

# SILVER LAKE WATERSHED MANAGEMENT PLAN – DIGITAL VERSION

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WASHINGTON STATE DEPARTMENT OF ECOLOGY

# Project Description:

This project has been funded by a grant administered by Department of Ecology with Centennial Clean Water Program funds, and is also financially supported by both Cowlitz County and Silver Lake Flood Control District. The goal of this project is to resurrect the information and suggestions contained within the Silver Lake Watershed Management Plan (SLWMP). The SLWMP is an incredibly informative and collaborative document authored in 1994, typed and previously available in paper-only format. Most members of the Silver Lake Watershed Advisory Council did not possess or have access to a copy of it before this project. In addition to improved accessibility, sections and suggestions can be extracted from the comprehensive document and considered in a more specific and practical way. For example, this project assisted in the development of Silver Lake Citizen's Workbook which highlights recommendations made in the SLWMP and solicits information and input from citizens.

The following digital version of the SLWMP was developed using a combination of optical character recognition technology (OCR) and manually entering text into a Microsoft Word document. Thank you to the author, Darin Houpt, for taking the time to perform OCR and send it to the Cowlitz County Health Department. The document has been replicated in as much as is practical. Several figures and graphs were not practical to reproduce by either method, and were omitted.



# Silver Lake Watershed Management Plan

Prepared for

Cowlitz County

In accordance with Task III of the Silver Lake Phase II Restoration Project

Department of Ecology Centennial Clean Water Fund Grant No. G9200033

By

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Mr. Dale Henderson (Rural Residential)

A special thanks to the landowners in the Silver Lake Watershed without whose cooperation and continuing participation has made this project possible.

# **Forward**

The Silver Lake Inventory Report is intended to be utilized in conjunction with the Silver Lake Watershed Management Plan. The Silver Lake Watershed Inventory report provides a more comprehensive review of the individual inventories. The Silver Lake Management Plan provides background information, a watershed characterization, a brief summary of the individual inventory items addressed in the inventory document, the recommended alternatives developed by the watershed advisory committee, and a listing of implementation activities to dates.

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# CHAPTER 1

## INTRODUCTION

### **Goal and Objective Statements**

The overall goal for the project is:

Identifying and managing the sources of phosphorus in the Silver Lake watershed.

Since phosphorus tightly binds to soil particles and movement of phosphorus occurs when soil is displaced through erosion processes, this goal was translated to "find and correct" erosion problems in the watershed.

The objectives for reaching the goal include:

- 1) Preparing a watershed management plan for voluntary implementation.
- 2) Inventorying land uses and identify elements of each landuse that have potential to result in soil disturbance.
- 3) Establishing a watershed advisory committee both technical and functional to review the inventory data and generate the recommended management alternatives.
- 4) Involving the public whenever possible, both one-on-one and in groups, during the inventory process to encourage information sharing.

### **Project Area**

Silver Lake is located 5 miles East of the Interstate 5 corridor from Castle Rock, Washington along State Route 504 (Figure 1.1). As one of Western Washington's few warm water reservoirs, Silver lake ranks as premier Spiny Ray fishery as well as providing recreational opportunities including water-skiing, boating, birdwatching, and camping. Since Silver Lake is entering the latter stages of eutrophication, the balance between the traditional uses man has made of the watershed and natural tendency for accelerated weed growth is particularly fragile. The inventory information was collected on a subwatershed basis. Appendix 15 provides an exploded map of the watershed identifying the subwatersheds as delineated by the Conservation District. When possible, boundaries were established to correspond with those delineated by Washington State University in two previous projects.

**Figure 1.1 Silver Lake Watershed Inventory Project Area**

< Figure not available >

## **History**

Silver Lake was formed about 2500 years ago. Very large lahars (mudflows) were generated by the catastrophic draining of a lake or lakes that had been dammed by past debris avalanches from nearby volcanic Mount St. Helens. The mudflows flowed into outlet creek and dammed its valley and formed Silver Lake (Pringle, 1993). The resulting dam consisting of a plain of mud and debris did not allow efficient drainage of the lake. Lake levels were known to fluctuate greatly. As residential use increased along the lake's shores, so did concern for the fluctuating lake levels. Concerns centered around property damage and loss of shorefront property. Additional concerns were voiced regarding the flooding of septic systems (SCS, 1966).

In response to these concerns citizens initiated a study to explore the feasibility of installing a water level control structure on Outlet Creek. In October 1971 sufficient funding was obtained to modify the Outlet Creek channel and construct the control structure.

In 1974, a mere 2 years following the construction of the control structure, excessive weed growth was observed in the lake. Concerns arose over the loss of recreational opportunities due to accelerated weed growth. In 1975 Washington State University completed a study of lake eutrophication to help determine current problems and explore possible solutions. As reported by Bhagat (1975) the major findings of the study were:

- 1) At least 50% of the inflow of nutrients is retained in the lake.
- 2) Hemlock Creek, the major tributary to the lake, contributes more than one-third of the total annual inflow of nitrogen and 45 % of the phosphorus.
- 3) The phosphorus input from the septic systems is significant presently but the input will be reduced by the interceptor sewers recently installed in part of the affected area (Streeter's Area).
- 4) At the current rate of productivity, aquatic macrophytes and algae derive approximately 50% of their nitrogen and 67 % of their phosphorus from the lake sediments and from the regeneration of nutrients from plant die-off, and the remaining requirement is satisfied from the inflowing nutrients.

The study recommended selective harvesting of aquatic plants, short-circuiting or by-passing of Hemlock Creek flows, lake level management, nutrient reduction from adjacent landuse activities, and controlling the input of nutrients from septic systems as the practical and economical means to control the excessive growth of aquatic plants.

Little or no implementation of the recommendations has been undertaken to date.

In 1987, as a result of increased community activity, Cowlitz County and Washington State Department of Ecology initiated the Silver Lake Restoration Project Phase I and funded Washington State University to prepare a diagnostic and feasibility study for the restoration of Silver Lake (Moore, 1990). This study, completed in 1990, identified phosphorus as the nutrient of concern in the lake. WSU identified several restoration schemes to be considered for a Phase II Silver Lake Restoration Project including dividing the lake into three management zones, biological macrophyte control, dredging, bottom screening, waterfowl management, watershed nutrient diversion, and public information and education.

## **Project Development**

In 1991, Cowlitz County was granted funding through Washington State Department of Ecology's Centennial Clean Water Fund to begin Phase II of the Silver Lake Restoration Project. The three project tasks for this project include the introduction of grass carp to the lake, long-term lake-water quality monitoring, and providing assistance to the landowners in the watershed with the development of a Watershed Management Plan (WMP). Eighty-three thousand White Amur grass carp were introduced into the lake during May and June of 1992. A contract was awarded to KCM consultants to conduct long-term lake monitoring. Cowlitz Conservation District contracted with Cowlitz County on December 31, 1991 to conduct an inventory of the watershed and assist the landowners with the development of a Voluntary Watershed Management Plan.

### **Project Initiation**

A technical advisory committee met to discuss the problems and recommend a plan of work. Included in the development of the plan of work were Department of Ecology, Cowlitz County, Department of Fisheries and Wildlife, USDA Soil Conservation Service, and Cowlitz Conservation District.

The Silver Lake Work Plan can be found in appendix 1. Department of Ecology encouraged the use of WAC 400-12, a listing of parameters to be considered significant sources of non point pollution, as a guide through the project. Additionally, they provided an outline of critical elements that should be addressed in watershed management plan outside the Puget Sound Region. These items were utilized to assist in the development of the inventory procedures and the Watershed Management Plan.

Cowlitz Conservation District developed inventory procedures for the collection of data and the documentation of problems identified in the watershed. These procedures were reviewed by a technical advisory committee consisting Department of Wildlife, Department of Fisheries, Department of Natural Resources, USDA Soil Conservation Service, and CD representatives.

The project was initially presented to the Silver Lake community through the use of a water quality questionnaire delivered to all landowners. The survey form introduced the Conservation District, the Watershed Planning project, and served as an additional media source to identify a public meeting in the community. The public meeting was held on ??????? at the Silver Lake Grange and approximately 100 people attended. A major aspect of the public meeting was to identify landowners interested in assisting the District by serving on a Watershed Advisory Committee.

## Watershed Advisory Committee

A Watershed Management Planning Advisory Committee (Committee) was established to provide direction to the District during the watershed inventory, review and discuss inventory information for identification of concerns, and to develop recommended alternatives to address concerns. The Committee consisted of community landowners representing all of the land use interests in the watershed. Decisions were made through a consensus building approach, and functioning of the Committee was governed by a basic set of ground rules including;

- Listen to others
- Share opinions and concerns with the committee
- Be prepared for meetings and attend regularly
- Maintain open communication with the other committee members and the District

Meetings were held as needed (approximately every other month) to review the inventory information and generate management alternatives. It was agreed that the District develop a rough draft of alternatives for the individual inventory sections to provide a starting block for Committee discussions. The responsibility of the committee was to edit, add, or delete alternatives to arrive at the recommended alternatives that would be incorporated into the Watershed Management Plan. Being a voluntary plan several considerations guided the development of the recommended alternatives including:

- Willingness of individual landowners to implement the alternative
- Redundancy of the alternative with existing regulations
- Costs associated with the recommendations and opportunities for technical and financial assistance
- Practicality of the alternative

## Public Participation

District staff encouraged individual landowners to accompany them while conducting various aspects of the inventory relevant to their property. Effort was extended to inform landowners of the purpose of the project and to share technical management information whenever possible.

The District also participated in quarterly meetings of Cowlitz County's Silver Lake Watershed

Advisory Committee to provide progress updates and share information. This committee consists of community landowners, public agencies, and private organizations. Progress reports were delivered monthly during public meetings of the Cowlitz Conservation District Board of Supervisors. During “Coast Weeks” district staff made a project presentation to an interest group embarking on a canoe tour of the lake. District staff also met with Silverlake Flood Control District to inform them of the project and to discuss opportunities for participation in implementing the plan.

## **Regulations Impacting Watershed Decisions**

Cowlitz County codes/regulations were reviewed to assure compatibility with the recommended alternatives. The Silver Lake area is not zoned at this time. Lot sizes are governed under a Comprehensive Plan. Regulation governing practices such as grading and clearing, stormwater runoff, and road maintenance do not exist. However, several federal and state regulations apply that may require permits to undertake projects. The following provides a brief list and description of permits that may affect implementation of the recommended alternatives.

### **Shorelines and Floodplain Permits**

Proposed projects within the designated floodplains, or shorelines of the State within Cowlitz County may require a Floodplain and/or Shoreline permit. A State Environmental Policy Act (SEPA) checklist and determination of the environmental impacts may be required as part of these permits.

### **Hydraulic Project Approval**

Any activities within the ordinary high water lines in waters of Cowlitz County may require a Hydraulic Project Approval (HPA). Compliance with the State Environmental Policy Act is required prior to issuance of an HPA. Use of explosives in water requires a blasting permit. Water diversions, or ponds for fish, may require fish screens or fish stocking permits.

### **Water Quality Standards Modification and Water Rights**

Any construction or chemical applications in the waters of Cowlitz County may require a Water Quality Standards Modification Approval. Also, a Water Right permit may be required for the withdrawal or use of State waters.

### **Forest Practices Application and Aquatic Lands Lease**

The removal, or harvest, of timber (more than 5000 board feet) may require a Forest Practice Application. Buffer zones are often required near streams and lakes. The State of Washington owns the beds of most navigable water bodies. Any construction, filling, dredging or drilling in major streams of Cowlitz County may require an Aquatic Lands Lease.

## US Army Corps of Engineers' Permits

The placement of dredged or fill material in waters or wetlands of the United States, or the placement of structures in navigable rivers may require Section 404 or Section 10 permits from the Corps of Engineers. The Corps has the responsibility for determining whether a specific wetland area is within their jurisdiction.

## **Future Regulations**

### Growth Management Act

Under the State of Washington 's Growth Management Act (1994), Cowlitz County will be working with communities to zone Cowlitz County. The Act is intended to work from the ground up. Citizens are encouraged to identify problems and concerns that need to be addressed and to work directly with the County in preparing ordinances .

### State Department of Health, On-site Sewage Systems

On March 9, 1994 the State Board of Health adopted new rules and regulations governing on-site sewage systems (chapter 246-272 WAC) that go into effect on January 1, 1995.

# WATERSHED CHARACTERIZATION

## **Climate**

The areas climate is predominantly a mid-latitude, west coast marine type and is controlled predominantly by prevailing westerly winds from the Pacific Ocean. Summers are comparatively dry and cool and winters are mild, wet, and cloudy. The average January temperature is 38°F and the average July temperature is 63.5°F. Average annual precipitation for the watershed is 62 inches and is delivered primarily as rainfall. Most of the precipitation occurs between October and March.

## **Topography**

A watershed is defined as an area of land that delivers runoff to a common point. The Silver Lake watershed encompasses approximately 26,000 acres. The topography of the watershed is that of a depressional area, characterized by the lake, surrounded by rolling hills. Elevation ranges from 486.5 feet at the crest of the containment structure to 2500 feet at the watershed divide in Hemlock Creek. Eighty percent (803) of the watershed lies to the South of the lake. Streams feeding the lake include Hemlock Creek (383 of the watershed), Sucker Creek (143 of the watershed), and numerous unnamed tributaries. Silver Lake has a surface area of approximately 1650 acres.

## **Landuse**

Landuse was initially identified by using maps and aerial photography. Agriculture landuse was considered to be any managed pasture or hayland. Urban residential was considered to be those areas currently being served by a sewer system. Rural residential was delineated from non-industrial woodlands based on acreage and the presence of a residential dwelling. Wooded tracts less than 10 acres with a residential dwelling was considered rural residential landuse. Wooded tracts greater than 10 acres or those without a residential dwelling was considered non-industrial woodlands. Table 1.1 provides a breakdown of landuse.

**Table 1.1 Landuse**

Landuse	Percent of Watershed
Agriculture	2.5
Rural Residential	2.0
Urban Residential	1.5
Non-Industrial Woodlands	10.5
Industrial Woodlands	65.2
State/County	2.4
Lake	6.4
Wetlands	9.5

The major agriculture use in the watershed is located in the Lower Hemlock Creek area and along Carnine Road located at the West end of the watershed. Rural residential use is concentrated in the North, East, and West ends of the watershed. The Streeter 's Resort area in the North side of the watershed is the area considered urban residential. The non-industrial woodlands is distributed throughout the North, East, and West ends of the watershed. Industrial woodlands owned by Weyerhaeuser dominate the South side of the watershed with minor holdings by International Paper and Longview Fibre in the North and West ends of the watershed.

There are approximately 147 miles of road and 80 miles of typed streams (Department of Natural Resources stream types).

Comparisons with landuse descriptions in the 1966 conservation district watershed work plan (CD, 1966) indicates a rural residential landuse increase from 1% to 3.5% . In 1966, 128 farms were identified through census figures. One hundred were considered part time farms and average 40 acres in size. A majority of these farms utilized their associated woodlands for grazing. Eighteen farms were considered economic units. Current landuse patterns indicate a 10 acre average farm size and from 5 to 10 economic units.

## **Geology**

The watershed is dominated by volcanic rocks and deposits that indicate a multitude of volcanic events (see map, Appendix 2). The oldest of these is the Goble Volcanics which consist of two separate units. The lower basaltic-andesite lava flows are characteristic of the upper most watershed. This deposit is relatively stable and not easily eroded. The lower watershed is dominated by the volcanistic sedimentary deposits of the upper Goble Volcanics. This deposit mainly consists of sandstone, siltstone and conglomerate. These rocks weather more easily, and can often erode when left exposed.

The younger Wilkes Formation borders the northern side of the lake. It is composed of tuffaceous siltstone and sandstone, which in some locations weathers into bentonitic clays. These clays are often associated with landslides and are relatively easy to erode. There is one large landslide mapped in the northern most portion of the watershed associated with this deposit. There are numerous smaller ones not indicated on the geology map.

There are a few localized deposits of lahar and pyroclastic flows from Mt St Helens. These are relatively young and erode easily. They are occasionally associated with slope failure.

Recent alluvial deposits are found along stream channels and along the lake where many of the streams enter. As this material is unconsolidated it easily erodes where stream banks are unprotected.

Landuse management decisions involving this geologic unit should be made with these characteristics in mind.

## **Soils**

The soils on the North side of the lake and areas immediately surrounding the lake are of the Seaquest- Olympic association. These soils are gently sloping to steep, well-drained soils that formed in old sediments and weathered basalt and andesite on uplands. The dominant soils in this association are well-drained. Seaquest soils formed in old alluvial sediments. They have a surface layer of very dark brown silt loam and a subsoil of dark-brown and brown silty clay loam and clay loam. Olympic soils formed in weathered basalt and andesite. They have a surface layer of dark-brown silt loam and a subsoil of dark reddish-brown and dark-brown silt loam and silty clay loam. Depth to bedrock is greater than 6 feet in most places (SCS, 1974).

The remainder of the watershed 's soils are of the Olympic association. Olympic and Hazeldell soils make up 90 percent of the association. These soils are gently sloping to steep, well-drained soils that formed in weathered basalt and andesite on uplands. They have a surface layer of dark-brown silt loam and a subsoil of dark reddish-brown and dark-brown silt loam and silty clay loam.

A more defined listing of individual soil series and limitations can be found in chapter 3.

## **Vegetation**

The vegetative cover of the watershed is that typical of Southwest Washington. Douglas-fir (*Pseudotsuga Menziesii*) and Red Alder (*Alnus Rubra*) are the principal forest species. Western Red Cedar (*Thuja plicata*) is prevalent on wetter sites. Typical understory species include Cascade Oregon Grape (*Mahonia nervosa*), Western Swordfern (*Polystichum munitum*), Red Huckleberry (*Vaccinium parvifolium*), Vine Maple (*Acer Circinatum*), and Salal (*Gaultheria shallon*). The Department of Natural Resources searched the Natural Heritage Information System for information on rare plants, high quality native wetlands, and high quality native plant communities in the Silver Lake area. A high quality plant community of Douglas-fir/California Hazel/Swordfern association was identified within Seaquest State Park. The Natural Heritage Information System is not a complete inventory of Washington's natural features. The information provided does not eliminate the need or responsibility for detailed on-site surveys.

## **Fisheries and Wildlife**

The Washington State Department of Fish and Wildlife (DFW) provided fisheries and wildlife information from their databases including their Priority Habitat and Species Project, Nongame Data System, Washington Rivers Information System, Electrofishing database, and others. Federal and State Threatened and Endangered Species identified in the watershed include Bald Eagles and a Federal candidate species the Redlegged Frog. The following is a species list provided by the DFW.

## Federal And State Threatened And Endangered Species

Bald Eagle(\*) nesting territories (4) with 2 active nests  
Bald Eagle winter communal roost (probable)

Redlegged frog (federal candidate species)

## Reptiles And Amphibians

Snakes - Northwest garter snake, Common garter snake

Amphibians - Rough skinned newt, Northwestern salamander, Van-Dyke's salamander(?)(\*), Pacific giant salamander, Cope's giant salamander(?), Long-toed salamander, Ensatina, Western red-backed salamander, Pacific tree frog, Bullfrog

## Fish

Salmonids - Steelhead/rainbow trout (\*), Cutthroat trout (\*), Coho Salmon

Warmwater Fish - Largemouth bass, Pumpkinseed, Bluegill, Crappie, Perch, White Amur/Grass carp, Three spine stickleback, Cottids (e.g. Torrent sculpin), Dace, Largescale sucker

## Birds

Wading/Shore - Great blue heron (\*) (old rookery in Hemlock Creek), Virginia rail, American bittern, Sora, Coot, Common snipe, Western sandpiper, Lesser yellowlegs, Killdeer

Songbirds - (numerous species) Rufous hummingbird, Anna's hummingbird (?) Band-tailed pigeon (\*), Mourning dove

Raptors - Osprey (\*) (nest on south side of lake), Red-tailed hawk, Northern harrier, Sharp-shinned hawk, Cooper's hawk, American kestrel

Cavity Nesting Ducks - Bufflehead, Goldeneye, Wood duck, Mergansers

Dabbling ducks - Cinnamon, Blue-winged and green-winged teal, Wigeon, Mallard, Canvasback, Redhead, Pintail, Scaup, Shoveler, Canada geese (nesting and wintering)

Owls - Western screech, great-horned, Northern saw-whet, Northern pygmy, Barn, Barred (?),

Swifts and Swallows - Black swift, Vaux 's swift (\*) (?), Purple martin (\*), Tree, Violet green, Barn, and Cliff swallows

Woodpeckers - Pileated (\*), Hairy, Downy, Common flicker, Red-breasted sapsucker

## Mammals

Insectivores - Shrews (3-4 sp.), Coast mole, Townsend 's mole

Bats - Hoary, Silverhaired, Big brown, Little brown, Yuma Myotis (?), other Myotis sp. (3?)

Carnivores - Black bear, Cougar( +)

Furbearers - River otter, Muskrat, Beaver, Striped skunk, Coyote, Possum, Nutria, Mink, Raccoon, other Mustelids (long-tailed and short-tailed (?) weasels

Rodents - Mountain beaver, Douglas' squirrel, Porcupine, Pacific jumping mouse, White-footed deer mouse, Townsend's vole, red-backed vole, Northern flying squirrel, Woodrat

Cervids - Roosevelt elk (\*), Black-tailed deer (\*)

Wild horses also inhabit the cutover timberlands on the South side of the lake. This year (1994) five adults and one foal were located on the 1300 road system. These horses were spotted several times during the course of the inventories.

This listing is considered not to be complete but drawn only from available information; a comprehensive species list will involve extensive field work and review.

Eagle monitoring is a component of the phase II water quality monitoring.

Notes:

? - Species are suspected and likely to occur but have not been verified

+ - Species are causal; all other species listed nest and/or winter in the watershed

\* - Species are listed as priority species by the Department of Fish and Wildlife

## Archaeology

No historic or archeological sites of significance are known to exist in the watershed. The entire watershed has not been surveyed and is considered by the State Archeological Society to have high potential for relics.

## Recreational Opportunities

Information regarding recreation effects on Silver Lake was obtained by discussion with people that managed the facilities, the answers to a questionnaire regarding septic systems and yard maintenance,

discussion with Cowlitz County Parks and Recreation Department personnel and a general knowledge of the area. Visits were made to all of the identified recreation areas and discussion held with operators where possible .

The following public use recreation areas are located on Silver Lake:

### Seaquest State Park

The park is currently running at capacity from June through September and it is felt there will be increased use during the rest of the months when the modifications to Highway 504 are completed. There are no plans to expand at the present time, however there are three hundred acres to the North where expansion could take place. This area would not be in the Silver Lake drainage so other than road traffic it would not affect Silver Lake. The majority of the surface runoff is directed toward the Toutle drainage. The park's septic system was renovated about five years ago and is in good shape. There have not been any problems with it since the renovation. The system is maintained on a regular basis and the drainfields are located in the Toutle drainage. The system is not operating near capacity, not even during the periods when the park is the most busy. The effluent is pumped to the drainfield and maintenance personnel keep spare pumps on hand in case of pump failure. If expedient repairs could not be made to the system, the park Manager stated that the park would be closed.

### US Forest Service Mount St Helens Interpretive Center

The center has a peak capacity of six thousand visitors daily. This number of visitors is reached on some days. Through 1992, use held steady at about 500,000 visitors annually and in 1993 visitation was over 650,000. This usage will continue to increase as Highway 504 is modified and the visitor facilities up at the Monument are completed, bring greater traffic to the area.

The state has purchased 250 acres of the wetland area lakeward of the Center. This area will be used as mitigation for the Spirit Lake Highway construction. Several agencies are currently working together to fund a boardwalk over this area. The boardwalk is currently under design, with construction hopefully during the winter of 1994 and Spring of 1995. The boardwalk would have little or no effect on the water quality of Silver Lake. There is no intent or area for any increased parking facilities. There is no collection system for parking lot runoff and it eventually empties into Silver Lake.

The Interpretive Center's septic system is considered adequate and there is no intent of expanding it. The effluent is pumped up to the Seaquest State Park drainfield, which is in the Toutle River drainage. During 1993 there was a break in the effluent line where it runs under the Spirit Lake

Highway. That break was repaired and no further problems have been experienced. The septic system is maintained by Seaquest State Park personnel on a regular basis and has redundancy built into it which would take care of pumping in case of temporary failure. The Center would be closed if expedient repairs could not be made.

## The Department Of Wildlife Boat Launch Facility

This facility is by far the busiest of the boat launch facilities on Silver Lake. The entire facility was rebuilt last year and the parking lot is often full during the weekends when the weather is nice and/or the fishing is good. There are two vault toilets on the property. Surface drainage is not collected and eventually gets into Silver Lake.

## The Cowlitz County Wildlife League

The League is a private boat launch recreation area. It has a maximum of one hundred fifty memberships, sixty-five boat slips and several tent and trailer spaces. Parking areas are not paved. At present, there are less than 150 members. The facility is on a septic system which was checked by the Cowlitz County Health Department this year and there were no problems.

## Streeter Resort

This resort is a recreational area which does a fair amount of boat launching. It has a daily picnicking area and seven RV hookups. The area is on sewers. The owners are currently building a new bathhouse which will also be on the sewer system. They hope to expand the number of RV hookups in the future but that will be several years from now. Surface runoff is not collected and eventually gets into Silver Lake.

## The Silver Lake Motel And Resort

This resort has six motel units, five cabins, twenty RV hookups and thirteen tent spaces. The owners are just starting to build the business back up and very seldom run at capacity. There is a boat launching facility, however because of the steepness of the launching ramp and the lack of parking, it does not receive much use, except by the people staying at the facility. The owners do not have any plans to expand in the near future. The facilities are on a septic system which was pumped during 1993. The current owners have not had any problem with the system. Surface runoff is not collected and eventually gets into Silver Lake.

## Boat Launch And Rental Facilities

There are two boat launch and rental facilities along Highway 504, one east of Paine Road and one east of George Taylor Road. Each has about twenty boats available for rental. The facility east of Paine Road, Bean 's Landing, has just reopened. It has one port-a-potty which is pumped on a weekly basis. Surface runoff is not collected at either facility and parking is extremely limited at both facilities. Surface runoff eventually gets into Silver Lake.

## Future Recreation

Cowlitz County is currently negotiating for property on Silver Lake next to the Department of Wildlife boat launch facility off Kerr Road. This property will be used for a recreation facility. Current plans call for a day use area with ten picnic tables with fire rings, twenty-six car parking lot and sanitary facilities as appropriate. This facility must be constructed by the end of 1997 as a requirement of the Silver Lake Restoration Grant with the State of Washington Department of Ecology. Currently, Cowlitz County will be responsible for the construction and maintenance of the facility.

Although no other plans for additional recreational facilities are currently known, the cleanup of Silver Lake and the heavy volume of traffic as a result of the Mount Saint Helens National Volcanic Monument facilities make the area a prime target for future recreational development.

## CHAPTER 2

*Editor's Note: The typed original document contains several pie charts and bar graphs, and some questions are not presented in sequential order. The charts and graphs were mostly unsuccessful in converting to digital format. In these cases, results are given via narrative instead. The questions are also presented in sequential order.*

### **Silver Lake Questionnaire Results**

#### **Introduction:**

As a part of the watershed management plan phase of the Silver Lake restoration project, Cowlitz Conservation District recently completed a water quality survey of landowners within the drainage. Questionnaires were sent to 533 property owners of which 105 (20%) were returned. Property owners were identified through the use of County tax lot information.

The purpose of the survey was to gather data on residents' awareness, and knowledge of water quality values. In addition, questions were asked concerning activities that depend on or impact water quality. This information will be utilized by the Silver Lake watershed planning committee, Cowlitz County, and the Cowlitz Conservation District for exploring approaches to solve watershed management problems.

A graphical presentation is utilized to provide a summary of the questionnaire results. Appendix 4 provides a copy of the questionnaire. Appendix 5 provides a listing of the comments received with the returned forms.

### **Discussion:**

The general format provides the question number, the question, a graph of the results, and a brief summary of the graph. Where appropriate, the survey questions have been grouped and summarized.

Question 1 and 2 determine whether the respondents feel there is a pollution problem and how serious they feel the problem is.

**Question 1: Do you think there is a pollution problem at Silver Lake?**

Yes - 85.7%  
No Reply - 7.6%  
No - 6.7%

**Question 2: How serious is the pollution problem?**

Very Serious - 62.9%  
Mod. Serious - 20.0%  
Not very Serious - 6.6%  
No Reply - 5.7%  
Don't Know - 2.9%  
Not a Problem - 1.9%

From these graphs, it is evident that a majority of the respondents feel there is a serious pollution problem.

There are two general types of pollution. Point source pollution is from sources that can be easily pinpointed such as a sewage treatment plant or a pipe from an industrial plant discharged directly into a body of water. Non point source pollution is from sources difficult to pinpoint such as runoff from homes, streets, parking lots, farms, and forests into streams and lakes. The runoff may include oils, eroded soils, chemicals, septic tank effluent, or animal wastes. Question 3 consisted of two parts and was used to determine how serious the respondents believe these sources are.

**Question 3A: How serious is point source pollution?**

Very Serious - 28.6%  
Mod. Serious - 19.0%  
Not Very Serious - 18.1%  
No Reply - 13.3%  
Not a Problem - 12.4%  
Don't Know - 8.6%

Half the respondents believe that point source problems are serious.

**Question 3B: How serious is non-point source pollution?**

Very Serious - 51.4%  
Mod. Serious - 29.5%  
No Reply - 7.6%  
Not Very Serious - 5.7%  
Don't Know - 3.8%

Not a Problem - 1.9%

A majority of the respondents believe that non-point source pollution is a serious problem. These questions are misleading because they do not specify whether response should be directed at the pollution sources in general or as related to the Silver lake drainage. This leads to two interpretations of the responses. First, the respondents feel non point source pollution is more serious than point source pollution. Second, non point source pollution is still considered more serious than point source pollution but point sources may exist in the drainage. The response as to the seriousness of point source point pollution suggested that the question may be confusing. Point source pollution, in a traditional sense, rarely occurs in a rural watershed. However, a review of comments delivered with the survey indicated that the potential for point source pollution may exist and be a significant contributor in the drainage (appendix 5).

Questions 4 through 6 were utilized to determine how serious an impact pollution has on activities and what are the primary activities of the respondents.

**Question 4: How have changes in water quality impacted your enjoyment or use of the following activities?**

Activity - Majority of Respondents indicated:

Boating - Serious Impact

Canoeing - Serious Impact, followed closely by Doesn't Apply

W. Skiing - Serious Impact

Fishing - Serious Impact

Swimming - Serious Impact

Eating Fish - Serious Impact, followed closely by Mod. Impact

Wildlife - Mod. Impact

Other - Serious Impact

This question indicates that four activities, boating, swimming, fishing, and water skiing, were identified as those affected the most by changes in water quality. Responses to the "Others" option included; hunting, trapping, wind surfing, smell, model planes, and model boats.

**Question 5A: Which activity in question 4 concerns you the most?**

Boating and Fishing tied at 24.8% for the activity that is of the most concern for being impacted by changes in water quality. No reply was at 21%. Swimming/wading received a large number of responses as well, at 17.1%. Wildlife was at 6.7%.

**Question 5B: Which activity from question 4 is your 2nd most concern?**

Again, fishing and boating received the highest response at 19% and 18.1%. Swimming/wading and eating fish tied for third choice at 12.4% each.

**Question 5C: Which activity from question 4 is your 3rd most concern?**

At 14.4% each, boating and swimming tied for the activity of the 3rd most concern, with water-skiing and fishing close behind at 10.5% and 9.5%.

**Question 6A: What activities do you engage in?**

As expected from the previous questions, boating, fishing, swimming/wading, and eating fish top the list of activities that people personally engage in. Wildlife viewing/sightseeing received a number of responses, but was not thought to be seriously impacted (question 4) and thus not a great concern (question 5 A-C). Responses to the "Others" option included; hunting, trapping, wind surfing, smell, model planes, and model boats.

**Question 6B: What activities do you see others engage in?**

Water Skiing - 18.9%  
Canoeing - 16.3%  
Boating - 14.4%  
Fishing - 14.1%  
Swim / Wade - 13.9%  
Eating Fish - 12.0%  
Wildlife - 9.6%  
Other - 0.8%

All activities were represented strengthening the responses to the questions regarding seriousness of affects (question 4) and activities of most concern (question 5A-C).

Coupling these questions it becomes apparent that boating, fishing, swimming/wading, and water-skiing are the activities that the respondents are with the most. This corresponds closely with the responses to question 4 in which these activities were identified as the most seriously affected by changes in water quality. Question 6A and 6B indicate that all activities are represented either from personal activity or through feedback from others.

**Question 7: Indicate potential sources of non-point source pollution that you have actually observed in the Silver Lake drainage.**

Source of Pollution listed in order of reported observance:

Litter  
Forest erosion  
Forest fertilization  
Use of lawn and garden chemicals and fertilizers  
Oily runoff from parking lots and roads  
Septic system failure  
Runoff from construction sites  
Oil and antifreeze dumping in drains or on the ground  
Others

All the provided sources and a few "Others" appear to have been actually observed within

the drainage. Litter on the shore is observed the most followed by forest runoff/erosion, forest fertilization, use of lawn and garden fertilizers, chemicals, oily runoff, and septic system failure.

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Questions 8 through 14, 19 and 20 provided information about the respondents and residences around the lake. These questions provided general demographics of the population. Additionally, this information will be utilized later to provide some insight on how representative is the sample.

**Question 8: How far away is your property from the lake?**

Fronts on lake - 47.6%  
>1000 ft - 22.9%  
200-1000ft - 15.2%  
<200 ft - 12.4%  
Don't know - 1.9

**Question 9: How many acres do you own or rent?**

1-5 acres - 35.9%  
1 acre - 35.0%  
> 50 acres - 10.7%  
10-25 acres - 10.7%  
25-50 acres - 1.9%

A majority of the respondents own property which fronts on the lake, however the response to this question appears to be representative of the population. A majority of the population density is located within a 1000 feet of the lake with larger tracts, thus sparser density, located away from the lake. Question 9 supports the response to question 8 in that a majority of the acres owned is in the 0-5 acre range. This is what one would expect with a majority of the population owning lots within 1000 feet of the lake.

**Question 10: How long have you owned this property?**

10-25 years - 36.2%  
25-50 years - 22.9%  
1-5 years - 21.9%  
5-10 years - 15.2%  
>50 years - 1.9%  
< 1 year - 1.9%

The majority of the respondents have been long term residents of the watershed. This

sustains the response to the significance of the problem and observed sources of non-point source pollution questions.

**Question 11: What are your reasons for living on this property?**

Rural lifestyle - 16.7%  
Rec. Opportunities - 15.3%  
Silver Lake - 15.1%  
Good place to retire - 14.8%  
Nat. resources other than lake - 8.7%  
Family / Friends - 8.5%  
Climate - 6.4%  
Investment - 6.1%  
Grew up here - 5.6%  
Employment / Business - 2.8%

**Question 12: What is the primary use of your property?**

Residence - over 60%  
Vacation - over 20%  
Recreation - approximately 8%  
Investment - 3%  
Commercial - 2%  
No response - 5%

**Question 13: What is the usual number of occupants?**

# of occupants - approximate # of respondents  
2 occupants - 45 respondents  
3 occupants - 14 respondents  
4 occupants - 14 respondents  
No response - 10 respondents  
1 occupant - 5 respondents  
0 occupants - 3 respondents  
5 occupants - 2 respondents  
6 occupants - 2 respondents  
7 occupants - 1 respondent  
9 occupants - 1 respondent

**Question 14: What is the anticipated future use of this property?**

A majority of the respondents utilize their property as a year round resident. Vacation use also received a number of responses. Question 14 shows a shift from vacation use to year round residence in the future.

**Question 15: Which of the following approaches are effective in correcting or preventing water quality problems?**

Education received the highest "effective" response (70 %). Each of the remaining responses received equivalent "effective" response (50%) including Action Programs, Technical Assistance, and Land Use Controls.

**Question 16: Have you participated in any of the following activities?**

Virtually all the respondents indicated that they participate in recycling efforts. Approximately half of the respondents have attended meetings on water pollution. A majority indicated that they have donated time or money to a cause, yet few have actually participated in implementing a water quality project.

Response to this question suggests that the environment is important, and that meetings may be useful to relay information to the public in regards to Silver lake. Additionally, it appears that the respondents may have the initiative to tackle the problems independently (dollars/time), particularly if guidance is provided in a clean-up type project. The following question conveys this attitude about taking on the problem. The question consists of two parts.

**Question 17: What are your most frequent and reliable sources of information?**

The Daily News and the Advocate solicited the highest response while government agencies, radio/TV, and private business received the least in both frequency and reliability. Cowslip received approximately 50% response in both categories.

**Question 18A: Would you vote for a program with a cost to your household?**

**Question 18B: If yes, indicate the amount you're willing to contribute.**

Eighty-three (79%) of the respondents indicated the willingness to vote for a program to reduce nutrient input and slow eutrophication if it had a cost to their household. A number of the "No Reply" responses, indicated that the question was vague in that it didn't specify how often the contribution would be. However, a majority of the "No Reply" responses noted on the survey form that they would be willing to contribute if it were a one time contribution and some even indicated on an annual basis. Forty-four percent of these 83, or 37, respondents indicated that they would be willing to contribute 50 dollars. A number of these indicated, "or more" on the survey form.

The following question was utilized to determine the most effective way to deliver information to the citizens of the drainage. The results are presented in the following 2 graphs

**Question 19: Are any members of your household under 18 years of age?**

No - 65.7%  
Yes - 28.6%  
No Reply - 5.7%

A majority of the respondents do not have members of the family under 18 years of age. This indicates that educational activities involving landowner responsibilities targeting schools may be ineffective. However, user's may be school age and may benefit from educational activities.

**Question 20: Which category best describes your occupation?**

Previous questions alluded to this response in that a majority of the respondents were long term residents, family size was small, and that the Silver Lake community provides a good place to retire. Various interests are represented here and these interests may have differing opinions (presented later). This variability should be considered in the establishment of a watershed committee.

Retired - 43 respondents  
Service - 26 respondents  
Manufacture - 12 respondents  
Forestry - 7 respondents  
Homemaker - 4 respondents  
Agriculture - 2 respondents

**Recommended Alternatives**

1) Utilize the questionnaire:

- throughout the inventory process.
- for development of a method to share plan information with the public.
- in developing a means to implement the recommended alternatives in the plan.

# CHAPTER 3

## SOILS SUMMARY

### **Introduction**

An increased sediment load is often the most important adverse effect of management activities on streams (EPA, 1991). Sediment is undoubtedly the number one non point source pollutant. Sediment is the product of erosion processes at work on soils. Soils vary greatly as to their susceptibility to erosion. An understanding of soils and their limitations is one of the most important factors for land managers to be aware of.

The erodibility of soils is dependent of physiographic and edaphic factors. Physiographic factors can directly and indirectly influence soil erodibility. Slope and length of slope are two factors which directly effect soil erodibility through their influence on surface runoff. Elevation and aspect indirectly effect soil erodibility due to their influence on soil development. Edaphic factors refer to properties of soil that relate to plant production. These are notably the texture and structure of the soil. These factors determine the stability of surface aggregates and their resistance to detachment by rain (Brown, 1985).

The soils information provided was obtained from unpublished data from the USDA Soil Conservation Service that is in the process of being published as the soil survey for Cowlitz County.

Soil associations are landscapes that have distinctive proportional patterns of soils. They normally consist of one or more major soil and at least one minor soil, and are named for the major soil. The soils in one association may exist in another association, but in a different pattern. Soil associations are used to obtain a general idea of the soils in an area. They are not suitable for site specific planning because the soils in anyone association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

In the Silver Lake watershed, the soils on the North side of the lake and areas immediately surrounding the lake are of the Seaquest-Olympic association. These soils are generally gently sloping to steep, well-drained soils that formed in old sediments and weathered basalt and andesite on uplands. The dominant soils in this association are well-drained. Seaquest soils formed in old alluvial sediments. They have a surface layer of very dark brown silt loam and a subsoil of dark-brown and brown silty clay loam and clay loam. Olympic soils formed in weathered basalt and andesite. They have a surface layer of dark-brown silt loam and a subsoil of dark reddish-brown and dark-brown silt loam and silty clay loam. Depth to bedrock is greater than 6 feet in most places (SCS, 1974).

The remainder of the watershed's soils are of the Olympic association. Olympic and Hazeldell soils make up 90 percent of the association. These soils are gently sloping to steep, well-

drained soils that formed in weathered basalt and andesite on uplands. They have a surface layer of dark-brown silt loam and a subsoil of dark reddish-brown and dark-brown silt loam and silty clay loam.

Soil series represent the individual soils mapped in a soil association. Information provided for soil series is used for site specific planning. It should be noted that mapped series may contain inclusions of other soils and do not preclude the need for site investigations to confirm the soils characteristics. Thirty-six soil series are identified in the Silver Lake watershed. Table 3.1 provides the soil series and percent of the watershed they represent.

**Table 3.1** Soils in the Silver Lake Watershed

SOIL SERIES #, NAME, and SLOPE RANGE	PERCENT OF THE WATERSHED
147 Olympic Silt Loam 8-20% Slopes	34.98
78 Hazeldell Gravelly Silt Loam 30-65% Slopes	11.76
76 Hazeldell Gravelly Silt Loam 8-20% Slopes	10.61
195 Semiahmoo Muck 0-1 % Slopes	07.41
Open Water	05.63
146 Olympic Silt Loam 2-8% Slopes	04.74
192 Seaquest Silt Loam 0-8% Slopes	03.91
34 Coweeman Silty Clay Loam 3-30% Slopes	03.15
193 Seaquest Silt Loam 8-20% Slopes	02.90
148 Olympic Silt Loam 20-30% Slopes	01.94
134 Natal Silty Clay Loam 0-4% Slopes	01.71
187 Sauvola Loam 15-30% Slopes	01.61
105 Lacamas Silt Loam 0-6% Slopes	01.46
199 Snohomish Silty Clay Loam 0-1 % Slopes	01.44
65 Godfrey Silt Loam 0-3 % Slopes	01.33
246 Voight Silt Loam 5-30% Slopes	00.79
91 Jonas Silt Loam 5-30% Slopes	00.68
92 Jonas Silt Loam 30-65 % Slopes	00.61
185 Saul vola Loam 0-8 % Slopes	00.61
77 Hazeldell Gravelly Silt Loam 20-30% Slopes	00.50
194 Seaquest Silt Loam 20-30% Slopes	00.46
33 Coweeman Silt Loam 5-15% Slopes	00.35
252 Xenon Silt Loam 5-30% Slopes	00.28
180 Sara Silt Loam 8-15% Slopes	00.20
52 Forsyth Very Cobbly Loamy Sand 0-30% Slopes	00.16
179 Sara Silt Loam 0-8% Slopes	00.14
186 Sauvola Loam 8-15% Slopes	00.14
159 Pheeny-Rock Outcrop Complex 65-90% Slopes	00.11
189 Schneider Very Gravelly Loam 30-65 % Slopes	00.09
124 Man Silt Loam 8-20% Slopes	00.07
109 Lithic Haplumbrepts 50-100% Slopes	00.06

197	Siouxon Very Cobbly Silt Loam 30-65%	00.06
161	Pits	00.05
80	Hazeldell Gravelly Silt Loam, Tuff Substratum 30-65% Slopes	00.04
149	Olympic Silt Loam 30-65% Slopes	00.02

## Non-Technical Soil Descriptions

A nontechnical description of the individual soil units identified in table 3.1 can be found in appendix 6.

### Agriculture

According to Soil Conservation Service capability units, 79% of the watershed is suitable for the production of cultivated crops and pasture plants. Sixty-seven percent of this ground is recognized as having an erosion hazard and 12% is recognized as being limited by wetness. Two and one-half percent of the watershed is currently being utilized for agriculture purposes. The primary limitations for soils currently in agriculture use for production of pasture and hay are a seasonal high water table and the hazard of flooding. Non-technical soil descriptions for the major soils being utilized for agriculture purposes can be found in appendix 7. More detailed information can be obtained through the Soil Conservation Service Soil Survey for Cowlitz county.

### Residential

The predominant soil concern for residential areas is the suitability for septic systems and erosion potential during construction activities. Sixty percent of the soils have moderate and 40% have severe limitations for standard septic systems. Moderate limitations are predominantly due to slow percolation rates in the soil. Severe limitations include, in order of predominance, slope, wetness/slow percolation rates, ponding, poor filter characteristics, presence of a cemented pan, and depth to bedrock. Soil mapping units may have inclusions of other soils up to five acres in size. The limitation rating for an individual soil does not preclude the need for a site specific investigation. Septic limitation, erosion hazard, and compaction hazard ratings for the individual soil series can be found in appendix 8. Eighty-four percent of the soils are characterized by a slight hazard for erosion when exposed. Fifteen percent have a moderate and one percent have a severe erosion hazard. Erosion can be increased through soil compaction by reducing the infiltration rate of the soil. Reduced infiltration rates can lead to ponding of water and surface runoff. Ninety-eight percent of the soils in the watershed are rated as having a severe compaction hazard under moist conditions.

## Forestland

All of the soils in the watershed with the exception of the wetlands soils along the lake's margin are suitable for timber production. Several soil limitations should be considered during management activities. Appendix 9 provides a table of limitations for the individual soils in the watershed.

Erosion hazard rates the risk of off-road soil erosion after fire, grazing, or forest management activities that expose bare soil. Slight ratings indicate that preventative measures are not generally needed under ordinary circumstances. Moderate ratings indicate that some erosion control measures will be needed. Severe ratings indicate that special precautions and measures will be needed to avoid or minimize soil erosion. These ratings are dependent on rainfall amount and intensity, plant recovery rate, soil erodibility (texture/structure), and slope. Eighty-four percent of the soils in the watershed are rated as having a slight erosion hazard. Fifteen percent have a moderate and one percent have a severe erosion hazard. Moderate and high ratings indicate the need for use of special harvesting systems and alternative site preparation techniques and timing.

Ninety-eight percent of the soils in the watershed are considered stable. Two percent are considered unstable.

Yarding activities can alter the erosion hazard on roads and skidtrails by compacting soils. Erosion can be increased through soil compaction by reducing the infiltration rate of the soil. Reduced infiltration rates can lead to ponding of water and surface runoff. Site productivity can also be reduced by compaction. Compaction hazard rates the risk that damage may occur to the soil structure as a result of equipment use when soils are moist or wet. Compaction is dependent on the soil moisture level, texture, amount of coarse fragments, and structure. Compaction is *also* dependent on the type of equipment, number of passes, and the amount of debris on the soil surface. Ninety-eight percent of the soils in the watershed are rated severe for compaction hazard. Moderate and high ratings indicate the need to carefully plan yarding operations to minimize areas compacted, choose the right equipment, and be aware of seasonal limitations. The use of designated skidtrails and protection of the duff layer are always advised to minimize damage to the soil resource.

Equipment limitation rates the difficulty of using wheeled or tracked ground based equipment as a result of soil, topographic, or climatic characteristics. Soil related physical impediments, slope, and soil wetness are the predominant limitations. The main physical limitation for the soils are muddy conditions (77% of soils), steepness of slope (15% of soils), seasonal high water table (7% of soils), and rock outcrops/occasional snowpack/none (1%). Moderate and high ratings indicate the need for suiting equipment to the site and for timing operations to avoid seasonal limitations.

Unsurfaced roads and skidtrails have limited use due to softness during moist conditions on all the soils. This indicates the need for surfacing on roads or scheduling of activities during periods of low soil moisture.

Windthrow hazard rates the soil as to the risk of trees being uprooted by wind. These ratings consider soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. Rooting depth can be restricted by a high water table, underlying bedrock, or an impervious layer. Loose soil may result in poor anchoring of roots. Ratings indicate the need for care in harvesting and thinning forest stands. Eighty-four percent of the soils are rated as having a slight windthrow hazard. Eight percent of the soils have a moderate rating and 8% have a severe windthrow hazard rating. Moderate and high ratings indicate the need for care in harvesting and thinning prescriptions for stands.

Seedling mortality ratings indicate the risk of death for natural or planted tree seedling as influenced by soil or topographic conditions. Factors considered include soil chemistry, soil drainage, soil water holding capacity, temperature and moisture regime, and slope and aspect. Ninety-two percent of the soils are rated as having a slight risk. Eight percent are rated as severe primarily due to a seasonal high water table. Moderate and high ratings indicate the need to consider these sites for alternative species, larger stock, special site preparation, surface drainage, or reinforcement plantings.

Plant competition rates the likelihood of plants effecting the establishment of trees. Climate and soil characteristics account for plant competition problems. In many cases, the key to predicting plant competition problems is the quantity and proximity of undesirable plant seed sources or the quantity of unwanted brush rootstock that will resprout after harvesting. Ninety-nine percent of the soils are rated high with regards to plant competition. High ratings indicate the need for careful site preparation and the potential need for mechanical or chemical treatment of invading vegetation after planting.

# CHAPTER 4

## RURAL RESIDENTIAL

The Rural Residential evaluation of the Watershed Management Inventory includes three elements:

Sewer Systems

Septic Systems

Yard Maintenance

### **Sewer Systems:**

#### Existing Sewer System

The existing Toutle-Streeter Resort sewage system was constructed in 1974 and 1975 and consists of a headworks structure with comminutor and bar screen, an oxidation ditch, secondary clarifier, chlorine contact basin and effluent pumps, an aerobic digester, sludge drying beds, and a small control and lab building. The treated effluent is pumped into an outfall line which flows, by gravity, into the Toutle River.

Gibbs & Olson (1983) completed a study of the system with the purpose of determining what would be required to extend the system to serve the Sequest Park, Forest Service and Mt St Helens Interpretive Center vicinity, and the intervening area between the existing sewerage system and Sequest Park.

The Gibbs & Olson report recommended that a new digester needed to be added to the sewage treatment plant regardless of whether the service area was extended. They also recommended that the existing sludge drying beds be covered. Subsequently, the Forest Service decided to go with an on site disposal system. Since extension of the project was never undertaken, the recommendations in the Gibbs & Olson report were not implemented.

The existing plant which is designed to handle 0.25 million gallons a day, operates in the range of 0.15 to 0.20 million gallons a day. Currently, there are no problems with the plant, it functions quite well, and has the capacity to handle additional sewerage from the existing service area.

The Gibbs & Olson 1983 study states that the system "had a wet weather to dry weather flow ratio of about 2: 1 during the time frame studied. They concluded from that and discussions

with sewage treatment plant operators that the system was subject to very little infiltration and inflow. It is felt, therefore, that the system, with proper operation and maintenance, will not have any harmful effects on Silver Lake. However, the collection system is almost twenty years old, and if a proper level of maintenance is not carried out, there COULD be harmful effects on Silver Lake.

## Future Expansion

The existing system is designed for greater capacity than it is now handling. Bob Vaught, Cowlitz County Public Works, indicates that since the plant is almost twenty years old and the last study of the system was done in 1983 by Gibbs & Olson, it would not be prudent to assume that the plant's capacity could be increased without further study.

Discussion with Bob indicated that two areas of specific interest would be the solids and sludge handling and the infiltration and inflow. Local citizens living between Hall Road and Seaquest Park have indicated an interest in extending the system to pick up their area, and in the spring of 1992, a petition was circulated. That petition was submitted to the county on November 23 1992. The Board of County Commissioners wrote to Mr. Dale Henderson, chairman of the Toutle Community council, informing him that the petition was found to be not sufficient as required in RCW 36.94. Any such study would need to take into account not only expansion of the service area, but current thinking of expansion within the service area.

Seaquest State Park and the Mount St. Helens Interpretive Center have both sized their septic systems to cover present and future needs. Their drain fields are located such that they drain into Toutle River drainage, not Silver Lake drainage.

Discussion with a Seaquest State Park representative indicated that the State Parks policy has been to connect to a utility system when it has been extended into their area. They feel that connection to any extended system would be seriously considered.

The Forest Service representative said that because their system is so new and has been sized for future expansion it would be questionable if the Interpretative Center would connect to any extended system. However, connection would be evaluated at the time of availability.

## Septic Systems:

### Review of Existing Data

Bhagat, et al, (1975) utilized a tracer study, as a part of a Washington State University (WSU) lake study, to determine if septic systems were impacting the lake. Fluorescent dye was deposited into eleven residential systems and the lake was monitored for two consecutive days with a fluorometer to detect the dye. The results of this study is

presented in the following table as reproduced from the WSU Study.

**Table 4.1 Fluorescent red dye detection in the lake water**

Location	Meter Reading - % full scale	
	November 20 (p.m) *	November 21 (a.m.)
1	1.5 +/- 1.5	0.0
2	31.2 +/- 1.5	3.0 +/- 1.5
3	48.7 +/- 1.5	0.0
4	25.5 +/- 1.5	3.0 +/- 1.5
5	27.7 +/- 1.5	0.0

\* Dye was deposited between 8:30 and 10:30 am on November 20, 1974

These results suggest that movement through a system occurs rapidly (approximately 12 hours). Dissipation/dilution appears to occur within 24 hours.

Little information was submitted with this data concerning soil moisture conditions.

Monthly

precipitation data for 1973 reveals that total precipitation for the months of October and November were 58% and 27% respectively below the 1955 to 1973 average rainfall.

This suggests that soil moisture was below the average for these months.

Annual phosphorous and nitrogen input to the lake was derived from the following assumptions and estimates;

- i) Each person's daily sewage was assumed to contribute 4.4 grams of phosphorus and 10.0 grams of nitrogen.
- 2) Total people days spent at Silver lake. were determined from estimates of lake perimeter population (550), percent of people as permanent residents (20-25%), and summer influx of visitors (220,000).
- 3) The loss of nutrients in the soil of septic drainfield was assumed to be 25%.

These parameters resulted in a contribution of 3,130 kg of nitrogen (3% of total load) and 1377 kg of phosphorus (23% of total load) to the lake.

In a second WSU study, Moore (1990), septic systems were not identified directly. Water quality monitoring for the purpose of preparing a nutrient budget revealed that Basin 1 (area on North side of lake) was a significant contributor of phosphorus and nitrogen to the lake.

## Inventory

The results of the WSU studies provided assistance in developing the plan of work for the watershed inventory. Four aspects were identified as concerns for rural residential areas in the workplan. These include identification of the number of septic systems and their location in relation to soil and water resources, current management of septic systems, sewage system management and capacity, and the use of lawn and garden fertilizers and chemicals. The conservation district was responsible for the completion of the first aspect. The county is responsible for the remaining three. Appendix 8 provides soil limitation information relating to septic systems.

## Soil Suitability

Soil Conservation Service soil survey maps were utilized to determine the suitability of soils for the use of septic systems (appendix 8). Sixty percent of the soils have moderate limitations and 40% have severe limitations for septic systems. The accuracy of these maps is considered valid to five acre inclusions. The major limitation is moderately slow permeability associated with Olympic and Seaquest soils. Additional limitations include slope and areas with a high seasonal water table.

## Proximity to Water Resources

A 200 foot zone from all discernible water resources on USGS topographic maps was established on county tax lot maps to estimate the number of systems with a high potential for impacting water resources. Any portion of a tract lying within this zone resulted in inclusion to this group. The 200 foot zone originated from what was felt to be an average design for septic systems (Buchman, 1992), and Department of Health rules and regulations. On average, septic tanks were considered to be within ten feet and drainfields within 30 feet of the house. Drainfields typically consist of 3 lines approximately 70 feet in length. According to the July 1983 Rules and Regulations of the State Board of Health for On-Site Sewage Disposal Systems, a 100 foot setback from surface waters should be maintained for subsurface soil absorption systems. This regulation coupled with average system designs resulted in a 200 foot zone. The rules and regulations governing on-site sewage disposal systems are currently under revision.

## Number of Septic Systems & Their Location in Relation to Soil & Water Resources

The database generated for the public survey was utilized to determine the total number of septic systems within the drainage. This database was prepared from county tax lot maps. Two assumptions were made to facilitate this determination. First, all tracts identified on the tax lot maps were considered to represent a residence. Second, all residences in the Streeter's area (E. 112 sec. 35 and W. 112 sec. 36 TION RIW) were assumed to be on sewer systems.

The following table provides the estimates for; the number of residences, the number of residences on sewers, the number of residences with septic systems and the number of residences with septic systems within the 200 foot zone.

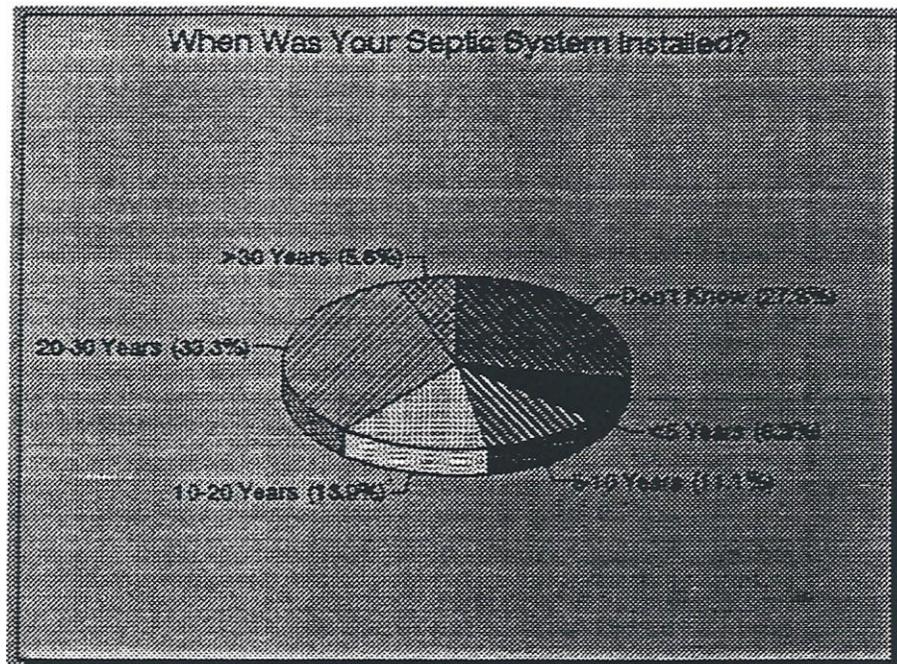
**Table 4.2: Breakdown of residences as related to water resources**

DISTANCE FROM WATERBODY	NUMBER OF RESIDENCES
< 200 feet from waterbody	+ 84 (6 considered large capacity)
> 200 feet from waterbody	+ 310
no residence observable	15
Number of residences on sewer	174
Total number of potential systems	394
Total number of Residences	568

One hundred and twenty parcels of land lie within 200 feet of a watercourse leading to the Lake. Of these, 69 have building improvements on them which are valued at \$5000 or greater. Questionnaires were sent to the owners of all 69 of these parcels inquiring about their method of sewage disposal, maintenance of the system, date the system was installed, and problems with the system. They were also asked if we could test dye their systems. A copy of the Questionnaire is attached as Appendix 10. We sent a follow up mailing and included a questionnaire on lawn maintenance. We received 40 replies, and 36 of the respondents agreed to have their systems dye tested. The following illustrates the results of the septic system questionnaire.

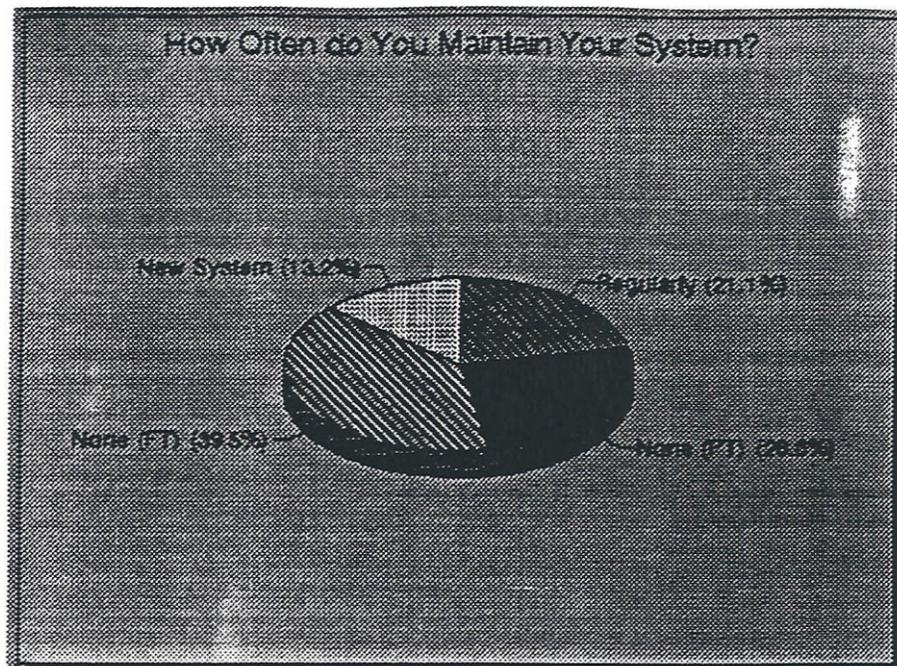
Septic System Questionnaire Results

**Figure 4.1**



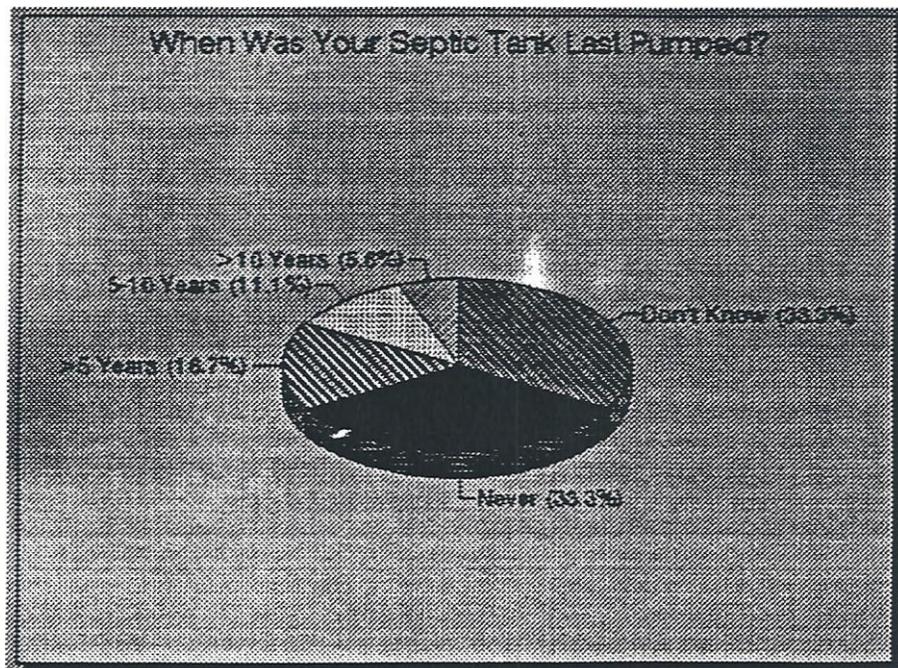
A majority of the respondents (67 %) indicated that they did not know when the septic system was installed or the system was more than 20 years old.

**Figure 4.2**



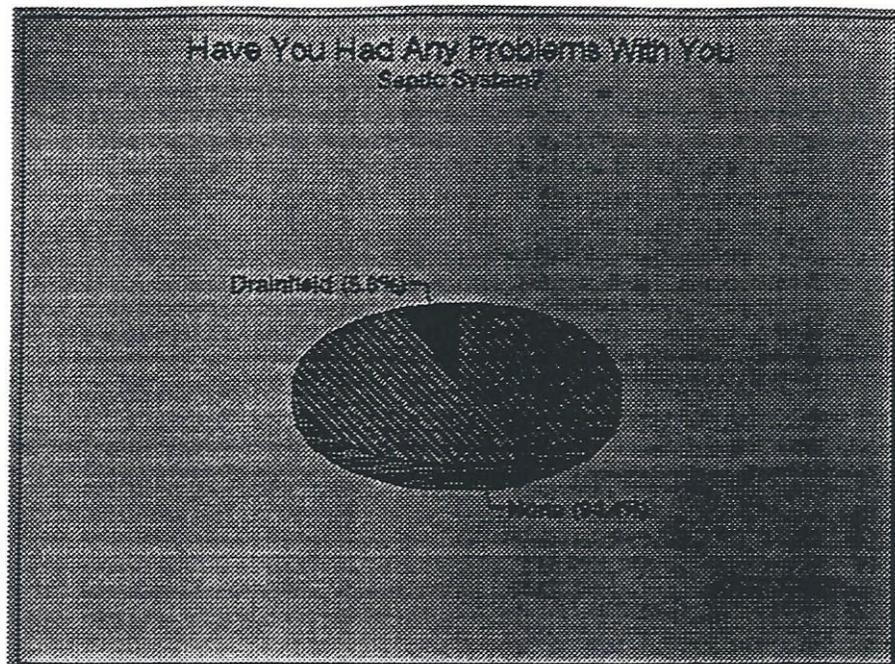
Only 21 % of the respondents indicated that their systems are maintained regularly.

**Figure 4.3**



A majority of the respondents indicated that they don't know when or that their septic system has ever been pumped.

**Figure 4.4**



Ninety-five percent of the respondents indicate that they have not had any problems with their septic systems.

Although a majority of the respondents indicate no problems with their systems, the first three illustration indicate that septic system awareness and management is very limited in the watershed. Filtration effectiveness of a system can be greatly reduced without noticeable evidence of a problem.

Mr Robert Buchman of the Cowlitz County Health Department conducted an evaluation of most of these systems during the first four months of 1994. His report is attached as appendix 11. Of the systems Mr. Buchman checked, none had any problems. Three homes were dye tested because of suspected problems. Dye was not visually detected during follow up visits.

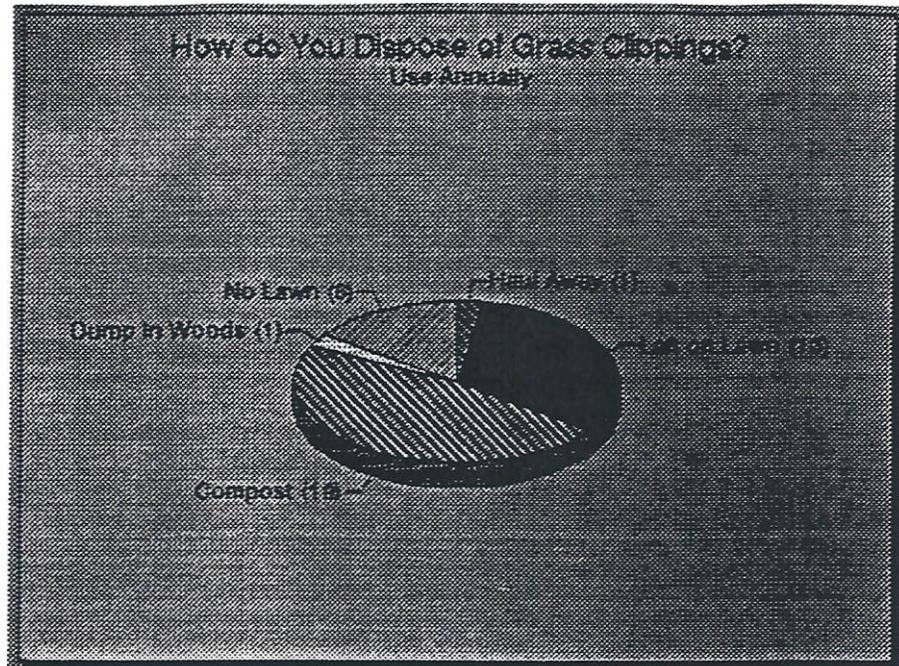
### **Yard Maintenance:**

In order to determine the current practices for lawn maintenance (fertilization), a second questionnaire was sent to the same residents as described in the Septic System section of this report. Copies of the Yard Maintenance questionnaire that were mailed out are attached as appendix 12. The following illustrates the results for the three questions asked of landowners.

#### **Figure 4.5 < not available >**

Twenty-eight of the forty returns (70%) said they do not use fertilizer on their yards. Eight of the forty returns (20%) said that they used a commercial fertilizer such as weed and fee or 20-20-10, and the other four returns (10%) indicated that they used manure of some kind on their yards. Of the thirty percent that fertilize, 67% use commercial fertilizer and 33% use manure. Survey respondents indicate that commercial fertilizer use ranges from 5-60 pounds and averages 35 pounds. Those using manure indicated a use ranging from 20 - 350 pounds and an average use of 90 pounds. Of the twelve replies indicating the use of fertilizer, a total of 280 pounds of commercial fertilizer was reported as used in year, and manure used in a year varied from a pick-up load to 350 pounds.

#### **Figure 4.6**



The majority of those who have a lawn, either compost their grass clippings or leave them on the lawn. One reply indicated that the property owner piled the clippings back in the woods and another indicated that they haul away the grass clippings.

### Watershed Population Estimates

Responses to the Silver Lake questionnaire provide an estimate of current population. Questions 12 (use of property) and 13 (number of occupants) were utilized to estimate population.

**Table 4.3 Estimated population**

Full-time residents	1027
Part-time residents	462
Total potential residents	1489

Assumptions made in utilizing this data include: 1) The sample is representative of the population. 2) Full-time residents include those who responded "residence" on use of their property (remaining categories were considered part-time residents).

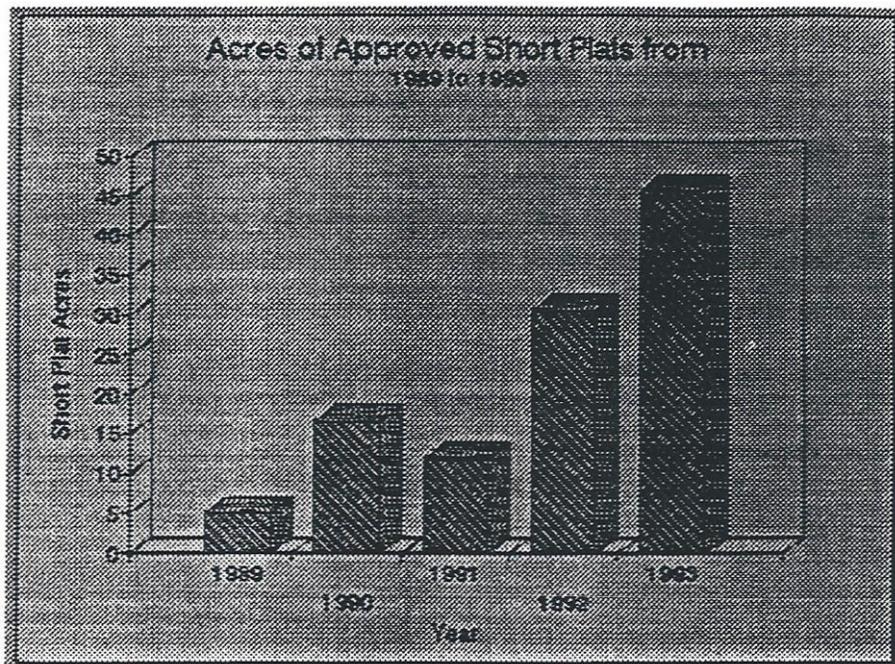
Washington State University's 1974 project estimated population of the lakes perimeter at 550. Washington State University's 1988 project estimated population of the lakes perimeter at 600, an increase of 50 from the 1974 study.

A 1966 multi agency study was conducted to identify land treatment measures and

structural (spillway) measures to alleviate flood problems. This study provided a population estimate of 930 people in the entire watershed.

Cowlitz County provided approved short plat information for 1988 - 1993. This information is illustrated in figure 4.8.

**Figure 4.7**



This information provides an indication of the relative growth rate of the community and trend for the future.

## Summary

Although Cowlitz County's inventory of septic systems indicated no visual problems observed in the field, both of Washington State Universities studies indicate that septic systems are a major water quality concern in the watershed. A portion of the septic system problem has been corrected by connecting the Streeters area to the Toutle sewage treatment facility. However, questionnaire indicators of the current level of awareness and management of septic systems and rate of development suggest that septic systems are still a major concern. The Gibbs and Olson (1983) study of the Toutle sewage treatment facility indicates that the present system was capable of expansion but maintenance of the aging collection system is critical to protect the water quality of Silver Lake. An additional study is recommended prior to expanding the system due to the timeframe since the last review.

## **Recommended Alternatives**

- 1) Conduct an analysis/feasibility study of the existing treatment plant directed at future expansion to service residential areas from Hall Road to Carnine Road. The study should include analysis of the existing collection system.
- 2) Expand the sewer system to service residences from Hall Road to Carnine Road. Expansion should consider determining public acceptance, installation costs, and concerns for additional burden of expense on residences currently being serviced by the system. Explore additional funding sources for expanding the sewer system.
- 3) Develop a community education and information program that addresses concerns for:
  - o Awareness of the Silver Lake Watershed Management Plan
  - o Participation in implementing the Watershed Plan
  - o Sound septic system management
  - o Lawn and garden maintenance
  - o Informational fact sheet concerning phosphorus in the environment
  - o The Growth Management Act
  - o Awareness of existing codes/regulations
- 4) Obtain baseline data for current soil nutrients levels and fertilizer needs for residential areas.
  - o Encourage local vendors to stock a "Silver Lake" low phosphorus fertilizer mix for lawns and gardens.
  - o Provide technical information to local fertilizer vendors so they can make proper recommendations.
- 5) Develop a community committee to work with Cowlitz County during the development of ordinances under the Growth Management Act to help address water quality concerns.
- 6) Encourage pesticides recovery program in the Silver Lake area for urban and rural landowners.
  - o Develop and share information on available collection dates and locations

# CHAPTER 5

## AGRICULTURAL INVENTORY

The inventory procedure included a visit to each field in each sub watershed to gather data on the operation through interview with the owner if available, take certain field measurements and compile the data. Along with field sampling, estimates of data and field estimates were compiled into a spreadsheet and used to develop the narrative. Of the 612 acres identified from remote sensing of aerial photography and topographic maps, 477 acres were identified in the field as actually having agricultural values. To put perceptions of the extent of land used for agriculture in perspective, the total agricultural land use is less than 2 % of the watershed. Appendix 13 provides the inventory format - data input form.

### Statistics for silver lake agricultural land use

#### Terms

- Landscape Unmanaged = usually old fields, no longer farmed but with potential for agricultural use
- Landscape Managed = same however the area is mowed, clipped or maintained for landscaping
- GC = good condition, FC = fair condition, PC = Poor condition

This is the condition of the forage resource from the standpoint of watershed values. For example: Stands composed of deep rooting perennial grasses and legumes with a stubble height of 6 inches or more going into the winter season when runoff is likely to occur will be rated as good. In this watershed, hydrologic condition equates to forage value for grazing livestock. Stands rated as PC are composed of shallow rooting, usually sod forming species and due to the grazing pressure are less than 1 inch stubble height at the onset of the runoff season.

#### Kind of operations and extent

**Table 5.1 Approximate acres of agricultural land**

SUB WATERSHED	Hay	Pasture	Used for Both	Landscape Unmanaged	Landscape Managed	TOTAL
B3 Hemlock Cr.	88	73	(70)			161
B2 Outlet Area	24			3		27
B 1 North side	35	48	(45)	8	9	100
B5 Carmine Area	80	67	(110)	18		165
SU 1 Headquarter!		18	(10)	6		24

TOTAL	227	206	(235)	35	9	477
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Approximately 47 landowner have parcels with potential for agricultural production on some scale. Agricultural operations range in size from 1 acre pastures to nearly 100 acres of hay and pasture.

**Table 5.2 Average size of total farm holdings dedicated to agricultural purposes**

Subwatershed	Acres	Average Size (acres)	Kind of Livestock	Animal Units
B3	161	53	CATTLE	88
			HORSES	15
B2	27	5	NONE	
B1	100	10	CATTLE	50
			HORSES	12
B5	165	10	CATTLE	40
			HORSES	10
SU1	24	8	CATTLE	5
TOTAL	477	10		220

Less than 5 operations annually sell livestock or livestock products. Less than ten operations sell hay of a commercial quality annually.

#### Inventory Conditions

**Table 5.3 Pasture and hayland condition**

SUB WATERSHED	HAY			PASTURE			TOTAL
	GC	FC	PC	GC	FC	PC	
B3	88				3	68	161
B2		24				3	27
B1	18	19			48	15	100
B5	80	18			37	30	165
SUI					18	6	24
TOTAL	186	61			106	122	477

Throughout the field inventory, special emphasis was given to detection of soil movement as a consequence of agricultural activities. No sheet and rill erosion was identified. This is due to the fact that none of the agricultural land has been tilled for a long time and the ground cover is mostly long lived grass and broad leaf forbs. The predominate species on most lands with potential for agricultural production are species that tend to tiller from the growing points to form a durable sod that is resistant to erosive forces. However, unless careful management practices that reduce erosion are implemented, upland fields with slopes exceeding 3% and/or uninterrupted slope lengths exceeding 100 feet will likely erode during periods of high rainfall if the soil surface is bare. Management practices are available to landowners to minimize or eliminate that risk. Erosion is occurring along 30% of the streambanks of riparian areas in the agricultural setting. Much of this riparian erosion is triggered by disturbance of protecting vegetation by livestock or wildlife or equipment trailing down the streambank. Once the vegetation is disturbed, stream energy has the opportunity to displace exposed soil particles thereby causing erosion.

Wildlife habitat values are highly variable throughout the agricultural areas. Generally, agricultural fields that are adjacent to forested areas and wetlands, provide habitat for a wide variety of species because of the habitat edge that provides easy access and escape from feeding opportunities provided by the fields. Habitat in areas where field boundaries are contiguous with other similar fields or urban influences offer more opportunity for habitat improvement. (ie. fence row plantings of cover and food species, control of feral or predatory domestic animal, etc.) Habitat availability can result in a negative impact to agricultural interest. Without coordination of wildlife management with agricultural resources, significant damage to agricultural crops by wildlife can occur. For example: Wild geese tend to concentrate in large numbers on new seedlings and either reduce crop production by consuming plants, or pull and trample seedlings. Elk and deer consume forage yearlong resulting in reduced farm crop yield, damage to plants by grazing when they are low in vigor due to winter conditions and trampling when soils are saturated which can damage plant growing points and dislodge soil particles into water runoff. Various rodents consume significant amounts of forage and damage low vigor forage plants due to the timing of their use.

There are no known endangered or threatened wildlife species that inhabit the agricultural lands, however migratory peregrine falcon, aluetiona geese, and bald eagle may make incidental use throughout the geographic area.

It was anticipated that soil compaction would be a problem that accompanied livestock access during the period when soils were saturated. A layer of two to three inches of compacted soil at a depth of 3- 4 inches below the surface was found only in places such as trails or "feeding grounds" where cattle were forced to concentrate. However, one hayfield was compacted in a two inch layer at a depth of 8 inches. This was most likely due to tillage with a moldboard plow when the soil was too wet.

No landowners interviewed indicated regular applications of plant nutrients nor did they

use a soils nutrient analysis to determine fertilization needed to be part of their management. Occasionally, pesticides are applied as a spot treatment to control noxious weeds. Specific targets include Tansy Ragwort (Senecio jacobaea) and Canada Thistle (Cirsium arvense). Broadcast application of restricted use pesticides currently is rare. However, pesticides including such products as glyphosate (ie. Roundup) may be used occasionally as part of seedbed preparation in lieu of tillage.

Since most hay and pasture stands are in excess of 15 years of age, this has been occurring only occasionally.

Livestock watering sources are strictly a matter of convenience rather than animal health or water quality. Where wetlands or drainage ditches or streams are adjacent to pasture fields, generally they are open to direct livestock access. An estimated 10% of the livestock in the watershed are watered exclusively by domestic sources and that is usually because no naturally occurring surface source is accessible.

## Inventory of Management Systems

Currently, most livestock owners continuously graze pastures all season long and feed supplemental forage on the field in times of forage shortfall. If the pasture area is also used for hay, the livestock are in many instances held on a "sacrifice" pasture area until after hay harvest or pushed into adjacent woodland areas for forage. Similar use is made of some "sacrifice" pastures in the winter on some farms where seasonal feeding occurs.

Typically, pastures are fenced with conventional barbed 4 wire fencing around the perimeter of the property. Adequate cross fencing is typically a temporary electric fence wire. Interview with some operators indicated attempts to rotate pastures to facilitate haying early in the season. Although many livestock owners calve year long, some of the larger operations strive to either fall calve (rarely) or spring calve commonly. Although some operators provide supplemental feed in a centralized feeding area, usually a barn, most livestock have free access to pasture fields throughout the feeding season. There are no true confinement operations. Animal waste is generally distributed naturally by livestock rather than stored as in a confinement operation for application when plants more readily utilize nutrients.

## Recommended Alternatives

- 1) Encourage the use of alternative livestock water sources including pipelines and troughs and rocked/controlled stream access. (Recognize that this practice is site specific and may not work everywhere.)

2) Encourage use and application of pesticides and nutrients, WHEN USED\*, according to plant needs and label instructions. \*NOT INTENDED TO ENCOURAGE THE USE OF PESTICIDES AND FERTILIZERS.

3) Encourage the implementation of pasture management systems optimizing hydrologic values while meeting landowner objectives. Including but not limited to:

- Re-seeding, rotation grazing, deferred grazing, winter confinement, nutrient management...
- Maintain or upgrade existing facilities or management tools (ie. fencing, water facilities)
- Encourage management for optimum pounds of livestock rather than numbers.
- Improve hay and pasture conditions on all fields to a "GC" good condition
- Encourage improved pasture maintenance
- EXPLORE new technology that may decrease the cost of improving agricultural conditions.

4) Manage water table on low-lying pastures (eg, manipulate lake level as tool for vegetation management)

5) Implement streambank protection including bio-engineered, revegetation, and rip rap projects to minimize/reduce erosion problems associated with agricultural landuse.

In order to encourage landowners to consider new management strategies, information and education regarding the benefits to not only the producer but the other natural resources will need to be emphasized. For example: Replacing shallow rooted, short season, low producing pasture species with deep rooted, later maturing, high producing species; will not only increase production but also save nutrient cost, reduce watering needs, save costs of purchasing supplemental feed and reduce runoff/sediment movement into the Lake. There is no reason for good resource management to be a burden on the landowner... financially or from the standpoint of property rights.

# CHAPTER 6

## FOREST LAND INVENTORIES

### Age Classes

Industrial and non - industrial forest land comprises a conservative estimate of 76% of the watershed. Several inventories were conducted on forest lands including identification of age classes, non- industrial surveys, and harvest area inventories. Forest age classes were interpreted from 1990 aerial photography and verified in the field during road and stream inventories. The age class stratification utilized is as follows;

- H - Recent harvest, 0 years of age
- A - Stands 1 - 5 years of age
- B - Stands 6 - 10 years of age
- C - Stands 11 - 20 years of age
- D - Stands greater than 21 years of age

Since photography available was 3 years old, all recent harvest and young stands were identified during other inventory activities and mapped in the field. Table 6.1 provides a summation of the forest land age classes within the watershed.

**Table 6.1 Forestland age classes**

Age Class	Percent of Forestland (19632 acres)
H - Recent Harvest	11.5
A - 1-5 years	14.5
B - 6-10 years	11.0
C - 11-20 years	17.0
D - 21 + years	46.0

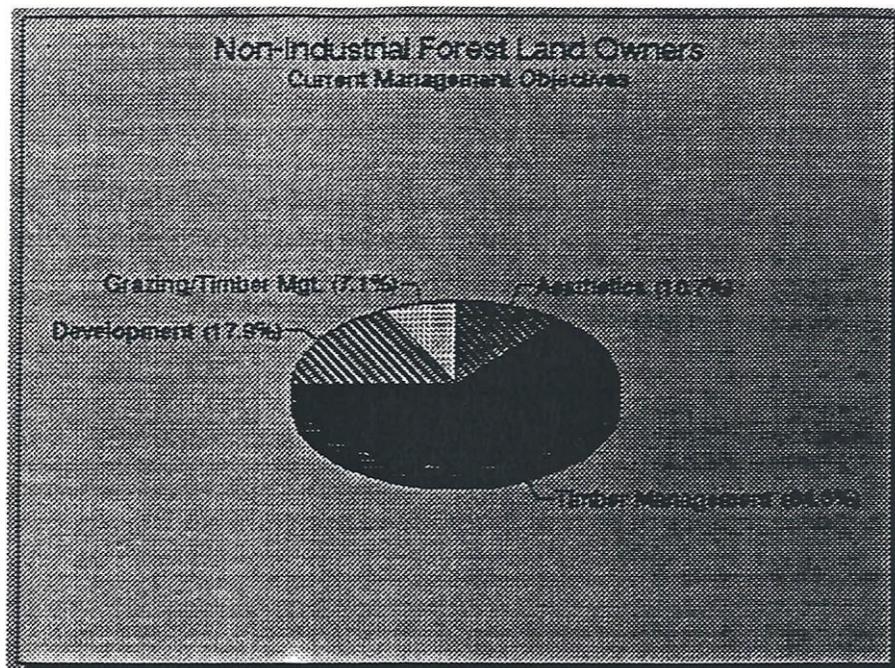
### **Non-Industrial Forestland Questionnaire**

Fifty-eight non-industrial forest land owners were identified in the watershed from County tax lot maps and aerial photography. Property was classified as non-industrial forest land based on acreage and the presence of a residence. Ownerships greater than 10 acres and ownerships less than ten acres without the presence of a residential dwelling were considered to be non-industrial forest land ownerships. Non-industrial forest land surveys were

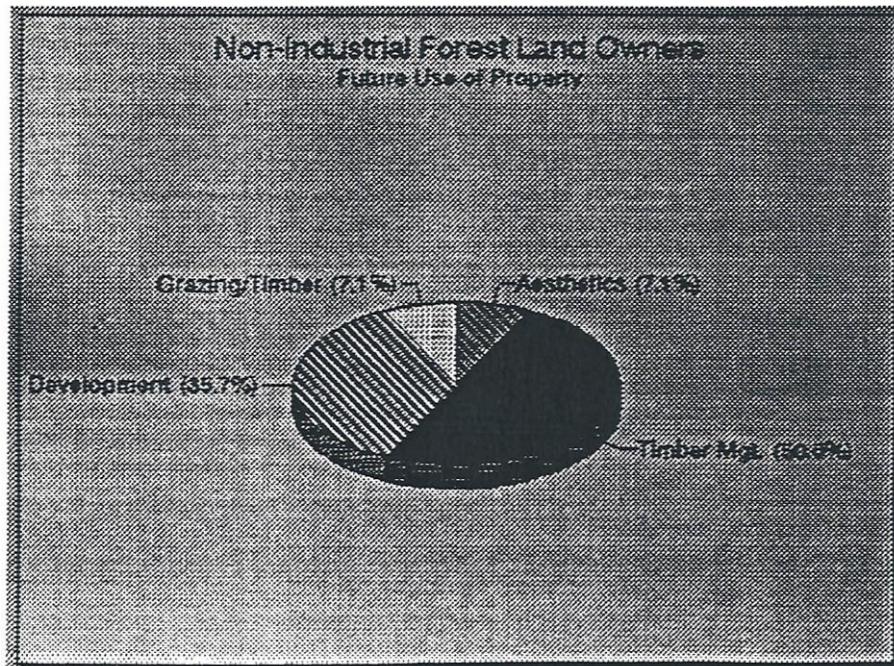
conducted in the field and by telephone to obtain information regarding the current management, future use, and intensity of management. These surveys also allowed for stand age class updates, identification of road segments that could not be identified from aerial photography, and identification of recent harvest areas.

Twenty-eight owners (48 %) were surveyed. Acreage ranged from 7 acres to 360 acres with an average holding of 45 acres. Figures 6.1 and 6.2 provide the current management objectives and future property use respectively for those surveyed.

**Figure 6.1 Current management objectives**



**Figure 6.2 Future property use**



The current management objectives indicates that 18% of the non-industrial forest land (NIF) owners are developing their property. The acreage size associated with this development ranges from 14 to 25 acres with an average of 19 acres. Most of the consideration for development is concentrated on the smaller tracts. This may be an indicator that a number of the tracts classified as rural residential (< 10 acres with residential dwelling) may be being considered for development too. Two NIF owners surveyed indicated that their objective included managing for both livestock and timber. Six owners indicated that they are currently grazing their woodlands.

The future property use (figure 6.2) indicates that 36% of the NIP owners are contemplating development at this time as an option. Most of the shift is from current management objectives of timber management. The acreage size associated with future development ranges from 15 to 154 acres with an average of 58 acres.

Those surveyed were asked what management activities they have conducted on their properties to obtain an idea of the activity levels of the NIP owners. Figure 6.3 provides an indication of the activities that non-industrial woodland owners have implemented.

Figure 6.3 Activities implemented by non-industrial woodland owners

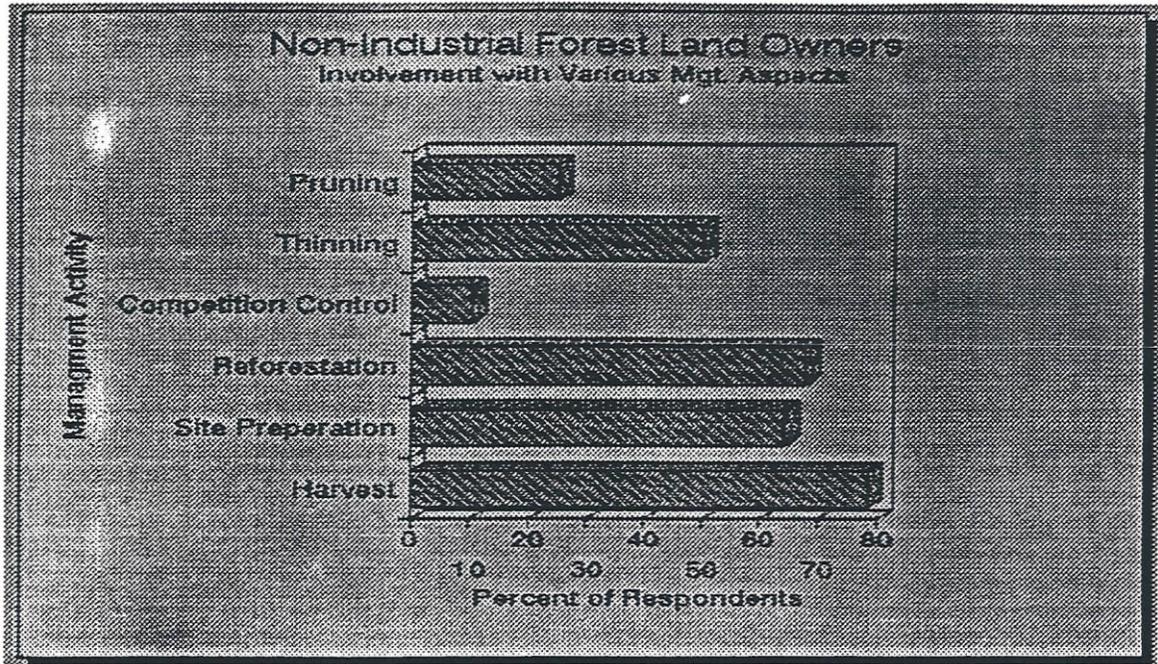
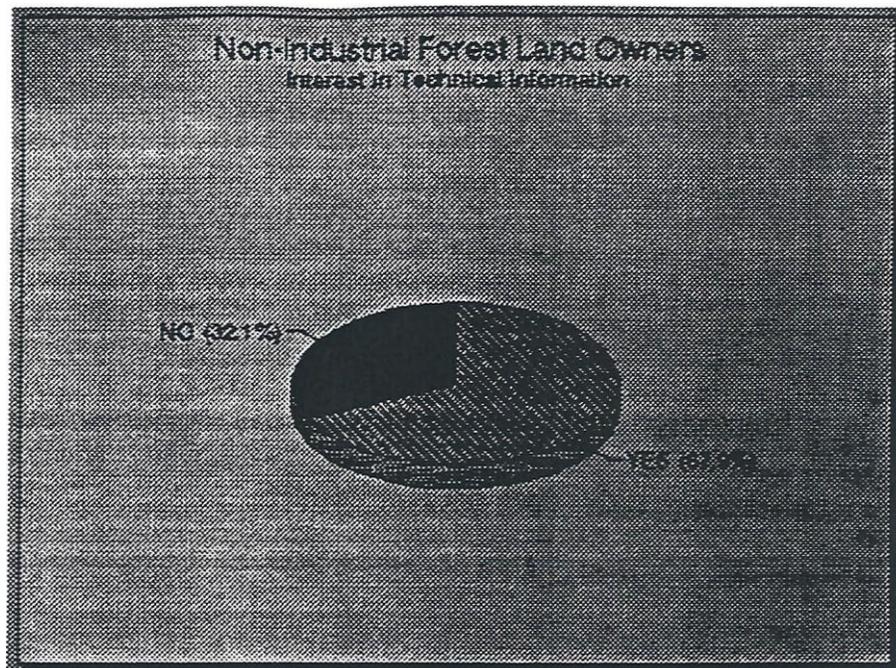


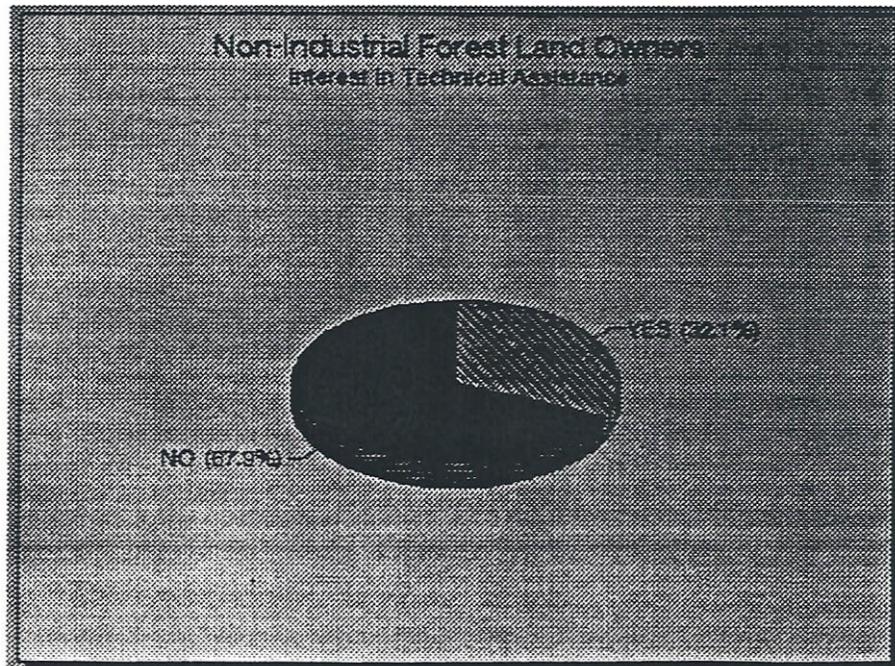
Figure 6.3 indicates that a majority of the NIF owners are actively managing their property. The only concern is with the lack of competition control, however the inventory did not allow for the assessment of whether this practice was needed on the sites.

To assist with the development of the management plan recommendations, NIF owners were asked if they were interested in receiving technical information regarding the management of timber resources and what programs are available for technical assistance. They were also asked if they were interested in on-the-ground technical assistance. Figures 6.4 and 6.5 illustrate their response.

**Figure 6.4 Interest in receiving technical information regarding forest management**



**Figure 6.5 Interest in on-the-ground technical assistance**



A majority of the respondents (68 %) were interested in receiving information regarding the management of timber resources and listing of available technical and financial assistance. However, a majority of the respondents (68 %) were not interested in on-the-ground technical assistance, at least at this time.

## **Harvest Area Inventory**

### **Nature Of Harvest Problems**

Soil erosion is the process by which soil is detached, transported, and deposited by water, wind, gravity, ice, and man's activities. For eroded soil to become a problem for streams, the transport mechanisms must deliver the soil to the stream. Erosion is also a concern for soil productivity. Erosion hazard describes erosion potential by area and landuse; it reflects the combined effects of erodibility and erosivity. Erodibility refers to the characteristics that govern the susceptibility of the material subject to erosion. Erosivity refers to the characteristics of the erosion agent (water). Falling rain is more erosive than water moving over the surface of the soil (Hewlett, 1982).

As indicated in chapter 3, erodibility of soils generally increases with the increasing silt content. Physiographic features, including slope and slope length, directly influence the erodibility of soils and the erosivity of rainfall. The local climate provides the mechanism by which soils erode. Rainfall characteristics, primarily rainfall intensity and duration at lower elevations, govern the erosion processes on disturbed soils. These factors primarily influence the amount and velocity of surface runoff.

Undisturbed forest soils are protected from rain drop impact by overlying vegetation and a thick layer of organic matter. Hewlett (1982) indicates that approximately 1 metric ton of

organic debris per hectare will absorb 98 % of rainfall energy. Forest floors usually vary from 1 to 5 metric tons per hectare. Infiltration rates are generally far in excess of usual rainfall intensities (Rothacher, 1967). Under these circumstances, surface runoff and subsequent erosion will rarely occur.

Disturbed forest soils are subjected to erosion through various processes. The cause of which generally centers around the alteration of the hydrologic processes. Exposure of mineral soil to raindrop impact has a high potential for eroding. Unprotected soil particles are detached by raindrop splash and the structure of the surface soil can be altered. Fine particles moved by raindrops can seal the larger pores in the soil reducing infiltration rates. Under these circumstances, rainfall which once entered and travelled through the soil may become surface runoff.

Mechanical compaction of surface soils by machinery or animals can reduce infiltration rates resulting in increased surface runoff. Yarding and site preparation activities remove vegetative cover, disrupt the organic layer, and can compact the soil surface. These combined factors can create high erosion rates in localized areas. A tractor skidtrail is the classic example. Infiltration rates have been shown to decrease dramatically with the number of passes on a skidtrail. According to Brown (1985), infiltration rates on skidtrails eight years old were found to be similar to rates on one year old skidtrail. Compaction problems can persist for several years. Invasion of vegetative cover on a compacted skidtrail generally lags behind the establishment of vegetative cover on uncompacted soils. Without proper drainage and protective cover, skidtrails can concentrate water and erosion results.

Brown (1985) cites several studies which indicates that the felling of trees usually does not affect the delivery of sediment to the stream. However, it is the yarding of trees which often causes soil disturbance and erosion. Carefully planned and executed yarding practices, particularly with cable systems, do not increase sediment delivery to streams. However, ground-based yarding has the potential to disturb large areas of soil resulting significant erosion unless skidtrails are well planned. A well planned, designed, and executed network of skidtrails and proper drainage features can reduce the delivery of sediment to the stream to near pre-harvest levels.

Swanson (et al., 1987) identified the key factors controlling the deliver of sediment to streams. These factors are as follows; 1) the intensity of disturbance, 2) the aerial extent of disturbance, 3) the proximity of the disturbance to the stream system, and 4) the storm events experienced during the periods when the site is most sensitive to erosion. Hewlett (1982) and Brown (1985) indicate that the lack of uniform slopes, invading vegetation, and residual woody debris from harvest activities limit the extent of surface runoff, and therefore erosion and sedimentation. Hewlett (1982) suggests that 90% of the sediment delivered to streams originates from roads and poor channel zone practices. The proximity of the disturbance to the stream system is perhaps the most important factor controlling the delivery of sediment to streams. Additionally, as land managers, it is a factor that can be

controlled.

## Inventory Information

Initially, harvest area inventories were planned to be conducted on recently harvested areas and stands 1-5 years of age. Shortly into the harvest area inventories it was realized that inventorying stands in the 1-5 year age class is nearly impossible. The rapid invasion and growth of vegetation make it difficult at best to observe erosion processes except on highly disturbed sites. Remaining inventories were conducted on recently harvested areas.

The non-industrial forest land surveys identified 9 harvest areas to be inventoried. Twenty-six recent harvest areas were identified on industrial ground. Harvest area inventories consisted of ocular observation to identify sources of erosion and more importantly the delivery of eroded soil to the stream system. Although a hillslope may show evidence of erosion broken terrain (slope breaks), remnant woody debris, and emerging vegetation results in deposition and storage of eroded soil on the hillslope. Therefore, efforts were concentrated on those areas with the highest probability of sediment delivery to the stream.

## Industrial Ownerships

All of the harvest sites inventoried on industrial property were yarded with cable systems, shovel logged or a combination of both. Piling and burning of slash was the primary method of site preparation and was conducted on slopes less than thirty percent. Although erosion evidence was observed in various areas of the harvest unit, a majority of the sediment generated was intercepted by slash, vegetation, or a break in slope and was not found to be delivered to the stream systems. Buffer strips along type 1-3 water were found to be functioning effectively at preventing the delivery of sediment to the stream. Of greatest concern is the slopes adjacent to the type 4, 5, and ephemeral draws. These drainages provide a break in slope that can result in gouging and increased compaction of the soil during yarding. Mechanical breakdown by yarded logs as they are removed from streamside areas may also destabilize banks and expose them to erosive forces of the stream. Invasion of vegetation occurs rapidly in the Silver Lake area, however yarding corridors experiencing extensive soil disturbance are slow to revegetate. On type 4 and 5 streams, the use of mechanical equipment during site preparation activities was avoided. Some disturbance was observed along the smaller ephemeral draws.

## Non-Industrial Ownerships

Eight of the sites on non-industrial ground were clear-cut and one was thinned. Site slope ranged from 0-30%. One site was adjacent to a type 1 and type 3 stream. Four sites impacted ephemeral draws and three sites had no impact on streams. The type 1, 3, and one ephemeral draw (type 5) received a buffer strip. The type 1 stream was buffered by pasture.

The type 3 received a fifty foot timbered buffer, and the ephemeral draw received a fifteen foot buffer. On all the sites in which a buffer strip was maintained, little/no erosion evidence was observed along these streams attesting the importance of proximity of disturbance to streams. All of the sites were yarded with ground-based systems. Piling, and piling and burning, were the primary forms of site preparation. As would be expected with ground-based operations, site disturbance was greater than that associated with cable and shovel logging systems. Several situations occurred where skidtrails crossed type 3 and smaller streams. As with the industrial inventories, erosion evidence was found throughout the harvest site, but eroded material was deposited within a short distance by slope breaks, surface roughness features, vegetation, and residual slash. Primary skidtrails and areas adjacent to streams including type 4, 5, and ephemeral draws are the primary concern. In most cases delivery of sediment to streams was associated with the skidtrail network particularly where type 5 streams were crossed. Most erosion was confined to the primary skidtrails (those receiving multiple passes by yarding equipment). Additional problems were identified with streambanks and hillslopes into streams and ephemeral draws that had soils or banks disturbed by yarding activities. None of the sites utilized mitigative measures such as a critical area planting or installation of cross drains (waterbars) on skidtrails.

## **Recommended Alternatives**

- 1) Whenever possible, utilize cable yarding systems, one pass shovel logging, or designated skidtrails to minimize soil disturbance. By laying out skidtrails in advance and tailoring timber felling to the layout, the area of soil disturbed can be greatly reduced.
- 2) Avoid using ground-based equipment for harvesting during wet periods. The potential for soil compaction and displacement increases with increases in soil moisture. Operations should be suspended or mitigating practices used when soil displacement and compaction becomes evident (for example when rutting exceeds 4 inch depth). Techniques to reduce soil impacts such as encouraging slash accumulations on skidtrails should be considered. For example; layers of slash can aid in supporting equipment, reduce the ground pressure exerted by machinery, and help reduce soil displacement.
- 3) Avoid soil disturbing activities in riparian zones of type 4, 5, and ephemeral draws. Design and plan harvest units to facilitate yarding material away from these channels instead of across. When crossing is unavoidable, strive for full suspension to minimize streambank disturbances or minimizing the number of crossing locations for ground-based equipment. Conduct restoration measures where soil disturbance is unavoidable. Techniques including directional felling, whole tree yarding, and establishment of equipment activity "use zones" outside riparian zones should be considered during planning stages.
- 4) Encourage the awareness and use of available technical and financial assistance for planning and implementing harvest activities. Encourage local agencies to use cost share incentives for landowners to use these practices.

5) Ground cover plantings should be used on all disturbed soil areas that have the potential of eroding and being delivered to the stream system. Establish protective cover prior to the first winter.

6) Install waterbars on skidroads or corridors that do not have natural breaks to reduce delivery of water and sediment directly to the stream.

7) Develop and distribute a current listing of available technical and financial assistance to non- industrial woodland owners.

8) Develop and distribute to non-industrial woodland owners information concerning management opportunities and techniques for improving management of natural resources.

# CHAPTER 7

## ROAD INVENTORY

Inventory of road systems within the watershed was conducted during the summer of 1992. The primary purpose was to study existing conditions and identify problems as well as opportunities for improvements. Road and culvert inventory forms were developed to assist in standardizing the way in which data was collected (Appendix 14). Roads were inventoried by segments. A road segment is defined as the length of road which drains to a common point. Eight hundred fifty-two road segments were identified in the watershed.

The inventory consisted of three parts. Part one consisted of collecting data related to various components of the road including the running surface, cut and fill slopes, and ditch. The second part concentrated on components of culvert installations including the type of culvert, fill material condition, culvert inlet and outlet conditions, and the condition of the area receiving the culverts discharge. The third part consisted of inventorying mass failures.

Roads were identified through the use of Weyerhaeuser Company road maps, USGS topographic maps, and 1990 aerial photographs. Unmapped roads identified during the inventory were mapped on USGS topographic maps. Road segments and culvert installations were identified in the field and plotted on the topographic maps (Appendix 15). Information collected consisted primarily of ocular estimates of conditions. Road slopes were measured with a clinometer and road lengths were measured from Weyerhaeuser Company road maps and USGS topographic maps.

### **Road Characterization**

The road system within the Silver Lake Watershed is 146.5 miles in length. All accessible roads were inventoried to identify problems associated with the delivery of water and soil to the stream system. To obtain the necessary inventory information from inaccessible areas, permission and keys were provided by landowners. It is anticipated that this inventory encompassed 95% of the roads in the watershed.

Access is controlled on 28.5 miles (19.4%) of road. Control is accomplished by 6-gates (4 industrial, 2 non-industrial), 4-tank traps, and by woody vegetation re-establishing on non-maintained roads. Additional gates are currently being installed. The industrial roads are identified on hunter's maps and are generally open to we public during the fall hunting season.

In order to quantify data on different types of roads, roads were identified as paved, main

haul, spur, unimproved, 4 wheel drive, or impassible in order to quantify the different types of roads. Paved roads include a State highway and county roads. Forest access roads were delineated as main haul or spur predominantly by size (width) and by the landowners numbering system. In general, "hundred" roads (1300, 1600, ... ) were considered main haul. An unimproved status was assigned to roads without surfacing yet still passable. Four-wheel-drive status was assigned to those roads that were not negotiable with a two-wheel-drive pickup. The length and average width of roads by status is provided in table 7.1.

**Table 7.1 Road length and average width by type of road**

ROAD TYPE	LENGTH (miles)	AVERAGE WIDTH (feet)
Paved	21.2	25
Main Haul	14.1	27
Spur	107.2	15
Unimproved	3.9	11
4-Wheel-Drive	0.1	08

Road slope ranges from 0 % to 14 % with an average road slope of 4 %.

An important component of the road inventory process was to identify road segments which deliver soil and water directly to the watershed's drainage system. These road segments are called contributing segments. Contributing roads have the potential to deliver soil and water directly into the stream system. The Washington Forest Practices Board (1993) classifies type 5 streams as, "all natural waters not classified as Type 1, 2, 3, or 4; including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks and drainageways having short periods of spring or storm runoff. "

Although not intended to include roads, this definition describes road behavior. Roads can greatly increase the length of the stream system during rainfall-runoff events. Increasing the length of the stream system increases the drainage density of the watershed. Drainage density is an indicator of how a watershed will respond to a storm event. Watersheds with a high drainage density tend to yield runoff faster and at a higher magnitude than the same watershed area with a low drainage density.

Of the 146.5 miles of road within the watershed, 74.3 (50.6%) contribute to the drainage system. Table 7.2 illustrates the miles of contributing road segments within the watershed according to the type of drainage (DNR stream types) impacted. Untyped streams are streams identified on USGS 7.5 minute topographic maps that have not been typed by DNR. Ephemeral refers to streams that flow water intermittently. According to the DNR's forest practices regulations, both categories are considered type 5 streams. An additional category titled "wetlands" was added to identify road segments contributing runoff directly to wetlands.

**Table 7.2 Length of road contributing runoff to surface waters**

DRAINAGE TYPE	LENGTH OF CONTRIBUTING ROAD (miles)	Percent of Total
1	5.3	7.1
2	0.0	0.0
3	4.5	6.0
4	14.6	19.7
5	4.9	6.6
Untyped	3.7	5.0
Ephemeral	41.1	55.3
Wetlands	0.2	0.3
Total	74.3	100.0

Table 7.2 indicates that roads have caused the stream system to be lengthened up to 74.3 miles. There are 80 miles of typed (DNR stream types) streams in the watershed (DNR type maps do not include ephemeral draws which may easily account for more than 80 additional miles of stream). The addition of 74.3 miles of road results in an 193 % increase over DNR typed stream length. A majority of the road impacts (86.6%) occur in the smaller streams (type 4, 5, Untyped, and Ephemeral) of the upper watershed. Potential impacts to the stream system is analyzed with the stream survey information.

## **Nature of Road Problems**

### **Introduction**

In numerous studies road building and road maintenance activities have been identified as a primary source of sediment. (EPA, 1991). Water can erode the road surface, cut banks, fill slopes, and ditches. Beschta (1978) showed a major increase in sediment yield following road construction activities. This increased yield rapidly declined as roads stabilized. Reid (1981) examined erosion sources from gravel surfaced roads for a variety of road types and levels of use. On heavy use roads, surfaces were identified as the primary sediment source while only 0.4% of the sediment yield originated from the cut slope. On abandoned roads 55% of the sediment yield was generated from the cut slope. By paving a road, the sediment yield was shown to reduce by a factor of 236 and cutslope and ditch erosion processes become dominant. Reid (1984) showed that heavily used roads contribute 130 times as much sediment as an abandoned road. Burroughs and King (1989) suggest that of the sediment produced on forested roads 60% originates from the fill slope, 25% originates from the travelled surface, and 15% originates from the cutslope and ditch. These figures represent sediment produced, but not the sediment delivered to the stream system. Fill slope sediment production is less significant compared to the travelled surface, cut slope, and ditch produced sediment when it comes to sediment delivery. Cut slopes and portions of the travelled surface deliver the sediment produced directly to the ditch. Ditches in turn, deliver the sediment entering them directly to a culvert, often at a stream crossing.

Roads can alter the hydrology of a hillslope. The result may be increased or reduced delivery

of storm runoff to the drainage system and increased incidence of mass failures. Roads can increase the delivery of storm runoff to the drainage system by intercepting surface and subsurface runoff from upslope areas and by added runoff from the road surface. Roads can reduce storm runoff to a drainage by intercepting water that once was delivered by natural hillslope process and delivering it to a neighboring drainage. Numerous studies indicate watersheds susceptible to mass failures are very sensitive to road building. In the Silver Lake watershed mass failures are not a concern. Only 2 mass failures were observed in the Silver Lake watershed. Both failures were small and associated with stream banks.

The remainder of this document provides an indication of problems encountered with the road system. Inventory information has been included in the appendices identifying problem segments.

## Road Surface Erosion

Road information collected includes the length, slope, amount of surfacing present, type of surfacing material, condition of the road prism, and type of erosion evidence (Appendix 16). The amount of surfacing present was categorized by depth of the material. A 6 inch lift of 4 inch-minus pit run rock was observed as the standard for most of the roads in the watershed. The categories utilized in the inventory refers to the depth of surfacing material that has not been displaced or driven *into* the road grade. A "trace" category was used for roads in which a measurable depth was not apparent. Trace amounts indicates that the surfacing material was observed but traffic had either displaced or driven the rock into the road so that fine particles were dominant. Surfacing material was predominantly 4 inch-minus pit run rock. Road prisms which have been rutted by vehicle traffic were found to be the most important prism category for visual evidence of sediment movement. Surface erosion indicators include four groups: 1) Surface (sheet) Erosion - usually evident by accumulation of sediment in low points of the road 2) Storage - the storage of sediment behind an obstruction on the road surface, 3) Rills - the scouring of channel in the road surface up to 1 inch wide by 1 inch deep, and 4) Gullies - indicated by scouring greater than 1 inch wide by 1 inch deep in the road surface.

The predominant factors controlling erosion of a road surface include length, slope, surface roughness, rainfall intensity, and rainfall duration. As one of these factors increases (with the exception of surface roughness), the opportunity for erosion will too. An increase in surface roughness generally results in a decreased opportunity for erosion because rainfall impact and velocity of the runoff is reduced. Comparing erosion evidence with surface roughness (includes the presence and depth of 4 inch-minus pit run rock), average road length, and average road slope information reflects these relationships. Table 7.3 illustrates the relationships (paved roads were omitted because there is no visual erosion evidence).

**Table 7.3 Comparison of road surface erosion and average road length and slope**

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SURFACING Presence/Depth of 4"- minus pit run rock	EROSION EVIDENCE	AVERAGE LENGTH (feet)	AVERAGE SLOPE (percent)
None	None	638	3.0
None	Surface	300	5.0
None	Gully	1150	4.0
Trace	None	884	4.0
Trace	Surface	934	3.7
Trace	Storage	1330	3.7
Trace	Rill	3636	2.6
Trace	Gully	1271	5.7
0-2" depth	None	694	4.2
0-2" depth	Surface	744	3.0
0-2" deeth	Storage	1809	3.0
3-6" depth	None	1068	3.5

Table 7.3 indicates that the severity of erosion evidence is related to the length, slope, and surfacing of the road segment. Careful examination of the table reveals that the severity of erosion increases with either length, slope, or both. Additionally, length, slope, or both increases for segments with different levels of surfacing but exhibiting the same erosion evidence of erosion evidence (eg. For roads with gully erosion evidence, compare the average length and slope for roads with "no surfacing" and those with a "trace" of surfacing).

The lack of road side ditches was found to greatly influence the amount and severity of erosion evidence. Ditches allow the road surface to drain itself. Lack of ditches allows runoff to collect and concentrate on the road surface. Concentrating flows on the road surface increases the degree of runoff erosion. Only 6 percent of the roads lack ditches. However, 69% and 53 % of the roads showing rill and gully erosion respectfully, lacked ditches. These roads are predominantly unimproved (9/13 segments - 69%) and spur roads (22/608 segments - 4%)

Surface erosion indicators observed during the road inventory will be presented by type of road.

Paved roads show no signs of surface erosion.

Ninety main haul road segments were identified. All were surfaced with 4 inch-minus pit run rock (rock). A trace of the surfacing material was evident on all but one segment. Road prism were predominantly crowned. Eleven road segments (12%) exhibited signs of surface erosion. Six hundred and eight spur road segments were identified. Surfacing material ranged from none (bare soil) to 3-6 inches of 4 inch-minus pit run rock (rock). Erosion evidence was found to be related with the amount of rock and by the presence of a rutted road prism. Erosion was not observed on roads with a 3-6 inch depth of rock.

Four percent of the roads with a 0-2 inch depth of rock showed evidence of surface erosion. Twenty-two percent of the roads with trace amounts of rock exhibited erosion indicators including rills and gullies. Rutted road prisms were observed only on roads with trace amounts of surfacing material. Of these roads, 73% exhibited erosion.

Thirteen unimproved road segments were identified. Seventy percent of these roads had a bare soil surface. The remaining roads (30%) had trace amounts of rock. Eighty-nine percent of the roads with bare soil surface showed rill and gully erosion. Gullies were the major indicator of erosion on bare soil surfaces, but were also associated with a rutted road prisms and often a lack of road side ditches. On unimproved roads with a trace of rock, erosion was associated with rutted road prisms.

The relationship of road surface erosion to the level of management activity was evaluated. Assumptions were made that roads with stands less than 5 years old either above or below the road will have higher vehicle use than older stands. This assumption does not account for other roads travelled by vehicles to reach the activity area. Roads showing different types of erosion were identified for all the combinations of stand ages above and below the road. The length of road showing erosion evidence for a particular stand combination was divided by the total number of roads for the stand situation. This data was interpreted to determine the percent occurrence of erosion evidence for each stand situation. This rudimentary evaluation suggested that roads within active management areas (harvest) are vulnerable to surface or sheet erosion evidence. Storage of sediment behind obstructions, rill, and gully erosion tends to occur on roads through older stands (less management activity). Road maintenance and frequent vehicle travel may reduce the opportunity for rills and gullies to form. The predominance of surface erosion indicators in areas with high vehicle use supports the conclusions by Reid (1984) that heavily used roads generate fine sediment by the breakdown of surfacing materials and the pumping action of tires on road bed materials. As traffic activity is reduced, runoff patterns establish a channel and begin to stabilize and act more like a stream system. Litter accumulating on the road surface may block these channels resulting in the storage of sediment in micro sediment basins and the road ditches. When storage occurs, sediment contribution is merely postponed not stopped.

## Road Cut Slopes

Sloughing (dry ravel) of the road cut slopes was the predominant means of erosion observed during the inventory. Significant erosion by water was not readily observed in the watershed (ie. rills, gullies, or pedestalling of soil - an indicator of sheet erosion). Sloughing is the downward movement of soil due to the force of gravity. The result is an apron of loose sediment, generally soil aggregates, accumulating in the ditch. Sloughing can be accelerated by the removal of the sediment apron or toe of the slope. Removal of this material is common with road maintenance. Ditch flows can also erode the toe of the sediment apron relocating the material within the ditch or delivering it to a culvert. Cutbanks are also susceptible to frost action and a lowering of soil moisture during summer months which can reduce the cohesiveness of soil aggregates. Both processes can result in increased delivery of soil to a ditch. Berglund (1978) indicates that erosion by sloughing can be greater than water erosion. Vegetative cover, height of the cut bank, and the angle of the cutbank are the predominant factors influencing bank sloughing. The same factors govern the amount of erosion by water.

Rooted vegetation provides tensile strength to the soil profile and tends to bind soil aggregates into a stable mat. Roots bind soil particles increasing their resistance to erosive forces. Vegetation protects the soil surface from the impact of raindrops which can dislodge soil particles resulting in erosion. Management activities can effect the amount of vegetation. Timber harvest can remove vegetation during yarding operations. Road maintenance can offset the value of grasses by removing the toe of the slope. Burroughs and King (1989) suggest that with a vegetation density of 70%, sediment production can be reduced by 80-100%. Berglund (1978) stated that a vegetative density of 40-50% can significantly reduce erosion while a density of 70-80% will effectively control erosion. These figures were utilized with cut bank: information generated during the inventory to place road segments into poor, fair, and excellent cutslope vegetative cover categories. Inventory information for cut slopes includes cut slope height, cut slope angle, percent vegetated percent density of vegetated areas, and evidence of erosion. Figure 7.1 provides the length of road by vegetative condition.

### **Figure 7.1 Length of road by vegetative cover condition**

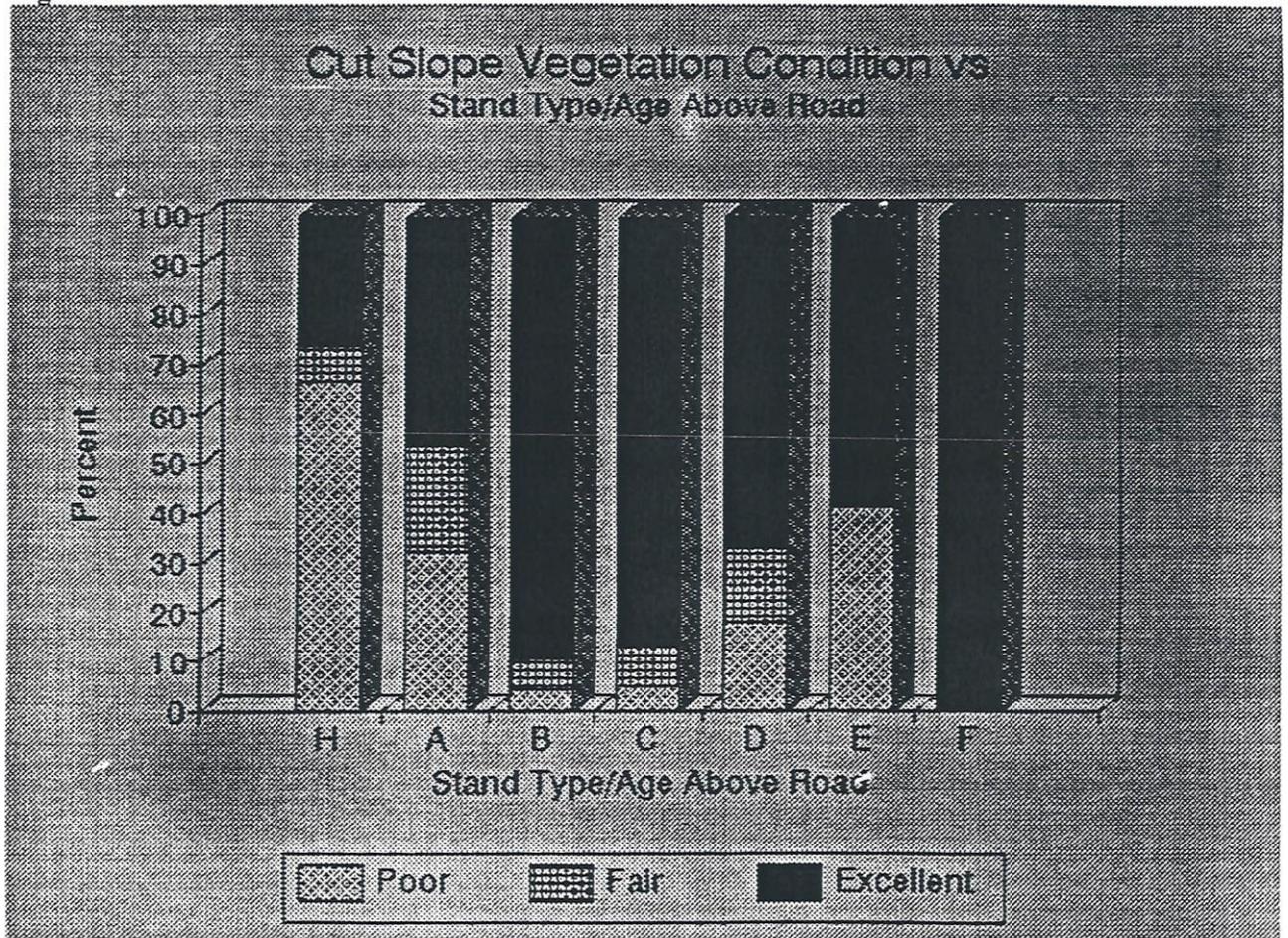
< chart available in paper version only >

Road segments in poor and fair cover categories are identified and additional data provided in appendix 17.

Burroughs (1989) suggests that broadcast seeding of grasses on slope of 75% (.75: 1) is not very successful unless the vertical height is less than 8 feet. Inventory information was collected for average height and angle of the segment's cut slope. This information identified that broadcast seeding of cut slopes would not be impaired due to slope and height on 86% of the roads with cutslopes in poor or fair condition.

Management activities can impact the amount of vegetation on road cut slopes. The predominant activity in the watershed is timber management. Harvest activities include road building, road reconstruction, road maintenance, yarding, and site preparation. While road

**Figure 7.2**



building results in bare cut slopes, the remaining activities can also reduce the amount of vegetation. Figure 7.2 depicts the amount of cut slopes by vegetative condition compared with stand age and type. Figure 7.2 represents the percent occurrence of poor, fair, and excellent condition for road reaches with a given stand type/age above them. Two stand types are identified in the table.

Timber stands and fields (F - pasture/grass). Timber stands are further delineated by age class. The age classes for timber stands are: H - current years harvest, A - 1-5 years, B - 6-10 years,

C - 11-20 years D 21- 50 years, and E - 50+ years. Figure 7.2 indicates that age of the stand is related to the amount of cut slopes in the various condition categories. For stands in the D and E age classes, poor cut slope vegetation condition is predominantly due to newly constructed roads. The F category includes those roads through agricultural land and residential settings where grass is the predominant cover. As seen in figure 7.2, these areas are characterized by well vegetated cut slopes.

## Ditch Erosion

Ditch water can be generated from several sources including surface runoff from the road surface, interception of surface flow from upslope areas, and interception of subsurface flow from upslope areas. Large volumes of water can result in erosion of the road ditch. Several factors affect ditch erosion including the stability of the soil forming the ditch, hydrologic area of the road delivering runoff to the ditch, imperviousness of the road surface, area of upslope areas delivering runoff to the ditch, slope of the ditch, rainfall intensity, and rainfall duration. Ditch erosion is indicated by down cutting or lateral cutting of the ditch. The inventory identified sediment storage in the ditch. However, stored sediment may be due to erosion on the cut slope or road surface. Road segments are identified and additional data provided in appendix 18.

Thirty-two road segments ( $32 / 793 = 4\%$ ) or 50,518 feet ( $50,518 / 774,048 = 6\%$  of total) show evidence of ditch downcutting. One main haul and 20 spur segments exhibited downcutting at the time of the inventory. However, a number of segments were identified as freshly maintained (scraped). These segments showed downcutting following winter runoff. Most of these segments had long reaches of road prior to a relief or stream crossing culvert. Ten paved roads and one unimproved road showed ditch downcutting. Although most of the downcutting appears to be on spur roads, a different relationship is evident when the length of these segments is compared with the total length of road within each road type. Table 7.4 illustrates this comparison.

**Table 7.4 Occurrence of ditch downcutting by road type**

Type of Road	# of downcutting segments	Percent of Segments	Total # of Segments	% of Total Segments
Main Haul	1	3.1	90	1.1
Spur	20	62.5	600	3.3
Unimproved	1	3.1	13	7.8
Paved	10	31.3	89	11.2

Paved roads showed the most downcutting per unit of road length. This may be attributed to their virtually impervious surface. Maintenance activities increase the potential for ditches to erode by exposing the soil and removing material that may break up the energy of ditch flows. Soils are an important factor in determining the potential for a ditch to erode. Occurrences of road problems were compared by soil type. The percentage of roads on each

soil type that exhibited erosion was determined. These percentages can be used to help identify soils susceptible to erosion. Although two percentages were higher, differences appear to be due to the presence of a paved surface or increased length or slope. Stand type and stand age above the road helped determine if the presence of downcutting is being influenced by increased runoff associated with the removal of plant cover and soil disturbance. Downcutting can be related to the stand above the road by its implication for the road to have been recently built or maintained. As for the soil assessment, stand type and age appears to be over shadowed by the importance of length and slope of the road segments. The average length and slope for roads with ditch down cutting is compared with that for all the roads in table 7.5.

**Table 7.5 Ditch downcutting by average length and slope of road segments**

ROAD TYPE	DITCHES WITH DOWN CUTTING		TOTAL ROAD LENGTHS	
	Average Slope (%)	Average Length (ft)	Average Slope (%)	Average Length (ft)
Main Haul	2.0	3616	3.0	837
Spur	6.1	1380	4.1	930
Un-improved	8.0	2000	3.8	1599
Paved	4.3	1730	3.7	1273

Both the average slope and average length of the road segments exhibiting downcutting exceed the average slope and length of total road length for the type. This indicates the importance of length and slope. It should be noted that length measurements are for the entire segment (ie. runs from both sides of the culvert). This condition may be remedied on newly built roads due to changes in the Forest Practices Rules and Regulations. A number of the paved roads with evident downcutting are located in the Streeter's area. This indicates that increased runoff from residential development is an important factor to consider. Roof runoff from homes under construction is being routed directly to the ditch system.

While storage of sediment in road ditches is an indicator that sediment is moving through the ditch, its origin is uncertain. Three hundred one ( $301 / 794 = 38\%$ ) segments showed signs of sediment storage in the ditches. Fifty-three percent of these segments contribute directly to the stream system. Sediment can originate from the road surface, cut slopes, upslope areas, natural hillslope, and the ditch itself.

Evaluation of road types indicates that the occurrence of stored sediments increases on spur roads. This may be a reflection of ditch downcutting on paved roads and maintenance/downcutting observed on mainhaul roads. These road types may generate enough flow to transport sediment out of the ditch. Cutslope vegetation condition and indicators of management activities appear to greatly influence sediment stored in the ditch. There is an inter-

relationship between cut slope vegetation and stand type/age as presented earlier.

Table 7.6 provides the number of segments exhibiting stored sediment in ditches by the vegetative condition class of cut slopes.

**Table 7.6 Stored sediment in ditches compared with cutslope vegetative condition class**

Cut Slope Vegetation. Condition	# of Road Segments with Ditch Stored Sediment	Total # of Segments by Cut Slope Veg. Condition	Occurrence Percentage for Veg. Condition Class
Poor	166	216	77
Fair	61	98	62
Excellent	74	475	16

The occurrence of sediment storage in the ditch decreases with the establishment of vegetative cover on the cut slope. The relationship with stand age, and indicator of management activities, is re-iterated in table 7.7.

**Table 7.7 Stored sediment in ditches compared with stand age above road**

Stand Age	# of Road Segments with Ditch Stored Sediment	Total # of Segments by Stand Age Above Road	Occurrence Percentage by Stand Age Above Road
Recent Harvest	108	151	72
1-5 Years	38	74	51
6-10 Years	18	75	24
11-20 Years	28	117	24
21-50 Years	94	332	28
50+ Years	10	13	77
Fields/Yards (Grass)	2	25	8

As stand age decreases the occurrence of sediment storage in the road ditch below the stand increases. This appears to be the result of declining cut slope vegetation due to road maintenance or yarding activities, increased traffic, or lack of vegetation on newly built roads. The inventory indicates cut slope vegetation determines the occurrence of stored sediment.

# Culvert Inventory

## Introduction

Runoff and sediment generated on roads is generally delivered to a culvert. Road segments with culverts at stream crossings deliver road runoff and sediment directly to the stream system. Relief culverts are intended to drain road systems without impacting the stream system. They should outlet road runoff onto natural slopes away from streams. Relief culvert water is intended to disperse and infiltrate into the soil. On occasion relief culverts do not function as intended and can become a problem. Erosion at the culvert outlet can allow relief culvert water to impact streams or other road segments. Roads segments receiving relief culvert discharge from other road segments are seldom designed to handle the increase in water or sediment load and damage can occur. Although properly designed relief culverts do not impact water quality, they can be an indicator of sediment movement from road surfaces.

Culvert installations were inventoried to determine the type, diameter, skew, inlet conditions, outlet conditions, and whether the culvert was flowing water at the time of inventory. The inventory was conducted during the relatively dry summer of 1992. If an ephemeral draw and type 4 stream were found to have identical problems, the priority for correction would favor the type 4 stream crossing. However, if the ephemeral draw was found to have been flowing water and the type 4 was not, the priority for correction should favor the ephemeral draw. Culvert inlets and outlets were inventoried to estimate the available flow area. Documentation included: reason for reduction in flow area, percent fill vegetative cover, evidence of fill erosion, ponded water, and in the case of ditch relief culverts whether there was a functioning ditch dam to divert ditch flows into the culvert. Additional information gathered at culvert outlets included: outlet height, where the outlet was discharging water (fill material, natural slope), erosion evidence of the area receiving flow, and any special design measures incorporated in the installation.

## Culvert Characterization

Seven hundred and eighty-nine culverts were inventoried. Table 7.8 provides the quantity, average diameter, and diameter range of culverts by culvert types. Stream crossing culverts are provided by stream type.

**Table 7.8 Culvert characterization**

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