent.

9. Housing

a. **Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.**

Not applicable.

b. **Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.**

Not applicable.

c. **Describe proposed measures to reduce or control housing impacts, if any.**

Not Applicable.

10. Aesthetics

a. **What is the tallest height of any of the proposed structure(s), not including antennas? What is the principal exterior building material(s) proposed?**

Not applicable.

b. **What views in the immediate vicinity would be altered or obstructed?**

Not applicable.

c. **Describe proposed measures to reduce aesthetic impacts, if any.**

Not applicable.

11. Light and Glare

a. **What type of light and glare will the proposal produce? What time of day would it mainly occur?**

Not applicable.

b. **Could light or glare from the finished project be a safety hazard or interfere with views?**

Not applicable.

c. **What existing off-site sources of light or glare may affect your proposal?**

Not applicable.

d. **Describe the proposed measures to reduce or control light and glare impacts, if any.**

Not applicable.

12. **Recreation**

a. **What designated and informal recreational opportunities are in the immediate vicinity?**

Not applicable.

b. **Would the proposed project displace any existing recreational uses? If so, describe.**

Not applicable.

c. **Describe proposed measures to reduce or control impacts on recreation, including recreational opportunities to be provided by the project or applicant.**

Not applicable.

13. **Historic and Cultural Preservation**

a. **Are there any places or objects listed on or eligible for national, state, or local preservation registers known to be on or next to the site? If so, generally describe.**

Not applicable.

b. **Generally describe any landmarks or evidence of historic, archeological, scientific, or cultural importance known to be on or next to the site.**

Not applicable.

c. **Describe proposed measures to reduce or control impacts, if any.**

Not applicable.

14. **Transportation**

a. **Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.**

The RBC-GWMA is served by an extensive street and highway system. State Route (SR) 520 is the principal highway transportation corridor linking the Ground Water Management Area with Seattle, Bellevue, and King County. SR 520 is a heavily traveled passenger automobile and commercial truck transportation route.

King County maintains a network of roadways which provide local access to the unincorporated portions of the RBC-GWMA. Similarly, the City of Redmond maintains a system of streets within its corporate boundaries.

b. **Is the site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?**

Not applicable.

c. **How many parking spaces would the completed project have? How many would the project eliminate?**

Not applicable.

d. **Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe.**

The draft RBC-GWMP will not create the need for any new roads. However, a better understanding of traffic patterns and volumes in the RBC-GWMA will be necessary before there can be a significant effort to evaluate the potential risks to ground water from transportation-related spills.

e. **Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.**

Not applicable.

f. **How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.**

Not applicable.

g. **Describe proposed measures to reduce or control transportation impacts, if any.**

Not applicable.

15. Public Services

a. **Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally explain.**

The draft RBC-GWMP will increase the workload of programs within the RBC-GWMA relating to ground water contamination source control and ground water resource management efforts. Contaminant source control programs include underground storage tank management, on-site sewage disposal, solid waste disposal, hazardous waste management, stormwater management, pesticide and fertilizer use, well construction and abandonment practices, sewer pipe integrity, burial practices for human remains, sand and gravel mining operations, practices for land application of biosolids and effluent, special areas designations, and education programs.

Costs incurred as a result of administering the programs described in Section A. Question 11 above must be offset by a combination of permit fees and other sources. If adequate funding is not available, selected program elements must be eliminated from the RBC-GWMP. Table 1 (located at the end of this document) lists the affected agencies, estimated implementation costs, and approximate timeline for implementation.

b. **Describe proposed measures to reduce or control direct impacts on public services.**

For every recommended element of the draft RBC-GWMP which will likely increase the workload of a public service agency, a source of funding is identified to provide that agency with the resources necessary for implementation (refer to Table 1 at the end of this document). Should the identified source of funding (or a suitable alternate source) prove inadequate for the public service agency to implement a program element, that element will be modified or dropped from the RBC-GWMP in a subsequent revision.

16. Utilities

a. **Underline utilities currently available at the site:**

Electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic systems, other

b. **Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.**

The draft RBC-GWMP will not create the need for direct utility services.

## C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Sharon [signature]

Date Submitted: 12/20/94

## SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS

Nonproject proposals are those which are not tied to a specific site, such as an adoption of plans, policies, or ordinances.

Because these questions are very general, it may be helpful to read them in conjunction with the list of elements of the environment. When answering these questions, be aware of the extent of the proposal, or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general terms.

1. **How would the proposal be likely to increase discharge to water; emissions to air; production, storage, or release of toxic or hazardous substances; or production of noise?**

   The proposal will not increase discharges or emissions to any element of the environment.

   **Proposed measures to reduce or respond to such increases are:**

   The proposal is a Ground Water Management Plan which is intended to lessen the potential for adverse impacts on the quality of the Redmond-Bear Creek Valley ground waters from a variety of contaminant sources. The Plan proposes strengthening of the existing regulatory and/or administrative policy framework for the following activities:

   - Special area designations to enhance ground water protection,
   - Stormwater management,
   - Underground storage tank management,
   - Hazardous materials management,
   - On-site sewage disposal system use,
   - Education programs,
   - Pesticides and fertilizer use,
   - Sewer pipe integrity,
   - Solid waste landfills,
   - Human remains burial practices,
   - Sand and gravel mining practices,
   - Land application of biosolids and effluent practices,
   - Well construction and abandonment, and
   - Solid waste disposal.

Refer to Section A. Question 11 above and the Redmond-Bear Creek Valley Ground Water Management Plan for further discussion of the recommendations.

2. **How would the proposal be likely to affect plants, animals, fish, or marine life?**

The proposal will not adversely affect plants, animals, fish, or marine life.

**Proposed measures to protect or conserve plants, animals, fish, or marine life are:**

The RBC-GWMP supports a variety of proposed measures to protect water quality. While the major thrust of these efforts is oriented towards ground water, due to the interrelationship between ground water and surface water, ground water contaminant source control improvements may also serve to protect surface water quality. Protection of surface waters could serve to protect plants and animals which are exposed to such waters or that live within such waters. Instream resources may be preserved by reducing the impacts to ground water quantity.

3. **How would the proposal be likely to deplete energy or natural resources.**

The RBC-GWMP will not result in the depletion of energy or natural resources.

**Proposed measures to protect or conserve energy and natural resources are:**

The RBC-GWMP is intended to prevent depletion of ground water resources and to prevent adverse impacts associated with localized overuse and/or contamination of ground water resources.

In promoting efficient management of the area's ground waters, the draft RBC-GWMP proposes implementation of the management strategies outlined in Section A. Question 11 above and detailed in the Redmond-Bear Creek Valley Ground Water Management Plan.

4. **How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for government protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, flood plains, or prime farmlands?**

The proposal will not negatively or positively affect environmentally sensitive areas or areas designated (or eligible or under study) for government protection. However, the RBC-GWMP recommends designating Ground Water Management Areas as environmentally sensitive areas under SEPA. Designation of these areas may provide benefits, such as a source of funds to implement ground water protection measures, enhanced eligibility for grant funds, or expanded review of development proposals.

**Proposed measures to protect such resources or to avoid or reduce impacts are:**

No adverse impacts are anticipated, therefore no mitigation measures are proposed.

5. **How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?**

The RBC-GWMP does not recommend that any specific land or shoreline uses be prohibited. It does, however, recommend that tighter controls be imposed over a variety of land use activities such as on-site sewage system operation, hazardous waste disposal practices, underground storage tank operations, stormwater disposal practices, land application of biosolids and effluent, and solid waste handling. These controls may be viewed as a slight disincentive for new development, particularly commercial development, within the Ground Water Management Area.

**Proposed measures to avoid or reduce shoreline and land use impacts are:**

Since shoreline and land use impacts are generally viewed to be positive, no mitigation measures are proposed.

6. **How would the proposal be likely to increase demands on transportation or public services and utilities?**

<u>Transportation.</u> Increases in transportation demands are not anticipated as a result of implementation of the RBC-GWMP.

<u>Public Services</u>. The draft RBC-GWMP may increase the workload of programs within the RBC-GWMA jurisdiction relating to ground water contamination source control and ground water resource management. Table 1 (located at the end of this document) highlights the recommendations and funds necessary for implementation.

<u>Utilities</u>. If the recommendations of the draft RBC-GWMP are implemented, public water purveyors will be requested to conduct more extensive monitoring of their ground water sources including water level observations, frequent water quality analyses, and production metering.

In addition, the draft RBC-GWMP recommends that purveyors implement water use efficiency programs. Purveyors are recommended to conduct transportation-related hazardous material spills assessments within their wellhead protection areas.

**Proposed measures to reduce or respond to such demand(s) are:**

<u>Transportation</u>. Mitigation measures have not been proposed.

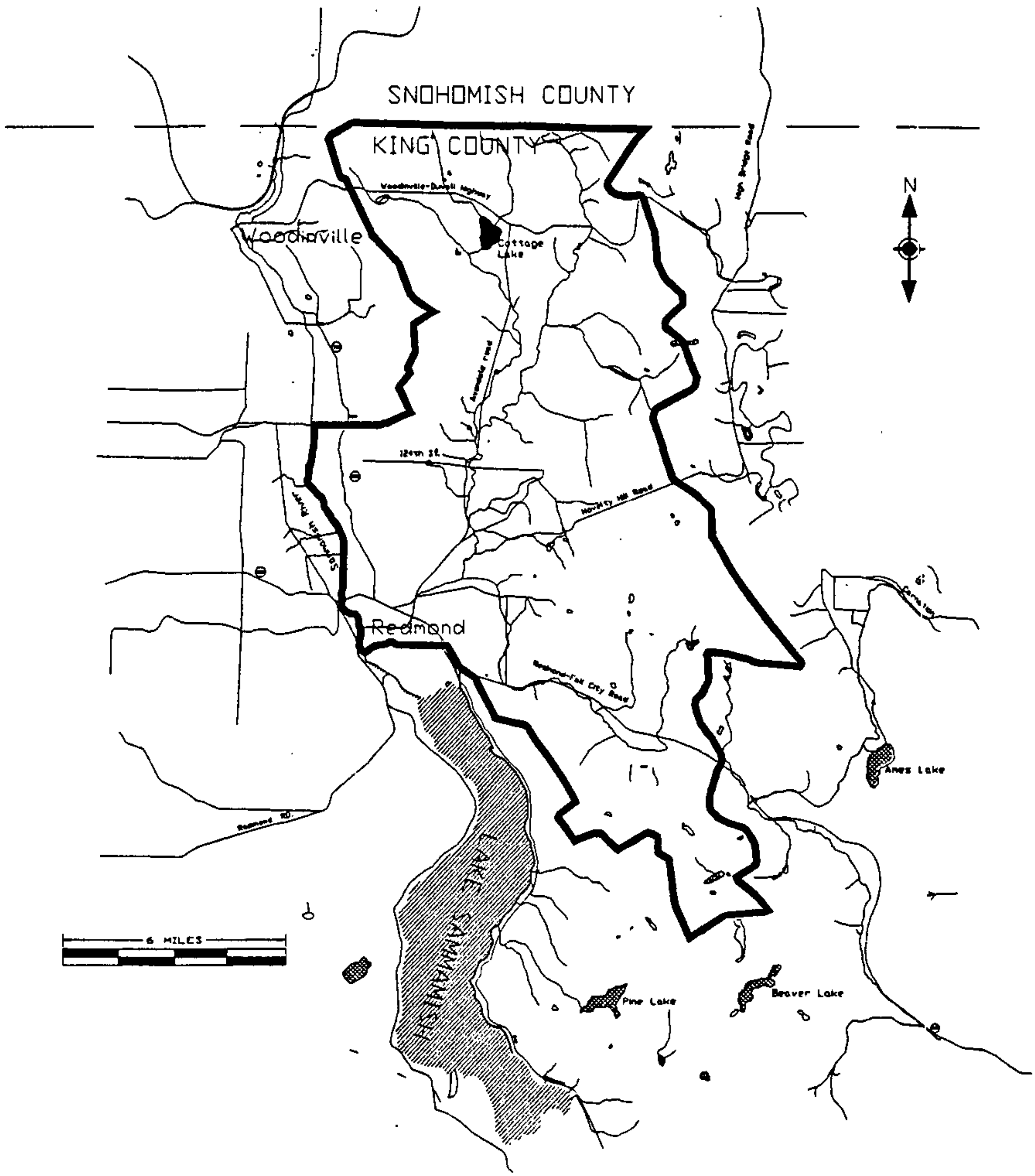
<u>Public Services</u>. For every recommended element of the draft RBC-GWMP which will likely increase the workload of a public service agency, a source of funding is identified in the draft RBC-GWMP to provide that agency with the resources necessary for implementation (refer to Table 1, located at the end of this document). Should the identified source of funding (or a suitable alternate source) prove inadequate for the public service agency to implement a program element, that element will be dropped from the RBC-GWMP in a subsequent revision or restructured.

7. **Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.**

The RBC-GWMP was prepared pursuant to the Ground Water Management Program provisions of Chapter 90.44 RCW, the state Regulation of Public Ground Water Act, and Chapter 173-100 WAC, Ecology's procedural regulations for Ground Water Management Areas and Programs. As stipulated in the aforementioned state codes, the Plan was developed in full consideration of the corpus of federal, state, county, and municipal laws and regulations concerning environmental protection.

procedural regulations for Ground Water Management Areas and Programs. As stipulated in the aforementioned state codes, the Plan was developed in full consideration of the corpus of federal, state, county, and municipal laws and regulations concerning environmental protection.

FIGURE 1 REDMOND-BEAR CREEK GROUND WATER MANAGEMENT AREA BOUNDARY



## TABLE 4.8.1 - IMPLEMENTATION PLAN ORGANIZED BY PRIORITY[1]

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 new prog | WQ - 4A1 Conservation | King County | TBD | | | | General Funds | 1 |
| 1 new prog | WQ - 4A1 Conservation | City of Redmond | 10,240 | | | | Redmond General Funds | 1995 |
| 1 form agree | WQ - 3A Water rights | NE Sammamish | | 500 | | | General Agency Funds | 1, ongoing |
| 1 new prog | WQ - 4A2 Conservation | SKCHD | 8160 | | | | General Funds | As per schedule |
| 1 res | WQ - 2A Data Needs | SKCHD in DCMP (See DCM-1) | | | | Aquifer Protection Fund | | 1 |
| 1 support | WQ - 2B Policies and Ordinances | GWAC | N/A - support is stated in GWMP | | | | N/A | 1 |
| 1 form agree | WQ - 3A Water rights | City of Redmond | 2,048 | | | | General Agency Funds | 1 |
| 1 new prog | WQ - 4A3 Conservation | SKCHD | 8160 | | | Aquifer Protection Fund | | 1 |
| 1 reg | WQ - 1B Policies and Ordinances | King County | | | 4,000 | | General Funds | 1 |
| 1 reg | WQ - 1B Policies and Ordinances | Ecology | 3,500 | 3,500 | 3,500 | | General Funds | 1 |

[1] All costs are estimates.

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | WQ - 1A Policies and Ordinances | City of Redmond | N/A, to be done as part of update or adoption | | | | Redmond general funds | 1 |
| 1 support | WQ - 4C1 Artificial recharge | NE Sammamish | No additional costs: possible future project | | | | Agency Funds | Purveyors time frame |
| 1 support | WQ - 4C1 Artificial recharge | Union Hill | No additional cost[2] | | | | Agency Funds | Purveyors time frame |
| 1 support | WQ - 4C1 Artificial recharge | City of Redmond | 10,240 | | | | Agency Funds | Purveyors time frame |
| 1 form agree | WQ - 3A Water rights | Union Hill | 500 | | | | General Agency Funds | 1, ongoing |
| 1 support | WQ - 1A Policies and Ordinances | King County | N/A, to be done as part of update or adoption | | | | | 1 |
| 1 reg | WQ - 1B Policies and Ordinances | City of Redmond | 2,048 | | | | Redmond General Funds | 1 |
| 1 new prog | DCM - 2 Data Collection, Analysis and Management | Ecology | 7,000 | 7,000 | 7,000 | | General Agency Fund | 1+ ongoing |

[2]The MPD progess will influence when and how this is done.

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | Education<br>PF - 2A Education and Proposed Programs<br><br>PF - 2B Education and Proposed Programs<br><br>ST - 3 Education<br><br>OS - 3B Household Hazardous Wastes<br><br>SW - 4 Education<br><br>UST - 3E Heating Oil Tanks<br><br>WC - 4 Education<br><br>WQ - 4B1 Xeriscaping<br><br>WQ - 4B2 Conservation<br><br>WQ - 4B3 Landscaping | SKCHD | 325,728 | 330,000 | 335,000 | Aquifer Protection Fund | | 1+ ongoing |
| 1 support | Education | GWAC | N/A - stated in GWMP | | | | | 1+ ongoing |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 new prog | DCM - 1 Data Collection, Analysis and Management | King County: SKCHD Task 1 & 2: 24,000 Task 3: 104,400 Task 4: 104,400 | 261,000 | 261,000 | 261,000 | Aquifer Protection Fund | | 1+ ongoing |
| 1 new prog | WQ - 4D1 Decline Limits | Ecology | | 140,000 | 140,000 | | General Agency Funds | 1 |
| 1 new prog | WQ - 4D1 Decline Limits | NE Sammamish | No additional cost* | | | | $4800/yr. from General Agency Funds | 1 + ongoing |
| 1 new prog | WQ - 4D1 Decline Limits | Union Hill | 8000 | 8000 | 8000 | | General Agency Funds | 1 + ongoing |
| 1 support | Education | City of Redmond | 51,200 | | | | Redmond General Fund | 1+ ongoing |
| 1 support | Education | Woodinville | 26,000 - 49,000 | | | | Woodinville General Fund | 1+ ongoing |
| 1 support | Education | Union Hill | 2400 500 400 1500 | | | | General Agency Fund | 1+ ongoing |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | Education | NE Sammamish[3] | 3500<br>200<br>600 | 3500<br>200<br>600 | 3500<br>200<br>600 | | General Agency Fund | 1+ ongoing |
| 1 support | Education | Conservation District | No additional costs | | | | | 1+ ongoing |
| 1 support | Education | WSU Cooperative Extension Service | No additional costs | | | | | 1+ ongoing |
| 15 comp prog | SA - 1C Adoption of general aquifer protection policies | King County<br><br>Task 4: | N/A , done by concurring with GWMP | | | | General Agency Funds | 1 |
| 15 comp prog | SA - 1B Elimination of categorical exemptions to SEPA | City of Redmond Task 2: | 204,800 | | | Aquifer Protection Fund | | 1996 |
| 15 comp prog | SA - 1A Designation of Environmentally Sensitive Areas | King County | Task 1: N/A, done by Concurring with GWMP | | | Aquifer Protection Fund | | 1 |
| 15 comp prog | SA - 1A Designation of Environmentally Sensitive Areas | City of Redmond | Task 1: N/A, done by Concurring with GWMP | | | | | |

[3]NE Sammamish costs are estimates, with all costs combined into the estimate. These estimates have not been approved by the Board of Commissioners.

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 15 comp prog | SA - 1C Adoption of general aquifer protection policies | City of Redmond | 10,240 | | | | General Agency Funds | 1995 |
| 15 comp prog | SA - 1B Elimination of categorical exemptions to SEPA | King County | 52,200 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 2 Minimum Wellhead Protection | City of Redmond (Management Committee) | 10,240 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1D Enhanced environmental review to protect aquifers | King County Task 5: | 52,200 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 2 Minimum Wellhead Protection | Management Committee | TBD | | | Aquifer Protection Fund | | 1997 |
| 15 comp prog | SA - 1E Ground water recharge areas | City of Redmond | N/A: done by concurring with GWMP | | | | | |
| 15 comp prog | SA - 1D Enhanced environmental review to protect aquifers | City of Redmond | 51,200 | | | Aquifer Protection Fund | | 1996 |
| 15 comp prog | SA - 1E Ground water recharge areas | King County | N/A: done by concurring with GWMP | | | | | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | ST - 2C Ground Water Quality Concerns - Study | City of Redmond | | | 20,480 | Aquifer Protection Fund (or grant) | | 1997 |
| 2 res | ST - 2C Ground Water Quality Concerns - Study | SKCHD | | TBD | | Aquifer Protection Fund (or grant) | | |
| 2 reg | ST - 4A Coordination Between Surface and Ground Water Planning Efforts: Ecology Programs | Ecology | | 35,000 | 35,000 | | General funds | |
| 2 res | ST - 2B Ground Water Quality Concerns - Facility Requirements | City of Redmond | | | 35,840 | Aquifer Protection Fund | | 1997 |
| 2 res | ST - 2C Ground Water Quality Concerns - Study | King County (SKCHD) | | TBD | | Aquifer Protection Fund (or grant) | | |
| 2 reg | ST - 5A Roadway Runoff | City of Redmond | | No additional cost | | | General Agency Funds | |
| 2 reg | ST - 6A Soil Amendment | King County | | TBD | | Aquifer Protection Fund (or grant, other sources) | | |
| 2 reg | ST - 5A Roadway Runoff | King County | | TBD | | | General Agency Funds | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | ST - 4C Coordination Between Surface and Ground Water Planning Efforts: King County | King County (SKCHD) | | 26,000 | | Aquifer Protection Fund | | |
| 2 reg | ST - 4B Coordination Between Surface and Ground Water Planning Efforts: Puget Sound Water Quality Authority | Puget Sound Water Quality Authority | No additional costs | | | | General Agency Funds | |
| 2 res | ST - 2B Ground Water Quality Concerns - Facility Requirements | King County | | TBD | | Aquifer Protection Fund | | 2 |
| 2 form agree | WC - 1A State Program | King County | | N/A | | | N/A | |
| 2 form agree | WC - 1A State Program | Ecology | | 70,000 | | | General funds | |
| 2 res | UST - 3D Heating Oil Tanks: Location | City of Redmond through Management Committee | | No additional cost | | Aquifer Protection Fund | | |
| 2 res | UST - 3D Heating Oil Tanks: Location | SKCHD | | 26,000 | | Aquifer Protection Fund | | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 form agree | WC - 1A State Program | City of Redmond | | N/A | | | N/A | |
| 2 new prog | WC - 1B State Program | SKCHD | | 52,200 | | Aquifer Protection Fund | | |
| 2 reg | WC - 2A Well Identification | Ecology | | TBD | | | General funds | |
| 2 reg | WC - 2A Well Identification | City of Redmond through the Management Committee | | No additional cost | | | General funds | |
| 2 reg | WC - 2A Well Identification | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 new prog | WC - 1B State Program | Ecology | | 70,000 | 70,000 | | General Agency Funds | |
| 2 res | UST - 3C Heating Oil Tanks: Abandonment and Maintenance | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 res | UST - 3A Heating Oil Tanks: Local Legal Authority UST - 3B Heating Oil Tanks: State Code Amendment | Ecology | | 1,750<br>5,000 | 100,000 | Aquifer Protection Fund | | TBD |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | WC - 2B Well Identification | City of Redmond | | No additional cost | | | General funds | |
| 2 reg | WC - 2B Well Identification | Ecology | | 17,500 | 35,000 | | General funds | |
| 2 res | WC - 3A Abandonment cost | SKCHD, through Management Committee | | | 13,080 | Aquifer Protection Fund | | |
| 2 res | WC - 3B Abandonment cost | Ecology | | 5,000 | 10,000 | | Agency funds | Next WAC revision |
| 2 pol | UST - 1A, 1B Augment State UST Program | SKCHD | 53,244 | 53,244 | 53,244 | Aquifer Protection Plan | Fees | 1,2,3 |
| 2 pol | UST - 1A, 1B Augment State UST Program | City of Redmond, through Management Committee | | No additional cost | | | Fees | 1,2,3 |
| 2 res | UST - 3A Heating Oil Tanks: Local Legal Authority UST - 3B Heating Oil Tanks: State Code Amendment | SKCHD, through Management Committee | | 16,000 | | Aquifer Protection Fund | | TBD |
| 2 reg | UST - 2B Exempt Tanks | SKCHD | | 8000 | | Aquifer Protection Fund | | TBD |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | UST - 2A Exempt Tanks | SKCHD, through Management Committee | | 8000 | | Aquifer Protection Fund | | As per schedule |
| 2 reg | UST - 1C Augment State UST Program | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 reg | ST - 6A Soil Amendment | City of Redmond | | No additional cost | | Aquifer Protection Fund (or grant, other sources) | | |
| 2 reg | WC - 2B Well Identification | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | City of Redmond (Task 1,2) | 25,600 | | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | Purveyors (Task 1,2) | | TBD | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | 1996 |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 5) | | | 8,000 | Aquifer Protection Fund | | 3 |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | Union Hill (Task 1,2) | | 1500 | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | NE Sammamish (Task 1,2) | 2000 | | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 2 new prog | OS - 1 Nitrate Concerns | Management Committee (Task 1,2) | | TBD | | Aquifer Protection Fund | | As per WHPP schedule |
| 2 res | HM - 5B Transportation-Related Hazardous Material Spills-Management Committee Evaluation | SKCHD (Task 4) | | | 8000 | Aquifer Protection Fund | | 3 |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | HM - 5B Transportation-Related Hazardous Material Spills-Management Committee Evaluation | Management Committee (Task 3) | | | No additional | Aquifer Protection Fund | | 3 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | Management Committee (Task 4) | | Incl in Chapter 4 | | Aquifer Protection Fund | | 3 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 3) | | 24,000 | | Aquifer Protection Fund | | 2 |
| 2 reg | HM - 2 Hazardous Waste Facilities Zones - Local designation | City of Redmond | N/A: accomplished by concurring with GWMP | | | | General Agency Funds | |
| 2 reg | HM - 2 Hazardous Waste Facilities Zones - Local designation | King County | N/A: accomplished by concurring with GWMP | | | | General Agency Funds | |
| 2 support | HM - 1 State Hazardous Waste Plan-Implementation | SKCHD | | 400 | | | | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | SKCHD (Task 3) | | 24,000 | 8,000 | Aquifer Protection Fund | | 1-3 |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | City of Redmond (Task 1,2) | | 30,720 | | | TBD | 1-3 1995 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 2) | | Included in data manage ment costs | | Aquifer Protection Fund | | Ongoing |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | King County: Emergency Management Div (Task 1) | | TBD | | | TBD | Ongoing |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | KC Fire Marshal (Task 1,2) | | TBD | | | TBD | 1-3 |
| 2 new prog | OS - 1 Nitrate Concerns | City of Redmond (Management Committee) | | | 25,600 | | Redmond General Funds | 1997 |
| 2 res | OS - 2A Hazardous Materials | SKCHD | | TBD | | Aquifer Protection Fund | Local Hazardous Waste Plan | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | King County (Task 1) | | N/A: done during code revision | | | General Agency Funds | |
| 2 reg | SG - 3 Fill Testing | City of Redmond | 25,600 | | | | Permit fees, general agency fund | 1995 |
| 2 reg | SG - 3 Fill Testing | King County | | TBD | | | Permit fees, general agency fund | 1 |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | City of Redmond (Task 1) | | N/A | | | | |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | SKCHD (Task 2) | | 500 | | Aquifer Protection Fund | | |
| 2 reg | ST - 2A Ground Water Quality Concerns - Zoning | King County | | TBD | | | General Agency Funds | |
| 2 reg | ST - 1A Runoff Versus Recharge | City of Redmond | 40,960 | TBD | | | General Agency Funds (SWM Utility) | 1995 |
| 2 reg | ST - 1A Runoff Versus Recharge | King County | | TBD | | | General Agency Funds | |
| 2 form agree | SG - 2 Reclaimed Sand and Gravel Mines: Comprehensive Plans | City of Redmond | N/A; included in Comprehensive Plan update work program | | | | General Agency Funds | 1996 |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 form agree | SG - 2 Reclaimed Sand and Gravel Mines: Comprehensive Plans | King County | N/A; included in Comprehensive Plan update work program | | | | General Agency Funds | |
| 2 educ | OS - 3A Household Hazardous Wastes | SKCHD (LHWMP) | | TBD | | | LHWMP fees | ongoing LHWMP |
| 2 reg | OS - 2C Hazardous Materials | SKCHD | | 4000 | | Aquifer Protection Fund | | 1 |
| 2 new prog | OS - 2B Hazardous Materials | SKCHD | | 4000 | | Aquifer Protection Fund | | |
| 2 reg | OS - 4A Operation and Maintenance | SKCHD | | 4000 | | Aquifer Protection Fund | | as per schedule |
| 2 new prog | OS - 4B Operation and Maintenance | SKCHD | | 52,200 | | Aquifer Protection Fund | | As per schedule |
| 2 new prog | OS - 5 Regulations | State Department of Health | | TBD | | | General funds | |
| 2 new prog | OS - 5 Regulations | Ecology | | TBD | | | General funds | |
| 2 reg | ST - 2A Ground Water Quality Concerns - Zoning | City of Redmond | | No additional cost | | | General Agency Funds | |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 3 res | SP - 1A Infiltration and Exfiltration: Studies | Sewer Agencies: City of Redmond | | 15,360 | TBD | | General Agency Funds | 1996 |
| 3 other | SP - 1C Infiltration and Exfiltration: Leakproof Piping | SKCHD | | | 400 | Aquifer Protection Fund | | |
| 3 other | SP - 2 Groundwater depletion - Backfill | SKCHD | | | 200 | | | |
| 3 form agree | SP - 1B Infiltration and Exfiltration: Programs | SKCHD | | | N/A: stated in GWMP | | | Upon approval |
| 3 res | SP - 1A Infiltration and Exfiltration: Studies | SKCHD | | | TBD | | Grant | |
| 3 reg | PF - 1C Pesticide and Fertilizer Use | City of Redmond | | | 15,360 | Aquifer Protection Fund | | 1996 |
| 3 res | PF - 1B Pesticide and Fertilizer Use | Cooperative Extension | | | No additional cost | | Included in present program | Upon Completion of the Program |
| 3 res | PF - 1B Pesticide and Fertilizer Use | City of Redmond through Management Committee | | | No additional cost | | | Upon Completion of the Program |
| 3 res | PF - 1B Pesticide and Fertilizer Use | King County | | | 8,000 | Aquifer Protection Fund | | Upon Completion of the Program |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | King County | | | TBD | Aquifer Protection Fund | | As per Implementation Plan |
| 3 reg | PF - 1C Pesticide and Fertilizer Use | King County | | | 16000 | Aquifer Protection Fund | | |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | City of Redmond | | | No additional cost | | | As per Implementation Plan |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | Conservation District | | | 94,900 | Aquifer Protection Fund | | As per Implementation Plan |
| 4 new prog | BSE - 1 Regulatory Program Staffing | SKCHD | 78,300 | 78,300 | 78,300 | | Permit fee | 1,2,3,4 As per schedule pending BOH approval |
| 4 support | BSE - 2 Guideline Revision | GWAC | | | N/A: stated in GWMP | | N/A | As per legislation |
| 4 reg | C - 1 Information - Studies | SKCHD | | | 16,000 | Aquifer Protection Fund | Grant (228,000) | 3 |
| 4 reg | SW - 2 Waste Screening | SKCHD | | | TBD | Aquifer Protection Fund | | 2 yrs after end of project |
| 4 reg | SW - 2 Waste Screening | King County Solid Waste Division | | | Included in program | | Included in program | 2 yrs after end of project |

TABLE 4.8.1 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 4 new prog | SW - 3 Abandoned sites | SKCHD | | 8000 | | Aquifer Protection Fund | | on-going |
| 4 reg | SW - 1C Standards | SKCHD | | | 4,000 | | Agency funds/general funds | |
| 4 reg | SW - 1C Standards | Ecology | | | 17,500 | | Agency funds/general funds | |
| 4 reg | SW - 1A Standards | Ecology | | 5,000 | 100,000 | | Agency funds | During MFS revision |
| 4 reg | SW - 1B Standards | SKCHD | | | 4,000 | | General funds | |
| 4 new prog | SW - 3 Abandoned sites | King County Solid Waste Division | | | In SWD work plan | | General funds | on-going |
| not ranked | SG - 1 BMP for Grading Permits | King County | TBD | | | Aquifer Protection Fund | | |

## TABLE 4.8.2. IMPLEMENTATION PLAN ORGANIZED BY AGENCY OR GOVERNMENT[1]

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | Education | City of Redmond | 51,200 | | | | Redmond General Fund | 1+ ongoing |
| 2 reg | HM - 2 Hazardous Waste Facilities Zones - Local designation | City of Redmond | N/A: accomplished by concurring with GWMP | | | | General Agency Funds | |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | City of Redmond (Task 1,2) | | 30,720 | | | TBD | 1-3 1995 |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | City of Redmond (Task 1,2) | 25,600 | | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 2 new prog | OS - 1 Nitrate Concerns | City of Redmond (Management Committee) | | | 25,600 | | Redmond General Funds | 1997 |
| 3 reg | PF - 1C Pesticide and Fertilizer Use | City of Redmond | | | 15,360 | Aquifer Protection Fund | | 1996 |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | City of Redmond | | | No additional cost | | | As per Implementa-tion Plan |
| 3 res | PF - 1B Pesticide and Fertilizer Use | City of Redmond through Management Committee | | | No additional cost | | | Upon Completion of the Program |
| 15 comp prog | SA - 1B Elimination of categorical exemptions to SEPA | City of Redmond Task 2: | 204,800 | | | Aquifer Protection Fund | | 1996 |

[1] All costs are estimates.

## TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 15 comp prog | SA - 1D Enhanced environmental review to protect aquifers | City of Redmond | 51,200 | | | Aquifer Protection Fund | | 1996 |
| 15 comp prog | SA - 2 Minimum Wellhead Protection | City of Redmond (Management Committee) | 10,240 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1C Adoption of general aquifer protection policies | City of Redmond | 10,240 | | | | General Agency Funds | 1995 |
| 15 comp prog | SA - 1E Ground water recharge areas | City of Redmond | N/A: done by concurring with GWMP | | | | | |
| 15 comp prog | SA - 1A Designation of Environmentally Sensitive Areas | City of Redmond | Task 1: N/A, done by Concurring with GWMP | | | | | |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | City of Redmond (Task 1) | | N/A | | | | |
| 2 reg | SG - 3 Fill Testing | City of Redmond | 25,600 | | | | Permit fees, general agency fund | 1995 |
| 2 form agree | SG - 2 Reclaimed Sand and Gravel Mines: Comprehensive Plans | City of Redmond | N/A; included in Comprehensive Plan update work program | | | | General Agency Funds | 1996 |
| 2 reg | ST - 5A Roadway Runoff | City of Redmond | | No additional cost | | | General Agency Funds | |
| 2 reg | ST - 6A Soil Amendment | City of Redmond | | No additional cost | | Aquifer Protection Fund (or grant, other sources) | | |
| 2 reg | ST - 2A Ground Water Quality Concerns - Zoning | City of Redmond | | No additional cost | | | General Agency Funds | |

**TABLE 4.8.2 (continued)**

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund* | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | ST - 1A Runoff Versus Recharge | City of Redmond | 40,960 | TBD | | | General Agency Funds (SWM Utility) | 1995 |
| 2 res | ST - 2C Ground Water Quality Concerns - Study | City of Redmond | | | 20,480 | Aquifer Protection Fund (or grant) | | 1997 |
| 2 res | ST - 2B Ground Water Quality Concerns - Facility Requirements | City of Redmond | | | 35,840 | Aquifer Protection Fund | | 1997 |
| 2 pol | UST - 1A, 1B Augment State UST Program | City of Redmond, through Management Committee | | No additional cost | | | Fees | 1,2,3 |
| 2 res | UST - 3D Heating Oil Tanks: Location | City of Redmond through Management Committee | | No additional cost | | Aquifer Protection Fund | | |
| 2 reg | WC - 2A Well Identification | City of Redmond through the Management Committee | | No additional cost | | | General funds | |
| 2 reg | WC - 2B Well Identification | City of Redmond | | No additional cost | | | General funds | |
| 2 form agree | WC - 1A State Program | City of Redmond | | N/A | | | N/A | |
| 1 reg | WQ - 1B Policies and Ordinances | City of Redmond | 2,048 | | | | Redmond General Funds | 1 |
| 1 new prog | WQ - 4A1 Conservation | City of Redmond | 10,240 | | | | Redmond General Funds | 1995 |
| 1 support | WQ - 4C1 Artificial recharge | City of Redmond | 10,240 | | | | Agency Funds | Purveyors time frame |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | WQ - 1A Policies and Ordinances | City of Redmond | N/A, to be done as part of update or adoption | | | | Redmond general funds | 1 |
| 1 form agree | WQ - 3A Water rights | City of Redmond | 2,048 | | | | General Agency Funds | 1 |
| 1 support | Education | Conservation District | No additional costs | | | | | 1+ ongoing |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | Conservation District | | | 94,900 | Aquifer Protection Fund | | As per Implementation Plan |
| 3 res | PF - 1B Pesticide and Fertilizer Use | Cooperative Extension | | | No additional cost | | Included in present program | Upon Completion of the Program |
| 1 new prog | DCM - 2 Data Collection, Analysis and Management | Ecology | 7,000 | 7,000 | 7,000 | | General Agency Fund | 1+ ongoing |
| 2 new prog | OS - 5 Regulations | Ecology | | TBD | | | General funds | |
| 2 reg | ST - 4A Coordination Between Surface and Ground Water Planning Efforts: Ecology Programs | Ecology | | 35,000 | 35,000 | | General funds | |
| 4 reg | SW - 1A Standards | Ecology | | 5,000 | 100,000 | | Agency funds | During MFS revision |
| 4 reg | SW - 1C Standards | Ecology | | | 17,500 | | Agency funds/general funds | |
| 2 res | UST - 3A Heating Oil Tanks: Local Legal Authority<br>UST - 3B Heating Oil Tanks: State Code Amendment | Ecology | | 1,750<br>5,000 | 100,000 | Aquifer Protection Fund | | TBD |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | WC - 3B Abandonment cost | Ecology | | 5,000 | 10,000 | | Agency funds | Next WAC revision |
| 2 form agree | WC - 1A State Program | Ecology | | 70,000 | | | General funds | |
| 2 reg | WC - 2B Well Identification | Ecology | | 17,500 | 35,000 | | General funds | |
| 2 reg | WC - 2A Well Identification | Ecology | | TBD | | | General funds | |
| 2 new prog | WC - 1B State Program | Ecology | | 70,000 | 70,000 | | General Agency Funds | |
| 1 new prog | WQ - 4D1 Decline Limits | Ecology | | 140,000 | 140,000 | | General Agency Funds | 1 |
| 1 reg | WQ - 1B Policies and Ordinances | Ecology | 3,500 | 3,500 | 3,500 | | General Funds | 1 |
| 4 support | BSE - 2 Guideline Revision | GWAC | | | N/A: stated in GWMP | | N/A | As per legislation |
| 1 support | Education | GWAC | N/A - stated in GWMP | | | | | 1+ ongoing |
| 1 support | WQ - 2B Policies and Ordinances | GWAC | N/A - support is stated in GWMP | | | | N/A | 1 |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | KC Fire Marshal (Task 1,2) | | TBD | | | TBD | 1-3 |
| 1 new prog | DCM - 1 Data Collection, Analysis and Management | King County: SKCHD<br>Task 1 & 2: 24,000<br>Task 3: 104,400<br>Task 4: 104,400 | 261,000 | 261,000 | 261,000 | Aquifer Protection Fund | | 1+ ongoing |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | HM - 2 Hazardous Waste Facilities Zones - Local designation | King County | N/A: accomplished by concurring with GWMP | | | | General Agency Funds | |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | King County: Emergency Management Div (Task 1) | | TBD | | | TBD | Ongoing |
| 3 form agree | PF - 1A Pesticide and Fertilizer Use | King County | | | TBD | Aquifer Protection Fund | | As per Implementation Plan |
| 3 res | PF - 1B Pesticide and Fertilizer Use | King County | | | 8,000 | Aquifer Protection Fund | | Upon Completion of the Program |
| 3 reg | PF - 1C Pesticide and Fertilizer Use | King County | | | 16000 | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1B Elimination of categorical exemptions to SEPA | King County | 52,200 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1D Enhanced environmental review to protect aquifers | King County Task 5: | 52,200 | | | Aquifer Protection Fund | | |
| 15 comp prog | SA - 1A Designation of Environmentally Sensitive Areas | King County | Task 1: N/A, done by Concurring with GWMP | | | Aquifer Protection Fund | | 1 |
| 15 comp prog | SA - 1C Adoption of general aquifer protection policies | King County Task 4: | N/A , done by concurring with GWMP | | | | General Agency Funds | 1 |
| 15 comp prog | SA - 1E Ground water recharge areas | King County | N/A: done by concurring with GWMP | | | | | |
| not ranked | SG - 1 BMP for Grading Permits | King County | TBD | | | Aquifer Protection Fund | | |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 reg | SG - 3 Fill Testing | King County | | TBD | | | Permit fees, general agency fund | 1 |
| 2 form agree | SG - 2 Reclaimed Sand and Gravel Mines: Comprehensive Plans | King County | N/A; included in Comprehensive Plan update work program | | | | General Agency Funds | |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | King County (Task 1) | | N/A: done during code revision | | | General Agency Funds | |
| 2 res | ST - 2C Ground Water Quality Concerns - Study | King County (SKCHD) | | TBD | | Aquifer Protection Fund (or grant) | | |
| 2 reg | ST - 1A Runoff Versus Recharge | King County | | TBD | | | General Agency Funds | |
| 2 reg | ST - 2A Ground Water Quality Concerns - Zoning | King County | | TBD | | | General Agency Funds | |
| 2 res | ST - 2B Ground Water Quality Concerns - Facility Requirements | King County | | TBD | | Aquifer Protection Fund | | 2 |
| 2 reg | ST - 6A Soil Amendment | King County | | TBD | | Aquifer Protection Fund (or grant, other sources) | | |
| 2 reg | ST - 5A Roadway Runoff | King County | | TBD | | | General Agency Funds | |
| 2 reg | ST - 4C Coordination Between Surface and Ground Water Planning Efforts: King County | King County (SKCHD) | | 26,000 | | Aquifer Protection Fund | | |
| 4 new prog | SW - 3 Abandoned sites | King County Solid Waste Division | | | In SWD work plan | | General funds | on-going |

**TABLE 4.8.2 (continued)**

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 4<br>reg | SW - 2 Waste Screening | King County Solid Waste Division | | | • Included in program | | Included in program | 2 yrs after end of project |
| 2<br>form agree | WC - 1A State Program | King County | | N/A | | | N/A | |
| 1<br>reg | WQ - 1B Policies and Ordinances | King County | | | 4,000 | | General Funds | 1 |
| 1<br>support | WQ - 1A Policies and Ordinances | King County | N/A, to be done as part of update or adoption | | | | | 1 |
| 1 new prog | WQ - 4A1 Conservation | King County | TBD | | | | General Funds | 1 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | Management Committee (Task 4) | | Incl in Chapter 4 | | Aquifer Protection Fund | | 3 |
| 2 res | HM - 5B Transportation-Related Hazardous Material Spills-Management Committee Evaluation | Management Committee (Task 3) | | | No additional | Aquifer Protection Fund | | 3 |
| 2<br>new prog | OS - 1 Nitrate Concerns | Management Committee (Task 1,2) | | TBD | | Aquifer Protection Fund | | As per WHPP schedule |
| 15<br>comp prog | SA - 2 Minimum Wellhead Protection | Management Committee | TBD | | | Aquifer Protection Fund | | 1997 |
| 1 support | Education | NE Sammamish[2] | 3500<br>200<br>600 | 3500<br>200<br>600 | 3500<br>200<br>600 | | General Agency Fund | 1+ ongoing |

[2]NE Sammamish costs are estimates, with all costs combined into the estimate. These estimates have not been approved by the Board of Commissioners.

**TABLE 4.8.2 (continued)**

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | NE Sammamish (Task 1,2) | 2000 | | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 1 new prog | WQ - 4D1 Decline Limits | NE Sammamish | No additional cost* | | | | $4800/yr. from General Agency Funds | 1 + ongoing |
| 1 form agree | WQ - 3A Water rights | NE Sammamish | | 500 | | | General Agency Funds | 1, ongoing |
| 1 support | WQ - 4C1 Artificial recharge | NE Sammamish | No additional costs: possible future project | | | | Agency Funds | Purveyors time frame |
| 2 reg | ST - 4B Coordination Between Surface and Ground Water Planning Efforts: Puget Sound Water Quality Authority | Puget Sound Water Quality Authority | No additional costs | | | | General Agency Funds | |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | Purveyors (Task 1,2) | | TBD | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | 1996 |
| 3 res | SP - 1A Infiltration and Exfiltration: Studies | Sewer Agencies: City of Redmond | | 15,360 | TBD | | General Agency Funds | 1996 |
| 4 new prog | BSE - 1 Regulatory Program Staffing | SKCHD | 78,300 | 78,300 | 78,300 | | Permit fee | 1,2,3,4 As per schedule pending BOH approval |
| 4 reg | C - 1 Information - Studies | SKCHD | | | 16,000 | Aquifer Protection Fund | Grant (228,000) | 3 |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | Education<br>PF - 2A Education and Proposed Programs<br>PF - 2B Education and Proposed Programs<br>ST - 3 Education<br>OS - 3B Household Hazardous Wastes<br>SW - 4 Education<br>UST - 3E Heating Oil Tanks<br>WC - 4 Education<br>WQ - 4B1 Xeriscaping<br>WQ - 4B2 Conservation<br>WQ - 4B3 Landscaping | SKCHD | 325,728 | 330,000 | 335,000 | Aquifer Protection Fund | | 1+ ongoing |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 3) | | 24,000 | | Aquifer Protection Fund | | 2 |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 2) | | Included in data management costs | | Aquifer Protection Fund | | Ongoing |
| 2 new prog | HM - 4 Implementation of the Emergency Planning and Community Right-to-Know Act (EPCRA) | SKCHD (Task 5) | | | 8,000 | Aquifer Protection Fund | | 3 |
| 2 support | HM - 1 State Hazardous Waste Plan-Implementation | SKCHD | | 400 | | | | |
| 2 reg | HM - 3 Implementation of the Uniform Fire Code (UFC) | SKCHD (Task 3) | | 24,000 | 8,000 | Aquifer Protection Fund | | 1-3 |

**TABLE 4.8.2 (continued)**

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | HM - 5B Transportation-Related Hazardous Material Spills-Management Committee Evaluation | SKCHD (Task 4) | | | 8000 | Aquifer Protection Fund | | 3 |
| 2 reg | OS - 2C Hazardous Materials | SKCHD | | 4000 | | Aquifer Protection Fund | | 1 |
| 2 new prog | OS - 2B Hazardous Materials | SKCHD | | 4000 | | Aquifer Protection Fund | | |
| 2 reg | OS - 4A Operation and Maintenance | SKCHD | | 4000 | | Aquifer Protection Fund | | as per schedule |
| 2 educ | OS - 3A Household Hazardous Wastes | SKCHD (LHWMP) | | TBD | | | LHWMP fees | ongoing LHWMP |
| 2 new prog | OS - 4B Operation and Maintenance | SKCHD | | 52,200 | | Aquifer Protection Fund | | As per schedule |
| 2 res | OS - 2A Hazardous Materials | SKCHD | | TBD | | Aquifer Protection Fund | Local Hazardous Waste Plan | |
| 2 reg | SG - 4 Zoning Code-Reclamation Plans | SKCHD (Task 2) | | 500 | | Aquifer Protection Fund | | |
| 3 other | SP - 2 Groundwater depletion - Backfill | SKCHD | | | 200 | | | |
| 3 other | SP - 1C Infiltration and Exfiltration: Leakproof Piping | SKCHD | | | 400 | Aquifer Protection Fund | | |
| 3 form agree | SP - 1B Infiltration and Exfiltration: Programs | SKCHD | | | N/A: stated in GWMP | | | Upon approval |
| 3 res | SP - 1A Infiltration and Exfiltration: Studies | SKCHD | | | TBD | | Grant | |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | ST - 2C Ground Water Quality Concerns - Study | SKCHD | | TBD | | Aquifer Protection Fund (or grant) | | |
| 4 reg | SW - 2 Waste Screening | SKCHD | | | TBD | Aquifer Protection Fund | | 2 yrs after end of project |
| 4 reg | SW - 1B Standards | SKCHD | | | 4,000 | | General funds | |
| 4 new prog | SW - 3 Abandoned sites | SKCHD | | 8000 | | Aquifer Protection Fund | | on-going |
| 4 reg | SW - 1C Standards | SKCHD | | | 4,000 | | Agency funds/general funds | |
| 2 res | UST - 3A Heating Oil Tanks: Local Legal Authority<br>UST - 3B Heating Oil Tanks: State Code Amendment | SKCHD, through Management Committee | | 16,000 | | Aquifer Protection Fund | | TBD |
| 2 reg | UST - 1C Augment State UST Program | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 reg | UST - 2B Exempt Tanks | SKCHD | | 8000 | | Aquifer Protection Fund | | TBD |
| 2 pol | UST - 1A, 1B Augment State UST Program | SKCHD | 53,244 | 53,244 | 53,244 | Aquifer Protection Plan | Fees | 1,2,3 |
| 2 reg | UST - 2A Exempt Tanks | SKCHD, through Management Committee | | 8000 | | Aquifer Protection Fund | | As per schedule |
| 2 res | UST - 3D Heating Oil Tanks: Location | SKCHD | | 26,000 | | Aquifer Protection Fund | | |

**TABLE 4.8.2 (continued)**

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 2 res | UST - 3C Heating Oil Tanks: Abandonment and Maintenance | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 reg | WC - 2B Well Identification | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 2 new prog | WC - 1B State Program | SKCHD | | 52,200 | | Aquifer Protection Fund | | |
| 2 res | WC - 3A Abandonment cost | SKCHD, through Management Committee | | | 13,080 | Aquifer Protection Fund | | |
| 2 reg | WC - 2A Well Identification | SKCHD | | 8000 | | Aquifer Protection Fund | | |
| 1 res | WQ - 2A Data Needs | SKCHD in DCMP (See DCM-1) | | | | Aquifer Protection Fund | | 1 |
| 1 new prog | WQ - 4A2 Conservation | SKCHD | 8160 | | | | General Funds | As per schedule |
| 1 new prog | WQ - 4A3 Conservation | SKCHD | 8160 | | | Aquifer Protection Fund | | 1 |
| 2 new prog | OS - 5 Regulations | State Department of Health | | TBD | | | General funds | |
| 1 support | Education | Union Hill | 2400<br>500<br>400<br>1500 | | | | General Agency Fund | 1+ ongoing |
| 2 res | HM - 5A Transportation-Related Hazardous Materials Spills-Purveyor Assessment | Union Hill (Task 1,2) | | 1500 | | | Purveyor funds with some Aquifer Protection Fund Augmentation, WHP grant funding | |
| 1 new prog | WQ - 4D1 Decline Limits | Union Hill | 8000 | 8000 | 8000 | | General Agency Funds | 1 + ongoing |

TABLE 4.8.2 (continued)

| GWAC Priority | Management Strategy | Agent | Cost Year 1 | Cost Year 2 | Cost Year 3 | AP Fund | Other Fund Source | Year |
|---|---|---|---|---|---|---|---|---|
| 1 support | WQ - 4C1 Artificial recharge | Union Hill | No additional cost[3] | | | | Agency Funds | Purveyors time frame |
| 1 form agree | WQ - 3A Water rights | Union Hill | 500 | | | | General Agency Funds | 1, ongoing |
| 1 support | Education | Woodinville | 26,000 - 49,000 | | | | Woodinville General Fund | 1+ ongoing |
| 1 support | Education | WSU Cooperative Extension Service | No additional costs | | | | | 1+ ongoing |

[3]The MPD progess will influence when and how this is done.

# APPENDIX L
# DECLARATION OF NON-SIGNIFICANCE

DETERMINATION OF NONSIGNIFICANCE

Redmond Bear-Creek Valley Ground Water Management Plan

**Description of Proposal:** The Redmond-Bear Creek Valley Ground Water Management Plan (RBC-GWMP) was developed by the Redmond-Bear Creek Valley Ground Water Advisory Committee (RBC-GWAC) to meet the ground water protection needs of the area. The goal of the RBC-GWMP is to protect the quality and quantity of ground water within the area for present and future use, and to provide for effective and coordinated management of this essential resource. With expected increases in population and the populations' reliance on ground water it is clear that a comprehensive ground water plan tailored to the specific needs of the region is necessary to protect the ground water supply. Ground water provides most of the water used in the Redmond-Bear Creek Valley Ground Water Management Area (RBC-GWMA) for private, municipal, industrial, and agricultural needs.

**Proponent:** Seattle-King County Health Department on behalf of the Redmond-Bear Creek Valley Ground Water Advisory Committee.

**Location of Proposal:** The RBC-GWMA is located in north central King County, approximately 20 miles northeast of Seattle, Washington (refer to Figure 1). The RBC-GWMA covers approximately 50 square miles. It is bounded on the west by the Sammamish River and on the north by the Snohomish-King County line. The eastern boundary follows the topographic divide between the Bear Creek and Snohomish River valleys. The southern boundary coincides with the topographic divide between the Evans Creek Valley, the Sahalee Plateau, and Lake Sammamish. The Bear Creek Valley bisects the study area north to south, and the Evans Creek Valley bisects the southern tip east to west.

**Lead Agency:** Seattle-King County Health Department.

Under Chapter 173-100 WAC, the proposed ground water management program is subject to review pursuant to the State Environmental Policy Act. The lead agency is responsible for reviewing the environmental checklist and issuing a determination based upon the checklist. The lead agency recognizes that elements of the proposed ground water management plan may change during the concurrence process when implementing agencies, including the Seattle-King County Health Department, review the RBC-GWMP in its entirety for implementation feasibility.

The Seattle-King County Health Department, acting as the lead agency for this proposal, has determined that the proposed Redmond Bear-Creek Valley Ground Water Management Plan does not have a probable significant adverse impact on the environment. An environmental impact statement (EIS) is not required under RCW 43.21C.030(2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

This DNS is issued under Chapter 197-11-340(2) WAC: the lead agency will not act on this proposal for 15 days from the date below. Comments must be submitted by January 15, 1995.

**Responsible official(s), position/title:** Ms. Sharon Stewart Johnson, Acting Director of Public Health, and Mr. Carl Osaki, Chief of the Environmental Health Division.

**Phone(s):** 296-4603, 296-4722

**Address:** 110 Prefontaine Place S., Suite 600, Seattle, WA, 98104.

**Date:** 12/20/94 **Signature:** ______________________

**Date:** 12/12/94 **Signature:** ______________________

## APPENDIX M
## PUBLIC COMMENT AND LEAD AGENCY RESPONSE
**[to be included in the final draft after concurrence process]**

## APPENDIX N
## LETTERS OF CONCURRENCE BY AFFECTED JURISDICTIONS
**[To be included in the final draft after concurrence process]**

# APPENDIX O
# GUIDELINES OR THE DEVELOPMENT OF GROUND WATER MANAGEMENT AREAS AND PROGRAMS (Chapter 173-100 WAC)

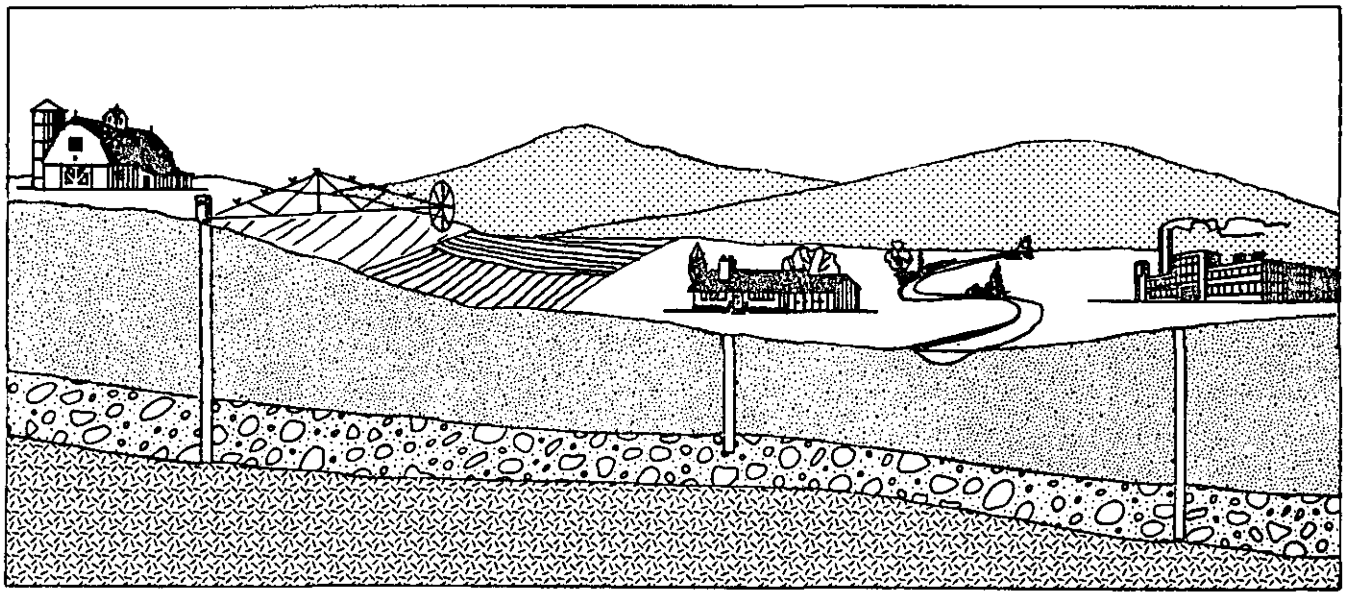
State of Washington
Department of Ecology

# GUIDELINES

# FOR

# DEVELOPMENT OF GROUND WATER MANAGEMENT AREAS AND PROGRAMS (CHAPTER 173-100 WAC)

DOE 86-2



WATER RESOURCES PLANNING AND MANAGEMENT SECTION

WASHINGTON STATE DEPARTMENT OF ECOLOGY

APRIL 1986

## Development
## of
## Ground Water Management Areas and Programs

In response to growing concern about Washington State's ground water resources, the 1985 legislature passed landmark legislation to assist state and local governments in effectively managing the public's ground water. Substitute House Bill 232 directed the Department of Ecology to establish a process for the identification and designation of ground water management areas and for the development of comprehensive ground water management programs. This process is described in *Chapter 173-100 WAC* of the state administrative code, entitled *"Ground Water Management Areas and Programs."* A copy of these regulations, which became effective on January 17, 1986, are included in this booklet.

There are several advantages to local agencies and user groups in using the process described in Ground Water Management Areas and Programs. The process is designed so that a ground water management program can be initiated and developed on the local level while at the same time be supported by state legislation and regulations. Development of these ground water management programs is intended to be a team planning effort utilizing resources from interested user groups and various local and state agencies. Chapter 173-100 WAC establishes a well defined process which allows for issues, concerns and opportunities from all interested groups and agencies to be incorporated into the planning process in an effective and efficient manner. It is this type of coordination which should facilitate a wider acceptance of the program and also provide a broader authority to implement and enforce the program. In addition, passage of the Clean Water Bill (ESSB 4519) by the 1986 Legislature will allow Ecology to contribute up to 50 percent in matching funds for the development of ground water management programs which follow this process.

This booklet is intended to assist local governments and water user groups in understanding Chapter 173-100 WAC and to serve as a guide for those who are interested in developing ground water management programs in their area. This booklet is designed to answer general questions about the process. For more detailed requirements and procedures leading to designation of ground water management areas and development of ground water management programs, Chapter 173-100 WAC should be reviewed.

The following questions and answers will provide information for developing a ground water management program.

***What is a "ground water management area?"***

A ground water management area is a specific geographic area which encloses one or more aquifers and in which there exists a justifiable concern for the quality and/or quantity of that ground water. The purpose of designating a ground water management area is to:

1. Protect the quality and quantity of ground water.
2. Meet future water needs while recognizing existing water rights.
3. Provide for effective and coordinated management of the ground water resource.

The regulation states that an area must first be designated by Ecology as a ground water management area before an advisory committee can be established to develop a ground water program.

Reference: WAC 173-100-050

***What does Ecology consider a "justifiable concern?"***

A list of concerns to help guide in the identification of probable ground water management areas is included in WAC 173-100-050 of the regulations. The following is a summary of that list:

1. Geographic areas where ground water quality is threatened or is susceptible to contamination. This includes contamination from land use activities and seawater intrusion.

2. Aquifers that are declining due to restricted recharge or over use. This includes aquifers which have the potential for over use based on projected future demands.

3. Aquifers that have been over appropriated and adjudications of water rights have not been completed.

4. Aquifers designated as "sole source aquifers" by the Environmental Protection Agency. Only three aquifers in the state have been designated as sole source. They are Whidbey, Camano and the Spokane-Rathdrum aquifers.

5. Aquifers identified as the primary source of a public water supply.

6. Aquifers where an approved coordinated water system plan has identified a need for a ground water management program.

***What is a "ground water management program?"***

A ground water management program is a comprehensive program designed to protect ground water quality and assure ground water quantity for current and future uses.

***A water user group or local government agency is interested in developing a ground water management program in their area. What is their first step?***

The first step is to develop a request for designation of the proposed area as a probable ground water management area. Development of a request requires several steps in itself, the most important one being coordination with local agencies and water user groups. Early involvement of all interested agencies and groups will help avoid problems later in the process. Coordination with the local county or counties is required so that written concurrence by the county or counties for appointment of a lead agency can be included in the request for designation.

Probable ground water management areas may be proposed for designation at any time by Ecology upon its own motion or at the request of other state agencies, local governments or ground water user groups.

***What is involved in developing a request for designation of a ground water management area?***

Developing a request for area designation will involve agency and user group coordination, information gathering and a minimum of one public meeting for public comment and review. The request should be in the form of a concise, factual report and contain the following:

1. A general description of and rationale for the proposed ground water management area boundary.

2. A list of concerns along with supporting documentation to substantiate those concerns. Utilizing available data from federal, state and local sources may help justify your concerns. Information from completed ground water studies, land use and water use records, local soils, geology and hydrology conditions and local expertise would be valuable as supporting documentation. Reference should be made as to how the information justifies your particular concern.

3. Goals and objectives for the proposed ground water management area.

4. An estimated cost of developing the ground water management program and potential funding sources.

5. Recommendations for agencies, organizations and groups to be represented on the advisory committee. The advisory committee will oversee and review the development of the ground water program. Membership of the advisory committee should represent

a broad spectrum of the public. A list of potential committee members and the responsibilities of the committee is described in WAC 173-100-090.

6. A recommendation for the lead agency, taking into consideration the responsibilities contained in WAC 173-100-080. Either Ecology or a local government agency may be the lead agency. The recommendation for lead agency shall first be submitted to the county or counties with jurisdiction over the proposed ground water management area. Written concurrence by the county or counties for lead agency should be submitted along with the request for designation. If the proposed area is entirely within one county, that county has the option to be lead agency if they so desire.

7. A list of those who have participated in the development of the request through public meetings, mailing lists and other interaction. The request should specifically address the extent of coordination and involvement by government agencies and user groups.

The request should then be submitted to Ecology, Water Resources Planning and Management, and also to other interested agencies and groups for their review and comments. These groups should be instructed to submit comments directly to Ecology. A list of those to whom copies of the request are mailed to should be sent to Ecology.

Reference: WAC 173-100-050

***What happens after a request is submitted to Ecology?***

When a request is received by Ecology it will be reviewed to make sure it complies with the intent and requirements of Chapter 173-100 WAC. Ecology will review the request on the following basis:

1. Do the proposed area boundaries constitute a logical groundwater management area based on the local hydrogeology?

2. Does the request contain all of the required components including justifiable concerns, goals and objectives, cost estimates and funding sources and a general description and rationale for the proposed area?

3. Have other interested agencies and groups been involved in formulation of the request? What level of coordination has gone into the development of this request?

4. Has at least one public meeting been held for review and comments? Was a broad spectrum of the public represented at this meeting?

5. Has a recommendation for the lead agency and advisory committee members been made? Has written concurrence for lead agency from the appropriate county or counties been included?

6. Has local government shown a willingness to cooperatively develop a comprehensive ground water management program?

If Ecology determines that the request meets the intent and criteria of WAC 173-100-050, Ecology will place the request on a general schedule for the designation of specific ground water management areas.

### *How does the General Schedule work?*

Ecology intends to designate a ground water management area as soon as possible after a request is received and they are placed on the General Schedule. The General Schedule guides Ecology in the order of designation of ground water management areas and also in the allocation of Ecology's available funding and staffing. The schedule will rank the relative priority of each probable ground water area based on:

1. The urgency of the problems or potential problems as described in the request for identification. Highest priority will be given to those areas where water quality is imminently threatened.

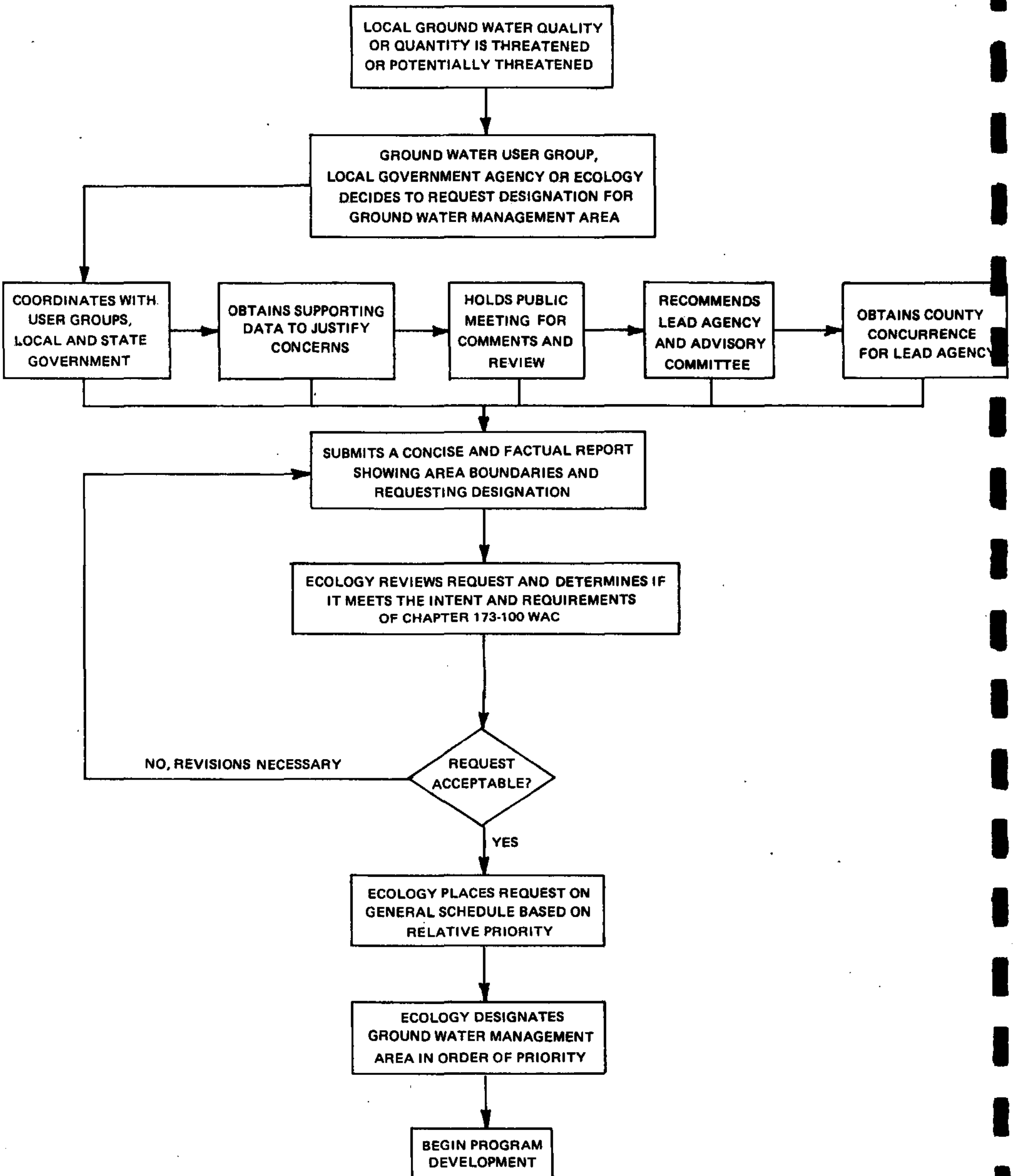
2. The availability of funding and staff on a local or state level to develop and implement a ground water management program.

As stated above, passage of the Clean Water Bill (ESSB 4519) will allow Ecology to contribute up to 50 percent in matching funds to public bodies for the development of ground water management programs. The ability and willingness at the local level to fund their share of the program will be a significant factor in determining priority.

Although Ecology will make every effort to avoid a delay in designation, a situation may arise where the number of requests for designation is so great that Ecology does not have the funding or staffing to handle all requests. In this case the higher priority areas will be designated first and the lower priority areas later. All requests which are put on the General Schedule will be designated as soon as state resources are available to do so.

Ecology may update and revise the General Schedule at anytime as needed. Ecology will notify the public of revisions through the news media and the Washington State Register. A public hearing will be held during June of each year for public comment on the General Schedule. Although requests may be submitted at any time, Ecology recommends that requests be submitted by April 1 of each year. This will allow time for Ecology to review the requests and place them on the General Schedule prior to the annual public hearing.

## REQUEST FOR GROUND WATER MANAGEMENT AREA DESIGNATION



Prior to designation of a ground water management area, Ecology will hold a public hearing within the local area for comments and review of the proposal. Upon designation, Ecology will issue an order which contains a general description of the planning boundary and documents the intent to develop a ground water management program for that area. It should be noted that the proposed boundary is only a planning boundary at this stage and may be modified as data is collected during program development.

Reference: WAC 173-100-060 and WAC 173-100-070

### *Once the area is designated as a ground water management area, what is the next step?*

After the area is designated the development of the ground water management program can begin. Ecology will seek nominations for representatives from those groups and agencies which were recommended to be on the Ground Water Advisory Committee. Ecology will then appoint the lead agency and advisory committee members in cooperation with the local governments and interested user groups.

The lead agency shall be responsible for coordination and undertaking the activities necessary for development of the ground water management program. This includes preparation of a work plan, coordinating data collection and scheduling advisory committee meetings. The lead agency may delegate the development of various elements of the ground water management program to other committee members or it may choose to hire a consultant to complete some tasks.

The advisory committee is responsible for overseeing the development of the ground water management program and assuring it is both technically and functionally sound. The committee will give final approval to the program before it is submitted to Ecology for certification. Ecology will participate on the advisory committee along with other state and local government agencies and ground water user group members.

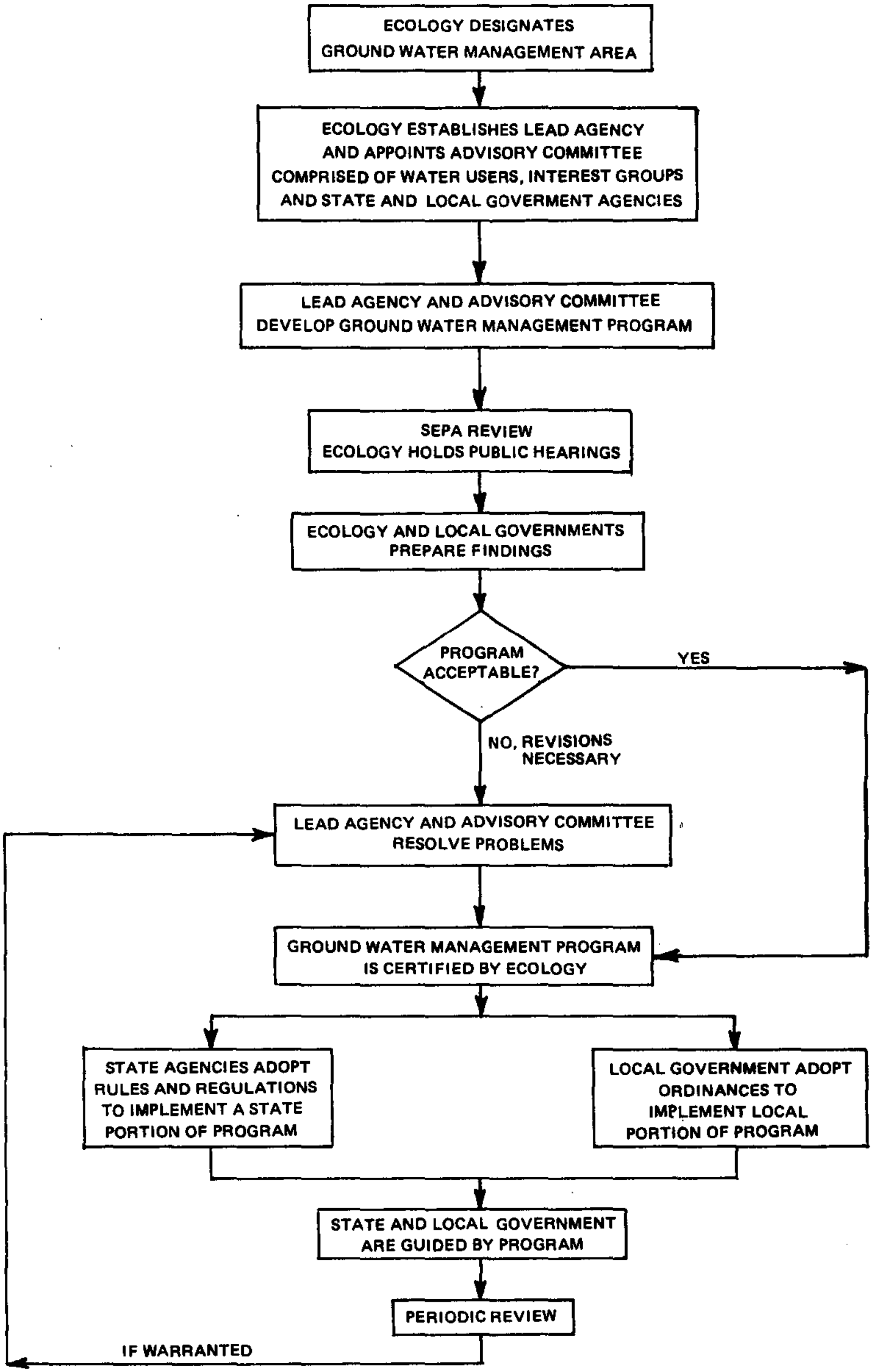
Reference: WAC 173-100-080 and WAC 173-100-090

### *What should be included in a "ground water management program?"*

The program for each management area will be tailored to the specific conditions of that area. Each ground water management program should include the following:

1. A section describing the collection and analysis of data, the area's hydrogeological characteristics, historical and projected ground water usage and jurisdictional boundaries and responsibilities.

# GROUND WATER MANAGEMENT PROGRAM DEVELOPMENT



2. A discussion of the type and extent of land use activities potentially affecting ground water quality and quantity.

3. Identification of water quantity and quality goals and objectives.

4. An alternatives section which outlines and evaluates various land and water use management strategies.

5. A section recommending specific management strategies for implementation.

6. An implementation plan including a detailed work plan, model ordinances and a monitoring plan and system for program review to assure goals and objectives are being met..

The time frame for program development will depend on each areas complexity both geologically and politically. Ecology feels an average of two to three years for program completion is a reasonable estimate at this time.

Reference: WAC 173-100-100

***What is Ecology's role after the ground water management program is completed?***

Upon completion, the proposed ground water management program shall be subject to review pursuant to the State Environmental Policy Act (SEPA). Ecology will hold a local public hearing for comment and review of the program. Following the hearing, the department and each local agency and user group will have 90 days to evaluate the program. If the program is found to be consistent with the intent of Chapter 173-100 WAC, Ecology will certify the program. Following certification, affected state agencies and local governments shall adopt or amend regulations and policies for implementation of the ground water management program.

Reference: WAC 173-100-120

All correspondence involving ground water management area designation or ground water management program development should be sent to:

Department of Ecology
Water Resources Planning and Management
Mail Stop PV-11
Olympia, Washington 98504-8711

(206) 459-6000

## SUMMARY OF RESPONSIBILITIES

| | |
|---|---|
| INITIATOR OF REQUEST ----------- (user group, Ecology or local government) | Coordination with local government, user groups with state government<br>Develop request for designation<br>Recommend lead agency and GWAC<br>Hold public meeting on request for area designation<br>Submit request to Ecology |
| Provide written concurrence on lead agency recommendation<br>Member of GWAC | --------------COUNTY GOVERNMENT |
| LEAD AGENCY -------------------- | Coordinate development of GWMP<br>Reviews workplan, schedule, budget for GWMP<br>Schedule GWAC meetings<br>Delegate activities to GWAC<br>Coordinate SEPA review |
| Oversees development of GWMP<br>revises workplan, schedule and budget for GWMP<br>Final review of GWMP before submittal to Ecology<br>Coordinates public review | --------------ADVISORY COMMITTEE |
| ECOLOGY ------------------------ | Places request for area designation on general schedule<br>Holds public hearing on request for area designation<br>Designates GWMA<br>Appoints lead agency and GWAC<br>Participates on GWAC<br>Holds public meeting upon plan completion<br>Certifies GWMP |

GWMA - Ground Water Management Area
GWMP - Ground Water Management Program
GWAC - Ground Water Advisory Committee

# Chapter 173–100 WAC
# GROUND WATER MANAGEMENT AREAS AND PROGRAMS



**WAC 173–100–010 Purpose.** The purpose of this chapter is to establish guidelines, criteria, and procedures for the designation of ground water management areas, subareas or zones and to set forth a process for the development of ground water management programs for such areas, subareas, or zones, in order to protect ground water quality, to assure ground water quantity, and to provide for efficient management of water resources for meeting future needs while recognizing existing water rights. The intent of this chapter is to forge a partnership between a diversity of local, state, tribal and federal interests in cooperatively protecting the state's ground water resources. [Statutory Authority: RCW 90.44.400. 86–02–004 (Order DE 85–24), § 173–100-010, filed 12/20/85.]

**WAC 173–100–020 Authority.** This chapter is promulgated by the department of ecology pursuant to RCW 90.44.400, 90.44.410, 90.44.420, 90.44.430 and 90.44.440. [Statutory Authority: RCW 90.44.400. 86–02–004 (Order DE 85–24), § 173–100–020, filed 12/20/85.]

**WAC 173–100–030 Overview.** This regulation establishes a process for the identification and designation of ground water management areas and for the development of comprehensive ground water management programs. From a general schedule of probable ground water management areas, the department of ecology in cooperation with local government will designate specific ground water management areas, subareas, or depth zones within such areas and will appoint a lead agency to develop a ground water management program and an advisory committee to oversee the development of the program for each designated area. Following completion of the program and a public hearing to be held by the department of ecology, the program must be certified to be consistent with the intent of this chapter. The program will then be implemented through state regulations and local ordinances. The programs must thereafter be periodically reviewed. [Statutory Authority: RCW 90-.44.400. 86–02–004 (Order DE 85–24), § 173–100–030, filed 12/20/85.]

**WAC 173–100–040 Definitions.** For the purposes of this chapter the following definitions shall apply:

(1) "Aquifer" means a geologic formation, group of formations or part of a formation capable of yielding a significant amount of ground water to wells or springs.

(2) "Department" means the Washington State department of ecology.

(3) "Ground water" means all waters that exist beneath the land surface or beneath the bed of any stream, lake or reservoir, or other body of surface water, whatever may be the geological formation or structure in which such water stands or flows, percolates or otherwise moves.

(4) "Ground water advisory committee" means a committee appointed by the department to assist in the development of a ground water management program.

(5) "Ground water area or subarea" means a geographic area designated pursuant to RCW 90.44.130.

(6) "Ground water management area" means a specific geographic area or subarea designated pursuant to this chapter for which a ground water management program is required.

(7) "Ground water management program" means a comprehensive program designed to protect ground water quality, to assure ground water quantity and to provide for efficient management of water resources while recognizing existing ground water rights and meeting future needs consistent with local and state objectives, policies and authorities within a designated ground water management area or subarea and developed pursuant to this chapter.

(8) "Ground water management zone" means any depth or stratigraphic zone separately designated by the department in cooperation with local government for ground water management purposes within a ground water management area. Ground water management zones may consist of a specific geologic formation or formations or other reasonable bounds determined by the department consistent with the purposes of this chapter.

(9) "Ground water right" means an authorization to use ground water established pursuant to chapter 90.44 RCW, state common or statutory law existing prior to the enactment of chapter 90.44 RCW, or federal law.

(10) "Ground water user group" means an established association of holders of ground water rights located within a proposed or designated ground water management area.

(11) "Lead agency" means the agency appointed by the department to coordinate and undertake the activities necessary for the development of a ground water management program. Either the department or an agency of local government may be the lead agency.

(12) "Local government" means any county, city, town, or any other entity having its own incorporated government for local affairs including, but not limited to, a metropolitan municipal corporation, public utility district, water district, irrigation district, and/or sewer district.

(13) "Local government legislative authority" means the city or town council, board of county commissioners, special district commission, or that body assigned such duties by a city, county or district charter as enacting ordinances, passing resolutions, and appropriating funds for expenditure.

(14) "Probable ground water management area" means a specific geographic area identified by the department, in cooperation with other state agencies, local government and ground water user groups, as a candidate area for designation as a ground water management area pursuant to this chapter. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-040, filed 12/20/85.]

**WAC 173-100-050 Probable ground water management areas.** The department in cooperation with local government and ground water user groups shall identify probable ground water management areas.

(1) Probable ground water management areas may be proposed for identification at any time by the department upon its own motion or at the request of other state agencies, local government or ground water user groups.

(2) Probable ground water management area boundaries shall be delineated so as to enclose one or more distinct bodies of public ground water as nearly as known facts permit. Probable ground water management subareas shall be delineated so as to enclose all or any part of a distinct body of public ground. Boundaries shall be based on hydrogeologic properties such as limits to lateral extent of aquifers, major perennial rivers, and regional ground water divides or as deemed appropriate by the department to most effectively accomplish the purposes of this chapter.

(3) The criteria to guide identification of probable ground water management areas shall include, but not be limited to, the following:

(a) Geographic areas where ground water quality is threatened;

(b) Aquifers that are declining due to restricted recharge or over-utilization;

(c) Aquifers in which over-appropriation may have occurred and adjudication of water rights has not yet been completed;

(d) Aquifers reserved or being considered for water supply reservation under chapter 90.54 RCW for future beneficial uses;

(e) Aquifers identified as the primary source of supply for public water supply systems;

(f) Aquifers underlying a critical water supply service area where the coordinated water system plan established pursuant to chapter 70.116 RCW has identified a need for a ground water management program;

(g) Aquifers designated as sole source aquifers by the federal Environmental Protection Agency;

(h) Geographic areas where the ground water is susceptible to contamination or degradation resulting from land use activities;

(i) Aquifers threatened by seawater intrusion; or

(j) Aquifers from which major ground water withdrawals have been proposed or appear imminent.

(4) The state agency, local government or ground water user group requesting probable ground water management area identification shall provide sufficient information for the department to determine if the area should be so identified. The department and other affected state and local governments and user groups may cooperate in preparing the request for identification.

(a) The request for identification shall be presented in a concise, factual report form and shall consider the guidelines and criteria set forth in subsections (2) and (3) of this section as they relate to the proposed area. It shall also contain: (i) Supporting data as to the need for such identification; (ii) a general description of and rationale for the proposed ground water management area boundary; (iii) goals and objectives for the proposed ground water management area; (iv) an estimated cost of developing the ground water management program and potential funding sources; (v) recommendations for agencies, organizations and groups to be represented on the ground water management area advisory committee; and (vi) a recommendation for the lead agency, taking into consideration the responsibilities contained in WAC 173-100-080.

(b) The recommendation for lead agency shall first be submitted to the county or counties with jurisdiction for written concurrence. Such written concurrence shall be included with the information required in (a) of this subsection. If such concurrence cannot be obtained, the department shall attempt to mediate an agreement between the parties.

(c) The agency or ground water user group initiating the request for identification shall hold at least one public meeting for the purpose of receiving comments from the public, affected local, state and tribal agencies and ground water user groups.

(d) Upon completion, the request for identification shall be submitted to the department and other affected state and local agencies and ground water user groups for their review and comment. Comments shall be submitted to the department.

(5) If the department is proposing an area for identification, the department shall prepare a report containing the information in subsection (4)(a) of this section, hold a public meeting, and submit the report to affected

state and local agencies and ground water user groups for their review and comment.

(6) Based upon review of the request for identification together with any comments received and a finding that the proposed area meets the guidelines and criteria of subsections (2) and (3) of this section, the department shall identify the proposed area as a probable ground water management area, establish the general planning boundaries and appoint a lead agency. When a probable ground water management area is included within only one county and that county indicates its desire to assume lead agency status, the department shall appoint the county as lead agency. The department shall notify affected state and local agencies, ground water user groups, tribal governments and local news media of such identification. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-050, filed 12/20/85.]

**WAC 173-100-060 General schedule.** The department shall establish a general schedule for the designation of specific ground water management areas. The general schedule shall guide the department in the designation of specific ground water management areas and in the allocation of the department's available water resources funding and staffing.

(1) The general schedule for designation of ground water management areas shall identify the relative priority of each of the probable ground water management areas. The relative priority of the probable ground water management areas shall be based upon:

(a) The availability of local or state agency resources to develop and implement a ground water management program;

(b) The significance, severity or urgency of the problems or potential problems described in the request for identification submitted for each area, with the highest priority given to areas where the water quality is imminently threatened;

(2) The department shall revise the general schedule as needed to comply with the intent of this chapter. After each revision the general schedule shall be published in the news media and the Washington State Register. A public hearing will be held in June of each year to receive public comment on the general schedule. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-060, filed 12/20/85.]

**WAC 173-100-070 Designation of ground water management areas for program planning purposes.** The department shall designate ground water management areas by order of the department in accordance with the general schedule. The department shall hold a public hearing within the county or counties containing the probable ground water management area prior to such designation. The order shall be issued to the lead agency as well as the agency or ground water user group originally requesting identification of the areas, with copies sent to other affected state agencies, local governments, tribal governments and those parties recommended for ground water advisory committee membership. Copies of the order shall be published by the department in newspapers of general circulation within the area. The order shall contain a general description of the planning boundary for the ground water management area and shall state that the department, in cooperation with the lead agency and local government, intends to appoint a ground water advisory committee to oversee the development of a ground water management program for the area. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-070, filed 12/20/85.]

**WAC 173-100-080 Lead agency responsibilities.** The lead agency shall be responsible for coordinating and undertaking the activities necessary for development of the ground water management program. These activities shall include collecting data and conducting studies related to hydrogeology, water quality, water use, land use, and population projections; scheduling and coordinating advisory committee meetings; presenting draft materials to the committee for review; responding to comments from the committee; coordinating SEPA review; executing inter-local agreements or other contracts; and other duties as may be necessary. The lead agency shall also prepare a work plan, schedule, and budget for the development of the program that shows the responsibilities and roles of each of the advisory committee members as agreed upon by the committee. Data collection, data analysis and other elements of the program development may be delegated by the lead agency to other advisory committee members. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-080, filed 12/20/85.]

**WAC 173-100-090 Ground water advisory committee.** (1) The ground water advisory committee shall be responsible for overseeing the development of the ground water management program; reviewing the work plan, schedule and budget for the development of the program; assuring that the program is technically and functionally sound; verifying that the program is consistent with this chapter and with the respective authorities of the affected agencies; and formulating and implementing a public involvement plan.

(2) The membership of each ground water advisory committee shall represent a broad spectrum of the public in order to ensure that the ground water is protected and utilized for the greatest benefit to the people of the state. The committee shall include, but not be limited to, representation from the following groups:

(a) Local government legislative authorities within the designated area;

(b) Planning agencies having jurisdiction within the designated area;

(c) Health agencies having jurisdiction within the designated area;

(d) Ground water user groups within the designated area, including domestic well owners;

(e) The department;

(f) Department of social and health services;

(g) Other local, state, and federal agencies as determined to be appropriate by the department;

(h) Tribal governments, where a ground water management program may affect tribal waters;

(i) Public and special interest groups such as agricultural, well drilling, forestry, environmental, business and/or industrial groups within the area, as determined to be appropriate by the department.

(3) The department shall appoint, by letter, members and alternates to the ground water advisory committee after seeking nominations from the groups listed above. Members and alternates shall serve until the ground water management program for the area is certified. The department may appoint replacement members or alternates upon request of the appointee or the ground water advisory committee.

(4) The lead agency shall hold the first meeting of the ground water advisory committee within sixty days of the appointment of the committee. Public notice shall be given for each meeting. The lead agency shall chair the first meeting, during which the advisory committee shall determine, by general agreement, rules for conducting business, including voting procedures, and the chairperson of the advisory committee. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-090, filed 12/20/85.]

**WAC 173-100-100 Ground water management program content.** The program for each ground water management area will be tailored to the specific conditions of the area. The following guidelines on program content are intended to serve as a general framework for the program, to be adapted to the particular needs of each area. Each program shall include, as appropriate, the following:

(1) An area characterization section comprised of:

(a) A delineation of the ground water area, subarea or depth zone boundaries and the rationale for those boundaries;

(b) A map showing the jurisdictional boundaries of all state, local, tribal, and federal governments within the ground water management area;

(c) Land and water use management authorities, policies, goals and responsibilities of state, local, tribal, and federal governments that may affect the area's ground water quality and quantity;

(d) A general description of the locale, including a brief description of the topography, geology, climate, population, land use, water use and water resources;

(e) A description of the area's hydrogeology, including the delineation of aquifers, aquitards, hydrogeologic cross-sections, porosity and horizontal and vertical permeability estimates, direction and quantity of ground water flow, water-table contour and potentiometric maps by aquifer, locations of wells, perennial streams and springs, the locations of aquifer recharge and discharge areas, and the distribution and quantity of natural and man-induced aquifer recharge and discharge;

(f) Characterization of the historical and existing ground water quality;

(g) Estimates of the historical and current rates of ground water use and purposes of such use within the area;

(h) Projections of ground water supply needs and rates of withdrawal based upon alternative population and land use projections;

(i) References including sources of data, methods and accuracy of measurements, quality control used in data collection and measurement programs, and documentation for and construction details of any computer models used.

(2) A problem definition section that discusses land and water use activities potentially affecting the ground water quality or quantity of the area. These activities may include but are not limited to:

–Commercial, municipal, and industrial discharges
–Underground or surface storage of harmful materials in containers susceptible to leakage
–Accidental spills
–Waste disposal, including liquid, solid, and hazardous waste
–Storm water disposal
–Mining activities
–Application and storage of roadway deicing chemicals
–Agricultural activities
–Artificial recharge of the aquifer by injection wells, seepage ponds, land spreading, or irrigation
–Aquifer over-utilization causing seawater intrusion, other contamination, water table declines or depletion of surface waters
–Improperly constructed or abandoned wells
–Confined animal feeding activities

The discussion should define the extent of the ground water problems caused or potentially caused by each activity, including effects which may extend across ground water management area boundaries, supported by as much documentation as possible. The section should analyze historical trends in water quality in terms of their likely causes, document declining water table levels and other water use conflicts, establish the relationship between water withdrawal distribution and rates and water level changes within each aquifer or zone, and predict the likelihood of future problems and conflicts if no action is taken. The discussion should also identify land and water use management policies that affect ground water quality and quantity in the area. Areas where insufficient data exists to define the nature and extent of existing or potential ground water problems shall be documented.

(3) A section identifying water quantity and quality goals and objectives for the area which (a) recognize existing and future uses of the aquifer, (b) are in accordance with water quality standards of the department, the department of social and health services, and the federal environmental protection agency, and (c) recognize annual variations in aquifer recharge and other significant hydrogeologic factors;

(4) An alternatives section outlining various land and water use management strategies for reaching the program's goals and objectives that address each of the ground water problems discussed in the problem definition section. If necessary, alternative data collection and

analysis programs shall be defined to enable better characterization of the ground water and potential quality and quantity problems. Each of the alternative strategies shall be evaluated in terms of feasibility, effectiveness, cost, time and difficulty to implement, and degree of consistency with local comprehensive plans and water management programs such as the coordinated water system plan, the water supply reservation program, and others. The alternative management strategies shall address water conservation, conflicts with existing water rights and minimum instream flow requirements, programs to resolve such conflicts, and long-term policies and construction practices necessary to protect existing water rights and subsequent facilities installed in accordance with the ground water management area program and/or other water right procedures.

(5) A recommendations section containing those management strategies chosen from the alternatives section that are recommended for implementation. The rationale for choosing these strategies as opposed to the other alternatives identified shall be given;

(6) An implementation section comprised of:

(a) A detailed work plan for implementing each aspect of the ground water management strategies as presented in the recommendations section. For each recommended management action, the parties responsible for initiating the action and a schedule for implementation shall be identified. Where possible, the implementation plan should include specifically worded statements such as model ordinances, recommended governmental policy statements, interagency agreements, proposed legislative changes, and proposed amendments to local comprehensive plans, coordinated water system plans, basin management programs, and others as appropriate;

(b) A monitoring system for evaluating the effectiveness of the program;

(c) A process for the periodic review and revision of the ground water management program. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-100, filed 12/20/85.]

**WAC 173-100-110 SEPA review.** The proposed ground water management program shall be subject to review pursuant to the State Environmental Policy Act, chapter 43.21C RCW, as required under the applicable implementing regulations. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-110, filed 12/20/85.]

**WAC 173-100-120 Hearings and implementation.** (1) Upon completion of the ground water area management program, the department shall hold a public hearing within the designated ground water management area for the purpose of taking public testimony on the proposed program. Local governments are encouraged to hold joint hearings with the department to hear testimony on the proposed management program. Following the public hearing, the department and each affected local government shall prepare findings on the ground water management program within ninety days. This period may be extended by the department for an additional ninety days. The findings shall evaluate the program's technical soundness, economic feasibility, and consistency with the intent of this chapter and other federal, state and local laws. The findings shall identify any revisions necessary before the program can be certified and shall contain a statement of the agency's concurrence, indicating its intent to adopt implementing policies, ordinances and programs if required, or a statement of nonconcurrence with the program if such be the case.

(2) The lead agency will consolidate the findings and present them to the advisory committee. Statements of nonconcurrence shall be resolved by the committee and the program revised if necessary.

(3) The program shall then be submitted by the ground water advisory committee to the department which shall certify that the program is consistent with the intent of this chapter.

(4) Following such certification, state agencies and affected local governments shall adopt or amend regulations, ordinances, and/or programs for implementing those provisions of the ground water management program which are within their respective jurisdictional authorities.

(5) The department, the department of social and health services and affected local governments shall be guided by the adopted program when reviewing and considering approval of all studies, plans and facilities that may utilize or impact the implementation of the ground water management program. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-120, filed 12/20/85.]

**WAC 173-100-130 Designation of ground water areas.** The procedures provided in RCW 90.44.130 may be utilized by the department to designate ground water areas, subareas, or zones for the purposes described therein either in conjunction with the procedures of this chapter or independently thereof. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-130, filed 12/20/85.]

**WAC 173-100-140 Inter-governmental agreements.** In order to fully implement this chapter, the department may negotiate and enter into cooperative agreements with Indian tribal governments, adjacent states and Canadian governmental agencies when a ground water management area is contiguous with or affects lands under their jurisdiction. Such cooperative agreements shall not affect the jurisdiction over any civil or criminal matters that may be exercised by any party to such an agreement. Inter-governmental agreements shall further the purposes of this chapter, and shall serve to establish a framework for inter-governmental coordination, minimize duplication, and efficiently utilize program resources to protect ground water resources. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-140, filed 12/20/85.]

**WAC 173-100-150 Appeals.** All final written decisions of the department pertaining to designation of ground water management areas, certification of ground water management programs, permits, regulatory orders, and related decisions pursuant to this chapter shall be subject to review by the pollution control hearings board under chapter 43.21B RCW. [Statutory Authority: RCW 90.44.400. 86-02-004 (Order DE 85-24), § 173-100-150, filed 12/20/85.]

**APPENDIX P**
**LIST OF RELATED DOCUMENTS**
**[Available upon request]**
**Data Collection and Analysis Plan**
**Data Management Plan**
**Quality Assurance Project Plan**
**Public Involvement Plan**
**Area Characterization Report**
**Data Analysis Report**