Johnson Creek Resources Management Plan

MAY • 1995

JOHNSON CREEK CORRIDOR COMMITTEE

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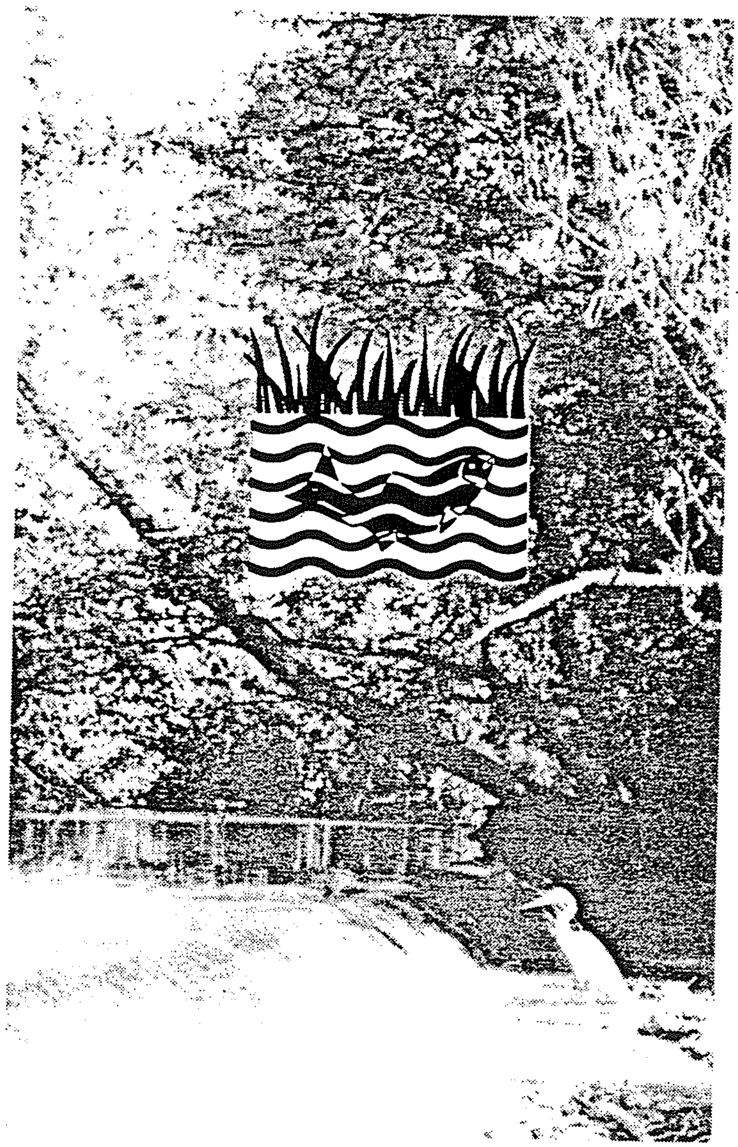

Prepared for:
JOHNSON CREEK CORRIDOR COMMITTEE

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MAY • 1995

JOHNSON CREEK CORRIDOR COMMITTEE[1]

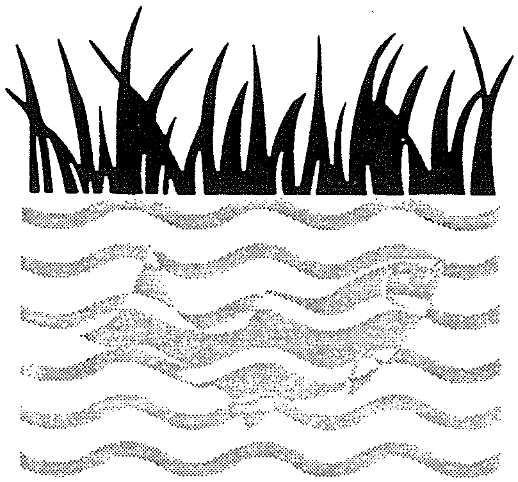
Linda Bauer	Pleasant Valley Neighborhood Association/Reach representative[2]
Bill Bradfield	Reach representative
Jim Carlson	Oregon Association of Nurserymen
Michael Carlson	Portland Audubon Society
Mary Anne Cassin, Co-Chairperson	City of Portland Bureau of Parks and Recreation
Nancy Chase	Metro Regional Parks and Greenspaces
Maggie Collins	City of Milwaukie Department of Planning
Howard Dietrich	Oregon Worsted Company/Reach Representative
Mohammad Fattahi	Clackamas County Department of Transportation and Development
Ed Fitzgerald, Alternate	Land Owners and Friends of Johnson Creek (L.O.A.F.)
Ernie Francisco	Reach representative
Rosemary Furfey	METRO
Ray Hites	Lents Neighborhood Association
Richard Holoch	Clackamas County Department of Utilities
Mart Hughes	Wetlands Conservancy
Steve Johnson, Co-Chairperson	Reach representative
Rob Kappa	City of Milwaukie City Council
Eric Machorro, Co-Chairperson	City of Portland Bureau of Environmental Services
Merrie and Barry Miller	L.O.A.F./Reach representative
Walt Mintkeski	Friends of Johnson Creek
Mel Miracle	City of Gresham Department of Public Works
Nadine Morris	Reach representative
Randy Nicolay	City of Happy Valley Department of Planning
Michael Nixon	Oregon Department of Environmental Quality
Arlene Palshikar	Reach representative
Clifton Lee Powell	Friends of Johnson Creek
Emily Roth	Oregon Division of State Lands

Bonnie Scheeland	Multnomah County Transportation Division, Department of Environmental Services
Molly Sullivan	Reach representative
Jeff Uebel	Reach representative
Laurie Wall, Alternate	City of Portland Bureau of Planning
Doug Warren	City of Portland Bureau of Planning
Ty Weisdorfer	Clackamas County Soil and Water Conservation District
Ela Whelan, Alternate	Clackamas County Department of Utilities
Dennis Wise	Oregon Department of Fish and Game

Notes:

1 Current members are listed. Former members include Jim Soli, Jean Ochsner, Barbara Walker, Carol and Michael Grant, and Linda Robinson.

2 Certain members represent citizen interests in particular reaches of the creek.



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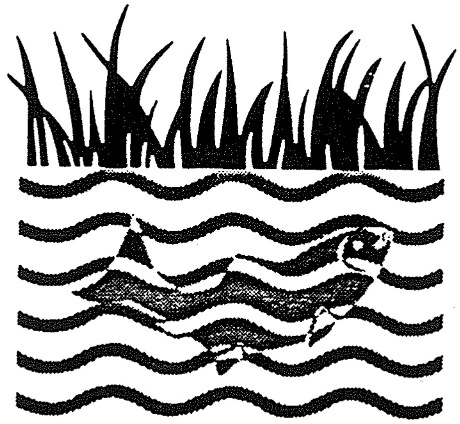


SUMMARY

This plan describes how the natural resources of the Johnson Creek watershed can be protected and restored. The plan was prepared by a committee of stakeholders, that is, a group of individuals with a stake in the future of the watershed. The Johnson Creek Corridor Committee includes residents, business owners, farmers, and representatives of government agencies.

Why the Plan is Needed

Johnson Creek is one of the last free-flowing streams in the Portland metropolitan area. From its origins in the Cascade foothills to its confluence with the Willamette River, Johnson Creek flows westward 25 miles, through the cities of Gresham, Portland, and Milwaukie. The creek drains a 54-square mile, partially-urbanized watershed with a population of about 130,000.

In common with many urban creeks, Johnson Creek has not fared well in the face of development. Much of its watershed has been converted from forest to farms, cities, and suburbs. Urban land uses and agriculture have encroached on the stream corridor, narrowing it and converting a natural, meandering stream into an often-polluted drainage channel. The natural resource values of the stream are much reduced. A few salmon and steelhead still return to the creek, but they are just remnants of former runs; only a few small islands of the original riparian forest continue to provide habitat for wildlife. In addition, flooding plagues creekside neighborhoods, frequently causing extensive damage – on February 24, 1994, a small flood caused damage valued at $375,000. A large flood similar to the one that occurred in 1964 can be expected to cause damage valued at $12,000,000 or more.

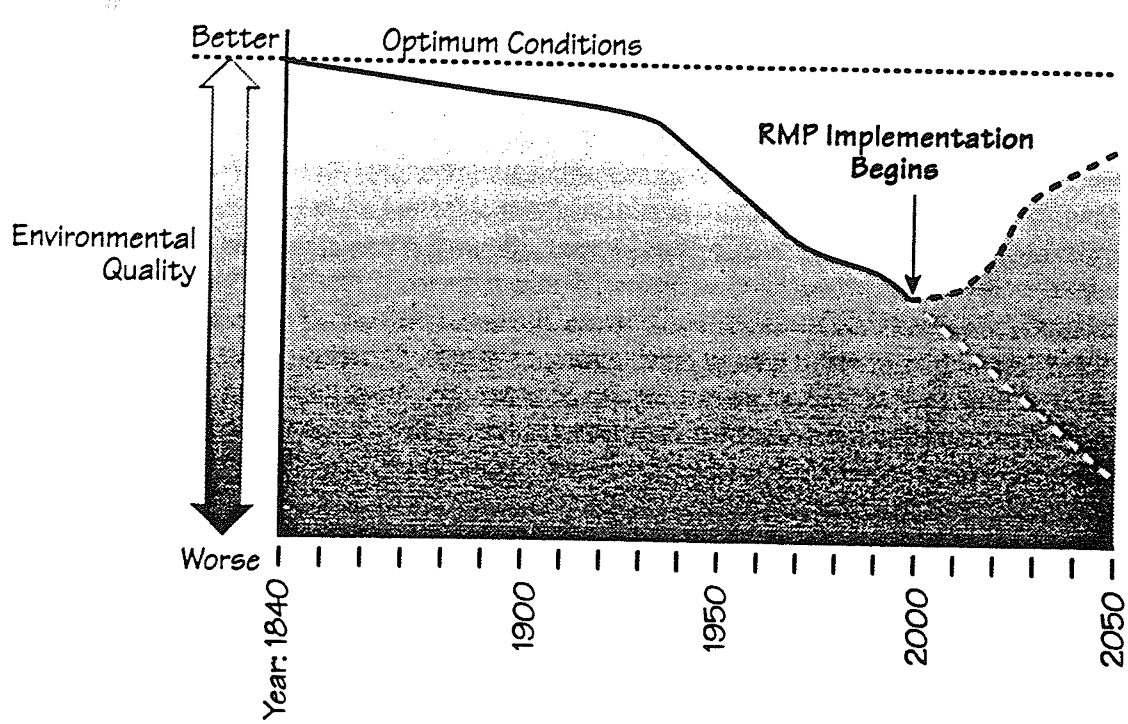
It is clear that, without intervention, Johnson Creek will continue to deteriorate. Metro estimates that the population of the four-county Portland metropolitan area will increase by 1.1 million in the next 50 years. Some of these newcomers are expected to make their homes in the Johnson Creek watershed. As the watershed urbanizes, runoff volumes and pollutant loads discharged to the creek will increase. Flooding will become more severe and the quality of water and wildlife habitat will decline.

Many are now recognizing that allowing urban streams to deteriorate squanders a valuable community asset. Wildlife use the waterways as a refuge and safe corridor for movement. City dwellers value the tranquillity of running water and birdsong in contrast to the noise and bustle of urban life. The presence of natural streams makes the city a better and more attractive place. And because attractive surroundings are such an important part of the quality of life, the value of homes and businesses within easy reach of preserved natural areas often increases. Thus, contrary to conventional thought, protecting natural resources can spark economic development.

Restoration of a stream, however, is no simple matter. It involves complex technical and political challenges. From a technical point of view, we need to understand the stream and be able to predict how it will respond to various management alternatives. Because stream restoration will not occur overnight, we need to establish institutions capable of implementing and financing a long-term improvement program. A number of sometimes conflicting goals (flood control, and preservation of natural areas, for example) will have to be reconciled. To deal effectively with these complexities, a comprehensive plan is

FIG 1

Alternative Futures for Johnson Creek



needed that takes into account all present and expected future activities in the watershed that can influence environmental quality. The RMP is such a comprehensive plan. It provides a framework for action that will halt deterioration of natural resources while simultaneously improving the quality of life. Figure 1 shows diagrammatically how the RMP could reverse the decline of Johnson Creek.

How the Plan Was Prepared

In 1990, a group of concerned residents and business owners joined with representatives of government agencies to begin seeking solutions to Johnson Creek's problems. The Johnson Creek Corridor Committee (JCCC), as the group was known, met monthly to reach consensus on a vision of the watershed's future and to establish a series of goals for a comprehensive plan. The Johnson Creek Vision was published by the committee in late 1992.

Based on the JCCC's vision, planning commenced in earnest in the summer of 1993. Technical consultants gathered and analyzed environmental data and began developing drafts of plan elements in concert with four task groups, or sub-committees, of the JCCC. The plan elements were reviewed and approved by the JCCC and integrated to form the draft RMP. The draft RMP was released for public review in the summer of 1994. After considering all comments received from the public the JCCC modified the draft and approved release of this final RMP.

The City of Portland, Bureau of Environmental Services, provided the primary funding and management assistance to the RMP planning process. The City of Milwaukie and Clackamas County also provided financial support. Many individuals gave their time to the program voluntarily.

The Johnson Creek Resources Management Plan

As its name suggests, the Johnson Creek Resources Management Plan is a comprehensive plan for managing resources in the Johnson Creek watershed. The plan comprises a series of actions which would result in the gradual environmental enhancement of Johnson Creek and its watershed, while solving the pressing flooding problem. It is organized in four integrated elements. Together the elements make up a comprehensive plan for management of the watershed. The plan elements are entitled flood management, pollution prevention, fish and wildlife habitat enhancement, and watershed stewardship.

The plan calls for both administrative and regulatory changes and for the construction of new facilities. The new facilities include flood detention basins, stormwater treatment facilities, and fish and wildlife habitat enhancement projects. The locations of the facilities called for in the plan are shown in Figure 2. Details of the plan, including all recommended actions, the party responsible for the actions, and estimated costs are contained in Chapter 4.

POLLUTION PREVENTION PLAN ELEMENT

In the 1940s, 1950s, and 1960s, the condition of many urban rivers in the United States became so objectionable that many local communities felt they had to act. Gross pollution of the Willamette River in Portland, for example, led to the construction of a sewer interceptor system and a treatment plant that discharges effluent to the Columbia River, where more dilution is available. Nationally, concern about environmental problems grew, culminating in the passage of much federal and state environmental legislation, including the federal Water Pollution Control Act Amendments of 1972, the nation's first comprehensive water pollution control legislation. A number of government programs stemming from the act have been in progress for twenty years. The pollution prevention element of the RMP builds on, and supplements, the existing programs.

Point sources of pollution in the Johnson Creek watershed (that is, easily identifiable discharges of sewage or industrial waste) are few in number and have little influence on creek water quality. They have been regulated for more than twenty years. The most important remaining pollutant sources are urban and rural runoff and illicit connections to the stormwater drainage system. The goal of this element of the RMP is to control these remaining pollutant sources. The following actions are included in the plan element:

- Fully implement urban stormwater management plans recently prepared by Portland, Gresham, and North Clackamas County, and in particular, the requirement to eliminate illicit industrial discharges to the municipal stormwater systems.

- Require stormwater pollution reduction facilities be built into all new development and significant re-development.

- Construct fifteen stormwater pollution reduction facilities in drainage subbasins that discharge, or have the potential to discharge, relatively-heavy pollutant loads to the creek. An example of a treatment system is shown in Figure 3. The on-stream flood detention basins, referred to in the following plan element, will also remove pollutants from creek water.

Currently, the discharge of stormwater from farms and managed forests is unregulated. The plan includes the recommendation that stormwater management plans be prepared for the rural portions of the watershed and implemented through voluntary agreements with landowners.

FLOOD MANAGEMENT PLAN ELEMENT

Early in the planning process it became apparent that providing existing structures with full protection from very large floods was practically impossible. Furthermore, residents of flood-vulnerable neighborhoods indicated that their highest priority was avoiding the cost and inconvenience associated with frequent small floods. Thus, the objective of the flood management plan element is to provide a reasonable level of flood protection to existing

JohnsonCreek

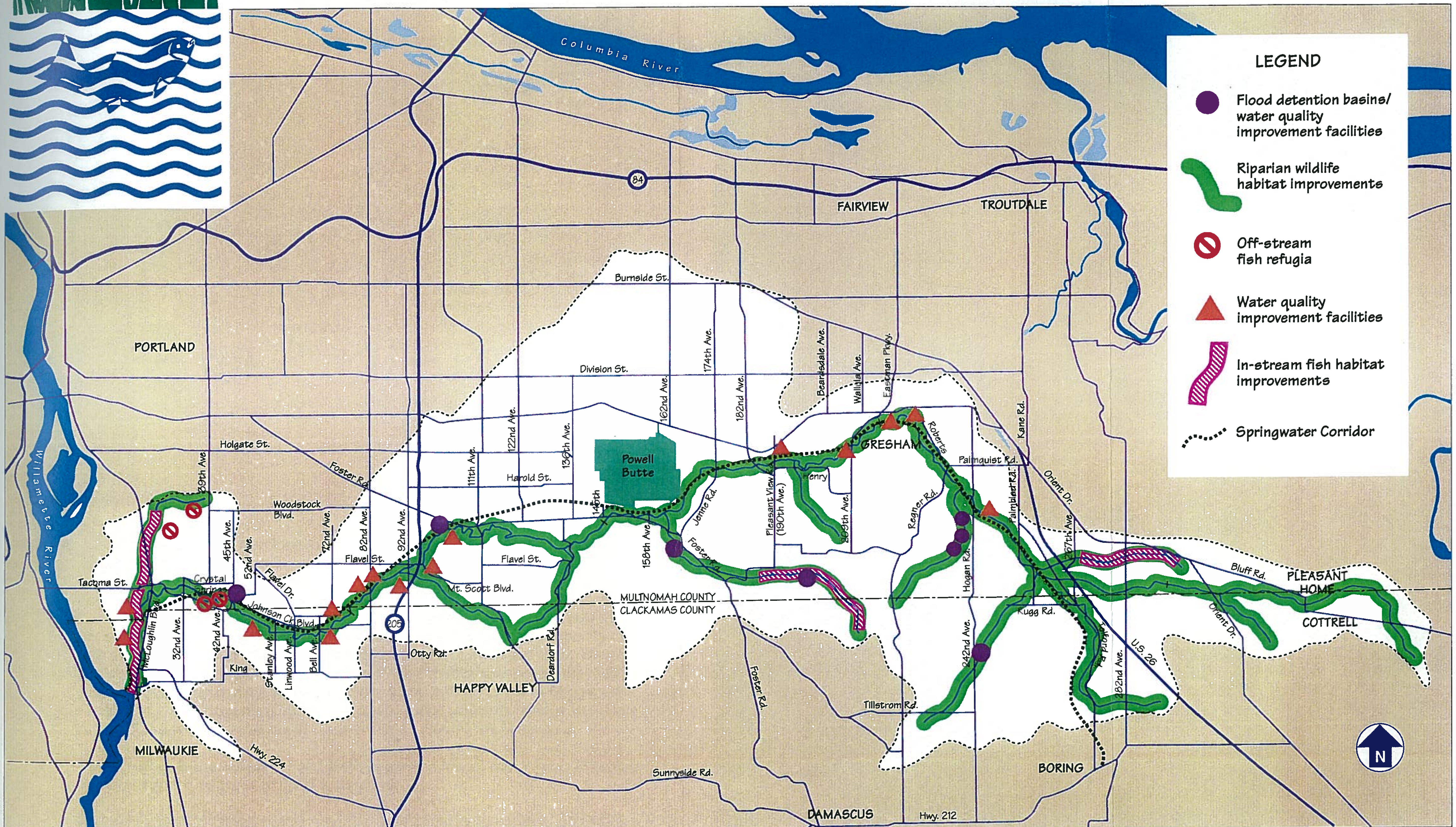
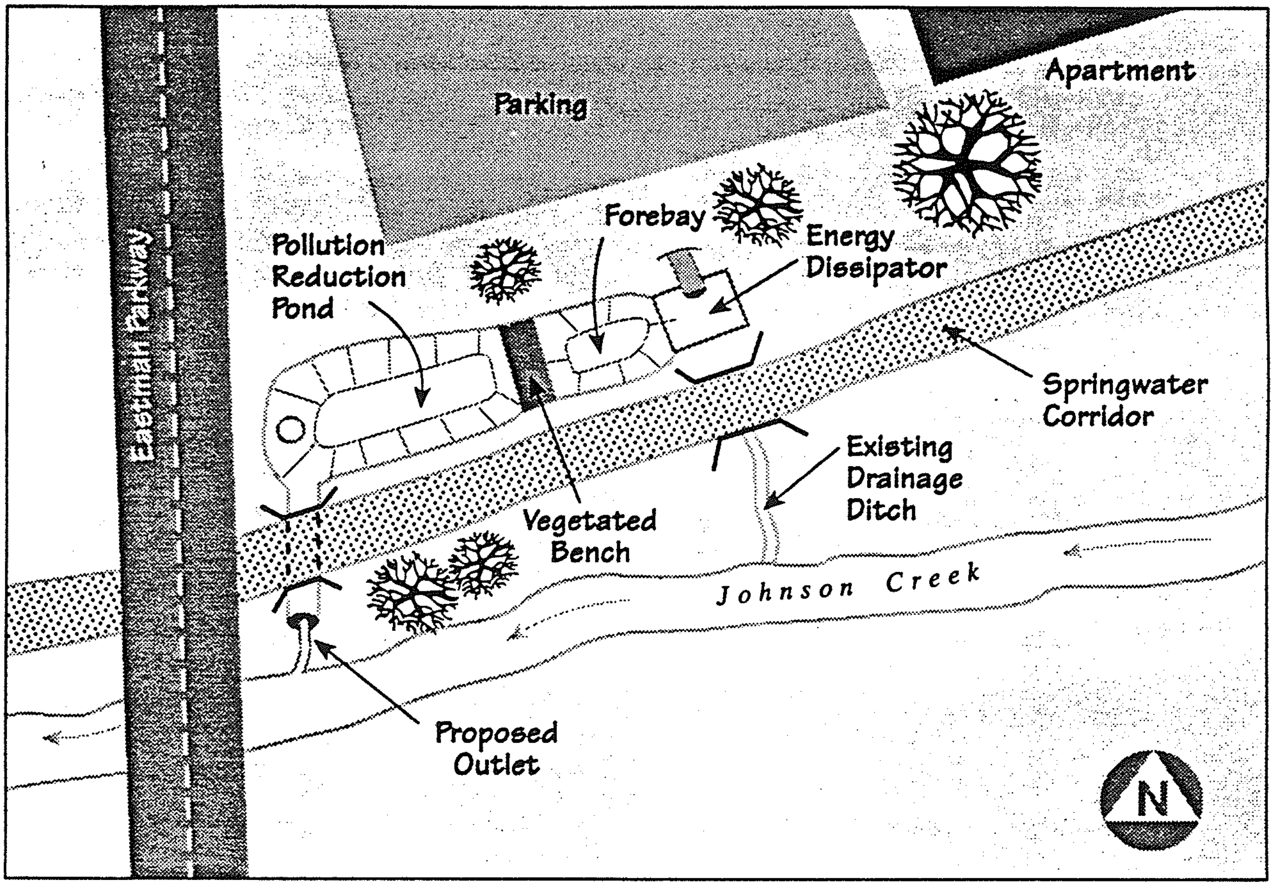


Fig. 2 Location of Proposed Improvements

FIG 3

Water Quality Improvement Facilities at Eastman Parkway Site



structures, while preventing new development from making flooding worse. The plan element includes the following actions:

- Construct on-stream detention basins with a combined capacity of 400 acre-feet in the upper watershed. The detention basins (see Figure 4) will be substantially dry except during severe storms. Provide off-stream storage with a capacity of 200 to 600 acre-feet in the Lents neighborhood, east of Interstate 205. The off-stream storage facilities in the Lents area will have multiple purposes; they will also improve water quality, expand wildlife habitat in the vicinity of Beggars-tick marsh and create opportunities for recreation. Once sufficient storage has been built, a flood relief channel could be constructed around the Lents area.

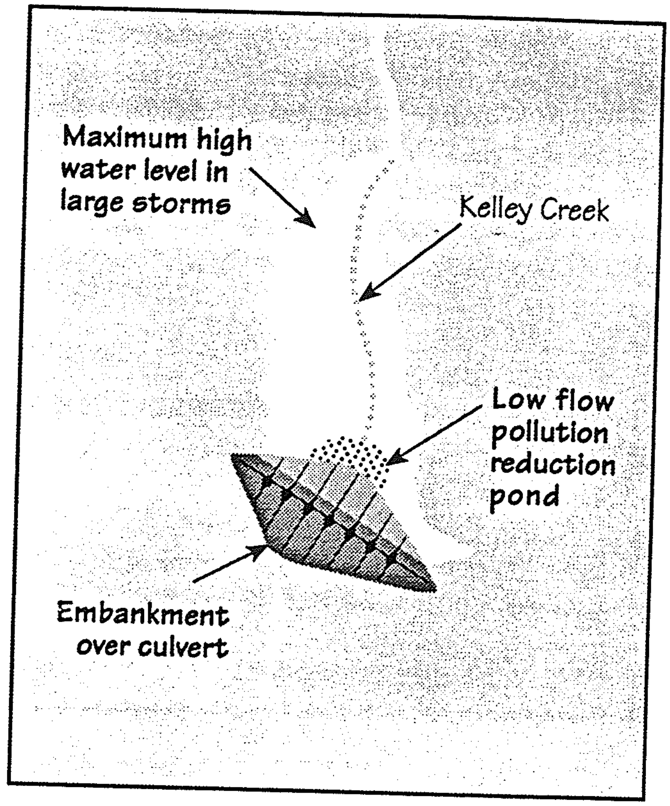
- Restrict filling in the 100-year flood plain to prevent loss of flood water storage and consequent increases in flood water levels.

- Maintain stream channels regularly so that their capacity to convey flood waters does not decline unacceptably.

- Establish emergency response procedures to minimize damage during floods.
- Limit future increases in peak flow by requiring that new developments include flood water storage facilities.
- Acquire the most vulnerable structures in the flood plain as they become available from willing sellers.

FIG 4

Detention Site on Kelley Creek at 190th Avenue



All the provisions in this plan element would allow the creek to be managed as a natural waterway in an urban area, rather than as a flood control channel.

■ FISH AND WILDLIFE HABITAT ENHANCEMENT PLAN ELEMENT

Waterways play a key role in the natural environment. The number of species found in and around rivers and streams far exceeds those found in the neighboring uplands. The river corridor contains a diversity of micro-environments that provide habitat for birds, mammals, reptiles, amphibians, and fish. Some of these species live permanently in the stream corridor, while others visit it periodically for food and cover. Because of the stream corridor's importance to wildlife, its pollution and degradation can have a severe and disproportionate effect on the ecology of an entire watershed.

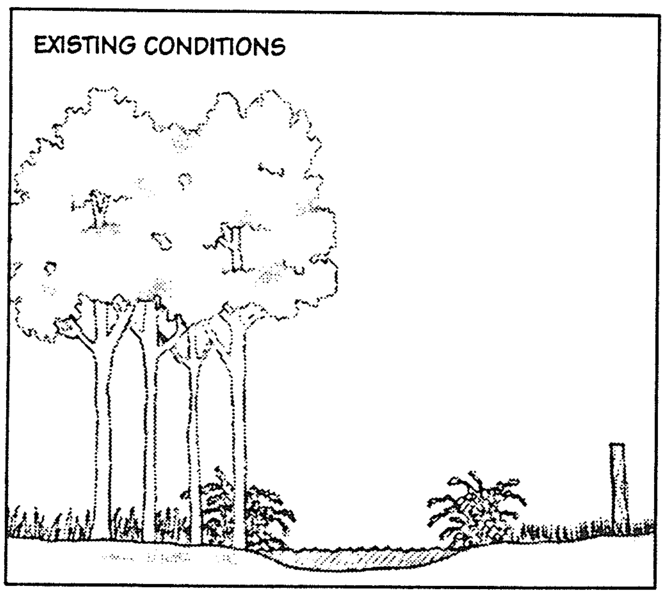
Development of the Johnson Creek watershed has had a profoundly adverse effect on the creek corridor. Almost all of the old-growth streamside vegetation has been cleared. The downstream reaches of the channel were rock-lined in the 1930s to reduce flooding. The rock-lining project not only destroyed any remaining old-growth streamside vegetation but also confined the stream within a channel and eliminated its ability to meander within its flood plain. Summertime streamflow has been reduced by development-related hydrologic changes and diversions for irrigation. Despite these great changes, the Johnson Creek corridor remains important for wildlife. Enough streamside vegetation exists to provide a corridor for wildlife movement; a remnant salmonid fishery still persists; beaver flourish and a few mink inhabit the least developed tributaries.

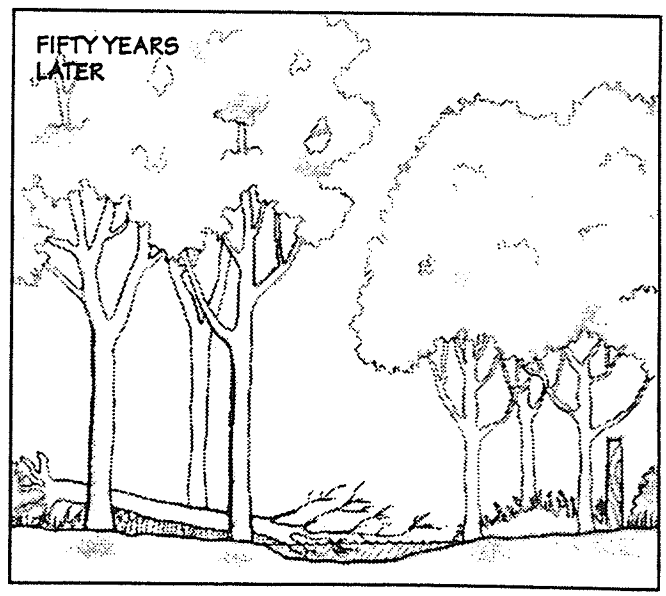
The goal of this element of the RMP is to restore high quality wildlife habitat throughout the creek corridor. The plan is based on the conclusion that fish and wildlife can best be helped by restoration of a close-to-natural riparian corridor. This will be done by revegetating the creek corridor with native trees and shrubs to the maximum extent possible in an urban, suburban, or agricultural setting. The revegetated riparian corridor will provide a diversity of habitats for terrestrial wildlife and provide shaded waters for fish and other aquatic life. It will also filter out sediments and reduce pollutant concentrations in stormwater runoff entering the stream. Although development of a mature riparian forest will take 50 years or more, significant improvements in wildlife habitat can be expected in 5 to 10 years. A number of interim measures will be taken to accelerate the recovery of salmon and steelhead stocks. The plan element includes the following actions to improve wildlife habitat:

- Remove non-native plants from public lands and replaced them with native trees and shrubs. Similar revegetation activities should be encouraged on private lands. Approximately 17 percent of the creek is currently owned by the public. The effect of revegetation on a stream cross-section is shown in Figure 5.

FIG 5

Typical Revegetated Creek Reach



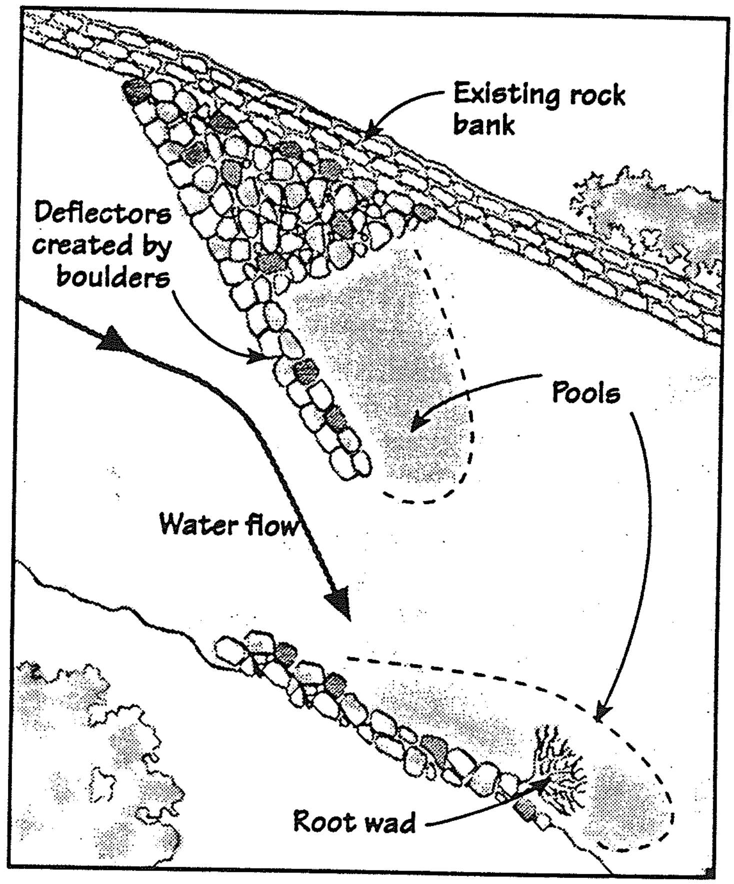


- Acquire ecologically-sensitive or high value wildlife habitats from willing sellers as they become available.

- Construction of off-stream ponds and channels to provide refugia for fish and to encourage future development of a self-sustaining run of coho salmon.

FIG 6

Typical In-stream Fish Habitat Enhancement Project



- Modify the stream channel in the lower reaches of Johnson Creek, Crystal Springs Creek, and several tributaries in the upper watershed to improve cover and spawning habitat for steelhead and chinook salmon. A typical in-stream modification is shown in Figure 6.

Critical to the success of the salmonid fishery will be the restoration of adequate summertime streamflow. The plan element recommends that this be accomplished by eliminating illegal diversions and by acquiring instream flow water rights.

■ WATERSHED STEWARDSHIP PLAN ELEMENT

Responsibility for maintaining environmental quality in the Johnson Creek watershed is shared by numerous agencies and individuals. No single agency focuses its exclusive attention on the watershed. Six municipalities lie partially within the basin, but their boundaries do not coincide with watershed boundaries. Environmental regulatory agencies, such as the Oregon Department of Environmental Quality, are organized in divisions or regions, which again do not follow watershed boundaries. The division of responsibilities tends to breed confusion and inhibit action. A key to the successful implementation of the RMP is the creation of an institution that has the well-being of the Johnson Creek as its first and only priority. The new institution will seek to obtain the benefits of a watershed perspective while working within the existing institutional structure.

Another critical factor determining the outcome of the RMP will be the engagement of citizens in plan implementation. Unlike many plans where the sole responsibility for implementation lies with government agencies, implementation of the RMP will rely on a combination of agency and citizen action. The plan involves a few large scale construction projects and a myriad of small corrective actions. It will fail if citizens and private property owners do not actively participate. The key element of the stewardship plan element is:

- Establish a Johnson Creek watershed management organization with broad stakeholder representation. It will have no statutory powers and will achieve its objectives by influencing existing decision-making bodies. The organization would likely evolve from the Johnson Creek Corridor Committee and should have at least one full-time staff-person who would act as the watershed steward. It will be financed by grants from private and public sources. The watershed management organization will foster a watershed stewardship ethic by acting as an educator, a disseminator of information and an organizer of volunteers. It will also serve as a forum for discussion of development proposals in the watershed and assist existing agencies in monitoring compliance with environmental laws and regulations.

The watershed stewardship plan element includes a number of other actions that will improve the quality of life and the environment in the Johnson Creek watershed:

- Coordinate plans for creek improvements with improvements to the Springwater Corridor Trail to maximize collective benefits.

- Protect historic structures, including the best examples of the Great Depression-era rockwork that lines the creek, and Native American artifacts.

- Modify land use regulations to protect natural resources from insensitive development.

In addition, the plan element recommends that various aspects of environmental quality, water temperature, numbers of returning fish, for example, be monitored to evaluate the success of the actions in the RMP and to determine whether course corrections are needed.

PAYING FOR THE PLAN

COSTS AND BENEFITS

The purpose of the RMP is to make the Johnson Creek watershed a better place to live. By protecting the environment, while allowing development to continue, the watershed will attract new residents and visitors. This will in turn increase the value of property and the patronage of local businesses. New jobs may be created and, as property tax receipts increase, cities and counties will have more funds to spend on local services and capital investments. Thus, the RMP will act as a catalyst for economic growth, producing widespread monetary benefits, as well as the more obvious non-monetary benefits of a pleasant environment.

A number of near-term monetary and non-monetary benefits will also result from the RMP. Diminution of flood risk for hundreds of homes and businesses will result in reduced flood insurance premiums, lowered damage costs, and improved public safety. The flood reduction components of the RMP would prevent damages estimated at, at least, $28 million over a fifty-year period. Actions in the RMP designed to improve water quality and fish and wildlife habitat are likely to bear fruit within a few years of implementation, providing recreational opportunities, and other non-monetary benefits.

TABLE 1
Estimated Public Sector Costs of RMP

	Initial Costs[b]		
PP-1	Capital	Program	Annual Costs
Pollution Prevention[a]	$300,000	$273,000	$15,000
Flood Reduction	14,000,000	165,000	158,000
Fish and Wildlife Habitat Enhancement	650,000	95,000	–
Watershed Stewardship	–	90,000	100,000
TOTAL	**$14,950,000**	**$623,000**	**$273,000**

Notes:

a Initial costs are non-recurring costs; that is they are costs which are only incurred once. Initial costs are sub-divided into capital costs and program costs. An example of an initial capital cost is the construction cost of a flood detention basin. An example of an initial program cost is the cost of drafting and adopting a non-point source pollution control ordinance.

b An estimated $800,000 per annum is already being expended by the cities of Gresham and Portland and Clackamas County to control pollution from urban stormwater in the Johnson Creek watershed.

In order to obtain these benefits, investments must be made. Most of the direct investment cost will be borne by the public sector. Private parties may make direct investments in improving the watershed's environment (for example revegetating privately-owned creekside lands with native trees and shrubs) but the investments will be entirely voluntary. Some secondary costs will be borne by private parties who are affected by environmental regulation stemming from the RMP. An example might be the loss of value of a privately-owned lot in the flood plain that becomes more difficult to build on as a result of environmental regulations in the RMP.

The estimated public sector cost of implementing the RMP is summarized by element in Table 1. The cost estimates should be regarded as planning level estimates. They are based on conceptual, rather than detailed, plans and programs.

The initial public sector cost of implementing the RMP is $15.6 million. All but about $650,000 will be construction cost. The remainder will be the cost to begin a variety of environmental improvement programs including forming the WMO. Continuing costs of about $300,000 per annum will be incurred to implement the RMP. One-third of the cost will be to run the WMO, while the remainder will be used to maintain facilities. The private sector cost of the RMP is estimated to be $1.4 million, primarily for revegetation of the mainstem Johnson Creek riparian corridor on private lands.

■ FUNDING

The RMP calls for actions by cities and counties, other government agencies, the yet-to-be created watershed management organization, and private individuals and corporations. Three actions in the RMP involve significant capital costs for cities and counties. They are the construction of flood reduction facilities, construction of stormwater pollution reduction facilities, and revegetation of the riparian corridor on public lands. By far the largest capital cost will be $14 million for construction of flood reduction facilities.

Each jurisdiction would obtain its share of capital costs in the manner it chooses. Several jurisdictions in the watershed charge property owners a fee for stormwater management. Stormwater management fees would be a logical choice as a funding source because flood reduction is a major component of stormwater management.

A large number of actions in the RMP will be undertaken by the newly-created watershed management organization (WMO). Obtaining a stable funding source for the WMO will be crucial to the success of the RMP. The WMO will seek grant funds or in-kind service contributions from local, state and federal governments and from private foundations

The public sector costs of the RMP will be shared by the jurisdictions in accordance with a yet-to-be-developed formula. The formula will take account of benefits received and responsibility for the problems that the RMP addresses.

CHAPTER 1

WHY THE RESOURCES MANAGEMENT PLAN IS NEEDED

WATERSHEDS AND THE QUALITY OF LIFE

Most people consider pleasant surroundings an important part of what makes life enjoyable. For some it's an apartment in the heart of the city; for others it's a neighborly suburb of well-tended homes and lawns; still others choose a cabin in the woods where the only sounds are birdsong and the wind in the trees. The choice is personal, but whatever it is, a common theme is evident – surroundings matter.

But what do our surroundings consist of? The region in which we live is an important part of our surroundings. Residents of the Pacific Northwest are fortunate to live in a region of great natural beauty with easy access to both the outdoors and the city. Then there is our home itself, where we are free to create the environment of our choice. Finally, somewhere in between is another geographic unit, a neighborhood or community or perhaps even a watershed. It is this third element of our surroundings, between the region and the home, that is the subject of this plan.

Social and economic life is organized around the community or neighborhood, but neither unit has much meaning from an environmental point of view. A more satisfactory defining unit for the natural environment is the watershed. The movement of water links all parts of the natural environment together. The amount of rainfall that falls on the watershed and remains in the soil determines the types of trees and shrubs that will grow there. The availability of year-round flow determines the types of fish that inhabit the watershed's streams. The amount and speed of runoff determine the characteristics of the stream channels. The natural linkages within an area are associated with the movement of water, thus the watershed becomes an important defining unit. This does not mean that the watershed is the only important ecological unit; it is, of course, part of a network of watersheds that form a regional ecosystem. The watershed is, however, the most logical unit to understand and manage.

THE JOHNSON CREEK WATERSHED

Johnson Creek drains a 55-square-mile, partially-urbanized watershed. It is one of the last free-flowing streams in the Portland metropolitan area. From its origins in the Cascade foothills to its confluence with the Willamette River, Johnson Creek flows westward 25 miles, through the cities of Gresham, Portland, and Milwaukie. Its watershed was first settled by people of European ancestry in the mid-nineteenth century and now has a population of about 130,000.

In common with many urban creeks, Johnson Creek has not fared well in the face of development. Much of its watershed has been converted from forest to farms, cities, and suburbs. Urban land uses and agriculture have encroached on the stream corridor, narrowing it and converting a natural, meandering stream into an often-polluted drainage channel. The natural resource values of the stream are much reduced. A few salmon and steelhead still return to the creek, but they are just remnants of former runs; only a few small islands of the original riparian forest continue to provide habitat for wildlife. In addition, flooding plagues creekside neighborhoods causing damage valued at several hundred thousand dollars each year.

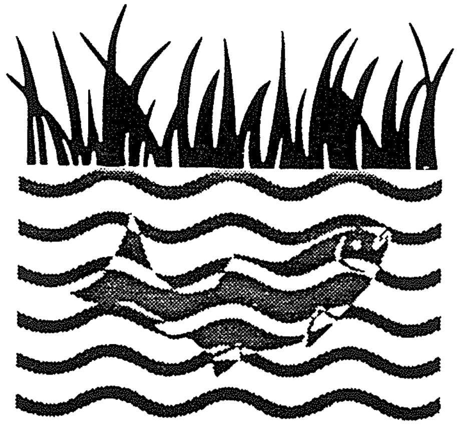
Despite the adverse effects of development on environmental quality, the watershed still contains valuable natural resources. Enough streamside vegetation exists to provide a corridor for wildlife movement; beaver flourish, together with a few mink; remnant runs of salmon and steelhead persist; and fragments of the original forest can still be found. But the remaining natural resources are under pressure; it is clear that without decisive action they are likely to slip away, bit by bit, as homes and businesses displace field and forest. Flooding will become more severe, water quality will decline, and the opportunity to restore the creek as a community asset will be lost.

ECONOMICS AND THE ENVIRONMENT

Protecting natural resources in an urbanizing area is difficult. It involves reconciling what some see as irreconcilable desires for economic development and environmental protection. Striking a balance between the human need for jobs, land for homes and businesses, and the needs of the environment is the basic purpose of the Johnson Creek Resources Management Plan. But it is not inevitable that economic development and environmental protection must pull in opposite directions. Sometimes they go in tandem. Protected and well-cared for natural areas like Beggars Tick Marsh and Powell Butte make the Johnson Creek watershed a better place to live. Studies have shown that proximity to natural areas raises property values. New residents and visitors, drawn to the watershed by its natural areas and recreational opportunities, patronize and strengthen local businesses. Thus a cycle of economic and community revitalization begins, sparked by wise environmental stewardship.

THE JOHNSON CREEK RESOURCES MANAGEMENT PLAN

Protecting the watershed involves complex technical and political challenges. From a technical point of view we need to understand the natural processes occurring in a stream and be able to predict how they will respond to management. Because stream restoration will not occur overnight, we need to establish institutions capable of implementing and financing a long-term improvement program. Sometimes, conflicting goals, flood control, and preservation of natural areas, for example, will have to be reconciled. To deal effectively with these complexities, a comprehensive plan is needed. The plan must take account of all activities in the watershed that adversely affect environmental quality and determine how they can be eliminated or changed. It must identify the actions individuals and units of government can take to first halt, and then reverse, the trend toward environmental degradation. Finally, it must set a course of action that will protect natural resources and improve the quality of life in the watershed over the next 50 years. The Johnson Creek Resources Management Plan (RMP) is such a comprehensive plan. Without the RMP, actions to protect the watershed's environment are likely to be uncoordinated and ineffective.



CHAPTER 2

HOW THE PLAN WAS PREPARED

PAST PLANS

Johnson Creek has suffered from water pollution and flooding for many years. As early as 1950 Congress authorized the U. S. Army Corps of Engineers to devise ways to relieve flooding on the creek. Between 1950 and 1990, a number of flood reduction plans were developed, but none were implemented. In 1949 a Johnson Creek Water Control District was formed. Aided by the Corps of Engineers, the district attempted to build flood reduction facilities until 1964, when it was disbanded. In the 1970s, the newly-formed Metropolitan Services Agency (METRO), again with Corps of Engineers assistance, developed a flood control plan. Like the earlier Johnson Creek Water Control Agency plan, METRO's plan failed to obtain voter approval.

Efforts to improve water quality have been more effective than the efforts to achieve flood control. The discharges of industrial waste that heavily polluted the creek in the past were eliminated or controlled in the 1960s and 1970s. Discharge of untreated domestic waste to the creek has been largely eliminated by the provision of public sewers and the private installation of properly-engineered septic tank systems. Still, water quality in the creek fails to meet many of the applicable stream water quality standards, and salmon and steelhead runs continue to hang by a thread.

By the 1980s, many residents of the Johnson Creek watershed were frustrated and disillusioned by the repeated failure of government to solve the watershed's problems. The situation was exacerbated by the lack of agreement among residents on how flooding should be controlled and how to pay for any needed facilities. Many watershed residents did not see how they would benefit from a single-purpose flood control project and, consequently, were unwilling to pay for one.

A Fresh Approach

By the late 1980s, the city of Portland had concluded it would have to play a more active role in solving the problems of the Johnson Creek watershed. In 1987, the Portland Bureau of Environmental Services prepared a drainage master plan for the city, including recently annexed neighborhoods in the Johnson Creek watershed. The plan indicated that more than 1,200 acres of the city lay within Johnson Creek's 100-year flood plain. In the same year Congress amended the Clean Water Act, making cities responsible for controlling pollution from stormwater.

Although Portland realized that it would have to deal with the so far intractable problems of the Johnson Creek watershed, it needed to avoid the pitfalls that destroyed earlier initiatives. It was clear that a new, fresh approach to planning was needed. To this end, city staff gathered information on other similarly-afflicted watersheds elsewhere in the nation and consulted with a number of experts. Case histories of other projects were examined to determine if there were common denominators for technical and political success. The city concluded that its Johnson Creek planning process would have the following features which have contributed to success elsewhere:

- Involvement of all who may be affected by the plan or otherwise have an interest in it (stakeholders).
- Multiple objectives and benefits – the plan will address all of the watershed's environmental problems rather than focusing solely on the flooding problem.
- Implementation of demonstration creek improvement projects while planning is proceeding.

The Johnson Creek Corridor Committee

The keystone of the new approach to planning was the formation of the Johnson Creek Corridor Committee (JCCC). In early 1990, the City of Portland began to identify stakeholders in the Johnson Creek watershed and to invite them to form a committee that would direct the new planning effort. Portland would provide the funds for the planning study and would be a member of the committee. Development of the Johnson Creek Resources Management Plan (RMP) would, however, be the responsibility of the committee as a whole. The first meeting of the corridor committee was held in May 1990. Subsequently, the committee has met at least bi-monthly.

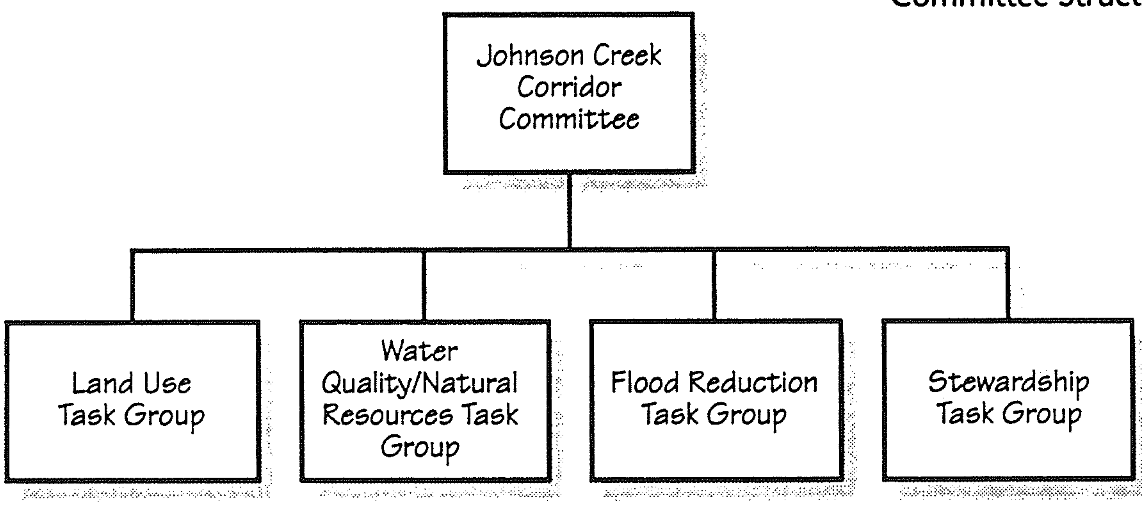
Membership of the JCCC has changed somewhat over the four-year planning period, but it has always included representatives of neighborhood groups, cities and counties, business, agriculture, and several state and federal agencies. Past and present committee members and their affiliations are listed in the frontispiece.

PREPARING THE PLAN

The planning process was divided into three phases. The first phase of the work included the establishment of goals for the plan and review of all existing relevant background information. The focus of the second phase was preparation of the draft RMP. The third phase of work involved public review of the draft RMP and preparation of the final plan.

FIG 7

Committee Structure



One of the JCCC's first tasks was to develop a vision of the future of Johnson Creek. After considering comments and suggestions from watershed residents at a series of public meetings and workshops, the committee published a document entitled "Johnson Creek Vision – A Look at the Future of the Johnson Creek Watershed." The JCCC also established 10 goals for the planning process. The goals are shown in Table 2. At the same time, consultants working for the committee reviewed all background technical information on the watershed and developed a work plan for Phase 2.

When Phase 2 commenced in July 1993, work on the RMP intensified. Consultants conducted a variety of field studies and analyses, and developed an overall framework for the RMP based on the JCCC's ten goals. The JCCC reviewed and approved the plan framework and directed the consultants to begin preparing drafts of plan elements, working closely with four task groups, or sub-committees, established by the JCCC. The committee structure is shown in Figure 7. The task groups consisted of JCCC members and others with expertise or a special interest in the subjects addressed by different plan elements. Once preliminary drafts of each plan element were completed, they were submitted to the full JCCC for discussion. Each individual proposed action in the RMP was reviewed and approved by the JCCC. The consultants then prepared a complete draft of the RMP incorporating the JCCC's comments and suggestions. The JCCC released the draft for public review in July, 1994.

Phase 3 began in September 1994 with a series of public meetings and open houses in different parts of the watershed. Written comments on the draft were accepted through the Fall. In January 1995, the JCCC considered all comments received on the draft and instructed the consultants to prepare a preliminary final RMP, incorporating those comments that the JCCC found to have merit. After thorough review of the revisions, the JCCC approved release of this final RMP.

Technical Studies

A number of technical studies form the foundation of the RMP. The studies were documented in a series of technical memoranda. Their titles are listed in Table 3. Bound copies of the technical memoranda are available for review at the offices of the City of Portland, Bureau of Environmental Services, Woodward-Clyde Consultants and at libraries within the watershed.

TABLE 2
Goals for the Johnson Creek Resources Management Plan
Developed by Johnson Creek Corridor Committee

GOALS

1. The water in Johnson Creek and its tributaries should meet water quality standards and allow for safe human and wildlife contact.
2. Good quality aquatic habitat for creek fauna, including resident and migratory fishes, should be restored and maintained.
3. Flood impacts should be minimized.
4. Natural areas should be preserved and restored.
5. Recreational opportunities should be available in the Corridor.
6. Economic Development, sensitive to the community, to the neighborhood, and to resource values should be supported.
7. Heritage value of Johnson Creek should be preserved and recognized.
8. The role of stewardship of natural resources should be taken on by landowners, special interest groups, and the general populace.
9. People should be aware of and educated about the resource values of the Johnson Creek basin.
10. The Johnson Creek basin should be a safe, clean, and aesthetically pleasing area that is appreciated by residents and visitors.
11. Both private and public values should be considered and respected.
12. Urban forestry objectives should be met in the Corridor.

TABLE 3
List of Technical Memoranda

No.	Author(s)	Title	Description
1	Davis	*Johnson Creek and Its Watershed – A Profile*	Provides a summary description of Johnson Creek and its watershed.
2	Kinsella, Anderson	*Summary of Land Use Regulations for Minimizing Hydrologic Impacts*	Provides a summary of research which describes the land use development standards set by agencies in other parts of the country to minimize flooding problems and/or address water quality concerns.
3	Reininga	*Water Quality in Johnson Creek – A Summary of Existing Studies and Data*	Provides a compilation of the available data from numerous water quality studies conducted in the Johnson Creek basin. Provides a basis for identifying major sources of pollutants in the creek and for selecting control measures to improve water quality.
4	Fowler, Kinsella	*Land Use Trends in the Johnson Creek Watershed*	Provides a summary of historical, existing and future land uses within the Johnson Creek watershed.
5	Reininga	*Potential Sources of Water Quality Pollutants in the Johnson Creek Watershed*	Provides information on sources of water pollutants and their importance in the watershed. Also describes the regulatory background to water pollution control.
6	Ellis	*Johnson Creek Benthic Macroinvertebrate Survey*	Provides a comprehensive survey of the macroinvertebrate community (aquatic insects and other aquatic invertebrates) of Johnson Creek. These aquatic insects are the food source for fish.
7	Smyth	*Johnson Creek Natural Resources Field Surveys and Existing Conditions Summary*	Analyzes data gathered in field surveys in 1993 and updates data gathered earlier.
8	Ellis	*A Summary of Existing Fish Population and Fish Habitat Data for Johnson Creek*	Summarizes most recent (1992-1993) salmonid population and habitat data collected by Beak Consultants, Oregon Department of Fish and Wildlife, citizen volunteers, and the author.
9	Harper	*Potential Institutional Arrangements for Long-Term Watershed Management in Johnson Creek*	Describes watershed management arrangements in different parts of the western United States, and how their organizational structures might be applied in the Johnson Creek watershed.

TABLE 3
List of Technical Memoranda (continued)

No.	Author(s)	Title	Description
10	Harper	*Summary of Land Use Regulations Designed to Protect Johnson Creek*	Describes the measures taken by governments in the watershed to protect streamside natural resources.
11	Sutherland	*Hydraulic Analysis of Early-Action Flood Reduction Projects*	Discusses of the role of bridges in impeding flow in Johnson Creek.
12	Reininga	*Temperature Modeling Results from Johnson Creek*	Discusses of water temperature and how it might be lowered by vegetative cover.
13	Bayh	*Program Support for Johnson Creek RMP Elements – A Survey of Public and Private Sector Possibilities*	Lists and discusses potential funding sources.
14	Demuth	*Cultural Resources Analysis for Johnson Creek Waterfall, Harney Street Fish Ladder, and Rock-lined Creek Bed*	Describes the current status of the Works Progress Administration rock work.
15	Sutherland	*Hydrologic Model for Flood Reduction Element*	Provides data on stream flow and water levels under a variety of conditions.
16	Ellis	*A Limiting Factor Analysis for Anadromous Salmonids in Johnson Creek with a Discussion of Habitat Rehabilitation Opportunities and Constraints*	Discusses the major limiting factors for salmonid populations in Johnson Creek, and opportunities for fisheries enhancement.
17	Smyth	*Wildlife Habitat Limiting Factors and Recommendations for Restoration, Enhancement and Protection*	Summarizes limiting factors for wildlife, recommendations for habitat improvement, and criteria to measure the success of habitat improvement projects.
18	Reininga	*Water Quality Monitoring in Johnson Creek to Detect Trends and Measure the Effectiveness of the Resources Management Plan*	Describes recommendations for a water quality monitoring program including: volunteer programs, compilation of data collected as part of other studies, temperature data collection, and development of a long-term monitoring plan.

CHAPTER 3

THE JOHNSON CREEK WATERSHED

Johnson Creek originates in the hills near Cotrell and flows westward approximately 25 miles to its confluence with the Willamette River. The Johnson Creek watershed, the area draining to Johnson Creek, is a roughly rectangular area of about 54 square miles. The watershed and its regional location are shown in Figure 8. The topography of the watershed is varied with a high point of 1,129 feet in the Boring Hills, near the creek's source, and a low point of sea level at the confluence with the Willamette. The western half of the watershed is developed, primarily as a low density residential area, but with pockets of commercial, industrial, and high-density residential land use. The eastern half is mostly open space and farms. The watershed lies within six political subdivisions: the cities of Portland, Milwaukie, Gresham, and Happy Valley; and the counties of Multnomah and Clackamas. The area of land within the watershed and within each political subdivision is shown in Table 4. The miles of mainstem of Johnson Creek that lie in each jurisdiction are also shown in the table. The current population of the watershed is estimated to be about 130,000.

LAND USE

Land is used for many different purposes in the Johnson Creek watershed. The western third of the watershed, primarily within Portland and Milwaukie, is the most heavily developed. The eastern third is mostly open space and agricultural land. The middle third, which includes the City of Gresham, is a mixture of low-density residential suburbs and open space.

Existing and predicted future land use in the Johnson Creek watershed is shown diagrammatically in Figure 9. Existing land use is about 54 percent farm, park and vacant lands, and 35 percent low density residential. High-density residential areas and commercial and industrial areas occupy 4 and 7 percent of the watershed respectively. If the watershed develops as envisioned in current city and county comprehensive land use plans, then the proportion of residential land use will expand at the expense of farms and open space. Future land use is expected to be 63 percent low-density residential, 22 percent farmland and open space, 9 percent commercial and industrial, and 6 percent high-density residential.

The urban growth boundary for the Portland metropolitan area passes through the watershed. Current city and county comprehensive land use plans established the urban growth boundary as it is today. METRO, the regional planning agency for the four-county Portland metropolitan area, recently approved a plan to accommodate an expected population increase of 1.1 million by the year 2040. The 2040 plan does not envisage any immediate changes to the urban growth boundary in the Johnson Creek watershed. Instead new residents would be accommodated by denser development of lands within the present urban growth boundary. However, the 2040 plan does identify lands south and east of Gresham as "urban reserve" or lands that could be included in the urban growth boundary at some future time. If this occurs, the proportion of open space and agricultural land in the watershed will decline even further.

TABLE 4
Land Area and Stream Miles By Jurisdiction

	LAND AREA		STREAM MILES	
JURISDICTION	Acre	%	Miles	%
Portland	13,393	39.5	7.8	30
Milwaukie	1,235	3.6	1.7	6
Gresham	7,610	22.4	5.0	19
Happy Valley	45	0.1	-	-
Multnomah	3,694	10.9	7.0	27
Clackamas	7,927	23.4	4.7	18
TOTAL	**33,854**	**100.0**	**26.2**	**100**

Population and Community Characteristics

The presence of prehistoric relics along Johnson Creek and its tributaries indicates that Native Americans inhabited or periodically used the watershed in the nineteenth century and before. In the mid-1800s, the abundant timber and game, fertile farmland, and the navigable Willamette River attracted settlers of European descent to the Willamette Valley. By 1900, Portland's population had reached nearly 100,000, and was served by an extensive railroad network. In 1903, the railroad was expanded through the Johnson

FIG 8

Johnson Creek Watershed

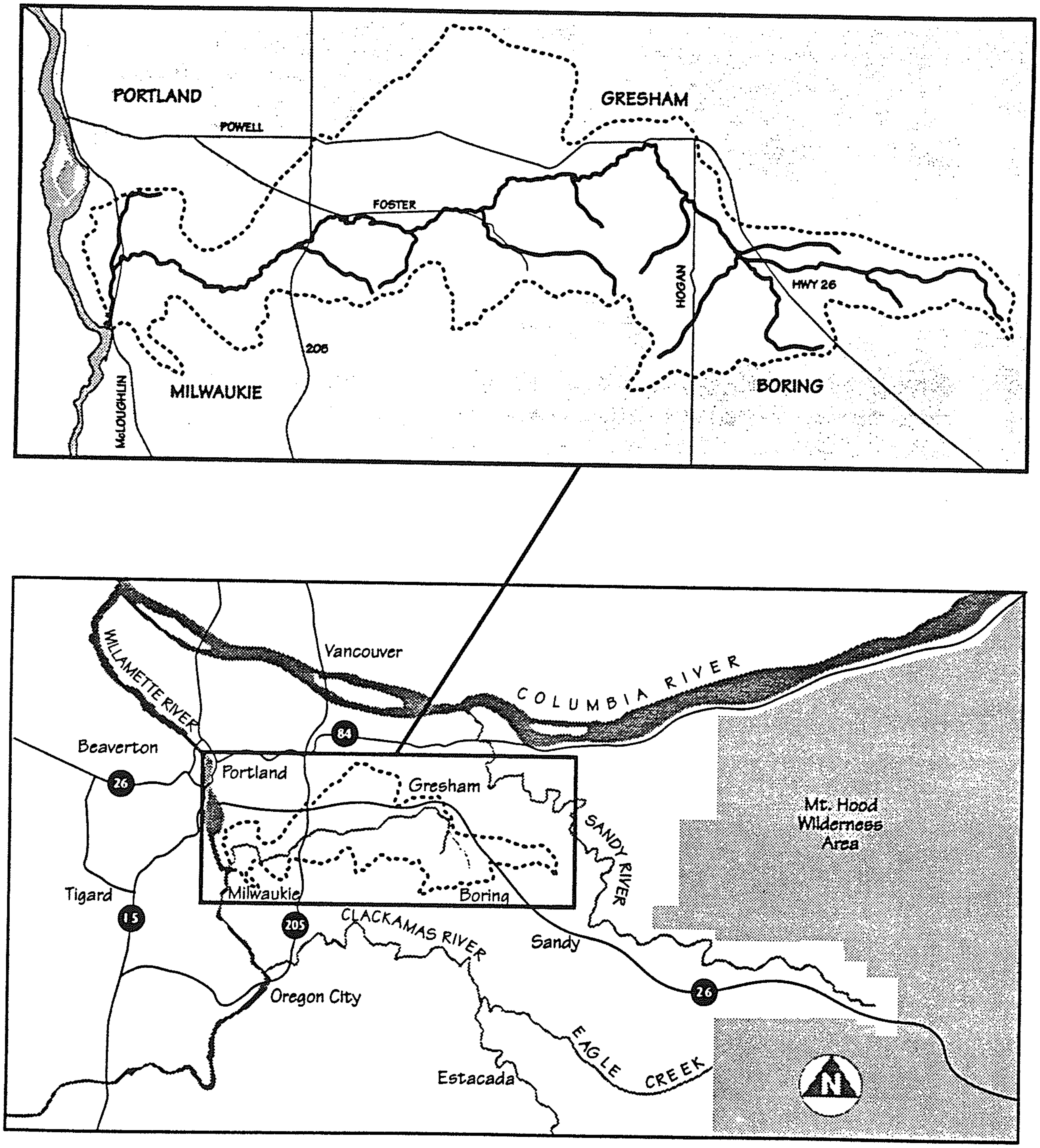
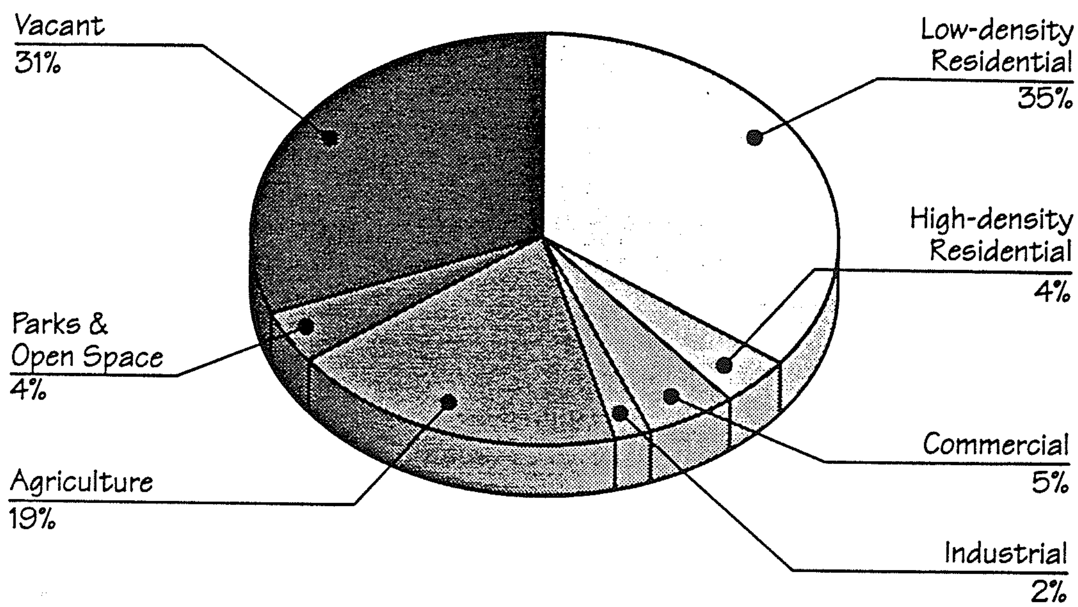


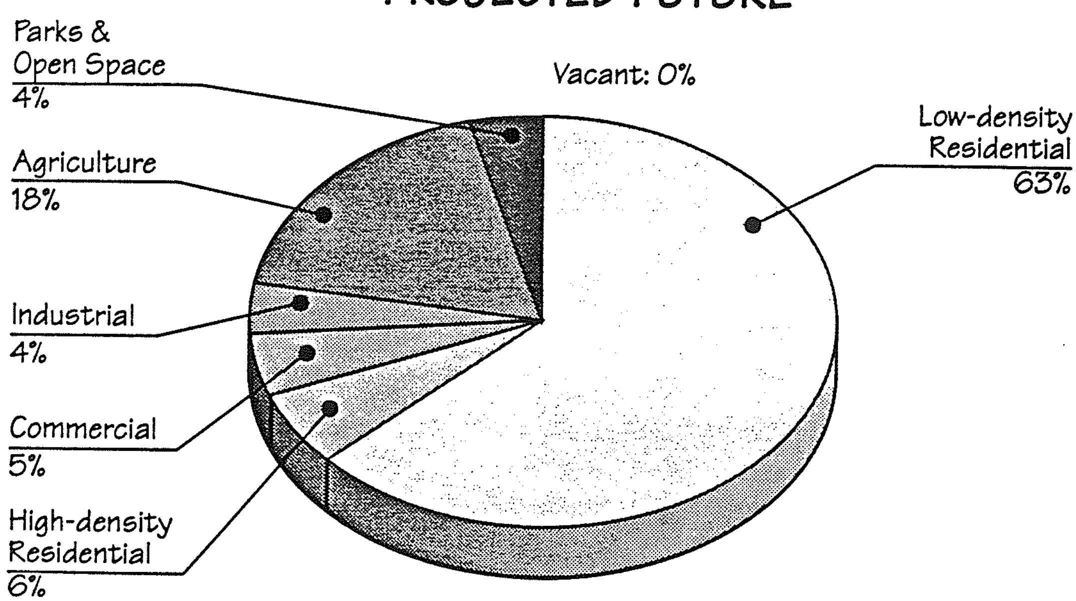
FIG 9

Land Use Percentages in Johnson Creek Watershed

EXISTING



PROJECTED FUTURE



Creek watershed to Gresham and on to Cazadero where a dam on the Clackamas River was under construction. Communities grew up all along the railway. The line had 54 stops, including stations at Sellwood, Milwaukie, Eastmoreland, Woodstock, Lents, Powellhurst-Gilbert, and Gresham. Although the Springwater Line discontinued service in the 1930s due to the effects of the Great Depression and the advent of the automobile age, the communities along the railway continued to thrive.

Population in the Johnson Creek watershed is growing rapidly. The estimated watershed population at the time of the 1980 census was 96,000. By 1990, it was approximately 120,000. Today, it is probably close to 130,000.

The socio-economic characteristics of the communities in the watershed are varied. At the western end of the watershed, Johnson Creek passes through Eastmoreland, one of Portland's most prosperous neighborhoods with household income almost twice the city's average. To the east, household income declines to less than the city's average in the Brentwood-Darlington and Lents neighborhoods of the Outer Southeast District.

Further upstream, Johnson Creek passes through Gresham, a rapidly-growing suburban community that is home to many Portland commuters. Household incomes in Gresham are higher than those for the Outer Southeast District of Portland.

Hydrology and Flooding

Rainfall in the Johnson Creek watershed averages 53 inches per year. About 20 inches per year drain from the watershed to the Willamette River via Johnson Creek. The remainder evaporates, is used by plants, or percolates deeply into the ground. Soils to the north of the stream are generally very permeable, while soils to the south are impermeable. As a result, most of Johnson Creek's tributaries originate from the south.

Johnson Creek is a "flashy" stream; that is, it responds rapidly to precipitation over its watershed. Water levels in the downstream reaches can rise and overflow stream banks within a few hours of the onset of rain. Damaging floods have often been associated with rainfall on accumulated snow. That was the case last year when a serious flood occurred on February 24, 1994, and also in 1964 when the largest recorded flood occurred.

A number of neighborhoods along the creek are subject to frequent flooding. The most severely affected area is in the Lents neighborhood near the intersection of S.E. Foster Road and S.E. 108th Avenue. Other flood vulnerable areas are at S.E. 158th Avenue and Foster, Bell Station, S.E. Johnson Creek Boulevard and S.E. 45th Avenue, and S.E. Milport Street.

Water Quality

Water quality in Johnson Creek is generally consistent with what might be expected in an urban creek. Water quality has probably improved considerably since 1935 when a surveyor noted that the creek was heavily polluted by domestic and sawmill wastes. Since that time domestic wastes have been diverted to the municipal sewer or engineered septic tank systems. Sawmill and other industrial waste discharges have either been discontinued or rerouted to the municipal sewer. Despite these improvements, water quality still does not meet federal and state standards for "fishable, swimmable" waters.

The principal source of pollutants entering the creek is stormwater runoff from urban and agricultural lands. Rain falling on streets, parking lots, homes and businesses, carries the detritus of city life into the storm drains and on to rivers and streams. Oil and grease, metals, and street litter are all washed into urban creeks without treatment. In agricultural areas, runoff carries eroded soil and pesticides into natural waterways. Water quality is also degraded by periodic chemical spills. Although spills do not occur often, they can have a devastating effect on water quality and aquatic life.

Biological Resources

Vegetation in the Johnson Creek watershed has been greatly altered since the beginning of European settlement in the mid-nineteenth century. Extensive old-growth coniferous forests were cut for timber and the fertile lowlands cleared for agriculture. Later, small residential communities were established, ultimately growing to form the current urban and suburban communities. Today, the watershed is a mosaic of vegetation types, including agricultural lands, urban and suburban landscapes, upland forest, riparian woodland, and wetlands. Remnants of pre-development vegetation are rare.

Wildlife within the more urbanized portions of the watershed is limited to those species capable of co-existing with humans and able to exploit small patches of suitable habitat within an urban or suburban landscape. They include American crow, American robin, European starling, song sparrow, Bewick's wren, house finch, cedar waxwing, violet-green swallow, belted kingfisher, great blue heron, mallard, wood duck, bushtit, black-capped chickadee, raccoon, opossum, nutria, and moles. The less developed areas in the upper watershed probably support a greater diversity of wildlife species that are characteristic of forest and farm land. They are likely to include many of the species common in the suburban areas but also western flycatcher, black-headed grosbeak, orange-crowned warbler, woodpeckers, black-tailed deer, coyote, deer mouse, voles, and bats.

Nothing is known about fish populations in Johnson Creek before European settlement. It seems likely, however, based on comparisons with less-disturbed streams in the lower Willamette watershed, that Johnson Creek supported runs of steelhead trout, coho, and chinook salmon. Conditions for these fish declined after the watershed was settled, logged, and converted to agricultural and urban uses. Channelization of much of the creek by the Works Progress Administration in the 1930s and the use of the creek for wastewater disposal further exacerbated already-deteriorated conditions. Water quality in the creek has probably improved somewhat in recent years. Currently, Johnson Creek contains many small non-game fish, but only a remnant of the historic salmonid runs.

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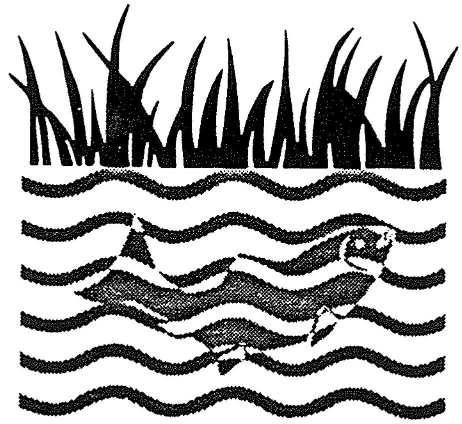


CHAPTER 4

THE JOHNSON CREEK RESOURCES MANAGEMENT PLAN

The Johnson Creek Resources Management Plan is a comprehensive plan for managing the natural resources of the Johnson Creek watershed. The plan is organized in four elements:

- Pollution prevention
- Flood management
- Fish and wildlife habitat improvement
- Watershed stewardship

The four elements are fully integrated with each other and, together, they comprise the comprehensive plan.

Each plan element begins with a description of the environmental problems afflicting the watershed and goes on to develop a strategy for their solution. The heart of the plan is a list of objectives and related actions. The objectives are general statements of intent based on the goals established by the JCCC and listed in Table 2. Under each objective are listed a series of actions that, if taken collectively, will result in the progressive enhancement of Johnson Creek and its watershed. In some cases, the party responsible for an action is a yet-to-be-formed watershed management organization (WMO). The WMO will be the successor to the JCCC as discussed in the Watershed Stewardship Plan Element.

POLLUTION PREVENTION PLAN ELEMENT

WATER POLLUTION AND ITS CONTROL

A BRIEF HISTORY OF WATER POLLUTION

The quality of water in Johnson Creek is influenced by a large number of natural and cultural factors. Before settlement or use by man, natural factors alone (topography, soils and vegetation) influenced creek water quality. Precipitation falling on plants, soils and leaf litter would dissolve salts and complex organic chemicals and carry them to the water course. Decaying vegetation would also contribute dissolved substances to the stream. Now these natural processes continue, but they are radically altered by the hand of man. Logging, agriculture, and urban development have changed the face of the watershed and with it the nature of the substances entering the creek.

The history of Johnson Creek parallels that of many streams and rivers in the United States. Relatively pristine in the days before European settlement, water quality deteriorated as the forests were cut and agriculture expanded. Further deterioration occurred as the industrial revolution transformed the economy and the cities grew. The quality of North American rivers and streams probably reached its low point in the 1940s and 1950s. Until that time government regulation of water pollution was limited to cases where public health was directly threatened. Little or no effort was made to protect water quality, aquatic life or the scenic quality of streams.

In the 1940s, 1950s, and 1960s the condition of many urban rivers became so objectionable that local communities were often forced to act. Gross pollution of the Willamette River in Portland, for example, led to the construction of a sewer interceptor system that conveyed sewage to a treatment plant which discharges to the Columbia River. Nationally, concern about environmental problems grew, culminating in the passage of much federal and state environmental legislation, including the Federal Water Pollution Act Amendments of 1972, the nation's first comprehensive water pollution control legislation.

FEDERAL WATER POLLUTION CONTROL LEGISLATION

The goal of the Water Pollution Control Act Amendments of 1972 was to restore all of the nation's waters to a "fishable and swimmable" condition. This goal was to be met by the establishment of a nationwide regulatory program called the National Pollutant Discharge

Elimination System (NPDES). Every wastewater discharge to the nation's waters was required to have a permit issued under the NPDES. The NPDES is administered by the U.S. Environmental Protection Agency (EPA). In Oregon, the EPA has delegated administration of the program to the Oregon Department of Environmental Quality (DEQ).

The amendments delineated two different sources of water pollutants, point sources and non-point sources. Point sources of pollutants are those that enter the nation's waters at a single, easily-identifiable point. A city wastewater treatment plant is an example of a point source because it discharges at a single location. Non-point pollutants are those that emanate from a dispersed source and enter waterways at many locations. Urban and agricultural areas are sources of non-point pollutants. They enter streams and rivers from numerous urban storm drains and rural drainage ditches.

Although it was always understood that a substantial proportion of the pollutants reaching the nation's waters were from non-point sources, little was done to control them in the two decades after passage of the amendments. Instead, control of point sources was emphasized because point sources produced the most severe and noticeable cases of pollution. In 1987, the Congress, dissatisfied with progress in controlling non-point sources of water pollutants, strengthened federal water pollution control legislation with the passage of the Clean Water Act. The act required the extension of the NPDES to cover urban runoff, a major non-point source of pollutants. Currently regulations written to implement the act require that large and medium-sized communities with separate municipal storm sewer systems obtain NPDES permits to discharge stormwater.

REGULATION OF WATER QUALITY IN JOHNSON CREEK

Control of water pollution is usually accomplished in four steps which are generally outlined in the Clean Water Act. First, the beneficial uses that a water body must support are identified. Second, instream water quality standards are set which will allow the desired beneficial uses. Third, limitations are set for pollutant discharges into the water body that are consistent with the instream water quality standards. These discharge limitations are often referred to as effluent limits. Finally, action is taken to ensure that pollutant discharges are controlled to the degree necessary to meet effluent limits. Each of these steps has been taken, fully or partially, in the Johnson Creek watershed.

The DEQ has prepared, and periodically updates, a statewide water quality plan. It was prepared pursuant to the Clean Water Act and is contained in Section 41 of the Oregon Administrative Rules. The plan establishes the designated beneficial uses of all water bodies in Oregon. The designated beneficial uses of Johnson Creek are public and private domestic water supply, industrial water supply, irrigation, livestock watering, anadromous fish passage, salmonid fish rearing, salmonid fish spawning, resident fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, and hydropower. This means that the waters of Johnson Creek must be managed to support the designated beneficial uses.

The DEQ has established instream water quality standards for Johnson Creek that are consistent with the beneficial uses. The standards are summarized in Table 5. The DEQ has also issued NPDES permits to several wastewater dischargers in the Johnson Creek watershed. The NPDES permits are consistent with the instream standards and are discussed later in this plan element. Despite the DEQ's actions to control point sources of water pollutants, water quality in Johnson Creek does not meet DEQ's instream standards.

Streams, or portions of streams, that remain out of compliance with instream standards after application of conventional controls to point sources are referred to as "water quality-limited." The Clean Water Act requires that water quality-limited stream segments be subject to further analysis to determine the level of control necessary to achieve

TABLE 5
In-stream Water Quality Standards for Johnson Creek

Dissolved Oxygen	Shall not be less than 90% of saturation at seasonal low or less than 95% of saturation in spawning areas during spawning, incubation, hatching and fry stages of salmonid fishes.
Temperature	No measurable increases shall be allowed outside of the assigned mixing zone, as measured relative to a control point immediately upstream from a discharge when stream temperatures are 58o F or greater; or more than 0.5o F increase due to a single-source discharge when receiving water temperatures are 57.5o F or less; or more than 2o F increase due to all sources combined when stream temperatures are 56o F or less.
Turbidity	No more than a 10 percent cumulative increase in natural stream turbidities shall be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity.
pH	Shall not be lower than 6.5 or greater than 8.5.
Fecal Coliform	Shall not exceed a log mean of 200 fecal coliform per 100 milliliters based on a minimum of 5 samples in a 30-day period with no more than 10 percent of the samples in the 30-day period exceeding 400 per 100 ml.
Total Dissolved Solids	Shall not exceed 100 mg/L.
Toxic Substances	Shall not be introduced above natural background levels in the waters of the state in amounts, concentrations, or combinations which may be harmful, may chemically change to harmful forms in the environment, or may bioaccumulate to levels that adversely affect public health, safety, or welfare; aquatic life; or other designated beneficial uses. And, toxic substances shall not exceed the most recent criteria values for organic and inorganic pollutants established by EPA and published in Quality Criteria for Water (1986).

compliance with instream standards. Mathematical models are used to establish a "loading capacity"; that is, the greatest amount of pollutant loading the stream can receive without violating water quality standards. Total maximum daily loads (TMDLs) are then established for each pollutant of concern and allocated among the various point and non-point sources of pollutants.

Although the requirement for waste load allocations in water quality-limited streams has been in effect for more than 15 years, it has been widely disregarded. Oregon, in common with most states, had not implemented the waste load allocation provision of the Clean Water Act by the late 1980s. At that time, Oregon's failure to perform waste load allocations was challenged in the courts. The court found in favor of the plaintiffs and directed the state to perform a waste load allocation for water quality-limited streams. The DEQ is currently analyzing two water quality-limited streams each year and establishing TMDLs. In the Portland area TMDLs have been established for the Tualatin River.

Pursuant to the Clean Water Act, the DEQ conducts a biennial review of water quality data from water bodies in Oregon and determines whether the water bodies meet ambient standards. It also identifies those water bodies judged to be water quality-limited. Johnson Creek is judged to be water-quality limited because it fails to comply with standards for bacteria and pH. The latter is a measure of the acidity or alkalinity of creek waters. A possible reason for summertime non-compliance with pH standards is excessive growth of algae which then affects water chemistry. The DEQ expects to establish TMDLs for Johnson Creek at some time in the future, but probably not for several years. Other water quality-limited stream segments in the state have been given a higher priority.

The pollution prevention element of the RMP will build on the foundation of water pollution abatement actions taken over the last 20 years. As a preface to the pollution prevention plan element, the following paragraphs describe water quality problems in Johnson Creek and the pollutant sources that cause them.

Water Quality Problems in Johnson Creek

Water quality in Johnson Creek is generally consistent with what might be expected in an urban creek. Water quality has improved considerably since 1935 when a surveyor noted that the creek was heavily polluted by domestic and sawmill wastes. Since that time domestic wastes have been diverted to the municipal sanitary sewer system or engineered septic tank systems. The sawmills have gone out of business and most other industrial waste discharges have been rerouted to the municipal sanitary sewer system.

The quality of water in Johnson Creek has been tested by a number of different agencies over the last twenty years. The most recent water quality studies were made by the U.S. Geological Survey, by the City of Portland, and by teams of volunteers organized by the City of Portland. Other information has been gathered by the DEQ and Portland State University. All available data on water quality in Johnson Creek has been compiled and analyzed for the RMP. The results of the work can be found in Technical Memorandum

No. 3 – *Water Quality in Johnson Creek – A Summary of Existing Studies and Data.* Various aspects of stream water quality are discussed below.

WATER TEMPERATURE

Water temperature depends on the source of stream water, the volume of flow, weather conditions, and the extent of shading by vegetation. It is important because certain fish species usually regarded as the most desirable, coho salmon for example, have a preferred temperature range and cannot survive when temperatures rise above the range. The EPA estimates that the maximum weekly average summer water temperature conducive to growth of coho salmon is 18°C. The maximum temperature coho salmon can survive for short periods of time is 24°C.

Water temperature in Johnson Creek in the summer is elevated above predicted temperatures for undevelopment conditions because flow and shading have been reduced. Continuous recording thermographs (temperature-measuring devices) were installed at several locations on Johnson Creek between June, 1992 and February, 1993. The highest temperatures were recorded in June, July, and August. Maximum average weekly water temperatures exceeded 18°C in all sections of the creek below Gresham. The maximum temperature recorded was 24°C.

DISSOLVED OXYGEN CONTENT

Almost all aquatic life needs dissolved oxygen to survive. In natural streams, oxygen is gradually consumed as leaves, algae, and other vegetation decay. It is replaced by oxygen dissolved from the atmosphere above the stream. In deep, warm, and slow moving streams oxygen can often become depleted. Oxygen depletion does not usually occur in fast moving, turbulent streams. For much of the year, dissolved oxygen levels in Johnson Creek are high. The highest and lowest dissolved oxygen values occur during summer when creek flow is low. The low values were recorded in the middle reaches of the creek and were attributed by the DEQ to decomposition of organic matter in stagnant pools. The high values occur during the daytime as a result of algal photosynthesis. The EPA average monthly dissolved oxygen criterion for most life stages of salmonids and other cold water fish species is 6.5 mg/l. In a recent survey conducted during summer low flows (August/September 1992), 18 of 112 samples (or 16 percent) had oxygen levels less than 6.5 mg/l. All of the low oxygen levels were measured between river miles 7 and 14 where the creek is relatively flat and flow rates are low compared to other reaches.

PLANT NUTRIENTS

In common with terrestrial plants, aquatic plants need nutrients (e.g., nitrogen and phosphorus) to grow. Aquatic plants obtain their nutrients from flowing water. If high concentrations of nutrients are available during the warm summer months, then excessive aquatic plant growth can choke a stream. Large crops of algae cause wide diurnal swings in dissolved oxygen content as the plants produce oxygen during daytime photosynthesis and consume oxygen during nighttime respiration. When the plants die, the mass of decaying vegetation can severely deplete oxygen content.

Although concentrations of nitrogen and phosphorus currently found in Johnson Creek are sufficient to cause it, excessive algal growth does not appear to be a major problem in Johnson Creek. Total phosphorus concentrations measured in the last four years in Johnson Creek have been in the range of 0.04 to 0.26 mg/l. While no instream standards exist for total phosphorus in Johnson Creek, similar standards set by the DEQ for summer time flows in portions of the Tualatin River are no more than 0.07 mg/l.

BACTERIA AND OTHER MICROBES

Bacterial contamination of stream water does not appear to have a harmful effect on aquatic life; however, it can adversely affect swimmers and consumers of fish or shellfish taken from bacterially-contaminated waters. Most studies of Johnson Creek waters have shown bacteria levels considerably in excess of the fecal coliform standards shown in Table 5. The fecal coliform standards are designed to protect the health of swimmers and others who use the stream for recreation.

SEDIMENT

All streams carry a certain amount of sediment as stream flow erodes banks and creates bars. Suspended sediment is not regarded as a pollutant unless it is present in excess. High levels of suspended sediment can directly injure fish and blanket the gravel beds needed for successful salmonid spawning. Salmonid eggs must be laid in well-aerated gravel, if they are to hatch successfully. In common with most streams, suspended sediment concentrations in Johnson Creek increase during storm events.

Sources of sediment in the watershed include bank erosion as the stream channel widens and deepens in response to increased post-development peak flows and runoff from construction sites, agricultural fields, logged areas and other areas where the ground surface is disturbed. Because of the increased availability of sediment compared to pre-development conditions, siltation of the stream channel during the periods between large storms has become more severe.

TOXIC MATERIALS

Toxic materials affect Johnson Creek in two ways. Certain toxic substances, heavy metals such as mercury, and synthetic organic chemicals like the pesticide DDT may be washed into the stream with storm runoff from agricultural fields and industrial sites. These substances, which are usually attached to particles of soil, sink to the bottom of the stream and are incorporated into the stream sediments. Depending on circumstances, the toxic substances may remain bound up in the sediments or they may be consumed by microorganisms and enter the food web. If they enter the food web, the substances can have adverse effects on aquatic life in unpredictable ways. For example, the reproductive failure of many fish-eating birds as a result of DDT-induced eggshell thinning was not foreseen.

Concentrations of copper, lead, and zinc in Johnson Creek sediments are higher than would be expected in an unpolluted environment. Concentrations of the pesticide DDT and the industrial chemical PCB in Johnson Creek sediments exceed (suggested) applicable EPA sediment criteria.

The other way toxic materials reach Johnson Creek is as a result of spills. Sudden discharges of industrial chemicals into the stream as a result of mishaps are quite common. For example, a chemical spill near SE 52nd Avenue on August 4, 1993, killed between 500 and 1,000 fish, including 15 steelhead. Less noticeably, spills of chemicals far from the creek may percolate into the groundwater and eventually migrate toward streams. While the effects of individual spills may dissipate within a few hundred feet, the cumulative effect of multiple spills is an important factor in reducing the value of Johnson Creek as fish habitat.

Sources of Pollutants

Potential sources of water pollutants can be conveniently divided into five categories as follows:

- Municipal wastewaters
- Industrial wastewaters
- Urban stormwater runoff
- Stormwater runoff and other wastewaters from rural areas
- Spills to ground and surface waters

Each of these pollutant sources is discussed below, together with an assessment of their effect on Johnson Creek water quality. NPDES pollutant discharge permits, on file at the DEQ for the Johnson Creek watershed, are discussed where applicable in the following description of pollutant sources.

MUNICIPAL WASTEWATERS

Municipal wastewater is a mixture of domestic sewage and commercial and industrial wastewater generated within an urban area. Municipal wastewaters are usually collected in underground sanitary sewers and conveyed to a treatment plant. After treatment, effluent is typically discharged to a large river or the ocean. Some low-density residential areas within a city may dispose of wastewater to individual septic tank and drain field systems. Septic tank systems are effective in urban settings only if lots are large, soils are ideal and the systems are well-maintained. As an urban area expands and population densities increase on the urban fringes, municipal sanitary sewer systems are usually built to replace septic systems. This process is proceeding in the Johnson Creek watershed. The following paragraphs describe the existing municipal sanitary sewer systems and septic systems in the watershed and describe their relationship to Johnson Creek.

■ LARGE COLLECTION SYSTEMS

The Johnson Creek watershed covers approximately 33,000 acres. Thirty-eight percent of the developed portion of the watershed is served by municipal sanitary sewers. The remainder is served by septic tanks, cesspools or very small packaged wastewater treatment plants. Major sanitary sewer systems are operated by the cities of Portland, Milwaukie, Gresham, Happy Valley, and Clackamas County. Table 6 shows the acreage of sewered area within each jurisdiction and within the watershed.

TABLE 6
Sewered Areas Within the Johnson Creek Watershed

Jurisdiction	Developed Area Within the Watershed (acres)	Sewered Area Present Area	Present %	Sewered Area Future Area	Future %
Portland	11,264	3,267	72	9,427	85
Milwaukie	1,235	1,235	100	1,235	100
Gresham	3,143	2,699	85	3,143	100
Happy Valley	45	0	0	0	0
Unincorporated Multnomah County	80	0	0	0	0
Unincorporated Clackamas County	4,984	554	11	554	11
TOTAL	**20,751**	**7,825**	**38**	**14,357**	**69**

In general, the older, more densely developed neighborhoods in Portland, Milwaukie, and Gresham are sewered, while the fringes of the cities and the unincorporated areas are unsewered. By the year 2000 relatively large areas in the Brookwild, Lents Junction, and Powellhurst neighborhoods of Portland will be sewered. The Gresham sanitary sewer system is also expected to expand by 2000 or shortly thereafter.

Portland's municipal sanitary sewer system differs from those of the other cities and counties within the watershed. Much of Portland's collection system is a combined system; that is, it collects both sanitary wastewater and urban stormwater. All other systems in the watershed collect only sanitary wastewater, while urban stormwater runoff is routed to a separate system of pipes and drainage ditches.

Combined sewer systems are an obsolete technology only found in the nation's older cities. They were built at a time when wastewater was not generally treated – it was simply piped to the nearest convenient water body and discharged at multiple locations referred to as outfalls. In Portland the water bodies were the Willamette River and Columbia Slough. After pollution of the Willamette became unacceptable in the 1940s, large interceptor sewers were built to convey wastewater from the city to a new treatment plant which discharged treated wastewater to the Columbia River. However, the capacity of the interceptor sewers is only about three times greater than the dry-weather wastewater flow. During anything other than light rain, the capacity of the interceptor sewers is exceeded, and combined sewage overflows to the Willamette River and the Columbia Slough at multiple locations. The City of Portland's on-going combined sewer overflow (CSO) control program is designed to correct, or at least minimize, the adverse effects of the overflows. No overflows occur in the Johnson Creek watershed.

Within the Johnson Creek watershed, about 2,100 acres of Portland are served by combined sewers. Another 1,100 acres are served by separate sanitary sewers that drain to the combined system. As Portland expands its wastewater collection system, it will only build separate sanitary sewers to avoid adding still more stormwater to an already overloaded combined system.

■ LARGE TREATMENT AND DISPOSAL SYSTEMS

Municipal wastewaters from the watershed are routed to one of three major treatment plants. Municipal wastewater from sewered areas of Portland is piped to the City of Portland's Columbia Boulevard Treatment Plant. After treatment, it is discharged to the Columbia River. Municipal wastewaters from sewered areas of Milwaukie, Happy Valley, and Clackamas County are piped to the Kellog Creek Treatment Plant operated by the Clackamas County Service District. Treated effluent is disposed of to the Willamette River. Municipal wastewater from Gresham is piped to that city's treatment plant at Sandy Boulevard and 201st Street where treated wastewaters are discharged to the Columbia River.

■ SMALL COLLECTION, TREATMENT AND DISPOSAL SYSTEMS

Two NPDES permits for discharges of domestic sewage in the Johnson Creek watershed are on file at the DEQ. They are listed in Table 7. A small domestic wastewater system serves the Happy Valley Homes mobile home park in unincorporated Clackamas County. The system includes a packaged treatment plant which discharges to Mitchell Creek, a tributary of Kelley Creek. The NPDES permit is for a discharge of 9,000 gallons per day of secondary-treated effluent.

During the high stream flow season, from November to March, a packaged treatment plant is also used to treat wastewater from the Pleasant Valley School in Portland (Gresham). The NPDES permit is for a discharge of 13,000 gallons per day to Kelley Creek. During the low flow season, from April to October, domestic wastewater from the school is discharged to a holding pond which is periodically pumped out and transported to Gresham's wastewater treatment plant.

Packaged treatment plants are small prefabricated plants that can be delivered by truck and installed on a prepared concrete pad. They are generally viewed with disfavor by water quality regulators because they must be actively maintained to produce satisfactory effluent. Packaged plants usually do not receive adequate maintenance and often fail to meet their prescribed effluent limits for this reason.

TABLE 7
NPDES Permits for Wastewater Discharges

Permit No.	Permittee	Location of Discharge	Volume (gal/day)	Type of Waste
100912	Happy Valley Homes, Inc.	River mile 1.3 on Mitchell Creek	9,000	Domestic
100686	Centennial School District Pleasant Valley School	Unnamed tributary to Kelley Creek	13,000	Domestic[a]
101133	Precision Castparts Corp.	Johnson Creek at river mile 3.0 and 3.5	365,000	Industrial - Cooling Water
0100-J	Industrial Materials Technology, Inc.	Drywell at river mile 4.2	35 - 135	Industrial - Cooling Water
0200-J	Gresham Court Club, Inc. which is now Cascade Court Club, Inc.	One mile N. of Johnson Creek at river mile 13.6.	Unknown	Industrial - Swimming pool filter backwash.
1700-J	Ted Decious Co., Inc.	Various Locations	Varies	Industrial - Washwater
1700-J	Northwest Natural Gas	Seeps into Ground	Unknown	Industrial - Washwater

Note:

a The packaged plant is used from November through March. Discharges go to a holding pond from April through October. The holding pond is periodically pumped out and wastes are taken to Gresham's treatment plant.

SEPTIC TANK SYSTEMS

As indicated in Table 6, septic tank systems currently serve approximately 62 percent of the developed portion of the watershed. Properly designed septic tank systems consist of a septic tank and drain field. Wastewater drains first to the septic tank where solids accumulate and are broken down by bacteria. The septic tank is usually an underground concrete or fiberglass structure. Effluent from the septic tank overflows to a drain field where it percolates into the ground. Septic tanks operate satisfactorily if they are designed to take account of soil and topographic conditions and are regularly maintained. Septic tank systems fail by "surfacing"; that is, effluent emerges at the surface rather than percolating into the ground.

Within the Johnson Creek watershed, septic tank systems are more likely to operate satisfactorily in the area to the north of the creek where soils are very permeable and groundwater levels are considerably below the surface. South of the creek, where soils are less permeable, there is a greater potential for problems. Paradoxically, it is in the area north of the creek that cess pits and septic tanks are being replaced by municipal sewers.

This is because the area north of the creek overlies groundwater bodies that are used for drinking water supply by the City of Portland and a number of small water purveyors. Discharges from thousands of individual cess pools and septic tanks are gradually increasing the nitrate content of groundwater. High nitrate concentrations can be harmful to infants. The Mid-County sewer project is designed to prevent nitrate from rising to harmful levels in the drinking water source.

Cities and counties were contacted to identify septic tank problems in the watershed. Clackamas County personnel indicated that septic tank systems are problematic in an area of the county bordered by I-205 on the east, King Road on the south, the City of Milwaukie on the west, and the Clackamas County boundary on the north. During the winter, soils in this area often become saturated and effluent from septic tanks surfaces rather than percolating into the ground. In a few cases, attempts have been made to solve the problem by constructing above-ground sand filters to increase treatment of septic tank effluent. However, the cost of each filter is about $10,000, so they are not likely to be applied widely.

■ MUNICIPAL WASTEWATER DISPOSAL AND JOHNSON CREEK WATER QUALITY

As described above, the large municipal sanitary sewer systems collect wastewater from the Johnson Creek watershed and convey it elsewhere. They do not discharge directly to Johnson Creek. Even when Portland's combined sewer system overflows, it does so to the Willamette River rather than Johnson Creek. Thus, operating as they should, the large municipal sanitary sewer systems have no adverse impact on water quality in Johnson Creek.

An exception to this may be the Johnson Creek interceptor sewer. The Johnson Creek interceptor, one of the large sewers built to direct combined sewage to the Columbia Boulevard treatment plant, parallels the creek from river mile 1 to river mile 12.5 at the Gresham city boundary. Because this line was buried below the water table, it was constructed with holes in the pipe bottom to prevent the pipe from being forced to the ground surface from water pressure in the soils (i.e., to prevent floatation). In its efforts to reduce groundwater infiltration to the combined system, the City has recently tried to plug some of the holes with concrete. However, obtaining a permanent seal is proving difficult. If the plugs can be maintained in place, then they would also prevent exfiltration. Exfiltration of wastewaters from the pipe could occur if the pressure of water in the pipe is greater than the water pressure of the soils. This is most likely to happen during dry periods when the water table is below the bottom of the pipe.

In addition to the Johnson Creek interceptor sewer, wastewater discharges from failing septic systems and small collection systems such as the packaged treatment plants located on Mitchell and Kelley Creeks (tributaries to Johnson Creek) could have a minor impact on water quality. The discharges from the treatment plants are too small to have much effect on water quality beyond their immediate vicinity.

INDUSTRIAL WASTEWATERS

Currently, two percent of the land in the Johnson Creek watershed is used for industrial purposes. Most industries within the watershed discharge their wastewater to the municipal sanitary sewer where it is treated and disposed of together with domestic sewage. A few industries discharge directly to surface or groundwater. A few others may be illicitly discharging to the separate storm sewer system. Direct industrial dischargers must obtain a permit under the NPDES system. Two kinds of direct industrial discharge permits are issued by the DEQ, general permits, and individual permits. Individual permits are issued to industrial dischargers that do not fall within any of the 10 general permit categories, or are unusual in some way.

One individual and four general direct industrial discharge permits are currently on file for the Johnson Creek watershed. Information from the permits is summarized in Table 7, together with information on domestic wastewater discharge permits. It should be noted that these permits are for the direct discharge of industrial wastewaters. They do not cover the discharge of potentially-polluted urban runoff from industrial sites. Separate permits are required for industrial stormwater discharges, and they are discussed later in this chapter.

■ DIRECT INDUSTRIAL DISCHARGES

The largest industrial discharger, and the holder of the individual industrial discharge permit, is Precision Castparts. Precision Castparts includes two casting foundries located next to each other on S.E. Johnson Creek Boulevard (a foundry is a plant where metals are melted and poured into molds or castings). One of the foundries uses titanium as a raw material, and one uses stainless steel alloys. The plant which uses stainless steel alloys discharges its process cooling waters to Johnson Creek at river mile 3.5. The temperatures of these discharges are often high ranging from 64°F to 115°F (18°C to 46°C). Precision Castparts plans to eliminate this discharge in the next year.

The four general industrial discharge permits are for: Northwest Natural Gas which discharges vehicle washwater to the ground at a location just south of Johnson Creek at river mile 6.6; the Ted Decious Company which discharges washwater from pressure washing of buildings to the ground and to the separate storm sewer system at various locations; the Gresham Court Club which discharges swimming pool filter backwash water to the separate storm sewer system approximately 1 mile north of the creek at river mile 13.6; and Industrial Materials Technology which discharges small volumes of cooling water to a dry sump just north of Johnson Creek at river mile 4.2.

Two other general permits were recently issued to permittees within the watershed. They are for temporary discharges to storm drains from groundwater remediation work associated with oil spills.

ILLICIT DISCHARGES TO STORM DRAINS

As noted above, most industrial process or cooling wastewaters generated in the Johnson Creek watershed are discharged to the municipal sanitary sewer system. Only a few industries discharge directly to surface or groundwater. However, it is suspected that some industrial wastewaters are being discharged to the separate storm sewer system in violation of the law. These illicit discharges may be a result of historic illicit connections unknown to the present owner, lack of familiarity with the law, or a deliberate attempt to circumvent water quality regulations.

In 1992 and 1993, municipalities in the watershed conducted investigations of storm sewer outfalls to determine whether flow was present during dry weather. These investigations were conducted to obtain data for NPDES stormwater permit applications. Flow during dry weather could be an indication of an illicit discharge. Table 8 shows the results of dry weather surveys in several local communities. In general, unexplained flow was found in about one-quarter of the outfalls surveyed. Some of the flow could be attributable to groundwater seepage, but it is likely that most is a result of illicit industrial discharges.

TABLE 8
Results of Dry Weather Surveys in Johnson Creek

Outfall Study Conducted By:	Number Investigated	Number Investigated with Flow	Percent of Investigated with Flow
City of Portland	111	30	27
City of Portland	33	7	21
City of Gresham	62	12	19
Clackamas County	45	12	27
TOTAL	**251**	**61**	**24**

INDUSTRIAL WASTEWATER DISCHARGES AND JOHNSON CREEK WATER QUALITY

Direct industrial discharges are not a major factor influencing Johnson Creek water quality. Most industrial wastewater is routed to the municipal sanitary sewer system and conveyed out of the watershed. Direct industrial discharges to surface and groundwater of the watershed are few and small in volume. The sole exception is the Precision Castparts cooling water discharge which may exacerbate the elevated creek water temperatures that occur in the summer. As noted above, this discharge will be eliminated shortly.

The industrial discharges with the most importance for water quality may be illicit discharges to the separate storm sewer system. Because these discharges are untreated and may be continuous, they can have a significant adverse impact on water quality and aquatic life. This is particularly true during the low flow period when little dilution is available and aquatic organisms are already under stress.

Stormwater runoff from industrial sites can also be important with respect to water quality. It is discussed in the following section, together with other elements of urban stormwater runoff.

URBAN STORMWATER RUNOFF

Urban stormwater runoff is rainwater or surface water that runs off streets, parking lots, storage yards, roofs and other surfaces, and flows into a natural waterway, drainage ditch or storm sewer system. As the runoff flows across these surfaces, it picks up pollutants such as bacteria, sediments, grease, oil, metals, garbage, pesticides, fertilizers, and detergents. Pollutants are carried into a separate municipal storm sewer system and from there into local rivers and creeks (or in some cases they are discharged into the ground).

The quality of urban stormwater runoff depends on land use and the activities that occur in a drainage area. Runoff from residential lands often contains pesticides and fertilizers associated with lawn and garden care; bacteria from pet wastes and litter; nutrients from yard debris, oil, grease, fuel, and detergents; antifreeze from automotive maintenance; and paints and solvents from home maintenance. Runoff from transportation corridors often contains oil, grease, fuels and antifreeze from automotive leaks; cadmium and zinc from tire wear; and copper from brake pad wear. Runoff from construction sites, which are present in all land uses, is a potential source of sediments and solvents. Runoff from commercial and industrial areas may contain a wide range of pollutants depending upon the industrial or commercial activity. Typical concentrations of pollutants in Portland's urban runoff from different land use types are shown in Table 9.

■ STORMWATER DRAINAGE SYSTEMS

Urban stormwater is conveyed away from homes and businesses in ditches and underground pipes, or storm sewers, that discharge to the nearest convenient natural waterway. In the more developed areas, the storm drainage system includes street curbs, gutters, inlets, and an extensive network of underground pipes. In the less developed areas, runoff is routed to swales and open drainage ditches.

North of Johnson Creek, and particularly in unincorporated Multnomah County, storm sewer design takes advantage of the natural permeability of the soil. Storm sewers are routed to dry wells or sumps where stormwater percolates into the soil. Elsewhere in the watershed soils are relatively impermeable and storm drainage is routed to surface streams.

■ STORMWATER PERMITTING PROGRAM

As noted earlier, in 1987 Congress amended the Clean Water Act and required that municipal and industrial stormwater discharges be included in the NPDES system. In

TABLE 9
Typical Pollutants of Concern Detected in Portland's Stormwater Runoff[a]

Parameter	Detection Limit		Predominate Land Use of the Drainage Area Sampled: Residential	Commercial	Industrial	Water Quality Standard[b]
Total Suspended Solids	1 mg/L	range: median:	18 - 127 46	14 - 295 69	37 - 1080 142	NA
Biochemical Oxygen Demand	1 mg/L	range: median:	nd - 30 7	nd - 108 11	12 - 160 49	NA
Total Phosphorus	0.05 mg/L	range: median:	0.07 - 1.20 0.22	0.06 - 1.10 0.27	0.35 - 1.30 0.63	NA
Nitrate	0.1 mg/L	range: median:	nd - 6.5 0.30	nd - 2.6 0.30	nd - 0.7 0.15	NA
Copper	0.001 mg/L	range: median:	nd - 0.049 0.012	0.003 - 0.100 0.022	0.013 - 0.120 0.045	0.008
Lead	0.001 mg/L	range: median:	0.003 - 0.038 0.010	0.014 - 0.270 0.056	0.008 - 0.170 0.039	0.028
Zinc	0.001 mg/L	range: median:	0.041 - 0.310 0.094	0.041 - 0.920 0.171	0.190 - 8.100 0.486	0.057
Total Oil and Grease	0.5 mg/L	range: median:	0.8 - 3.1 2.8	0.9 - 9.9 2.9	1.7 - 16.0 4.6	NA
Fecal Coliform	1 colony/ ml 100	range: median:	775 - 23,000 1,971	nd - 20,000 1,157	nd - 3,100 269	200

Notes:
- a Concentrations presented in the table represent event mean concentrations from samples collected during ten storm events (1991 – 1993).
- b These values for metals (i.e., copper, lead, and zinc) represent the acute criteria for aquatic species. These criteria are based on a hardness value of 43 mg/L which is an average hardness concentration for Johnson Creek.
- NA Water quality standards do not exist for these parameters.
- nd not detected

1990, the EPA issued regulations which require municipalities and industries to reduce pollution caused by urban stormwater runoff. The regulations require municipalities and specific classes of industries to apply for, and obtain, NPDES permits for their stormwater discharges.

Municipal permit applications include the results of monitoring and laboratory testing of stormwater to identify the types and concentrations of pollutants in runoff from different urban land uses. Municipal permit applications also include comprehensive stormwater management plans to reduce pollutants in urban stormwater runoff. Portland, Gresham, and Clackamas County were all required to apply for municipal stormwater discharge permits. Multnomah County is a co-applicant with both Portland and Gresham. Milwaukie and Happy Valley are co-applicants with Clackamas County. The three municipal permit applications were filed by these communities in May 1993. The DEQ expects to issue the stormwater permits discharge in 1995.

The industrial stormwater permit applications include the results of twice-yearly sampling of all of an industry's stormwater discharges and a stormwater pollution prevention plan. Currently, there are 20 permitted industrial stormwater discharges in the Johnson Creek watershed (see Appendix A). Existing stormwater permits within the Johnson Creek watershed cover discharges from construction, food processing, heavy industrial activities, light manufacturing activities, and transportation. Additional industrial stormwater dischargers exist in the Johnson Creek watershed which have not yet obtained the required permits from the DEQ.

When the NPDES stormwater regulations were developed by the EPA, it was recognized that controlling pollutants from non-point sources, such as urban runoff, was a very different proposition from the control of point sources. The control of point sources had been achieved largely by the application of structural, end-of-the-pipe treatment systems. End-of-pipe treatment is less applicable to non-point pollutant sources, such as urban runoff. Urban runoff is discharged to streams at numerous locations, through pipes, in ditches and across the surface of the ground. In a typical urban area, hundreds of systems would be needed to treat urban runoff. Because so many are needed, the treatment systems would have to be passive; that is, unlike sewage treatment plants, they would have to operate unattended. The technology of passive stormwater treatment facilities, usually referred to as pollution prevention, or water quality improvement facilities, is still evolving. In many cases there is insufficient space in already developed areas to build the facilities. Water quality improvement facilities are more practical in new development where they can be built as part of a comprehensive storm drainage system.

The NPDES stormwater regulations emphasize source control: the use of "best management practices," essentially good urban housekeeping measures, to reduce the availability of urban runoff pollutants at their source. Key elements of the stormwater plans from jurisdictions in the watershed are summarized in Table 10. An exception to the source control emphasis is the requirement that structural water quality improvement facilities be built into new development in some communities. Other structural controls may be needed in the future if source control proves to be insufficiently effective.

TABLE 10
Management Practices Proposed for NPDES Municipal Storm Water Permits

DESCRIPTION OF MANAGEMENT PRACTICES — PROGRAM PARTICIPANTS:	CITY OF PORTLAND	CITY OF GRESHAM	MULTNOMAH COUNTY	CLACKAMAS COUNTY*	ODOT
Structural and Source Controls for Residential and Commercial Areas					
Description of maintenance activities and maintenance schedule for structural controls to reduce pollutants	■	■	■	■	■
Description of planning procedures for developing, implementing, and enforcing controls to reduce the discharge of pollutants from areas of new development and significant redevelopment	■	■	■	■	■
Description of practices for operating and maintaining public streets, roads, and highways	■	■	■	■	■
Procedures to assure flood management projects assess impacts on the water quality of receiving waters and the existing structural flood control devices have been evaluated to determine if retrofitting the device is cost-effective	■	■	■	■	■
Program to monitor pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste	■		■	■	
Program to reduce pollutants associated with the application of pesticides, herbicides and fertilizers	■	■	■	■	■
Support government and community tree planting	■		■		
Evaluate practicability of providing financial incentives for property owners who protect natural areas considered to have valuable water quality characteristics	■		■		
Require operation and maintenance plans for facilities related to new private development	■	■	■	■	
Develop stormwater quality treatment facility requirements for new and redevelopment projects	■	■			
Program for Illicit Discharges and Improper Disposal Into the Storm Sewer System					
Program to implement and enforce an ordinance, orders or similar means to prevent illicit discharges to the storm sewer system	■	■	■	■	■
Description of procedures to conduct on-going field screening activities to search for illicit discharges	■	■	■	■	■
Procedures to investigate areas in question as detected during field screening	■	■	■	■	■
Procedures to prevent, contain, and respond to spills					
Program to promote, publicize, and facilitate public reporting of the presence of illicit discharges	■	■	■	■	■
Description of educational, public information, and other appropriate activities to facilitate proper management and disposal of used oil and toxic materials	■	■	■	■	■
Description of controls to limit infiltration of seepage from sanitary sewers to the municipal storm sewer system where necessary	■			■	

* Includes cities of Milwaukie and Happy Valley

TABLE 10
Management Practices Proposed for NPDES Municipal Storm Water Permits (continued)

DESCRIPTION OF MANAGEMENT PRACTICES / PROGRAM PARTICIPANTS:	CITY OF PORTLAND	CITY OF GRESHAM	MULTNOMAH COUNTY	CLACKAMAS COUNTY*	ODOT
Program to Monitor and Control Pollutants from Industrial Facilities Hazardous Waste Treatment, Disposal, Recover Facilities, and Municipal Landfills					
Procedures for inspections and establishing and implementing control measures for such discharges	■	■	■	■	
Describe a monitoring program for stormwater discharges associated with the facilities identified above	■	■	■	■	
Program to Implement and Maintain Structural and Non-Structural BMPs to Reduce Pollutants from Construction Sites					
Procedures for site planning which incorporate consideration of potential water quality impacts	■	■	■	■	■
Requirements for nonstructural and structural BMPs	■	■	■	■	■
Procedures for identifying priorities for inspecting sites and enforcing control measures which consider the nature of the construction activity, topography, and the characteristics of soils and receiving water quality	■	■	■	■	■
Description of appropriate educational and training measures for construction site operators	■	■	■	■	■

* Includes cities of Milwaukie and Happy Valley

■ URBAN STORMWATER RUNOFF AND JOHNSON CREEK WATER QUALITY

Urban stormwater is the largest source of pollutants entering Johnson Creek. Pollutants are primarily discharged to the creek during the wet season (November to May) following rainfall or snowmelt. In general, stormwater runoff pollutants are discharged at a time when streamflow is relatively high. Despite the high streamflow and the large amount of available dilution, instream concentrations of certain toxic metals (copper, lead, silver, and zinc) exceed applicable water quality standards.

Although urban runoff contributes a large mass of pollutants to Johnson Creek, the effects of most pollutants associated with urban runoff on instream water quality are transitory. Johnson Creek is relatively short and swift-flowing. Most pollutants discharged to the creek are rapidly carried out to the Willamette River. An important exception is sediments. Many of the more toxic parameters in urban runoff, namely metals, are associated with sediments. A portion of the sediments discharged with urban runoff settle out in the stream. Unlike the other components of urban runoff, polluted sediments may influence water quality year-round.

STORMWATER RUNOFF AND OTHER WASTEWATERS FROM RURAL AREAS

Most of the eastern end of the Johnson Creek watershed is open, rural land. Agriculture is the major activity in the eastern-most portion of the watershed. METRO estimates that approximately 30 percent of the watershed is devoted to agriculture, not including actively managed forests. As part of their Greenspaces program, METRO interpreted aerial photographs of the Johnson Creek watershed flown in 1992 and 1993 and classified the various agricultural land uses. Approximately 3,000 acres, or 50 percent of the agricultural lands, are devoted to cultivated crops or pasture. Another 1,160 acres, or 29 percent of the agricultural lands, are nurseries. About two percent of the agricultural lands is used for berry farms. The remaining 19 percent of the agricultural acreage could not be classified.

Sources of pollutants in rural areas of the Johnson Creek watershed include confined animal feeding operations (CAFOs) container nurseries, crop land, and grazing land. Discharges from two of these sources, CAFOs and container nurseries, are currently regulated by the DEQ. Stormwater runoff from cropland and grazing lands which may contain eroded soil, pesticides, and fertilizers, is not regulated.

■ CONFINED ANIMAL FEEDING OPERATIONS

Confined animal feeding operations (CAFOs), have considerable potential to harm water quality because they result in the accumulation of large amounts of animal waste at a single location. Animal waste, discharged to a stream untreated, has the same adverse effect on water quality as untreated human waste. It can cause oxygen deletion, nutrient enrichment, and elevated pathogenic bacteria levels.

CAFOs are regulated by the DEQ and the Oregon Department of Agriculture. The DEQ defines a CAFO as any operation where animals are confined for four months out of the year, or more, or any operation which includes a wastewater facility for animal wastes. CAFOs include feedlots, dairies and poultry production facilities. The DEQ issues water pollution control facilities (WPCF) General 0800-J permits to CAFOs for the land application of wastewaters. Although the permits are issued by the DEQ, the Oregon Department of Agriculture (ODA) maintains the permit files and administers the program. To date, three permits for CAFOs have been issued within the Johnson Creek watershed. In general, CAFO permits require that animal manure be stored properly so that there is no discharge to surface streams. Manure must be applied to cropland at a rate that corresponds to the crops' need for nutrients.

■ CONTAINER NURSERIES

Container nurseries are nurseries where plant stock is grown in containers rather than directly in the ground. Nurseries, both in-ground and container nurseries, are a major business in the Johnson Creek watershed. Containers are typically placed on graveled areas which act as underdrains. Pesticides, fertilizers and large amounts of water are applied to the containers during the dry summer months. With little or no soil to absorb them, pesticides and nutrients are washed into the underdrains. Until recently, drain water was discharged directly to drainage ditches and natural streams. As a first step toward abatement, the Oregon Association of Nurserymen, the ODA, and the DEQ developed a voluntary program for container nurseries to develop irrigation water management plans. The purpose of the plans is to eliminate discharge of irrigation water during the irrigation season (between May 1 and October 31 each year). To date, nineteen container nurseries have developed irrigation water management plans within the Johnson Creek watershed.

According to the Multnomah County agricultural extension service, a number of the container nurseries are voluntarily implementing a new practice of using a plastic burlap type of material to cover the ground under the containers (as opposed to using a gravel underdrain system). This permeable ground cover is used to prevent erosion and overland flow.

RURAL STORMWATER RUNOFF

Rural stormwater runoff is stormwater drainage and overland flow associated with open spaces, agricultural lands, managed forests, and sparsely developed lands outside urban areas. It is the least regulated major source of water pollutants. Runoff from open lands used for agriculture or silviculture differs from runoff from wilderness or natural areas. Agricultural activities and, to a lesser degree, forestry involve the periodic disruption of vegetation and the land surface. As a result the land becomes subject to much more rapid soil erosion. Eroded material is washed into natural stream channels at a rate that exceeds the stream's ability to move sediment downstream.

Agriculture's role in soil erosion has been recognized for many years. The dustbowl conditions of the 1930s were caused by soil erosion of marginal agricultural lands. The federal government, through the Soil Conservation Service, and local soil and water conservation districts, has sought to prevent a repetition by promoting farming methods that minimize soil erosion. However, even well-managed agricultural land still produces more sediment than natural areas.

Various chemicals, principally pesticides and fertilizers, are used in agricultural areas. Some of these chemicals are washed from plants and the soil and swept into natural drainage channels. Fertilizers washed into streams can result in nutrient-enrichment and the rapid growth of algae and other undesirable aquatic plants. Recently, the City of Portland obtained a list of agricultural chemicals commonly used in the Johnson Creek drainage area. This list includes more than 40 herbicides, fungicides, insecticides, and soil fumigants. For nurseries and crops, insecticides, herbicides, and fungicides are typically applied by spraying. The frequency of application generally ranges from two to six times a year.

GRAZING

Livestock grazing is widespread in rural areas of the Johnson Creek watershed. Unlike confined animal feeding operations, no permit is needed for conventional livestock grazing, where animals are not concentrated in a small space. Grazing can adversely affect water quality when livestock consume so much of the vegetative cover that soil erosion results. Furthermore, animals that use streams for their drinking water directly deposit fecal matter in the stream and accelerate erosion by consuming or trampling streamside vegetation. Mismanaged grazing can cause increased stream water temperature as a result of loss of shading, and elevated bacteria and sediment concentrations.

■ WASTEWATER FROM RURAL AREAS AND JOHNSON CREEK WATER QUALITY

The principal uncontrolled wastewater discharge from rural areas is stormwater runoff. While there is little data on pollutant concentrations in rural runoff from the Johnson Creek watershed, evidence suggests that pollutants from the agricultural areas are adversely affecting aquatic life. Particle size analysis of sediments in different reaches of the creek show higher concentrations of fine sediments in the upper watershed where agricultural activities take place. These fine sediments clog stream bottom gravels and make them unsuitable for spawning fish. Studies of macroinvertebrates, aquatic insects that provide food for fish, indicate that their number and diversity are much higher in the lower reaches of the creek than in the upper creeks. A plausible explanation is that pesticides contained in runoff from agricultural areas are depressing macroinvertebrate populations. Finally, studies by the U.S. Geological Survey have detected elevated pesticide levels in the sediments of Johnson Creek. Based on the above, it is apparent that water quality and aquatic life in Johnson Creek would benefit from better control of agricultural stormwater runoff.

SPILLS TO GROUND AND SURFACE WATERS

Spills to surface waters are usually not noticed or reported unless they are associated with fish kills. The Oregon Department of Fish and Wildlife maintains memoranda and reports regarding reported fish kills and other problems dating back to 1972. Of the 22 reports of fish kills from 1972 to 1988, sources were only identified for four of the episodes. Although these records indicate that spills severe enough to kill large numbers of fish are infrequent, their effects can be devastating. Lesser spills that may have chronic, adverse effects on aquatic life probably go unreported. Although there are a number of laws and regulations designed to prevent spills to surface waters they do not seem to be fully effective in protecting Johnson Creek.

Because groundwater provides much of the dry weather flow in Johnson Creek, the quality of the groundwater will influence the quality of water in the creek. West of Interstate 205, groundwater in the watershed flows generally westward toward the Willamette River. In areas downstream of S.E. 45th Avenue, where the creek is often in a canyon, numerous small springs discharge groundwater to it. Crystal Springs Creek, the major source of summertime flow in the lowest reaches of Johnson Creek, is fed by groundwater emerging from a spring at the the foot of an escarpment near S.E. 28th Avenue and S.E. Woodstock Boulevard. East of Interstate 205, groundwater flow is generally directed northward toward the Columbia Slough. Depths to groundwater in the Beggars-tick Marsh area are in the range 10 to 15 feet, but grow much greater moving northward. This reflects the granular character of soils in this area, where sumps are used to dispose of storm drainage waters (see discussion of watershed hydrology in flood management plan element).

Spills to the ground surface in the area east of Interstate 205 and north of Johnson Creek almost certainly percolate into the groundwater and move north toward Columbia Slough rather than south toward Johnson Creek. It is less clear where spills to the ground surface elsewhere in the watershed will travel. The great reduction in flow that occurs in the upper reaches of Johnson Creek in dry periods suggests that groundwater input to the creek is small, probably because much of the precipitation in the watershed runs off rapidly, or percolates into deep groundwater bodies far below Johnson Creek. Groundwater flow to Johnson Creek may be limited to a few areas where groundwater depths are shallow and springs emerge, or where local soil conditions result in a perched water table.

Although the relationship between spills that percolate into the ground and surface water quality in Johnson Creek is not known, spills or leaking underground tanks are potential sources of pollutants entering the creek in some parts of the watershed. DEQ lists eight sites in the vicinity of Johnson Creek where soil or groundwater is known to be contaminated. Four sites are listed as needing further action to clean them up. It appears that current federal and state programs to clean up existing contaminated sites and to prevent future contamination provide the creek with a reasonable level of protection from spills to the ground.

Pollution Control Strategy

Water quality in Johnson Creek has been, and continues to be, adversely affected by man's use of the watershed. In the last two decades, steps have been taken to improve water quality in the nation's streams, including Johnson Creek. Despite improvements, the creek remains polluted; it cannot meet the national goal of "fishable, swimmable" waters. Furthermore, it remains less of a natural resource than the community and the JCCC wish. In developing a strategy for further improvement, it is necessary to first answer a number of questions that will allow prioritization of pollution control activities: Which pollution sources are having the greatest adverse effect on the creek? Are there programs in place to control these pollution sources? How effective are the existing programs? The following paragraphs attempt to answer these questions. The answers are summarized in Table 11. They provide the basis for the priorities embodied in the pollution prevention plan element.

Direct permitted discharges of municipal and industrial wastewater are not a major problem for Johnson Creek. A control program is well-established and has been in place for 20 years. The RMP does not propose any new programs. Rather, it focuses on ensuring that the existing programs are effective.

Illicit industrial discharges to Johnson Creek via the separate storm sewer system are an important factor influencing water quality, particularly as they continue during periods of low creek flow. These discharges should be connected to the municipal sanitary sewer, but are usually inadvertently or, occasionally, deliberately connected to the separate storm sewer system instead. As part of their NPDES stormwater permit applications, Portland,

TABLE 11
Pollutant Sources and Their Importance to Johnson Creek

Pollutant Source	Existing Control Program?	Importance to Johnson Creek
Municipal/Industrial Wastewater		
• Direct discharges (permitted)	Yes	Low
• Failing septic tanks	Yes	Unknown, probably low
• Illicit connections	Yes*	High
Urban Runoff		
• Sediments and associated pollutants	Yes*	High
• Other pollutants	Yes*	Moderate
Spills	Yes	Moderate
Contaminated Groundwater	Yes	Unknown
Agricultural Wastewater		
• Rural runoff	No	High
• Container nurseries	Yes	Moderate
• Confined animal feeding operations	Yes	Low

Note:

* These programs are currently in the planning phase, effectiveness of the program will likely improve as plans are implemented.

Gresham, and Clackamas County are proposing programs to identify and eliminate illicit industrial connections. The RMP seeks to accelerate abatement of these pollution sources.

Urban runoff is the largest source of pollutants entering the stream. Although many of the effects of urban runoff are transient, the discharge of polluted sediments (and associated pollutants) can exert a long-term adverse effect on water quality. The existing urban runoff control program is at an early stage of development and emphasizes source control of pollutants. No municipal permits for stormwater discharge have yet been issued in the watershed, and only 20 of an estimated 200 industries have obtained permits for their stormwater discharges. The RMP seeks to build on the existing municipal stormwater runoff plans and supplement them with structural or end-of-pipe treatment systems where needed.

Wastewaters and runoff from rural areas are also a significant, although largely unmeasured, source of pollutants. Existing programs address the discharge of polluted irrigation water from container nurseries and from confined animal feeding operations, but they do not address the more general issue of rural runoff. Pesticides contained in the sediments of Johnson Creek are probably attributable to rural runoff in the upper watershed. The RMP proposes a more active approach to control of pollutants in stormwater runoff in the non-urban portions of the watershed.

Spills of various chemicals into Johnson Creek occur periodically. These spills do not occur often, but can have a devastating effect on water quality and aquatic life. Years of effort to improve a stream can be nullified in minutes, if a toxic chemical spill destroys a carefully-cultivated salmonid fish population. Federal regulations require that some facilities develop spill control, containment, and countermeasure plans. However, it does not appear that existing regulations are fully effective in preventing spills into Johnson Creek. The RMP needs to ensure that the arrangements for spill prevention are effective.

Plan Objectives and Actions

The pollution prevention plan is organized as a series of objectives and actions. The objectives are general statements of intent based on the goals established by the Johnson Creek Corridor Committee. They also respond to the pollution control priorities discussed earlier. The actions are specific programs and practices necessary to achieve the objectives and reduce water pollution. They are described below. Table 12 lists the objectives and actions, identifies the party responsible for each action, and includes an estimate of the cost of each action. In some cases, the party responsible for an action is a yet-to-be-formed watershed management organization (WMO). The WMO will be the successor organization to the Johnson Creek Corridor Committee (See Watershed Stewardship Plan Element).

OBJECTIVE PP-1
Prevent Pollution from Discharges of Municipal and Industrial Wastewater.

The actions under this objective address point sources of municipal and industrial wastewater in the Johnson Creek watershed.

Action PP 1-1
Periodically review direct discharges with applicable effluent limits and correct any violations.

There are three currently permitted direct discharges to Johnson Creek. The Happy Valley Trailer Park treatment system discharges an average of 9,000 gallons per day of treated domestic effluent to a tributary of Johnson Creek. Each year from November through March, the Pleasant Valley School treatment system discharges an average of 13,000 gallons per day of treated domestic effluent to a tributary of Johnson Creek. Precision Castparts discharges an average of 365,000 gallons per day of spent cooling water to Johnson Creek at River Mile 3.5. Each of these dischargers is currently required to meet waste disposal limitations and comply with minimum monitoring and reporting requirements.

Self-monitoring results are currently reported to the DEQ on a regular basis. Copies of the reports will be forwarded from the DEQ to the WMO. Where, and if, problems are

TABLE 12
Summary of Pollution Prevention Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective PP-1. Prevent pollution from discharges of municipal and industrial wastewater (JCCC Goals 1, 2, and 10)				
Action PP-1-1. Periodically review information on direct discharges with applicable effluent limits	WMO	Included in the cost of Action WS-1-3	Included in the cost of Action WS-1-3	C
Action PP-1-2. Permit no new direct municipal or industrial wastewaters to streams unless water quality is protected[1]	Oregon Dept. of Environmental Quality	0	0	B
Action PP-1-3. Conduct study of bacteria sources to determine role of failing septic tanks	Cities and counties	$75,000 (one-time cost)	$75,000 (one-time cost)	A
Action PP-1-4. Search for and eliminate illicit connections to the separate storm sewer system	Cities and counties	Included in Action PP-2-1	0	A
Action PP-1-5. Eliminate permitted discharges of industrial wastewater to the municipal separate storm sewer system[2]	Cities and counties	$18,000 (one-time cost)	$18,000 (one-time cost)	A
Action PP-1-6. Construct sanitary sewers to serve the problem septic/ cesspool area adjacent to the creek between river miles 4 and 6[3]	Cities of Milwaukie and Portland, and Clackamas Co.	$6,000,000 (initial cost)	0	C
Objective PP-2. Reduce pollutant discharge from urban stormwater runoff (JCCC Goals 1, 2, and 10)				
Action PP-2-1. Fully implement stormwater management plans developed for NPDES municipal stormwater permits[4]	Cities and counties	$800,000 per year	0	A
Action PP-2-2. Construct stormwater pollution reduction facilities in developed areas[5]	Cities and counties	$300,000 One-time cost and $15,000 annual cost	$300,000 One-time cost and $15,000 annual cost	A

NOTE:
1 This action involves no extra work. All proposed new discharges will be evaluated by DEQ in accordance with current procedures.
2 Portland has implemented this action. The RMP proposes to extend the action to Gresham and North Clackamas County
3 The priority of this action depends on the results of Action PP-1-3
4 The cost for this action represents planned expenditures on the Johnson Creek Watershed for the City of Portland, North Clackamas Co., and the City of Gresham. Rescheduling activities would not increase cost.
5 Estimated cost is for six high-priority stormwater pollution reduction facilities.

TABLE 12
Summary of Pollution Prevention Plan Element (Continued)

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective PP-2. Reduce pollutant discharge from urban stormwater runoff (JCCC Goals 1, 2, and 10) (continued)				
Action PP-2-3. Establish and implement comprehensive and effective basin-wide stormwater regulations for new developments[6]	Cities and counties (intergovernmental committee)	Included in Action PP-2-1	0	A
Action PP-2-4. Reduce pollutants in stormwater associated with construction activities	Cities and counties	Included in Action PP-2-1	0	A
Action PP-2-5. Ensure full compliance with industrial stormwater permits[7]	Oregon Department of Environmental Quality	$40,000 (One-time cost)	$40,000 (One-time cost)	A
Action PP-2-6. Periodically review information on municipal and industrial stormwater discharges	WMO	Included in Action WS-1-3	Included in Action WS-1-3	A
Objective PP-3. Reduce pollutant discharge from agricultural and other rural activities (JCCC Goals 1, 2, and 10)				
Action PP-3-1. Prepare water quality management plans for non-urban areas	Soil and Water Conservation Districts	$100,000 (One-time cost)	$100,000 (One-time cost)	A
Action PP-3-2. Develop and implement a rural non-point source pollution control program for non-commercial agricultural operations[8]	Soil and Water Conservation Districts	$40,000 (One-time cost)	$40,000 One-time (One-time cost)	B
Action PP-3-3. Periodically review information on container nurseries and confined animal feeding operation	WMO	Included in Action WS-1-3	Included in Action WS-1-3	C
Action PP-3-4. Periodically review compliance with Oregon Forest Practice rules	WMO	Included in Action WS-1-3	Included in Action WS-1-3	C

NOTE:
6 Related action: FM-1-1
7 This action is within DEQ's current responsibilities
8 Possible cost to private parties to abate pollution

TABLE 12
Summary of Pollution Prevention Plan Element (Continued)

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective PP-4. Prevent accidental spills into creek and tributary storm drains (JCCC Goals 1, 2, and 10)				
Action PP-4-1. Periodically review effectiveness of existing arrangements for spill prevention and control .	WMO/Portland Gresham, N. Clackamas Cty.	WMO cost included in Action WS-1-3	Included in Action WS-1-3	B

apparent or suspected, the WMO will work with the DEQ to ensure that any problems be corrected in a timely manner.

Action PP 1-2
Permit no new direct discharges of municipal or industrial wastewater to streams in watershed unless water quality is fully protected.

As noted above, there are three current direct discharges to Johnson Creek. Because water quality is already impaired and because very little dilution is available in the stream in the summer months, it would be preferable to avoid any new direct wastewater discharges. Within the urban areas, new municipal or industrial wastewater discharges should be routed to the municipal sanitary sewer. In rural or suburban areas, new residential or commercial development should be served by municipal sanitary sewers or effective septic tank systems. If there are no practical alternatives to a new discharge, then it must be treated to the degree that it reliably meets all applicable stream water quality standards.

The WMO will obtain notice of all new applications for waste discharges to Johnson Creek from the DEQ. The organization will comment to the DEQ on the acceptability of the applications with respect to meeting in-stream water quality standards. The proposed discharge will be evaluated with regard to its impact on the creek. The WMO may decide that the addition of a cool, relatively clean discharge may benefit the creek by adding to the flow volume. In most cases, new direct discharges will be opposed. The WMO will oppose the use of package treatment plants unless long-term maintenance can be guaranteed.

Action PP 1-3
Conduct study of bacteria sources in stream water and determine role of failing septic tanks in bacterial pollution.

Bacteria levels in Johnson Creek waters are usually higher than desirable. Bacteria levels are higher during wet weather than during dry weather, but almost always exceed standards for water-contact recreation. During wet weather, elevated bacteria levels are probably caused by stormwater washing domestic and wild animal excrement into the creek. The source of bacteria during dry weather is unknown. It could result from use of the creek by wild and domestic animals, or from failing septic tank systems or exfiltration from the Johnson Creek interceptor sewer. In order to target remedial action, it would be desirable to pinpoint the source or sources of bacteria in the creek. This can be done by examining the genetic structure of bacteria found in the creek. A similar study in the Pipers Creek watershed in Seattle identified domestic cats as an important contributor to bacteria in the creek. If the bacteria in Johnson Creek are of human origin, then it is likely they come from failing septic tanks or the interceptor sewer.

If it is determined that bacteria in creek waters are from pets, domestic animals and wildlife, then little can be done beyond implementing best management practices for stormwater runoff control to reduce the accumulation of various pollutants in the watershed (see Action PP-2). If the bacteria are shown to have a human origin, then the replacement of failing septic tanks and cesspools in certain parts of the watershed could be accelerated. It is not certain, however, that the benefits of reducing the bacteria levels in the creek are commensurate with the costs of control. Although it is always desirable to have relatively bacteria-free water in urban creeks, the actual threat to public health and aquatic life may be quite small.

Action PP 1-4

Search for and eliminate illicit industrial discharges to the municipal storm sewer system.

Illicit discharges to separate storm sewer systems are defined as any discharges that are not composed entirely of stormwater. Discharge of excess fire-fighting water and industrial wastewater discharges permitted by DEQ are exceptions to the rule. The latter circumstance is addressed in Action PP-1-5.

Elimination of illicit discharges is a major goal of the stormwater management plans recently prepared by Portland, Gresham, and Clackamas County (see earlier discussion of urban stormwater regulations and also Action PP-2-2). Each jurisdiction's stormwater plan includes a multi-step program to eliminate illicit discharges over a five-year period. None of the plans give special priority to the Johnson Creek watershed, so it may be several years before field crews investigating illicit connections reach the watershed. The WMO will request each jurisdiction to give high priority to detection and elimination of illicit connections in the Johnson Creek watershed. In establishing priorities within the watershed, it should be noted that illicit connections to combined sewers or to storm sewers that drain to sumps do not directly affect the creek.

Action PP 1-5

Eliminate permitted discharges of industrial wastewater, other than stormwater, to the municipal separate storm sewer system.

DEQ has historically issued permits which allow industries to discharge process or cooling wastewater to municipal storm sewers. An industry must treat its wastewater to the extent deemed necessary by DEQ, but is then permitted to use the municipal separate storm sewer to convey the treated wastewater to its ultimate disposal point, usually a stream or river.

The Clean Water Act amendments of 1987 made municipalities responsible for all pollutants discharged from their separate storm sewer systems to the waters of the United States. Although industrial wastewater discharge permits state that responsibility and liability for all discharges lies with the permittee, the pollutants contained in a permitted industrial discharge to the storm sewer system could become the ultimate responsibility of the municipality. To avoid this potential liability, Portland recently passed City Code Ordinance 17-39, which prohibits industrial process wastewater discharges, except for non-contact cooling water, to the municipal separate storm sewer system. Industries must now discharge process wastewater to Portland's sanitary sewer system or to the waters of the United States through a private sewer system. In either case, treatment would be required before discharge.
There are currently no permitted industrial wastewater discharges to municipal separate storm sewers in the Johnson Creek watershed. To avoid this undesirable circumstance in the future, jurisdictions without an ordinance, similar to that enacted by Portland, will adopt one.

Action PP 1-6

Replace failing septic tanks with sanitary sewers.

Cesspool and septic systems are often problematic in one of the oldest residential areas in the watershed. The area is bordered by I-205 on the east, King Road on the south, 55th Street on the west, and Alberta Street on the north. During wet weather, soils in this area often become saturated and effluent from cesspools and septic tanks discharges over the surface rather than percolating into the ground. The only practical solution is to replace the septic tanks and cesspools with an underground sewage collection system.

Several years ago, a study was conducted to determine which jurisdiction would build sewers in various portions of this area. It was decided that the Clackamas County Service District #1 will service the area to the east of Linwood Ave.; the City of Milwaukie will service the area to the west of Linwood Ave.; and the City of Portland will service the area that falls within the Portland Urban Services Boundary (basically, the portion of the area that lies north of Jordan Ave.). Plans have been developed for the layout of the system, but construction funding has not been forthcoming, in part because of limitations imposed by State Proposition 5. The WMO will work with Clackamas County, the City of Milwaukie, the City of Portland, and local legislators to seek funding for sewer construction.

OBJECTIVE PP-2

Reduce pollutant discharges from urban stormwater runoff.

The actions under this objective address the control of urban stormwater within the Johnson Creek watershed. They build on the existing control programs being implemented by jurisdictions in the watershed.

Action PP 2-1

Fully implement stormwater management plans developed for NPDES municipal stormwater permits.

Pursuant to the Clean Water Act, municipal stormwater permit applications were submitted to the DEQ on May 17, 1993 by Portland, Gresham, and Clackamas County. The Part 2 NPDES permit applications address stormwater discharges from the urbanized portion of the watershed, including the Cities of Portland, Gresham, Milwaukie, and Happy Valley, the portions of Multnomah and Clackamas Counties within the Urban Growth Boundary, and state-owned rights-of-way operated and maintained by the Oregon Department of Transportation (ODOT). At the heart of each permit application is a stormwater management plan. The management plan includes a variety of control measures designed to reduce stormwater pollution caused by urban runoff to the "maximum extent practicable." In general, the management plans emphasize the use of source controls rather than structural controls. Source controls are measures that seek to prevent pollutants getting into stormwater. Structural, or end-of-pipe, controls typically attempt to treat and remove pollutants after they have already contaminated stormwater. The management plans address the following major categories of discharges:

- Stormwater Discharges from Commercial and Residential Areas
- Illicit Discharges and Improper Disposal
- Industrial Discharges
- Stormwater Discharges from Construction Sites

Each permit application contains several control measures to address each of the above categories. Table 10 summarizes the key provisions of each plan. The plans will be implemented over an initial five-year permit period. The WMO will work to ensure the management plans developed by each jurisdiction are fully implemented.

Action PP 2-2

Construct stormwater treatment facilities in developed areas.

As noted above, the stormwater management plans prepared by Portland, Gresham, and Clackamas County emphasize source controls rather than structural or end-of-pipe controls. In many cases, however, it is unlikely that source controls alone will be sufficiently effective. An example might be a drainage basin with many roads, parking lots, and transportation-related businesses. Although education may reduce the use of the storm sewer system for the disposal of vehicle washwater, for example, it will not affect the build up of oil and grease and brake residue on the paved surfaces. Street-sweeping may reduce the availability of pollutant material on street surfaces, but it will not eliminate it. In cases such as this, where stormwater runoff pollutant loads are expected to be great, reliable pollutant removal can best be achieved by a combination of structural and non-structural measures.

The pollution potential of stormwater runoff could be greatly reduced by the installation of structural or end-of-pipe pollution reduction facilities that remove a portion of the contaminants from runoff before it enters natural waterways. Pollution reduction facilities might include wet ponds, filters (employing a cheap, easily replaceable filter medium such as leaf compost) or detention vaults. The choice of system depends on the amount and type of contaminants expected, availability of land, size of drainage area and maintenance requirements.

It would be very expensive to construct pollution reduction facilities at all points where urban runoff enters Johnson Creek. It will obviously be most cost-effective to construct pollution reduction facilities at outfall locations where pollutant loads are expected to be the highest. As part of Portland's municipal stormwater sampling for its NPDES permit, pollutant concentrations were measured in a number of stormwater outfalls discharging to Johnson Creek. The highest concentrations of pollutants were measured in stormwater runoff from industrial and commercial land uses (see Table 9).

Fifteen potential sites for structural stormwater treatment facilities were identified and are shown in Table 13. The sites are located at the downstream end of drainages that have exhibited high pollutant concentrations in stormwater, or contain land uses likely to generate above average pollutant loads. Conceptual sketch plans of the six highest priority stormwater pollution reduction facilities are shown in Figures 10 through 15. Three types of pollution reduction devices are proposed: wet ponds, vegetated swales and detention vaults. Wet ponds are ponds designed to retain some water year-round. The permanent ponds would support emergent and floating wetland vegetation. The effectiveness of wet ponds depends on their ability to detain urban stormwater for a sufficient period of time to allow polluted sediments to settle out. Even if there is insufficient land available to provide an ideal detention time, wet ponds still produce water quality benefits because they serve as a buffer between the storm drainage system and the stream. During the summer months storm drains often continue to drain small quantities of water from the urban area. These small flows, which may include groundwater, runoff from irrigated lawns and landscaping, runoff from car washing, and washdown water from paved surfaces, are often more polluted that wet season urban runoff. The wet pond may provide days of detention for these small flows, allowing their pollutant potential to be reduced before discharge to the creek. The avoidance of sudden shock loads of pollutants to the creek is particularly important in the summer, when creek flows are at a minimum and over-summering juvenile salmonids at their most vulnerable.

Vegetated swales provide some minimal pollution reduction by a combination of sedimentation and filtration through vegetation. The longer the swale, and the slower the water moves through it, the greater the pollutant removal. Like small wet ponds, their greatest benefit may be to intercept and delay small summertime shock loads.

Both wet ponds and vegetated swales are designed to operate with a minimum of maintenance. In fully developed urban areas, where there is no land available for wet ponds, detention vaults can provide some pollution reduction. Conventional detention vaults can remove sediments and oil from urban runoff by sedimentation and flotation, when flows are small enough to allow relatively quiescent conditions within the vault. Little or no removals can be expected in high flows; in fact, high flows will usually scour

TABLE 13
Stormwater Treatment Projects for Developed Areas

Outfall Location River Mile	Outfall Size	Characteristics of the Drainage Area	Sampling Results	Potential Water Quality Control Measure	Priority for Implementation
Main City Park in Gresham					
16.0	48" and 42"	Drainage from high density residential and commercial/industrial.	NA	Treatment Wetlands	A
Johnson Creek west of Walters Street					
15.7	30"	High density residential and commercial.	NA	Treatment Wetland	A
Eastman Parkway					
14.9	36"	Mixed single and multi-family residential.	NA	Detention Pond	A
SE 106th and Foster Road					
7.4	18"	Foster Rd. and commercial/ industrial land use.	Relatively high levels of TSS, BOD, COD, nutrients, oil & grease, and metals.	Detention Vault	A
Johnson Creek Blvd. east of Bell Station					
4.8	12"	Commercial/industrial land use.	Relatively high levels of TSS, nutrients, oil & grease, and metals.	Detention Vault	A
Johnson Creek Park					
1.3	30"	McLoughlin Blvd., residential / industrial land use.	Relatively high levels of nutrients and metals.	Vegetated Channel	A
Hogan Rd. Bridge					
17.8	12" and 18"	Drainage from Columbia Brickworks Inc.	High levels of TSS	Detention Vault	B*
72nd St. north of Johnson Creek Blvd.					
5.2	18"	Industrial/commercial land use.	High levels of TSS, BOD, COD, nutrients, oil & grease and metals.	Detention Vault	B*
Pleasantview Drive					
13.5	30"	Drainage from Powell Blvd.	NA	Detention Pond/ Treatment Wetland	B
Flavel just east of I-205					
6.6	Drainage Ditch	I-205 and single family residential land use.	NA	Vegetated Swale	B
Flavel and 92nd St.					
6.4	24"	Commercial/industrial land use.	Relatively high levels of mercury.	Detention Vault	B

TABLE 13
Stormwater Treatment Projects for Developed Areas (Continued)

Outfall Location River Mile	Outfall Size	Characteristics of the Drainage Area	Sampling Results	Potential Water Quality Control Measure	Priority for Implementation
Harney and 82nd St.					
5.8	21"	82nd St. and commercial land use.	NA	Detention Vault	B
Harney and 80th St.					
5.7	72"	I-205	NA	Treatment Wetland	B
Johnson Creek Blvd. and Wichita					
4.2	24"	Johnson Creek Blvd. and commercial/industrial land use.	Relatively high levels of metals.	Detention Vault	B
Ochoco St.					
0.7	48"	McLoughlin Blvd., residential and industrial land use.	NA	Treatment Wetland	B

* Discharges from these outfalls have been identified as containing elevated levels of pollutants. The sources of these discharges have be tracked to specific industrial facilities. These discharges would be reduced or eliminated when industrial NPDES stormwater permitting regulations are fully implemented (see PP-2-5). The WMO will assist DEQ in locating industrial stormwater dischargers and coordinate stormwater plan implementation with jurisdictions. However, because of their significant impact to water quality, these sites have bee identified as high priority and included in this list as potential sites for water quality treatment facilities.

out any accumulated materials in the vault. It is apparent that unmaintained conventional vaults probably remove very few pollutants over a season. Well-maintained vaults will produce some removals, but most of the accumulated material is likely to be coarse grit and sand. The finer particles in urban runoff are thought to carry the greatest pollutant load. It may be possible to improve the performance of vaults by developing a design that by-passes high flows around the vault and thereby preventing the scouring out of accumulated material. Vaults installed as part of the RMP will include a high-flow by-pass.

In recent years, considerable research has been conducted into new ways of reducing the pollution potential of urban runoff. New technologies include filters using sand and leaf compost as filter media. Several tests are underway in the Portland area. If the tests are successful then these new technologies could be considered for use in the Johnson Creek watershed. Currently, the City of Portland does not recommend the use of leaf compost filters.

Because local experience with stormwater pollution reduction facilities is limited, it was thought prudent to initially construct six systems to gain experience, before building the other nine, and perhaps, proceeding to a larger scale construction program.

Action PP 2-3

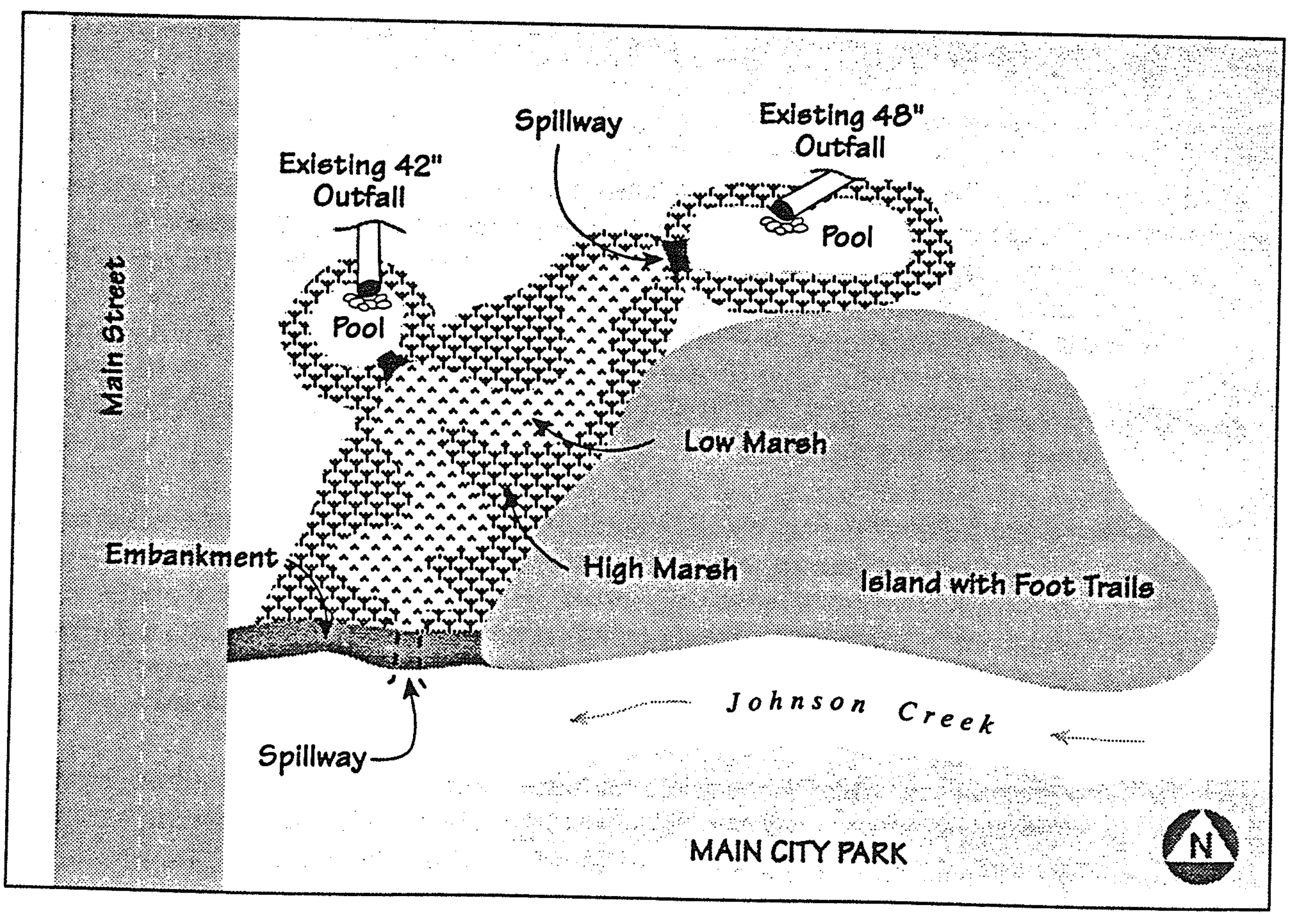
Establish and implement comprehensive and effective basin-wide stormwater regulations for new developments.

As the watershed continues to develop, the potential for urban runoff pollution will increase. To avoid this, the quality of stormwater discharged from new development and significant redevelopment will have to be controlled. The goal should be to limit post-development pollutant loads to the maximum extent practicable.

In most cases, stormwater quality control facilities are currently only required for public works projects and new development or redevelopment in designated environmental zones. However, recent NPDES stormwater regulations (described in Action PP-2-1) require municipalities to develop system-wide comprehensive master plans to "develop, implement and enforce controls to reduce the discharge of pollutants from areas of new development and significant redevelopment." In response to this requirement, the cities of Portland, Gresham, Happy Valley, Milwaukie, and Clackamas and Multnomah Counties have proposed various plans for reducing pollutants in runoff from new development and significant redevelopment (see Table 10). New

FIG 10

Gresham Main City Park Water Quality Improvement Facilities

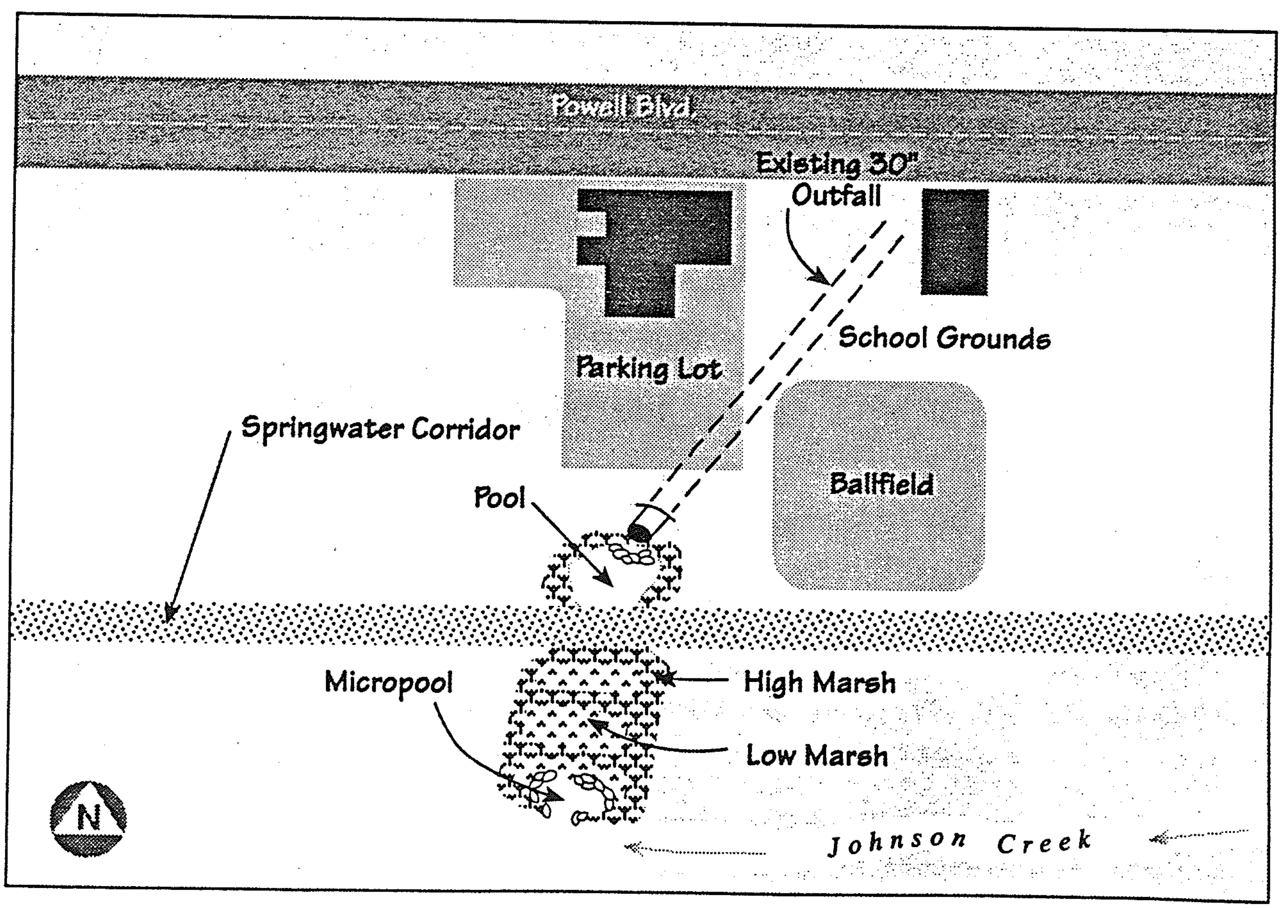


regulations, incentives, and education programs will assist developers in using the appropriate control measures in building the necessary stormwater-quality control facilities into their developments. For example, the City of Portland recently published an updated technical design guidance manual for stormwater quality improvement facilities. This manual will provide developers with guidance for selecting and designing stormwater quality treatment facilities to meet yet-to-be established city-wide stormwater quality treatment standards.

Cities and counties in the Johnson Creek watershed will fully implement plans to meet the municipal NPDES requirement to reduce the discharge of pollutants from areas of new development and significant redevelopment. Because the establishment of a comprehensive set of stormwater quality and quantity standards is technically complex and difficult, an intergovernmental committee will be established to consider the options and recommend an effective and equitable set of regulations for adoption and implementation by all jurisdictions within the watershed. The intergovernmental committee will consider options that integrate water quantity and water quality requirements.

FIG 11

Water Quality Improvement Facilities West of Walters Street



Action PP 2-4

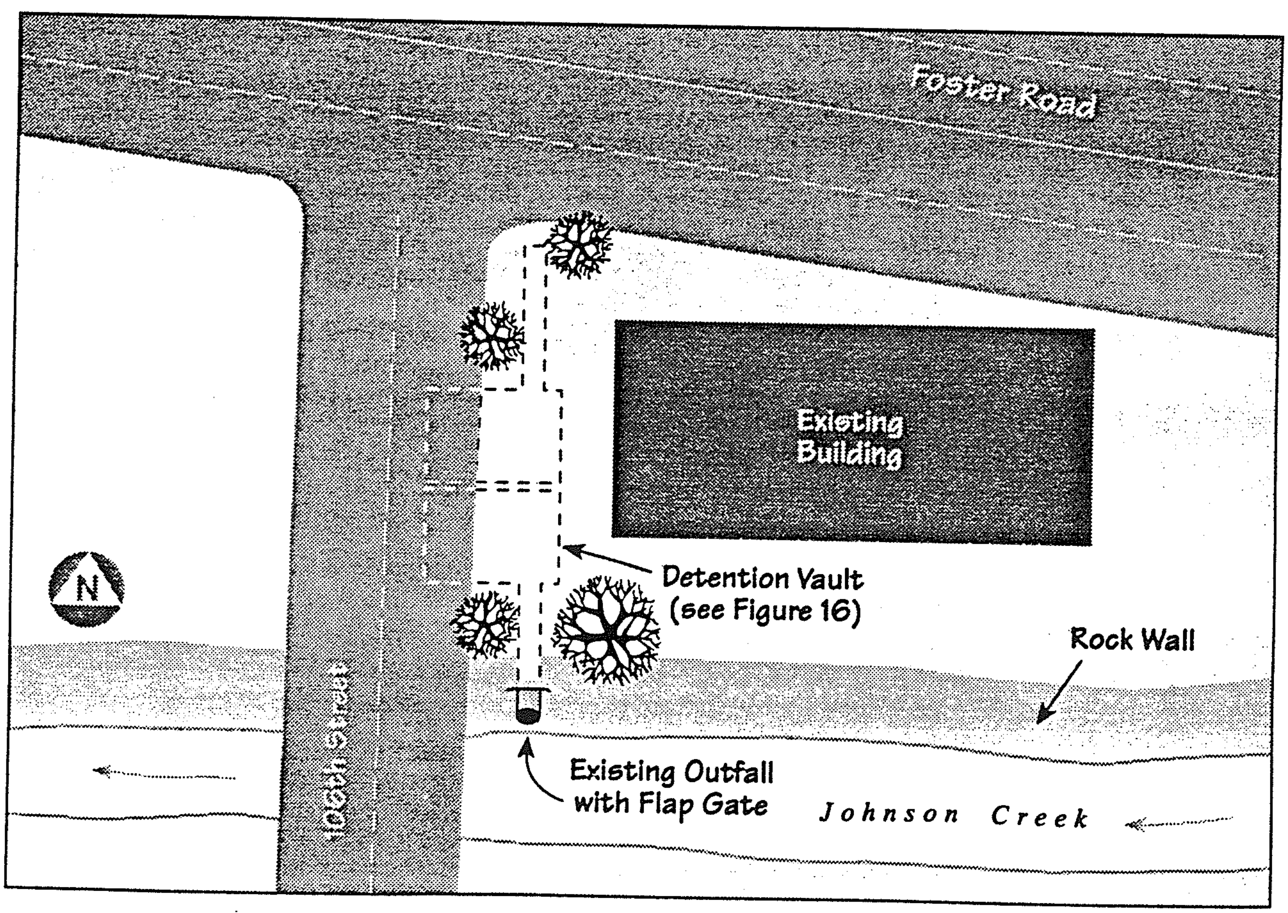
Reduce pollutants in stormwater associated with construction activities.

As discussed earlier, sediment discharges to Johnson Creek are adversely affecting water quality and aquatic life. In urban areas undergoing development, runoff from construction sites is generally noted as the largest source of sediment discharges. As development in the watershed progresses, the potential for the discharge of pollutants associated with construction sites will continue.

A construction site operator is required to obtain an NPDES general permit from the DEQ to discharge stormwater from construction activities, including clearing, grading, and excavation, which result in a disturbance of five or more acres. The permit requires the permit holder to implement an erosion control plan for the construction site which will minimize the erosion from disturbed land during the construction activities and specifies minimum monitoring and reporting requirements. The permit specifies that visible or measurable erosion that leaves the construction site is prohibited.

FIG 12

Water Quality Improvement Facilities at 106th and Foster Road

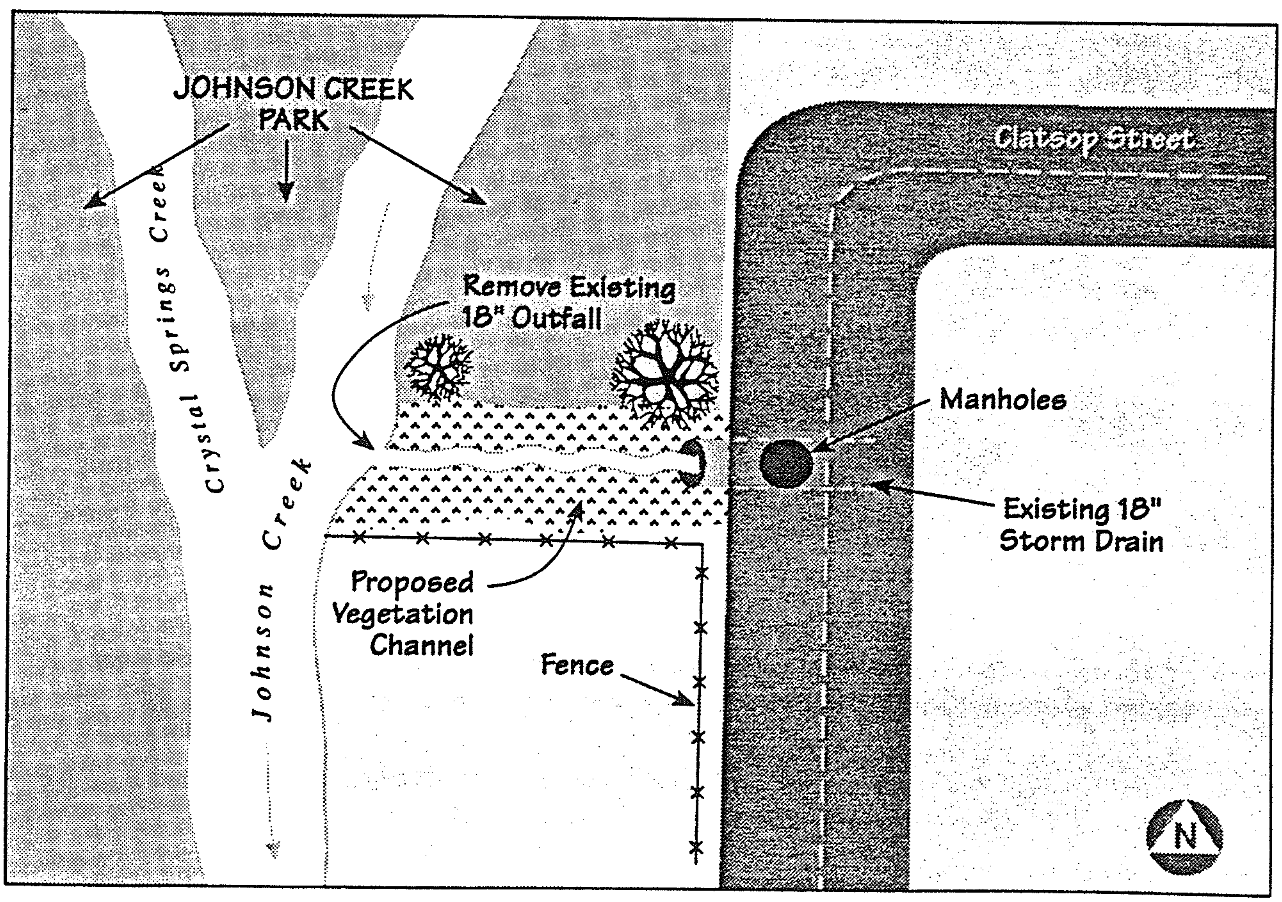


In addition, NPDES stormwater regulations (described in Action PP-2-1) require municipalities to develop programs to "implement and maintain structural and non-structural best management practices to reduce pollutants in stormwater runoff from construction sites to the municipal storm sewer system." The program must include procedures for site planning which incorporate consideration of potential water quality impacts, requirements for structural and non-structural best management practices, procedures for identifying priorities for inspecting sites and enforcing control measures, and educational and training measures for construction site operators. The goal of this regulatory requirement is to ensure that appropriate measures to control pollutants from construction sites are implemented and properly inspected and maintained.

In response to this requirement, municipalities have proposed in their stormwater management programs to review, and where necessary, improve existing programs to reduce pollutants associated with construction activities. As with controls proposed for new developments (Action PP 2-3), new regulations, incentives, and educational and

FIG 13

Water Quality Improvement Facilities at Johnson Creek Park



training programs will assist construction site operators in using appropriate control measures during construction.

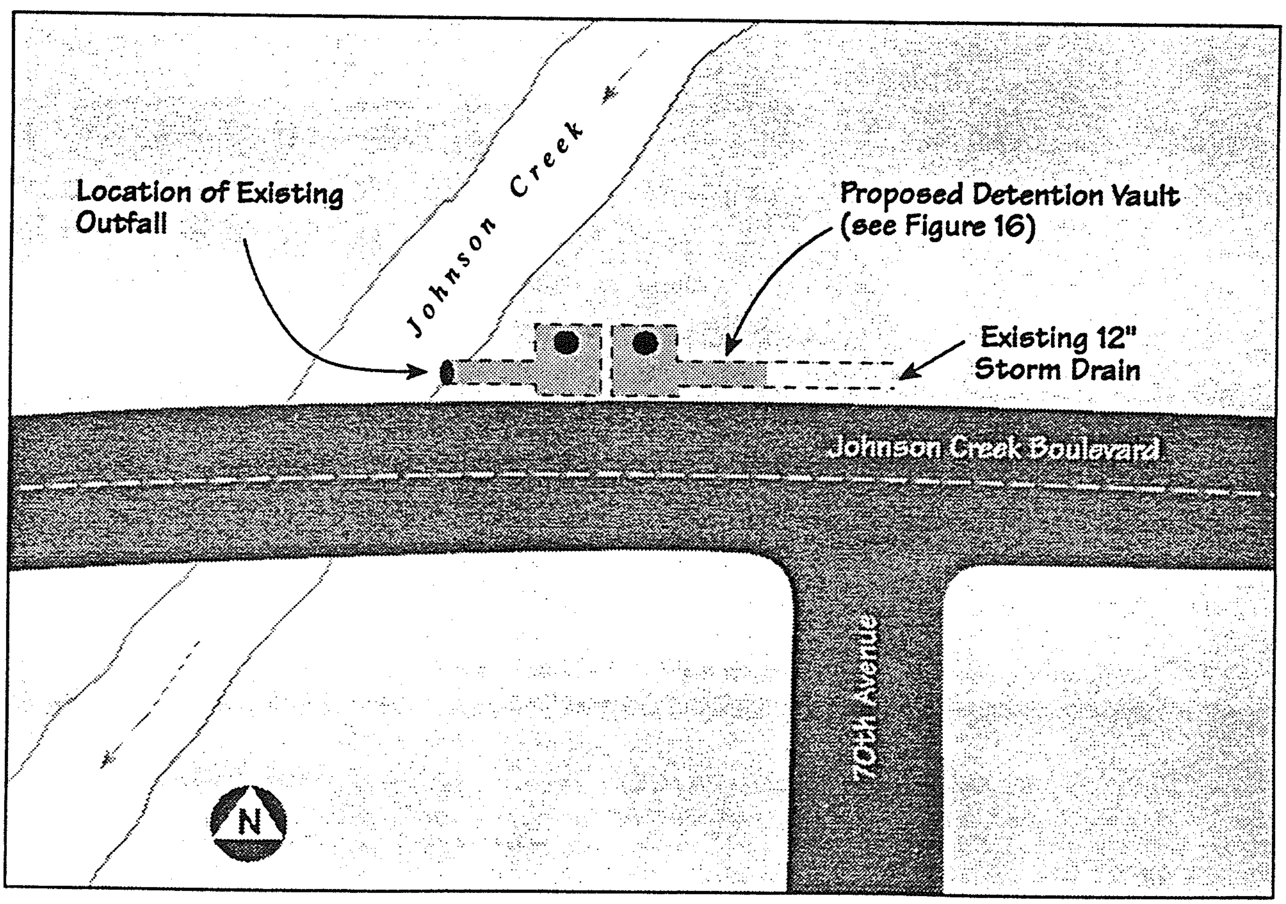
In order to reduce the discharge of pollutants associated with construction activities, the cities and counties in the Johnson Creek watershed will fully implement plans to meet the NPDES municipal requirements. Under Action PP 2-6, the WMO will review annual reports of progress with implementation of this requirement that are submitted to the DEQ. The WMO will use this information to check that compliance is occurring.

Action PP 2-5
Ensure full compliance with NPDES industrial stormwater permit requirements.

The Clean Water Act requires that industrial facilities obtain a NPDES Industrial Stormwater Permit from the DEQ to discharge stormwater associated with industrial activity directly to surface waters or indirectly through a municipal separate storm sewer system. The application requires each industry to develop a Stormwater Pollution Control Plan (SWPCP) for preventing or reducing stormwater pollution from their facility. SWPCPs must contain a complete site description, a stormwater

FIG 14

Water Quality Improvement Facilities at Johnson Creek Blvd.



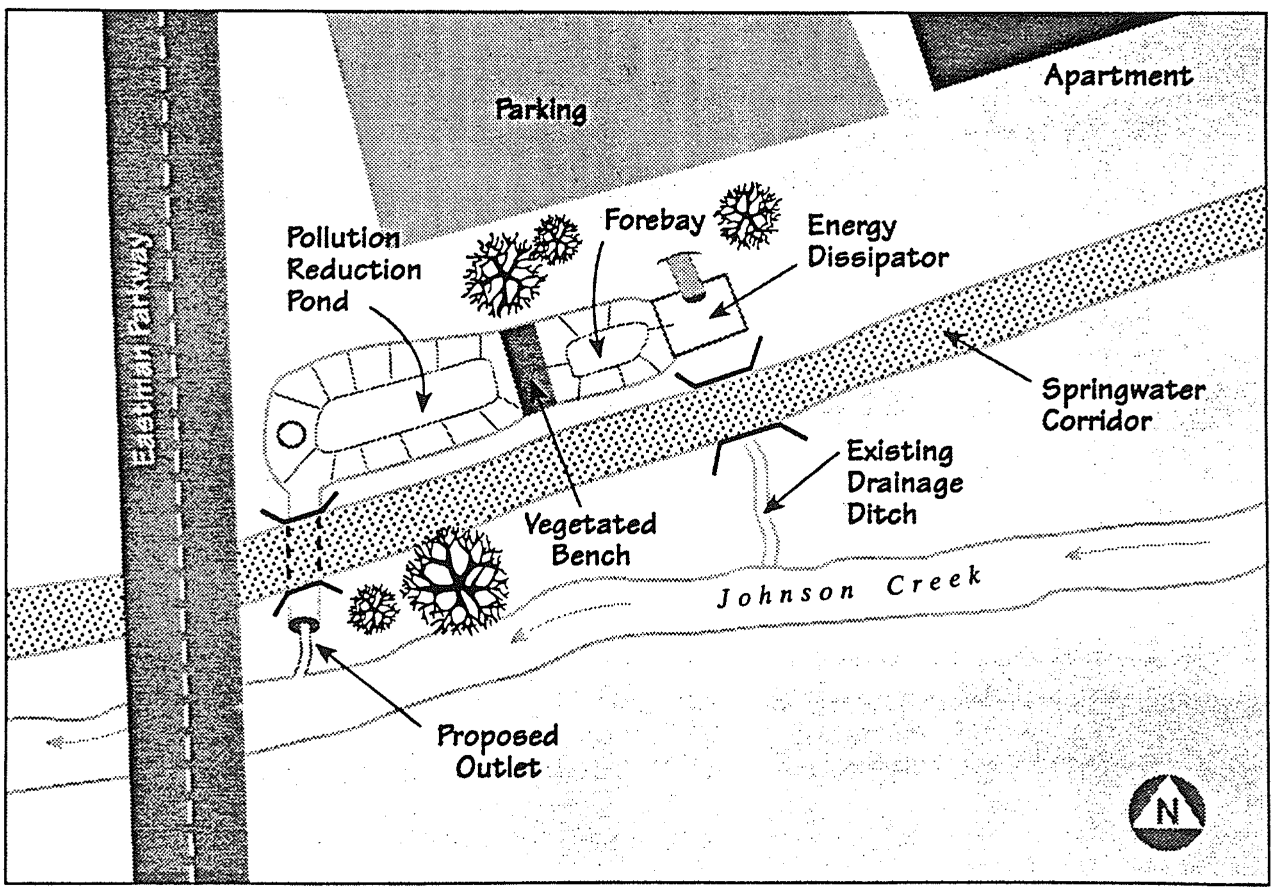
management plan and a description of procedures for spill control, maintenance, and employee education.

As part of their Part 2 NPDES Municipal Stormwater Permit Applications, the co-applicants for the Portland, Gresham, and Clackamas County permits identified industries within their jurisdictions which may be required to apply for NPDES Industrial Stormwater Permits. Approximately 200 industrial facilities were identified in the Johnson Creek watershed that may be required to obtain a stormwater permit. To date, only twenty industries in the Johnson Creek watershed (or roughly 10 percent) have applied for and received a stormwater discharge permit (they are listed in Appendix A).

Although responsibility for administering the industrial permit program belongs to the DEQ, cities and counties may have some interest in ensuring that industries that discharge to a municipal sewer comply with the industrial NPDES stormwater permit requirements. This is because cities and counties are ultimately responsible for all

FIG 15

Water Quality Improvement Facilities at Eastman Parkway Site



discharges from their storm drains. The WMO will work with cities and counties and the DEQ to help non-complying industries obtain the necessary discharge permits.

Action PP 2-6

Periodically review information on municipal and industrial stormwater discharges.

To ensure full compliance with the stormwater management plans developed by the municipal permittees, the WMO will review the annual compliance reports submitted to the DEQ by Portland, Gresham, and Clackamas County. The WMO will obtain a copy of the industrial SWPCP implementation schedules and track progress. Where compliance problems are evident, the WMO will work with the DEQ and local jurisdictions to ensure corrective action is taken.

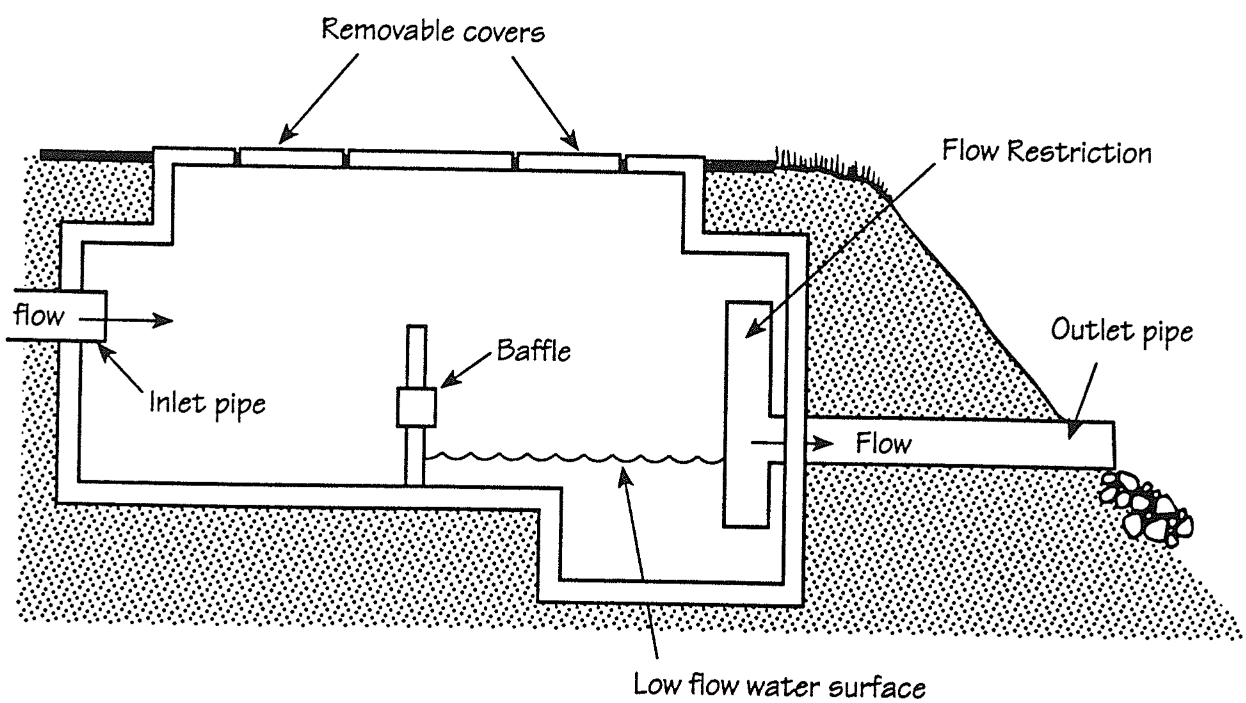
OBJECTIVE PP-3

Reduce pollutant discharge from agricultural and other non-urban economic activities.

Agricultural activities can have a profound effect on water quality. In the Johnson Creek watershed where land use is one-third rural, improvements in water quality will depend on the prevention and control of water pollution from rural land uses.

FIG 16

Typical Detention Vault



Action PP 3-1

Prepare water quality management plans for non-urban areas.

Historically, agricultural lands have been largely exempt from laws protecting water bodies from non-point sources of pollution. For example, the Clean Water Act addresses only urban and industrial stormwater discharges. To address water quality impacts from agricultural activities, a water quality management plan will be developed for the rural portion of the watershed. The plan will encourage voluntary implementation of best management practices (BMPs) to prevent or reduce water quality impacts from the following practices:

- Cultivation of cropland
- Grazing
- Irrigation of cropland
- Application of pesticides
- Application of fertilizers

Although site-specific pollution control measures will be developed in the agricultural water quality management plan, the general characteristics of best management practices are described below.

To prevent erosion from cropland, practices will be implemented in the field to prevent the transport of sediments (e.g., conservation tillage, critical area planting, etc.) and to route runoff through facilities that will remove sediments (e.g, vegetative filter strips, field borders, retention ponds, etc.).

The focus of grazing management will be on the riparian corridor; however, the health of the riparian system is also dependent on the proper management of upland areas. Grazing management measures will be used to reduce the physical disturbance of the streambanks, reduce the discharge of sediments, animal wastes, nutrients, and chemicals to the creek, and allow for revegetation along the corridor. Potential grazing management measures for the riparian corridor include fencing animals from selected areas of the corridor, providing stabilized access areas to the creek and providing alternative watering sites. Potential grazing management measures for upland areas include proper treatment and use of pasture lands and proper grazing intensities.

The goal of irrigation management is to reduce the amount of flow that is diverted from the creek, and to reduce non-point source pollution associated with irrigation return flows. A current inventory of water users on the creek will be developed under Action FW-5-1. This will include a list of the water uses related to irrigation. Irrigation management measures will be developed to reduce waste of irrigation water, improve water use efficiency, and reduce the total pollutant discharge from an irrigation system. Specific practices might include improved irrigation scheduling, efficient water application, efficient water transport, utilization of runoff or tailwater, and drainage water management. (Irrigation management measures for container nurseries are addressed separately under Action PP-3-3.)

The goal of pesticide management is to release fewer pesticides and/or less toxic pesticides into the environment and to use practices that minimize the discharge of pesticides to surface and groundwater. Potential practices may include the fostering of natural enemies of pests, use of crop rotations, destruction of pest breeding areas, and proper application rates.

The goal of fertilizer management is to minimize nutrient discharge to the creek and promote more efficient uses/applications of nutrients. Methods for the application of nutrients can generally be improved to reduce the discharge of nutrients into receiving waters. Practices include developing a nutrient budget for the crop, applying nutrients at the appropriate time, and applying nutrients in the amounts needed only.

The program described above to control non-point sources of pollutants will be voluntary. However, two recently established regulatory requirements may make some elements of the program mandatory: Oregon's Senate Bill 1010 and the 1990 amendments to the federal Coastal Zone Management Act.

Senate Bill 1010, which was recently passed in Oregon (ORS 568.900 to 568.933), applies to non-urban areas which lie within watersheds where total maximum daily loads (TMDLs) have been established for the receiving water. In these non-urban areas, the Oregon Department of Agriculture (ODA) must prepare water quality management plans. As discussed earlier, because Johnson Creek has been identified by the State as "water quality limited," TMDLs will be established at some time in the future. The requirements in Senate Bill 1010 may, therefore, eventually affect the Johnson Creek watershed.

The Coastal Zone Management Act was amended in 1990 to require the states to regulate non-urban areas located within the coastal zone boundary. Within this boundary, states are required to develop and enforce specific management measures and practices to reduce non-point source pollution. Although the Johnson Creek watershed is not currently included within the coastal zone boundary, the boundary is being reviewed. The National Oceanic and Atmospheric Administration recommended that Oregon extend the boundary in the Columbia River Basin to include watersheds on the Willamette River downstream from Willamette Falls (which would include the Johnson Creek watershed). A final decision will be made by July of 1995 regarding the extension of this boundary. If Portland is determined to be in the coastal zone, then portions of the RMP, including this action, may fulfill some of the Coastal Zone Act's requirements for nonpoint source pollution control.

Responsibility for preparing the water quality management plan for non-urban portions of the watershed will belong to the soil and water conservation districts or whomever else is designated by the Oregon Department of Agriculture. The WMO will work with the ODA, the DEQ, and the Clackamas and Multnomah County Soil and Water Conservation Districts to develop and implement a water quality management plan for the non-urban areas of the Johnson Creek watershed. The plan will cover both commercial and non-commercial farms.

Historically, the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) has advised farmers on environmentally-sound agricultural practices. Small grants are available from the service to implement agricultural best management practices for pollution control. Grants could be available to help implement the agricultural water quality control plan.

Action PP 3-2

Develop and implement a rural non-point source pollution control program for non-commercial agricultural operations.

A rural non-point source pollution program for non-commercial agricultural operations will be developed to prevent pollution from non-commercial ranches and farms typically not covered by state and federal programs for commercial farmers. Small non-commercial farms are common in the Johnson Creek watershed as they are on the fringes of many metropolitan areas. A similar program for non-commercial farms is in progress in the Tualatin watershed. The WMO working with the Multnomah and Clackamas County Soil and Water Conservation Districts will establish a list of best management practices for preventing pollution from small farms, horse pastures, etc., that are applicable to conditions in the Johnson Creek watershed. A key source of information will be the ODA publication, entitled "Water Quality Protection Guide: Recommended Pollution Control Practices for Rural Homeowners and Small Farm Operations." The non-point source pollution control program will emphasize education and dissemination of information on pollution prevention to rural homeowners and small farmers. Compliance with the identified best management practices will be voluntary. However, if the voluntary program proves to be ineffective, then the counties may wish to consider adopting a non-point source pollution control ordinance, similar to one in effect in Thurston County, Washington.

Action PP 3-3

Periodically review information on container nurseries and confined animal feeding operations.

The DEQ is the lead agency for water quality programs in Oregon but has designated the ODA as its management agency for water quality programs related to agriculture. To date, the DEQ and the ODA have developed water quality programs for two categories of agricultural operations: container nurseries and confined animal feed operations (CAFOs).

Currently, the ODA does not have an estimate of the compliance rate for container nurseries or CAFOs with the above programs. To inform the container nursery industry of the Statewide Container Irrigation Water Management Plan, the ODA mailed notices to all 4,950 Oregon licensed nursery growers, greenhouse growers, and nursery stock dealers. The ODA does not know how many of the licensed growers meet the definition of "container nursery"; therefore, compliance can not be estimated. The ODA relied on the cattlemen's associations to distribute information regarding the permitting program for CAFOs. Once again, the ODA has no estimate of the compliance rate for CAFOs because an inventory of existing CAFOs does not exist.

The WMO will obtain copies of the information provided to the ODA by container nurseries and the WPCF Permits issued for CAFOs by the DEQ. The WMO will work with the agricultural agencies (e.g., the ODA, the NRCS, the Soil and Water Conservation Districts) to encourage full compliance with the requirements of the programs, including the removal of all instream recirculation ponds for container nurseries. The WMO will also work with the agricultural agencies to identify container nurseries and CAFOs which have not complied with the above programs. The WMO will then work with the agricultural agencies to educate these operators about the programs to improve compliance. If a complaint is reported or a problem is suspected with a container nursery or CAFO, the WMO will work with the ODA regarding appropriate follow-up inspection and enforcement activities.

Action PP 3-4

Periodically review compliance with the Oregon Forest Practice Rules.

The Oregon Forest Practices Act regulates forest operations on private and state forest lands. Under the Act, forest harvesting and related activities must be reported to the State Forester. In some cases (e.g., when harvesting operations occur within 100 feet of a stream which supports anadromous fish), a written plan must be approved by the State Forester before operations are conducted. The Act also provides specific rules for the protection of riparian areas and sensitive resource sites such as significant wetlands or habitat for sensitive species.

By law, mills are not allowed to accept timber unless a record is provided that the State Forester was notified of the harvest. The State Forester offers subscriptions to the notifications submitted. The WMO will obtain a subscription for notifications submitted to conduct forestry-related activities in the Johnson Creek watershed. The WMO will review notifications and discuss any concerns with the State Forester. Where deemed necessary, the WMO may decide to contact the landowner and encourage appropriate control measures (as required under the Forest Practices Act) to protect water quality and natural resources. If problems associated with forestry related activities are reported to the WMO (e.g., sediments and debris noted in flow downstream from activities), the WMO will work with the State Forester regarding effective enforcement activities.

Objective PP-4

Prevent Accidental Spills into Creek and Tributary Storm Drains

Public consciousness of the potentially devastating effects of oil and chemical spills on the environment has led to a proliferation of laws and regulations. Despite the existence of these regulations, spills continue to adversely affect Johnson Creek. The approach taken here is to try to ensure that existing regulations are properly implemented in the watershed.

Action PP 4-1

Periodically review effectiveness of spill prevention and control regulations.

Spills to Johnson Creek are reported and investigated only when they are associated with fish kills. The Oregon Department of Fish and Wildlife maintains memos and reports regarding fish kills and other problems dating back to 1972. From 1972 to 1988, twenty-two reports of fish kills were recorded in Johnson Creek (average of more than one per year). Sources of these fish kills were identified only four times.

To prevent spills from occurring, federal, state, and local regulations have been enacted to regulate the generation, storage, transport, and disposal of hazardous compounds, including:

- Federal Resource Conservation and Recovery Act (RCRA)
- Federal Clean Water Act (CWA)
- Federal Superfund Amendments and Reauthorization Act (SARA) Title III
- Federal Clean Air Act
- State of Oregon Administrative Rules
- State Fire Marshal
- State Uniform Fire Code
- Municipal NPDES Stormwater Permits

The intent of these regulations is to prevent or minimize the potential release of toxic compounds into the environment. These complex, inter-related regulations are administered by several different agencies (e.g., U.S. EPA, the DEQ, the state fire marshal, and municipal governments).

The WMO will determine how existing regulations are applied in the watershed and which industries are covered. If a potential spill or accidental release is reported (e.g., a fish kill occurs and residents or volunteers report water quality problems), the WMO will work collaboratively with state and local response teams to determine the source of the spill. To prevent a recurrence, the WMO will examine the cause of the spill and work with responsible agencies to correct any deficiencies in the way spill regulations are implemented and to streamline procedures for spill response. The WMO will also assist responsible agencies with improvements in code compliance.

FLOOD MANAGEMENT PLAN ELEMENT

INTRODUCTION

Johnson Creek originates in the hills near Cottrell and flows westward approximately 25 miles to its confluence with the Willamette River. The Johnson Creek watershed, which has an area of approximately 54 square miles, was first settled by people of European ancestry in 1847 when a sawmill was established. Today, the western two-thirds of the watershed is primarily developed as low-density residential land use with pockets of high-density residential, commercial, and industrial land uses. The eastern third is rural, consisting mainly of small ranches, farms, and nurseries.

Settlement of a watershed creates conflicts between the creek's natural processes and the human desire for stability and predictability. Farmers straighten and change the course of creek channels to preserve farm lands and to increase the efficiency of farming operations. Since flat land is easy to develop, builders are attracted to the flood plain. Creek channels are filled and bridged and their courses changed to facilitate development. At the same time, the creek channels are expected to carry away the increased flows that result from development of the watershed. Almost inevitably, this sequence of events results in flooding of properties.

Flooding on Johnson Creek first became a problem in the 1920s after construction of a railroad accelerated settlement of the watershed. In 1933 and 1934, the federal Works Progress Administration widened, channelized, and rock-lined much of the lower-half of the creek. The project was driven primarily by a desire to provide work during the Great Depression rather than by a need to control damaging floods. Containment of the creek in a defined channel undoubtedly reduced the frequency of floods and increased the availability of buildable land in the historic flood plain.

The channel improvements in the 1930s did not solve the flooding problem. Damaging floods continued to occur on Johnson Creek. The most severe flood recorded occurred in 1964 when damages totaled approximately $3,000,000, expressed in 1994 dollars. More recently, the flood that occurred on February 24, 1994, caused estimated damages of about $375,000.

Several unsuccessful attempts were made in the 1970s and 1980s to solve the flooding problem on Johnson Creek. Now the Johnson Creek Corridor Committee has developed a plan to reduce flood damage, but this time as part of a comprehensive resource management plan for the watershed.

Watershed Hydrology

CLIMATE

Average annual rainfall in the Johnson Creek watershed varies from about 40 inches at the mouth to 70 inches in the upper watershed, with a watershed-wide average of 53 inches. Approximately 85 percent of the total annual rainfall occurs during the "wet season" which begins in October and runs through the end of May. Most winter precipitation falls as rain in large storms that last for several days. Average snowfall is 8 inches per year. The remaining 15 percent of the total annual rainfall occurs in short, intense storms in summer and fall.

Three rain gage stations located in the Johnson Creek watershed have continuous records since 1976. The longest continuous rainfall record in the Portland area was collected at the U.S. Customs House from 1872 until 1973; the current primary gage for the Portland metropolitan area is located at the Portland International Airport (1946–present). Neither of these long-term gages are located in the Johnson Creek watershed. The maximum recorded 24-hour rainfall in the Portland area was 7.66 inches on December 12-13, 1882. This amount exceeds the 24-hr, 100-yr (0.01 annual probability) storm intensity of approximately 5 inches, derived from the U.S. Weather Bureau's intensity-duration-frequency charts. The greatest rainfall amount recorded in a 24-hour period since 1940 (corresponding to the time when flow gage records were first available for Johnson Creek) is 4.4 inches on October 26-27 1994.

Temperature has also played an important part in the flooding history of Johnson Creek. Cold weather freezes the ground and decreases infiltration capacity. If a snowstorm is followed by warming temperatures and rain, the frozen ground will prevent infiltration of the snowmelt and rainfall. These conditions caused the flood which occurred in December 1964. A snow storm on December 21, 1964, was followed immediately by rain on December 22nd. The temperature increased 72°F within 24 hours, causing the snow to melt as the rain fell. This resulted in the highest flow ever recorded in Johnson Creek, 2,620 cubic feet per second (cfs).

LAND USE AND WATERSHED HYDROLOGY

The hydrology of the Johnson Creek watershed is affected by land use. As portions of the watershed are developed, runoff characteristics are altered. When forested areas are logged and replaced by agricultural fields, less rainfall is intercepted by vegetation. When urban development occurs, impermeable surfaces such as roofs, streets, parking lots, and driveways replace the original vegetated land surface, increasing both the volume and the speed of runoff.

Hydrologists have shown that development in a watershed usually increases the magnitude of the peak flow in the stream draining the watershed. The peak flow also occurs sooner than in undeveloped conditions. More water runs off rapidly during a storm rather than being detained in natural depressions and percolating into the ground. Because less water percolates into the ground, less is available to supplement stream flow after the storm has passed. Water entering the creek from the ground is the primary source of stream flow during dry periods. Thus, development tends to increase peak flows and diminish low flows. This phenomenon has probably occurred in the Johnson Creek watershed, although it is not evident from the records of streamflow. Diversion of water for irrigation has occurred throughout the period of record and masks the effects of land use changes in the watershed.

Existing land use in the Johnson Creek watershed is about 31 percent forest, farms, and open space, 4 percent parks, 19 percent agricultural, and 35 percent low-density residential. High-density residential areas, commercial, and industrial areas occupy 4, 5, and 2 percent of the watershed, respectively. If the watershed develops as envisioned in current city and county comprehensive plans (zoning plans), the proportion of residential land use will expand at the expense of forests and open space. Future land use, based on current community general plans, is expected to be 63 percent low-density residential, 18 percent agriculture, 4 percent parks, 6 percent high-density residential, 5 percent commercial and 4 percent industrial (see Figure 9).

RUNOFF AND DRAINAGE

The approximately 54-square mile Johnson Creek watershed can be divided into two areas based upon general hydrologic characteristics: the northern hydrologic area and southern hydrologic area. The northern hydrologic area generally consists of the area north of Johnson Creek between SE 82nd Avenue and Grant Butte. The northern hydrologic area occupies about 40 percent of the watershed. The southern hydrologic area consists of the remaining portion of the watershed. The hydrologic areas are shown in Figure 17.

Subsurface soil conditions are quite different in the two hydrologic areas. Soils in the northern hydrologic area are very permeable. Most of the precipitation over the northern hydrologic area percolates into the ground rather than running off to Johnson Creek. A portion of the stormwater from the northern hydrologic area reaches Johnson Creek via springs and seeps, but most of it flows northward, below the surface, towards the Columbia Slough. On the other hand, soils in the southern hydrologic area are rather impermeable. Most of the precipitation falling on the southern hydrologic area runs off to Johnson Creek and its tributaries.

Approximately nine square-miles of the watershed in the Lents-Powellhurst neighborhood is hydrologically isolated from Johnson Creek except during floods. Lying within the northern hydrologic area, the Lents-Powellhurst neighborhood has permeable soils and little runoff. Prior to development, what little runoff that occurred probably drained to a number of shallow depressions including Beggars-tick Refuge. Now, drainage from streets, parking lots, and other impermeable surfaces in the area is routed to dry wells or sumps. Sumps are designed to accelerate the percolation of stormwater into the ground. The area served by sumps is shown in Figure 18. Fill placed during construction of S.E. Foster Road and in its vicinity has also altered the drainage patterns. Before development, seasonal overflows from Johnson Creek and nearby springs and seeps probably supplied water to fairly extensive wetlands in the vicinity of Beggars-tick Refuge. Currently, Johnson Creek only flows across S.E. Foster Road to the wetlands area during floods.

Due to the characteristics of the two hydrologic areas, Johnson Creek and most of its tributaries begin in the southern hydrologic area. There are no major surface streams in the northern hydrologic area except Crystal Springs Creek. Crystal Springs Creek, which begins as a groundwater discharge at the base of a steep terrace escarpment, flows in a southerly direction over relatively impermeable alluvial deposits near the Willamette River. The confluence of Crystal Springs Creek and Johnson Creek is located in Johnson Creek Park at river mile 0.5.

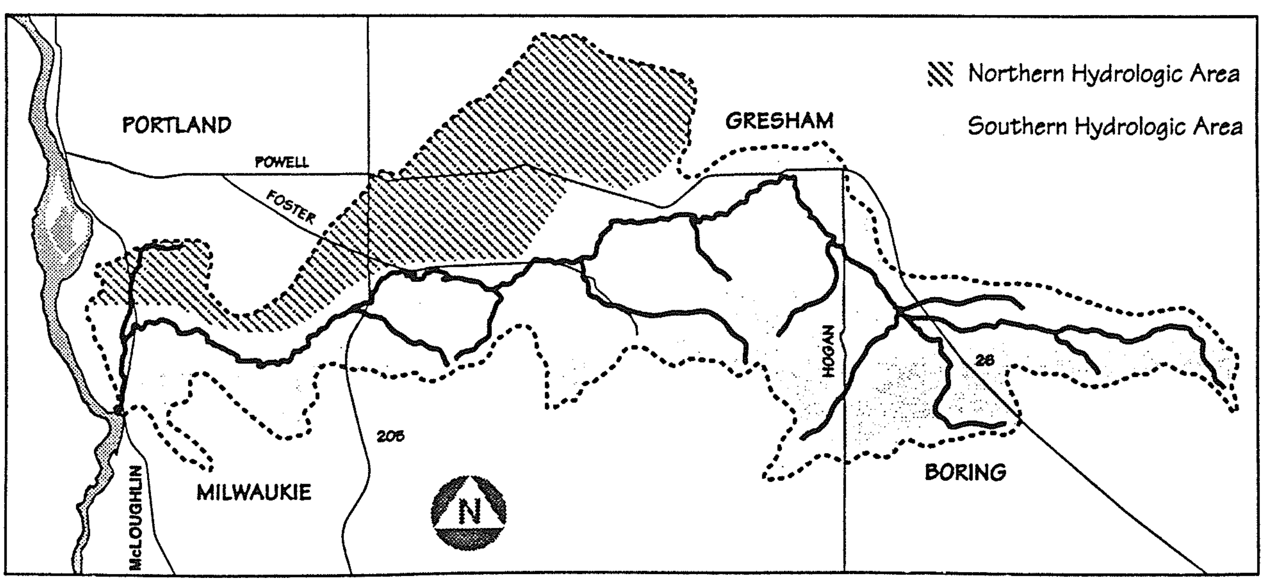
Drainage patterns in the far western end of the watershed have been altered by the construction of a combined sewer system. The Sellwood, Eastmoreland, Westmoreland and Woodstock districts drain to the City of Portland's combined sewer system rather than to Johnson Creek. The extent of the area served by combined sewers is shown in Figure 18. During light rainfall, surface runoff and sanitary sewage is directed to Portland's Columbia Boulevard sewage treatment plant and then discharged to the Columbia River. During moderate to heavy rainfall, the capacity of the untreated combined sewer system is exceeded and combined sewage is discharged directly into the Willamette River at several locations. Combined sewage is never discharged into Johnson Creek.

STREAM FLOW

There are two flow gaging stations on Johnson Creek operated by the U.S. Geological Survey (USGS). The Sycamore gaging station is located east of S.E. 145th Avenue at river mile 10.8. This gage measures flow from the upper 26.5 square miles, or about one-half

FIG 17

Hydrologic Areas



of the watershed. Continuous records for the Sycamore station are available from 1940 to the present. A second gaging station was installed in 1989 at the Milport Road bridge near the mouth of the creek. The Milport gage measures flow from 51.8 square miles, or almost 100 percent of the watershed.

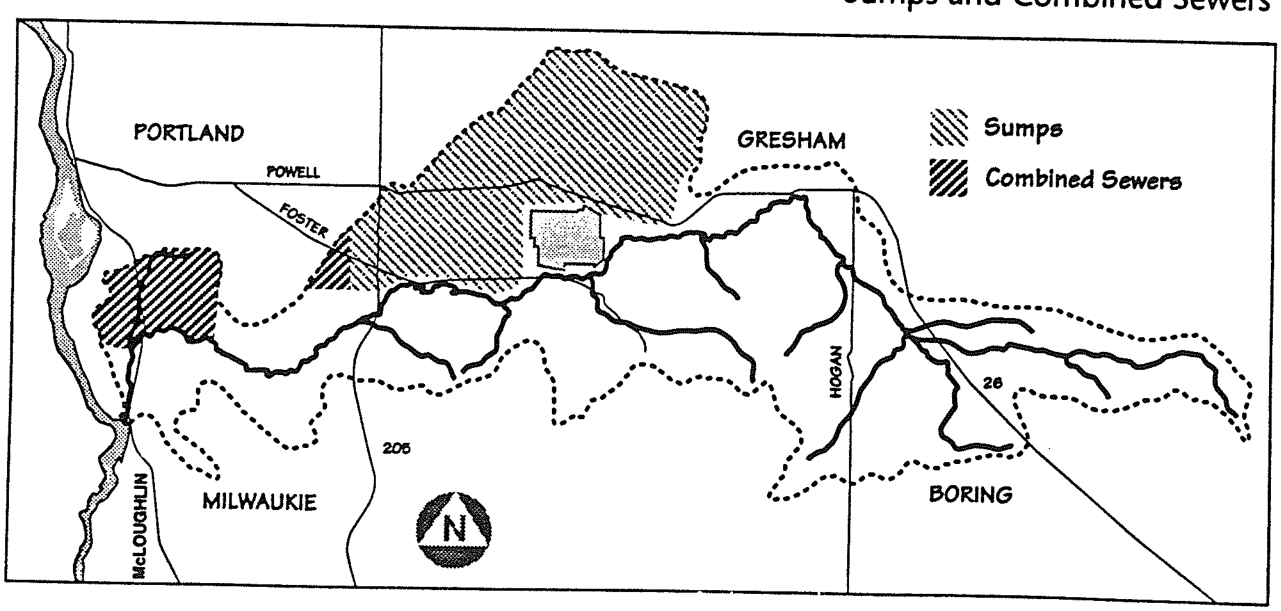
The long-term average flow at the Sycamore gage is approximately 53 cfs. The long-term average annual discharge is 39,400 acre-feet. Maximum flow usually occurs in December or January. Minimum flow occurs in August or September. The maximum flow of 2,620 cfs was recorded at the gage during the December 1964 flood. The minimum flow recorded was 0.08 cfs, which occurred in August 1966.

Although long term data are not available from the Milport Road gage, a comparison of its flow records with those from the Sycamore gage is revealing. In the 1990 water year, the total annual flow measured at the Sycamore gage was 30,570 acre-feet. The corresponding value for the Milport gage was 43,240 acre-feet. Although the watershed upstream of the Milport gage is almost twice as large as the watershed upstream of the Sycamore gage, total annual flow was only 45 percent higher. This is due to the high infiltration capacity of the soils in the northern hydrologic area and the combined sewer system located in the western portion of the watershed.

During dry periods when flow at the Sycamore gage was around 1 cfs, the Milport gage recorded a flow of about 16 cfs primarily due to inflow from Crystal Springs Creek. Thus, the upper portion of the watershed in the southern hydrologic area contributes a disproportionate share of total surface runoff, while the northern hydrologic area is primarily responsible for summertime base flow in the lower reaches of Johnson Creek. This is consistent with the earlier discussion of the hydrologic properties of the soils in the Johnson Creek watershed.

FIG 18

Sumps and Combined Sewers



FLOODING

Hydrologists characterize floods by their frequency of occurrence. For example, a 20-year flood is a flood that is expected to occur, on average, once every 20 years. It is an abbreviation for a "20-year return period flood." Its precise definition is a flood that has a 1-in-20 chance of occurring in any given year. It is a useful statistical concept, but it does not mean that a flood of that size will necessarily occur during a particular 20-year period. On average and over a long period of time, floods of that size can be expected to occur once every 20 years. Similarly, a 100-year flood is a flood that might be expected to occur only once every 100 years on the average. This extreme event has a one percent chance of occurrence in any given year but could actually occur several times within a 100-year period, or not at all.

All estimates of the size and frequency of future floods are based on an analysis of past streamflow and rainfall records and the assumption that climactic conditions will remain the same. If climactic conditions change, then predictions of future flooding may be in error.

HISTORIC FLOODING

Damaging floods have occurred on Johnson Creek at least 6 times in the last 30 years. The worst flood on record occurred in 1964, with a peak flow of 2,620 cfs measured at the Sycamore gage. After the 1964 flood, the Corps conducted a survey that indicated that about 1,500 structures were flooded, primarily between S.E. 82nd Avenue and S.E. 122nd Avenue. In their 1990 reconnaissance study report on Johnson Creek, the Corps estimated that about 2,000 structures lie within the 100-year flood plain below river mile 12.3.

On February 24, 1994, a flood occurred on Johnson Creek with a peak flow of 1,780 cfs at the Sycamore gage. It was estimated to be a 5-year return period flood. Approximately 40 structures were affected. The most severe flooding occurred in the Lents area along S.E. Foster Road between S.E. 106th Street and S.E. 112th Street.

FUTURE FLOODS

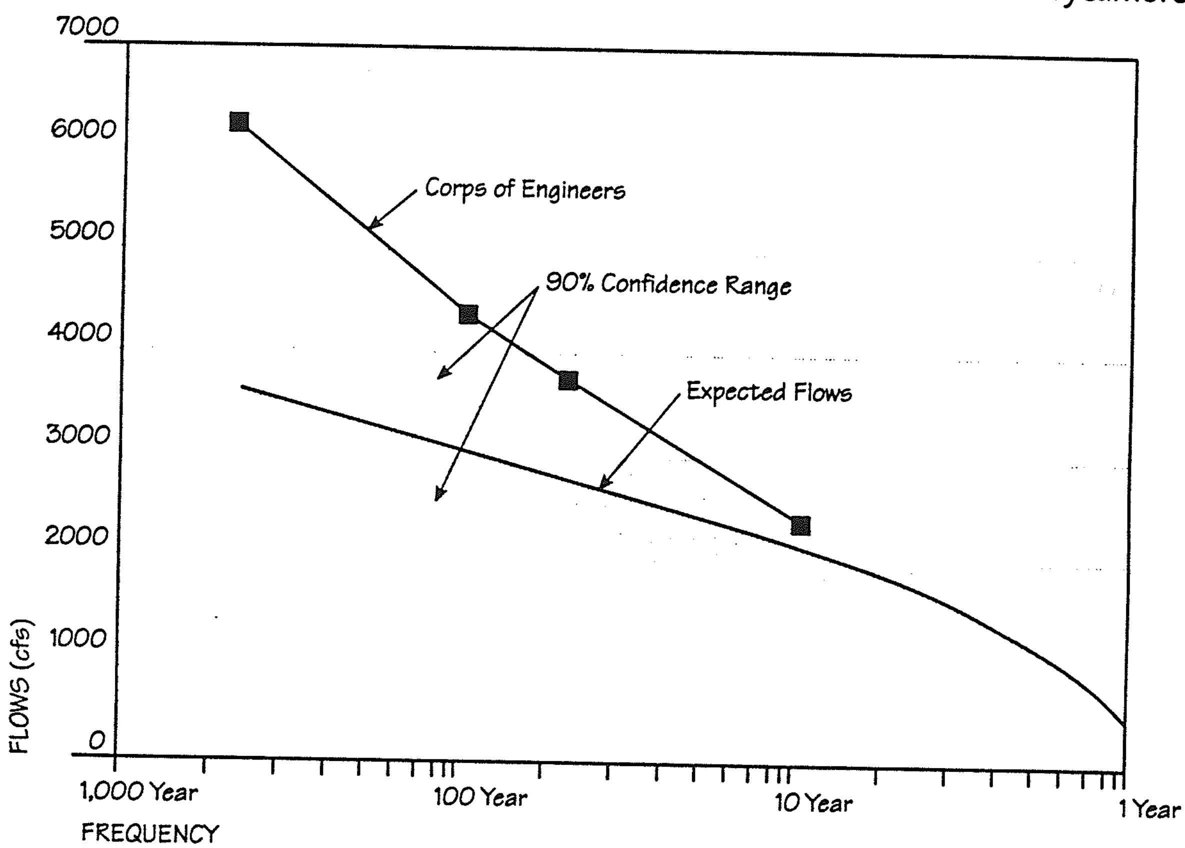
Two techniques are used to predict and analyze the severity of future floods: gage analysis and basin simulation. Gage analysis uses the long-term flow records available at the Sycamore gage to predict the peak flow and frequency of future floods, assuming no major changes in land use or vegetative cover in the watershed. Basin simulation uses computer models to simulate the behavior of the watershed and predict future peak flows under altered land use conditions. The computer models predict water surface elevations in floods of different sizes and allow evaluation of different flood reduction schemes.

■ GAGE ANALYSIS

Peak flood flows and frequencies obtained from a statistical analysis of gage records at Sycamore are shown in Figure 19. The results are compared to the Corps' estimates of peak flood flows made for the Multnomah County Flood Insurance Study (FIS) in 1980. For more frequent floods, those with less than 10-year return period, the estimates from the gage analysis are similar to those reported by the Corps. However, for less frequent floods, the Corps estimates are much higher than the estimates based on gage analysis. For example, the Corps estimates the peak flow associated with a 100-year flood to be 4,350 cfs. The corresponding estimated peak flow from gage record analysis is only 3,200 cfs, or 1,150 cfs lower (i.e., 26 percent lower) than the Corps' estimate. The difference in estimates is partly attributable to the 53-year stream-flow record available in 1994 compared to the 39-year record available to the Corps in 1980.

FIG 19

Predicted Flows at Sycamore Gage



■ BASIN SIMULATION

The most commonly used basin simulation models were developed by the U. S. Army Corps of Engineers Hydrologic Engineering Center (HEC). The models, HEC-1 and HEC-2, were used by Kurahashi and Associates (KAI), a member of the RMP consultant team, to model the Johnson Creek watershed. The hydraulic model, HEC-2, was used by the Corps of Engineers (Corps) in their earlier studies of Johnson Creek. However, the earlier work completed by the Corps was based on cross-sections of the creek channel measured more than 20 years ago. The channel cross-section may have changed considerably in 20 years as a result of siltation. To update the channel characteristics, the Cities of Portland and Gresham resurveyed each bridge spanning the creek and surveyed typical cross-sections (at approximately 500-foot intervals) up to river mile 22 during the summer of 1993. The updated bridge and channel cross-sections were used to develop new hydrologic and hydraulic models of the Johnson Creek watershed.

HEC-1 (the hydrologic model) is used to determine how rainfall during a storm becomes runoff to the creek. It uses physical properties of a watershed, such as soil characteristics, amount of impermeable surface, and slope, to calculate how much of the rainfall infiltrates into the soil and how much runs off as surface flow. Together with data on the intensity and distribution of the rainfall during the storm, the program calculates a "hydrograph" or picture of the amount of creek flow with time. The maximum amount of creek flow or "peak" of the hydrograph is the value usually reported as the magnitude of the flood. The shape of the hydrograph and the duration of flood flows are also important in determining how damaging a flood may be and how effective detention basins and other flood management strategies will be in reducing flood damages.

For the RMP modeling effort, the Johnson Creek watershed was subdivided into approximately 90 sub-basins which were assumed to have the same physical properties. HEC-1 was calibrated by comparing the results of the modeling effort with measured flows at the two USGS gaging stations. The calibration confirms that the properties assumed for the sub-basins are accurate enough to use the model to predict runoff and creek flow for rainfall events which have not been recorded, such as the 50- and 100-year floods.

HEC-2 (the hydraulics model) is used to predict the water surface elevation of creek flow. HEC-2 uses the physical properties of the creek channel and its flood plain, including channel shape and size, the hydraulic properties of bridges and culverts, and the resistance to flow in the creek channel, usually called the roughness (expressed as Manning's "n" value). The roughness takes account of the combined effect of the channel material, vegetation, sinuosity, and sudden changes in channel shape.

It is obviously important that the HEC-2 model accurately predicts water surface elevations. Checking the accuracy of a model is typically difficult due to the lack of information on large floods. Large floods are infrequent events; when they do occur city staff are usually preoccupied with emergency relief and are rarely available to measure the water surface elevations or creek flows. Very few water surface elevations or creek flows are available among the records of earlier floods on Johnson Creek. Fortuitously, from the point-of-view of the hydrologic studies, a 5-year return period flood occurred on February 24, 1994, enabling water surface elevations to be measured accurately at many locations. HEC-2 was calibrated by comparing predicted water surface elevations with those measured during the February 24, 1994, flood. This calibration confirmed that the channel cross-sections and roughness values are accurate enough to use the model to predict water surface elevations during future floods.

PREDICTED FUTURE FLOOD FLOWS

Table 14 shows estimated peak flows at the Sycamore and Milport gages under different land use conditions. The unusual hydrologic characteristics of the watershed are illustrated by a comparison of peak flows at the two gages under the existing land use condition. In most watersheds peak flow increases substantially as a flood moves downstream. As a flood moves down a stream channel, larger and larger areas contribute water to the flood. This effect is lessened somewhat by the tendency of peak flow to decline in a downstream direction as the stream channel broadens.

TABLE 14
Predicted Flood Discharges on Johnson Creek Under Different Land Use Conditions

Flood Return Period (yrs)	Streamflow (cfs)				
	Pre-Development[1]	Existing Land Use	Planned Future Land Use[2]	2040 Plan Land Use[3]	Watershed Buildout[4]
			Sycamore Gage (river mile 10.8)		
2	880	1340	1380	1480	–
5	1220	1760	1800	1920	–
10	1440	2030	2080	2210	3600
25	1740	2400	2450	2600	–
50	2050	2790	2840	3000	–
100	2410	3220	3280	3420	5200
500	3200	4060	4110	4260	–
			Milport Gage (river mile 0.5)		
2	1030	1500	1530	1670	–
5	1390	1790	1820	1930	–
10	1540	1870	1890	2250	2700
25	1790	2350	2370	2480	–
50	1930	2530	2550	2630	–
100	2370	2690	2700	2800	3000
500	2720	2880	2920	3240	–

Note:

1 Assumes watershed to be forested.

2 Planned future land use conditions that reflect current comprehensive planning within existing urban growth boundary and some reduction in development intensity due to natural resource area conflicts.

3 Assumes urban reserve areas in Metro's 2040 plan are converted to urban uses.

4 Assumes conversion of entire watershed to urban and suburban land uses.

During small floods in the Johnson Creek watershed, the peak flow at the Milport gage, near the creek mouth, is slightly higher than the peak flow at the Sycamore gage, near the watershed's midpoint. The difference between peak flows at the two gages is not great, however, because the western portion of the watershed contributes so little runoff. As noted earlier, much of the rainfall over the western end of the watershed either percolates into the ground or is diverted away from the creek by the Portland combined sewer system. Also, the watershed is long and narrow, characteristics that tend to prevent the development of large peak flows. Stormwater from the western end of the watershed discharges rapidly to the Willamette River long before flood waters from the upper basin arrive in the lower reaches of the creek.

On the other hand, during larger floods, peak flows at Milport are lower than those at Sycamore. This counter-intuitive phenomenon is a result of a portion of the flood flow being diverted into storage in the Lents area. Most of the flow remains in the stream channel and is recorded by the Sycamore gage but, in the Lents area, a considerable proportion overflows the creek banks and is temporarily stored. As a consequence, only a fraction of the flow reaches the Milport gage during the height of the flood.

Estimated peak flows for three future land use conditions are also shown in Table 14. The planned future land use condition is based on current city and county comprehensive plans and reflects the fact that development is currently limited to within the Urban Growth Boundary (about two-thirds of the watershed lies within the Urban Growth Boundary). The estimated peak flows under the planned future land use condition are only about two percent greater than for the existing land use. This is a result of the unusual hydrologic characteristics of the watershed, as described above, and the limited areal extent of new development. Much of the currently planned development involves expansion on the fringes of existing communities and redevelopment and densification of existing developed areas.

It is expected that the population of the Portland metropolitan area will increase by about one million by the year 2040. METRO, the regional planning agency for the four-county Portland metropolitan area, recently approved a plan to accommodate an expected population increase of 1.1 million by the year 2040. The 2040 plan does not envisage any immediate changes to the urban growth boundary in the Johnson Creek watershed. Instead, new residents would be accommodated by denser development of lands within the present urban growth boundary. However, the 2040 plan does identify lands south and east of Gresham as "urban reserve" or lands that could be included in the urban growth boundary at some future time. If these lands are developed then peak flows are estimated to be as shown under the 2040 condition in Table 14. It is apparent that the increase in development allowed under the 2040 plan has only a modest effect on peak stream flow.

Although there are no plans to develop the Johnson Creek watershed beyond the levels noted above, the effects of more intensive development were investigated. A future land use condition referred to as "watershed buildout" was modeled. Under this condition it was assumed that the watershed becomes fully developed in approximate proportion to the current mix of urban land uses. Peak flows in Johnson Creek as recorded at the Sycamore gage would increase by about 70 percent. In this, and the other land use conditions modeled, it was assumed that floodwater detention in new development either does not exist, or is ineffective.

FLOODING PATTERNS

An overall picture of how flooding occurs in the Johnson Creek watershed can be constructed from observations of past floods and model-generated predictions of future flooding. Table 15 shows flood-prone areas along the creek.

TABLE 15
Floodprone Areas Along Johnson Creek

River Mile	Location	Remarks
0.61	South of Milport	Overbank flooding in five-year storm, some damage in February 1994 storm
0.79-0.86	Between Milport and Portland Traction trestle	Overbank flooding in two-year storm
1.29-1.51	Johnson Creek Park and vicinity	Overbank flooding in two-year storm
2.47-2.59	Tideman Johnson Park	Overbank flooding in two-year storm, no structures involved
3.18-3.27	Johnson Creek Boulevard at 45th	Overbank flooding in two-year storm
4.35-4.43	Linwood crossing and vicinity	Overbank flooding in two-year storm
4.71-4.82	Bell Station and vicinity	Overbank flooding in two-year storm, some damage in February 1994 storm
5.24-5.41	Luther and 76th	Overbank flooding in two-year storm
5.72	82nd Avenue crossing	Overbank flooding in five-year storm
6.99	100th Avenue	Overbank flooding in five-year storm
7.45-8.98	106th Avenue to 120th Avenue	Continuous overbank flooding in five-year storm; overbank flooding in two-year storm around 112th Avenue. Considerable damage in February 1994 storm
9.27-9.87	Leach Botanical Garden and vicinity	Overbank flooding in two-year storm, no structures involved
10.66-10.83	148th Avenue and vicinity	Overbank flooding in two-year storm
11.24	158th Avenue	Overbank flooding in two-year storm

The most flood-vulnerable reach of the creek is in the Lents area along S.E. Foster Road between S.E. 106th Street and S.E. 112th Street. Historic maps indicate that, before development, much of the area was a wetland. Beggars-tick Marsh is a remnant of the wetland. The creek in this reach has a gentle slope and meanders considerably. The capacity of the creek channel in this area is approximately 900 cfs. An existing 72-inch bypass pipe, installed earlier to relieve flooding, increases total capacity to approximately 1,200 cfs. This is less than the peak flow associated with a 2-year return period flood. Thus, flooding in this area can be expected to occur every other year on average.

During floods that exceed channel capacity, water leaves Johnson Creek near S.E. 112th Street and flows across S.E. Foster Road. A portion of the flow is intercepted by the Springwater Trail Corridor fill and routed back toward S.E. Foster Road near S.E. 106th Street, where it crosses the road and re-enters the creek channel on the Freeway Land Company property. The creek channel on the Freeway Land Company property has a considerably higher capacity than the reaches of the creek just upstream. Another portion of the flow continues north into Beggars-tick Refuge. If the flood is large enough, two other low-lying areas begin to fill with floodwater. These are the Holgate Lake area to the north and east of the refuge and the resident neighborhoods to the west of the marsh. In both of these areas a relatively large number of structures are vulnerable to flooding.

Several other areas downstream of Lents are subject to flooding in relatively-frequent small storms (2- to 5-year return period storms). They include S.E. Umatilla Street (river mile 1.5), S.E. 45th Avenue, just upstream of the WPA-constructed fish ladder (river mile 3.2), Bell Station (river mile 4.7) and S.E. Luther Road (river mile 5.4). Relatively small numbers of structures are vulnerable at each of these locations.

If flow becomes great enough, properties in the vicinity of Crystal Springs Creek become vulnerable to flooding. In storms greater than the 50-year event, the path of floodwaters splits upstream of the S.E. Tacoma Street bridge. One flow path continues to follow Johnson Creek, while the other crosses Eastmoreland Golf Course and S.E. McLoughlin Boulevard, and joins Crystal Springs Creek in Westmoreland Park. The combined flows in Crystal Springs Creek exceed channel capacity, making properties lining the creek vulnerable to flooding.

A few areas upstream of Lents are also vulnerable to frequent flooding. They are in the vicinity of S.E. 151st Avenue and S.E. 158th Avenue. Only a handful of structures are vulnerable in small storms. In large storms (25-year return period and greater) about 50 structures could be affected in Portland and a few more in Gresham.

FLOOD DAMAGES

A post-flood damage survey was conducted after the 1964 flood, when approximately 1,500 structures were affected. It was concluded that the total cost of the damages was $500,000, expressed in 1964 dollars. Adjusting for inflation, the economic damage of such a flood today, would be $3,000,000, or about $2,000 per structure.

In their 1990 reconnaissance study report, the Corps estimated the value of damage that would be caused by floods of various sizes. The Corps used an estimation method developed by the Federal Emergency Management Agency (FEMA). The information developed by the Corps was adjusted to take account of the new estimates of flood frequency made by KAI. Table 16 shows the estimated damages associated with various return period floods.

After the recent flood in February, the City of Portland estimated the value of damages to be about $375,000. This is 45 percent higher than the estimate of $210,000 extrapolated from Corps of Engineers data. It is not clear whether the Corps' estimates undervalue damage that might occur in more severe and less frequent floods.

TABLE 16
Predicted Costs of Flood Damages Under Existing Land Use Conditions
(1994 dollars)

Flood Frequency (years)	Estimated Damage ($ Million)		
	Below Lents	At Lents	Total
2	0	0.05	0.06
5	0.02	0.18	0.26
10	0.05	5.11	5.4
25	0.06	10.22	10.8
50	0.11	11.92	12.6
100	0.13	13.87	15.1
500	0.92	14.6	16.3

Note: Damage estimates are based on the relationship between flood water levels and damage value established by the U.S. Army Corps of Engineers and the new estimates of flood frequency and peak flow made by Kurahashi and Associates. Actual damage estimates for the 5-year return period flood that occurred on February 24, 1994 are approximately $375,000. Thus, it is possible that predicted damages in larger floods are also underestimated.

Flood Reduction Strategy

The conventional approach to flood control in the urban environment has been to make improvements to channels so that they can accommodate higher flows. This was the approach taken by the Works Progress Administration when it widened and rock-lined Johnson Creek in the 1930s. Followed to its ultimate conclusion, the approach results in the conversion of natural streams to concrete-lined channels; the Los Angeles River is a notable example.

Two of the goals of the RMP established by the Johnson Creek Corridor Committee are to ensure "flood impacts are minimized," and "natural areas are preserved and restored." If the conventional approach to flood control were adopted, the two goals would be mutually exclusive because conventional channel improvements are entirely incompatible with the preservation of natural areas. Thus, to satisfy both of the JCCC's goals, flood control on Johnson Creek cannot rely heavily on conventional channel improvements. Two major consequences follow from this conclusion. First, and most obviously, flood reduction on Johnson Creek must primarily rely on measures other than conventional channel improvements. Less obviously, it must include measures to halt or slow the increase in peak flows that result from development. Without control of peak flows from new development, channel improvements or large-scale acquisition of flood plan lands could become virtually unavoidable at some time in the future. Instead of channel improvements, the flood reduction strategy must rely on measures such as on- and off-stream floodwater storage, that serve to offset the adverse effects of development and allow the channel to remain in a more natural state. Acquisition of the most vulnerable properties would also be desirable.

Plan Objectives and Actions

The first of the objectives listed below addresses the control of future peak flows from increased development of the watershed. The second objective addresses the need to minimize flood damage to existing structures. Table 17 lists the objectives and actions, identifies the party responsible for each action, and includes an estimate of the cost of each action.

OBJECTIVE FM-1
Minimize Post-Development Peak Flows.

As discussed earlier, urban development typically results in an increase in peak flows and total runoff volume. As indicated in Table 15, development of the Johnson Creek watershed has increased peak flows by approximately 40% compared to the undeveloped condition. Futher development or significant redevelopment would lead to increases in runoff volume, but the increases in peak flows are not likely to be great. However, if, as seems likely, the Urban Growth Boundary is modified at some time in the future, to allow urban development in the upper Johnson Creek watershed, peak flows could increase by up to 70 percent. Higher peak flows will exacerbate downstream flooding and impose flood control costs on Portland and Milwaukie that are attributable to development upstream. Furthermore, the need to provide flood protection from increased peak flows could force downstream communities to consider channelization, a flood control measure that is inherently incompatible with protection of natural resources and fisheries enhancement.

The only way to prevent or minimize future increases in peak flow is to build individual or regional stormwater detention facilities into all new development. In this way the monetary and environmental costs of flood control are imposed on those who cause the increase in peak flows, rather than on those who are simply subjected to them.

Three government agencies in the watershed have already adopted development standards that require some form of stormwater detention in new development. The existing standards are as follows:

TABLE 17
Summary of Flood Management Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective FM-1. Minimize Future Post-Development Peak Flows				
Action FM-1-1. Establish comprehensive and effective basin-wide stormwater drainage regulations for new developments[1]	Cities and Counties (intergovernmental committee)	$45,000 (One-time cost)	$45,000 (One-time cost)	B
Action FM-1-2. Implement basin-wide development standards for stormwater drainage[2]	Cities, Counties, and Developers	Not estimated	Not estimated	B
Objective FM-2. Reduce Flood Damage to Existing Structures				
Action FM-2-1. Construct flood reduction facilities	Cities and Counties	$14,000,000 (One-time cost) $75,000 (annual cost)	$14,000,000 (One-time cost) $75,000 (annual cost)	A
Action FM-2-2. Draft and adopt "Balanced Cut and Fill Standard" for the 100-year flood plain[3]	Cities and Counties	$15,000 (One-time cost)	$15,000 (One-time cost)	B
Action FM-2-3. Redefine FEMA 100-year flood plain[4]	Cities and Counties	$50,000 (One-time cost)	$50,000 (One-time cost)	A
Action FM-2-4. Establish channel maintenance practices handbook	Cities and Counties (intergovernmental committee)	$30,000 (One-time cost)	$30,000 (One-time cost)	B
Action FM-2-5. Maintain channel according to channel maintenance practices handbook[5]	Cities and Counties/ volunteers	$83,000 (annual cost)	$83,000 (annual cost)	B
Action FM-2-6. Establish emergency response team and procedures to minimize flood damage	Portland and Milwaukie	$25,000 (one-time cost)	$25,000 (One-time cost)	A
Action FM-2-7. Acquire properties vulnerable to frequent flooding as they become available	Cities and Counties	Not estimated	Not estimated	C

1 Related action: Action PP-2-3
2 No increase in public cost to implement modified standards. Increased development costs to comply with standards.
3 No increase in public cost to implement standards. Increased development costs to comply with standards. Some lots become unbuildable.
4 Action would reduce flood insurance costs and lead to appreciation of property values.
5 Assumes silt and large debris removed by City and Counties at 3-year intervals. Volunteers and homeowners trim vegetation.

- **City of Portland.** Limits the volume of stormwater runoff from new development in the Johnson Creek basin to 110 percent of the volume under pre-development conditions for the 10-year storm event. Also prohibits an increase in downstream peak flow.

- **City of Gresham.** Runoff during a 25-year storm shall not exceed the pre-development rate of runoff released during a 10-year storm.

- **County of Clackamas.** Detention for new developments (except single family residences) should be constructed for 25-year storms and release rates from the detention should not exceed the runoff rate from the pre-developed site during a 5-year storm.

The existing hydrologic development standards suffer from several disadvantages. Firstly, they are imposed uniformly within a political subdivision without regard for hydrologic considerations. This can produce the opposite of the effect intended. In most watersheds flooding can be prevented by ensuring that peak flows from different parts of the watershed do not arrive simultaneously at a single point. In a long and narrow watershed like the Johnson Creek watershed, this can best be accomplished by delaying the release of flood flows from the upper watershed until the lower reaches of the creek have drained to the Willamette River. Floodwater detention in the upper basin clearly serves a useful purpose while floodwater detention in the lower basin may simply decelerate draining of the lower reaches and thus increase peak flow and the severity of flooding.

A second disadvantage is illustrated by the inconsistent nature of each community's hydrologic development standards. The differing standards reflect the lack of agreement among engineers on how they should be drafted. As part of the work in support of the RMP a survey was made of hydrologic development standards used in different parts of the United States. The results are contained in Technical Memorandum No. 2 entitled "Summary of Land Use Regulations for Minimizing Hydrologic Impacts."

It is clear from the results of the survey that the lack of agreement on the best way to limit the adverse hydrologic effects of development is not confined to the Johnson Creek watershed. A number of technical and institutional issues remain unresolved. Many jurisdictions seek to limit post-development runoff to its pre-development value. However, there is no general agreement on how pre- and post-development runoff should be calculated or how the required detention facilities should be designed. In the Pacific Northwest some engineers believe that the conventional practice of designing detention facilities based on single, isolated storms may not provide the desired level of protection during the back-to-back storms common in the region. If they are correct, and a different runoff calculation method is appropriate, the required detention facilities could be much larger and more costly than they have been in the past.

Stormwater detention facilities can be constructed at each new development, or regional facilities can be built. In general, regional facilities are preferable because they are more likely to be properly designed and maintained. However, in already urbanized areas, suitable sites may be difficult to locate. Requiring all developers to provide stormwater detention is administratively simple and imposes less of a burden on public agencies than provision of regional storage. Some agencies, the Unified Sewerage Agency of Washington County for example, allow developers to contribute to a regional detention fund rather than build their own on-site detention facilities. The Unified Sewerage Agency also takes responsibility for maintenance of all private detention facilities.

It is important that the requirements for control of stormwater flow or quantity are coordinated with the requirements for control of stormwater quality. As part of their stormwater management plans, the cities of Portland and Gresham, and Clackamas County are developing standards and guidance documents for water quality control facilities for new developments. It is likely that these jurisdictions will require treatment of stormwater, probably sedimentation in vegetated basins. Thus, any standards for detention basins should take account of the need to control peak flow and the quality of discharged stormwater.

Action FM-1-1

Establish comprehensive and effective basin-wide stormwater drainage regulations for new developments.

It is clear from the discussion above that the establishment of a comprehensive set of standards to minimize the adverse hydrologic effects of development is technically complex. An intergovernmental committee will be established to consider the options and recommend an effective and equitable set of regulations for adoption by all jurisdictions within the watershed (see Action WS-1-1). The new standards will address:

- Runoff calculation methods.
- The characteristics and size of the design storm.
- Coordination of design criteria for control of stormwater quantity and quality.
- Differences in hydrologic development standards for different parts of watershed.

HEC-1 hydrologic model developed as part of the RMP will be useful in testing the effectiveness of different standards.

Action FM-1-2

Implement basin-wide development standards for stormwater drainage.

Jurisdictions within the watershed will adopt the development standards established in Action FM-1-1 and incorporate them into their zoning and development regulations.

OBJECTIVE FM-2

Reduce Flood Damage to Existing Structures.

The actions discussed above would limit future increases in peak flow, but would not reduce the flood risk to currently vulnerable properties. To develop a flood management plan to protect vulnerable properties, the study consultants and the Flood Management

Task Group met regularly over a six month period. Before proceeding with the development of specific flood control measures, two general issues were addressed by the consultants, the task group and the JCCC. The first issue revolved around whether the displacement of existing homes and businesses should be considered as part of the flood management plan. The Corps of Engineers have estimated that about 2,000 structures lie within the 100-year flood plain in the Johnson Creek watershed. This is a result of past government practices that allowed construction in the flood plain. For the last several decades local governments have prohibited or greatly restricted construction in flood plains as a way of preventing damaging floods. Consequently there are few vulnerable properties in Gresham, because much of that community's growth has occurred in the last 20 years when controls on development in the flood plain were in place. Although flood damages could be greatly reduced by the public acquisition and removal of flood-vulnerable properties, the JCCC concluded that the compulsory purchase of homes and businesses should not be a part of the RMP. The possibility of purchase of flood-vulnerable properties from willing sellers, as they become available, was retained and is described in Action FM-2-7.

The second general issue considered was what level of flood protection the plan should provide. It was becoming clear from early work by the consultants that provision of protection from very large floods, the 100-year flood for example, was not practically possible. Protection from the 100-year flood could be provided by extensive channel improvements, construction of very large floodwater storage reservoirs, or by large-scale acquisition of vulnerable properties. None of these approaches were deemed acceptable by the JCCC. Also their cost would be very great; for example, the City of Portland estimates that the cost of acquiring all property in the flood plain within its city limits would be several hundred million dollars. To further explore this issue, the study consultants held a series of meetings with local residents and neighborhood associations in the watershed. During these meetings, local residents, particularly those living in the Lents neighborhood, indicated that their primary concern was the frequent floods which cause damage on a regular basis (i.e., the 2- and 5-year floods). If flood reduction measures could prevent the more frequent floods, residents could accept the damage caused by larger, more infrequent floods. Based on these views, the consultants developed a flood control strategy to address the more frequent floods.

The first step in developing the strategy involved the analysis and prioritization of available flood control measures. The measures which were considered are listed below in order of applicability to conditions in Johnson Creek and compatibility with other elements of the RMP, that is, the highest priority measures are listed first.

- *On-stream Detention Basin.* An embankment is built across the creek to form an on-stream detention basin. No vegetation is removed in the detention area upstream of the embankment; it is left in its current natural condition. Dry-weather flows and flows associated with small storm events pass through a culvert under the embankment without being detained. During larger storm events (e.g., 2-year or larger storms), the capacity of the culvert would be exceeded and excess water would accumulate in the detention basin.

Floodwater would be temporarily stored in detention basins built on Johnson Creek and its tributaries in the upper watershed. By delaying flow from the upper watershed, peak flows would be reduced in downstream reaches of the creek, including those currently subject to frequent flooding. On average the on-stream detention basins would contain water for a day or two once every 2 to 5 years. A sketch of an on-stream detention basin is shown in Figure 20.

- *Off-stream Detention Basin.* Off-stream detention basins consist of normally dry basins connected to the creek by weirs or culverts. If creek flows exceed a certain value, excess water would flow over the weir into the detention basin. Floodwater stored in the detention basin would be slowly released back to the creek after the flood has passed. Peak flows would be reduced downstream of the detention basins. Off-stream detention basins can be located at any point along the creek where adequate space is available. Off-stream detention basins are more expensive than on-stream basins because they involve more complex and extensive earthwork and control structures.

- *High-flow Bypass.* Flooding occurs when the capacity of a creek channel is not large enough to convey the flow. A high-flow bypass provides a second channel or conduit, thus increasing the total flow capacity. During dry-weather flows and flows associated with smaller storm events, the creek remains in its original channel and the bypass channel is dry. During large storm events, both channels convey flow. High-flow bypasses can be very effective in reducing localized flooding. Their primary disadvantage is that they may simply transfer the problem downstream to another creek section where capacity may also be limited.

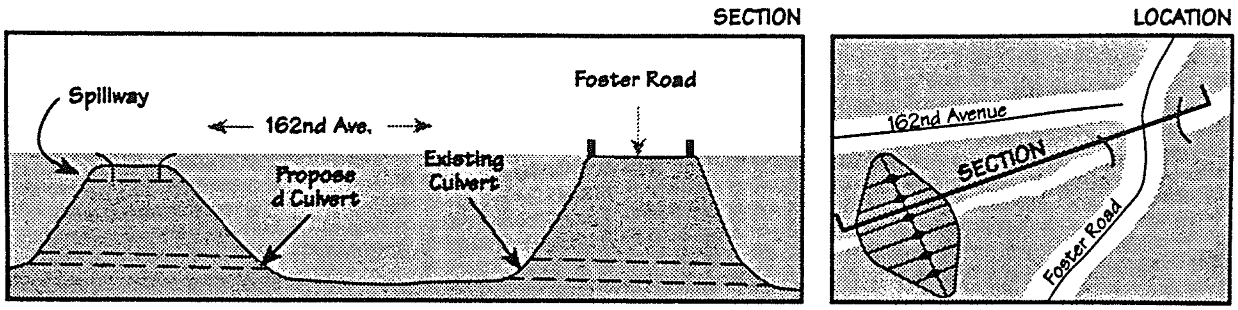
- *Modification of Structures.* Bridges or other structures in the creek may constrict flow and cause or worsen upstream flooding. The structures may be removed or modified, however, this may only transfer flooding problems downstream.

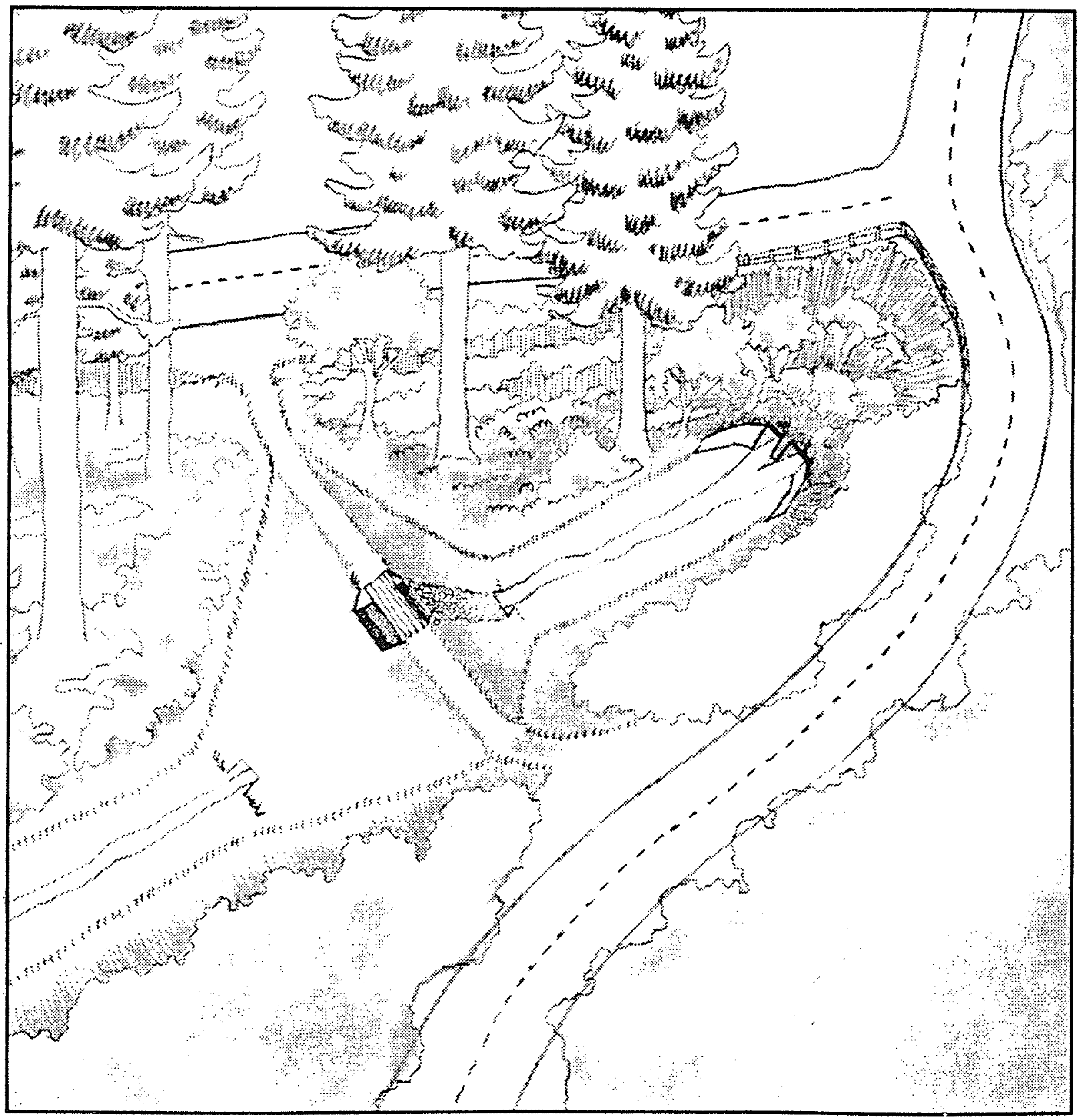
- *Dry Well Injection.* Dry wells operate by discharging stormwater or flood waters directly into the ground. There is some evidence to suggest that construction of large dry wells in the Lents area could relieve local flooding. Excavations have shown that a thick layer of cobbles, ten to thirty feet thick, lies four to ten feet below the surface. Dry wells could be used to inject overflow from Johnson Creek into this very permeable layer.

One additional flood control measure, floodproofing, was also considered, but not included in the above list for several reasons. Floodproofing is a method of modifying structures, currently subject to flooding, to eliminate or reduce damage. Floodproofing includes raising structures on their foundations and sealing doorways and windows with temporary dams. Floodproofing large numbers of structures is rarely cost-effective. Minor floodproofing may be appropriate when only a handful of structures are involved.

FIG 20

Perspective Sketch of Detention Structure





Of the five options listed above, three, on- and off-stream detention basins and high flow by-passes, appear to be the most promising for the Johnson Creek watershed. Dry well infiltration in the Lents area could play a part in a flood reduction plan, but it is currently unproven. Although there is evidence that a very permeable layer of gravel lies just below the surface of the soil to the north of the creek in the Lents area, it is not clear whether this layer is hydraulically connected to Johnson Creek. Also, it is not known whether groundwater levels rise in this permeable layer during wet periods, to the extent that drainage of flood water would be impossible or limited. Preliminary studies by the City of Portland suggest this option is unpromising.

Initially, it was thought that modification of bridge structures might reduce flooding on Johnson Creek substantially. The HEC-2 hydraulic model was used to examine the effect of bridges on flood flow in the reach of the creek below river mile 12. The model showed that while some bridges are contributing to local flooding problems, they are not a major cause of widespread flooding. Modification of some bridges would relieve local flooding here and there, and would reduce transportation disruption, but would not solve the more serious flooding problems. The study consultants identified ten bridges that cause a local increase in water surface elevation of at least one foot in a 10-year return frequency storm. Five structures were assigned the highest priority for action and the City of Portland is proceeding with plans to modify them. They are the private bridge near S.E. Luther Avenue, the Portland Traction Company trestle near S.E. Ochoco Street, the S.E. Ochoco Street bridge itself, the S.E. Stanley Street bridge and the S.E. Johnson Creek Boulevard bridge at S.E. 45th Avenue.

Action FM-2-1

Construct flood reduction facilities.

The various flood reduction measures described above were assembled into several alternative flood reduction schemes. The alternatives attempt to achieve a reasonable level of flood protection for existing structures, while retaining as much of the appearance and benefits of a natural creek as possible. All alternatives would include the modification of the five bridge structures noted above, and minor channel improvements. The minor channel improvements would involve clearing and trimming of mostly non-native vegetation to increase channel capacity in some reaches of the creek (see Actions FM-2-4 and FM-2-5).

- ALTERNATE A. Construction of on-stream detention basins in the upper watershed with a total storage capacity of approximately 400 acre-feet. Potential locations for detention basins are shown in Figures 21 through 24. The capacity of each detention basin is shown in Table 18.

- ALTERNATE B. Construction of Alternative A, together with a flood relief channel in the Lents neighborhood east of Interstate 205. The relief channel would route a portion of the floodwaters around the most flood-vulnerable area. The preferred location for the channel would convey floodwater across S.E. Foster Road to Beggars-tick Refuge, convey it in an open unlined channel along the edge of the Springwater Corridor, and return it to Johnson Creek under Foster

TABLE 18
Characteristics of On-stream Detention Basins*

Site	Maximum Water Surface Elevation (ft MSL)	Height of Structure (feet)	Storage Volume (ac-ft)
Kelley Creek above S.E. 162nd, lower site	295	30	84.5
Kelley Creek above S.E. 190th	440	35	38.5
Tributary below Hogan Rd., lower site	360	25	43.6
Tributary below Hogan Rd., middle site (existing Cedar Lake)	368	27	26.5
Tributary below Hogan Rd., upper site	395	25	50.0
Tributary near Hillview	440	15	145.0
	TOTAL VOLUME		**426.2**

Note: Final sites for the on-stream detention basins have not been selected. The sites listed in the table would provide the required volume of storage. These sites, and others, continue to be evaluated.

Road. As a less-desirable alternative, the capacity of the existing culvert pipe, which runs along Foster Road from S.E. 112th Avenue to S.E. 108th Avenue, could be increased and its outfall relocated beyond S.E. 106th Avenue.

- ALTERNATE C1. Construction of all elements of Alternatives A and B, together with off-stream storage in the Lents neighborhood, east of Interstate 205. The off-stream storage facilities would have a capacity of 660 acre-feet. They would be located on the Freeway Land Company site. The storage facilities would be designed for multiple use, combining flood reduction with wildlife habitat and recreation facilities.

- ALTERNATE C2. Alternative C2 would be the same as Alternative C1, except that the off-stream storage facilities would have a capacity of 200 to 600 acre-feet. They would be located on several parcels north of the creek, in the vicinity of Beggars-tick Refuge, and south of the creek near Brookside Drive and on portions of the Freeway Land Company property.

- ALTERNATE D. Alternative D would include the same upstream storage facilities as Alternative A, and the same off-stream storage facilities as Alternative C2. It would not include a flood relief channel at Lents.

The effects of each of the alternatives were examined using the hydrologic and hydraulic models. Alternative A offers the advantage that it provides a moderate level of flood protection to all downstream areas. It produces some reduction in flood flows along the entire length of the stream channel downstream of the detention basins. In no instance does it produce an increase in flow relative to the no action condition.

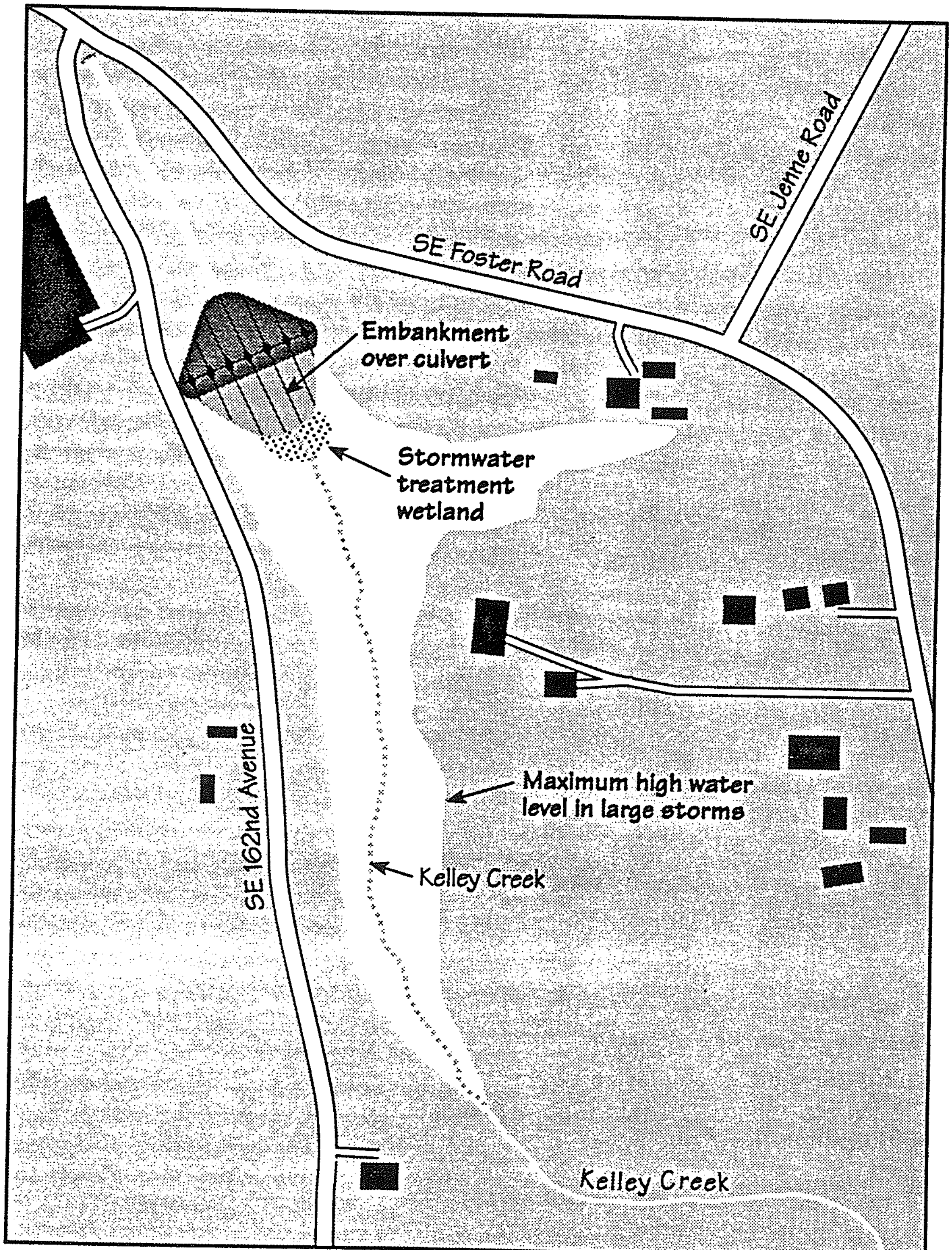
Alternative B would provide a greater level of flood protection to the Lents neighborhood upstream of Interstate 205 than would Alternative A. The flood relief channel at Lents would route a portion of flood flow around a reach of the creek which has very limited capacity. Alternative B would provide less flood relief to areas downstream of Lents than Alternative A. This is because the flooding that currently occurs in the Lents area protects downstream areas from flooding (see earlier discussion of historic flooding). The flood relief channel would prevent some of the floodwater from going into storage in the Lents area and would route it rapidly downstream. Under Alternative B, and viewed from the perspective of the areas downstream of Lents, the beneficial effects of upstream storage would be partly cancelled out by the effects of the flood relief channel in small- and medium-sized storms During large storms, 50-year return period and larger, the effects of the flood relief channel would more than cancel out the beneficial effects of upstream storage; downstream flow would be increased above the no project condition.

Alternative C includes the components of Alternative B and off-stream storage at Lents. It is similar to Alternative B in that it provides a greater level of flood protection to Lents, but it also seeks to offset the adverse downstream effects of Alternative B by providing additional storage. The off-stream storage at Lents would replace some of the inadvertent flood storage that now occurs in the same general area, and would wholly, or partly, counteract the effects of the flood relief channel. Two versions of this alternative were developed. Alternative C1 includes sufficient off-stream storage capacity, 660 acre-feet, to wholly counteract the effect of the flood relief channel. The only single site in the Lents area that can accommodate such a large storage facility is the Freeway Land Company site. However, use of the Freeway Land Company site for floodwater storage is in conflict with the Outer Southeast Community Plan. The Outer Southeast Community Plan reflects the community's desire to use the site for employment generation. Because the feasibility of Alternative C1 is in doubt, Alternative C2 was developed. Under Alternative C2, the off-stream storage at Lents would be located at a number of smaller sites. It is not clear how much storage can be developed in this way. For the purposes of the analysis, it was assumed that a minimum of 200 acre-feet could be developed at four or five sites. Modelling indicates that the storage included in Alternative C2 would partly counteract the effects of the flood relief channel. However, during large storms (50-year return period and greater), Alternative C2 would still increase flows downstream of Lents relative to the no project condition, but by a smaller margin than Alternative B.

The fact that Alternatives B and C2 result in increases in downstream flood flows may make them impossible to implement. Even though the increases are relatively small, they could raise difficult-to-resolve legal liability issues. Like Alternative C1, Alternative D was devised to provide increased flood protection in the Lents area without increasing downstream flood flows. It is similar to Alternative C2, except that it does not include a flood relief channel. Like Alternative A, it would produce flood reduction benefits along the entire length of the stream. Flood protection in Lents would be enhanced by routing some flood waters to local off-stream storage, but no attempt would be made to by-pass flow around the area.

FIG 21

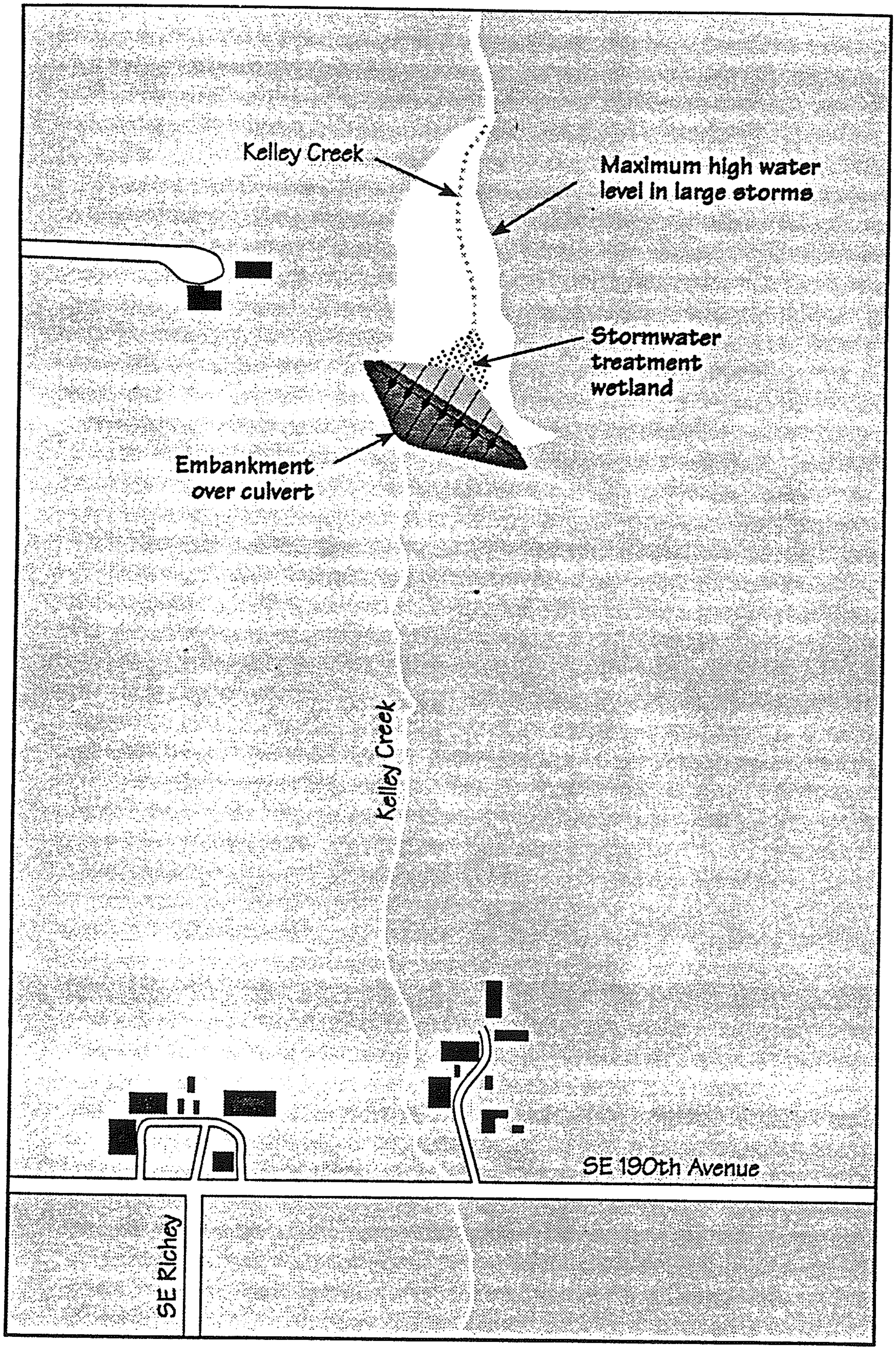
Detention Site on Kelley Creek Between 162nd Avenue and Foster Road



Note: Detention basins will only fill during storms larger than the two-year return period event

FIG 22

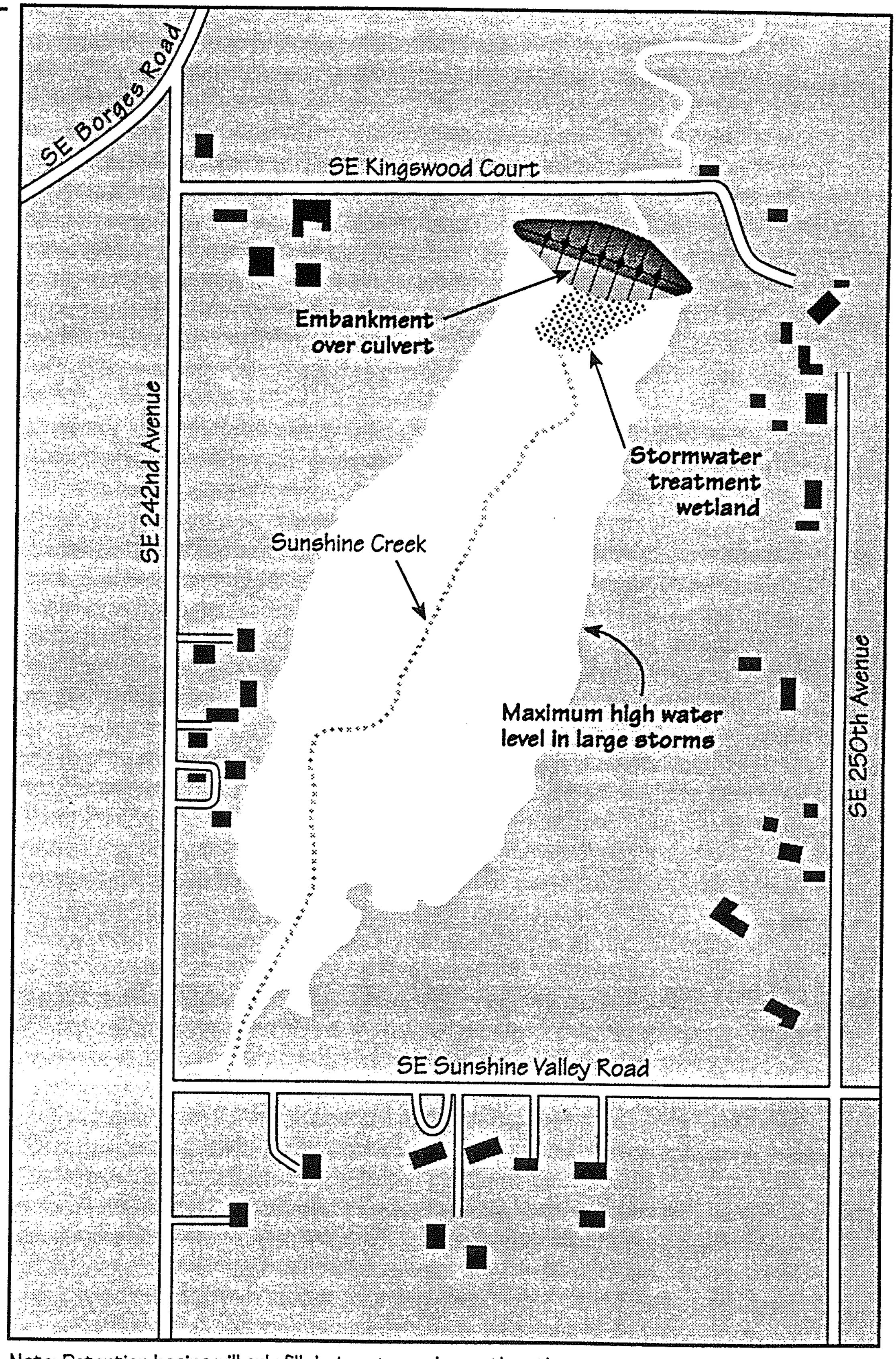
Detention Site on Kelley Creek at 190th Avenue



Note: Detention basins will only fill during storms larger than the two-year return period event

FIG 23

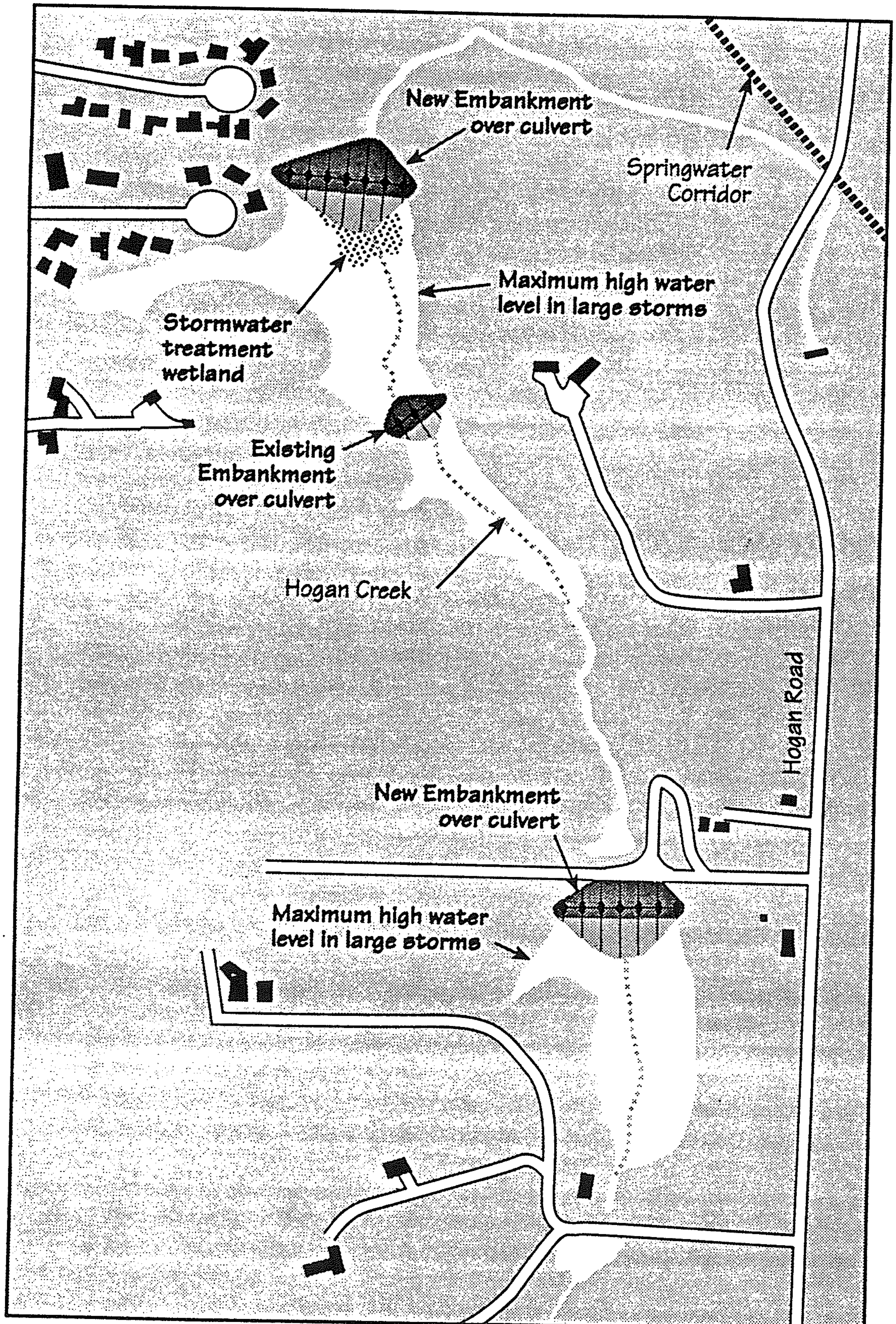
Detention Site at Hillview



Note: Detention basins will only fill during storms larger than the two-year return period event

FIG 24

Detention Site at Hogan Road



Note: Detention basins will only fill during storms larger than the two-year return period event

An alternative was considered that included off-stream storage and a flood relief channel at Lents, but no upstream storage. It was not evaluated in detail because of the difficulties in obtaining sufficient storage at Lents to counter the effect of the flood relief channel on downstream properties.

The monetary costs and benefits associated with the flood reduction alternatives are shown in Table 19. Alternative A would cost $7 million and would reduce flood damage costs over a 50-year period by approximately $28 million. It is clear that, over a 50-year life, Alternative A would return benefits considerably in excess of its costs. The benefits of Alternative B are more difficult to estimate but they, too, clearly exceed costs. Under Alternative B, flood damage downstream of Lents would be slightly greater than under Alternative A. On the other hand, flood damage at Lents would be decreased by an indeterminate amount. The benefit-cost ratio for Alternative B is clearly positive.

The benefit-cost ratios for both Alternative C2 and Alternative D are close to one. However, the benefits are underestimated somewhat, and so both alternatives would be expected to yield a positive benefit-cost ratio.

The flood reduction alternatives would produce some non-monetary benefits. The upstream detention basins that are a part of all alternatives would serve multiple purposes in that they would reduce flooding, improve water quality and preserve open space. A disadvantage of the detention basins is that property would be removed from the tax rolls. Also some believe that the dams would represent a barrier to migration of fish and other animals using the stream corridor. Others believe that problems associated with wildlife migration can be solved by careful design of the structures. The off-stream detention basins would also serve multiple purposes. Depending on the

TABLE 19
Costs and Benefits of Flood Management Alternatives[a]

Alternative	Estimated Capital Cost ($ million)	Avoided Damages[b] ($ million)	Benefit/Cost Ratio[c]
A	7	28	1.7
B	8	>28	>1.6
C2	14	>28	>1.0
D	13	>28	>1.0

Note:

a Information in this table is based on conceptual level facility plans.

b For 50-year period.

c Based on present value of cost and benefits assuming a 50-year useful life for flood reduction facilities and a four-percent discount rate.

design ultimately chosen, the off-stream basins would benefit water quality, wildlife habitat and recreation.

After thoroughly reviewing the alternatives, the JCCC selected Alternative C2, with the qualification that it be built in stages. The storage components of the alternative will be built first. The flood relief channel will not be built until it is clear that it will not increase downstream flood damage. This assurance would be provided by developing sufficient storage in the Lents area to prevent an increase in downstream peak flow, or by property acquisition and flood proofing in the flood-vulnerable downstream areas.

Action FM-2-2

Draft and adopt "balanced cut and fill" standard.

Current FEMA regulations define two flood zones: the floodway and the floodway fringe. A floodway is the part of the 100-year flood plain which must be kept clear of fill or other obstructions in order to convey the 100-year flood without an excessive increase in flood elevations. The floodway fringe is the portion of the 100-year flood plain outside of the floodway which may be developed if the fill does not cause the 100-year flood elevation in the floodway to rise more than one foot (Figure 25). If a developer or creekside resident can show that fill in the floodway fringe will not increase the upstream 100-year flood elevation more than one foot, then development is allowed.

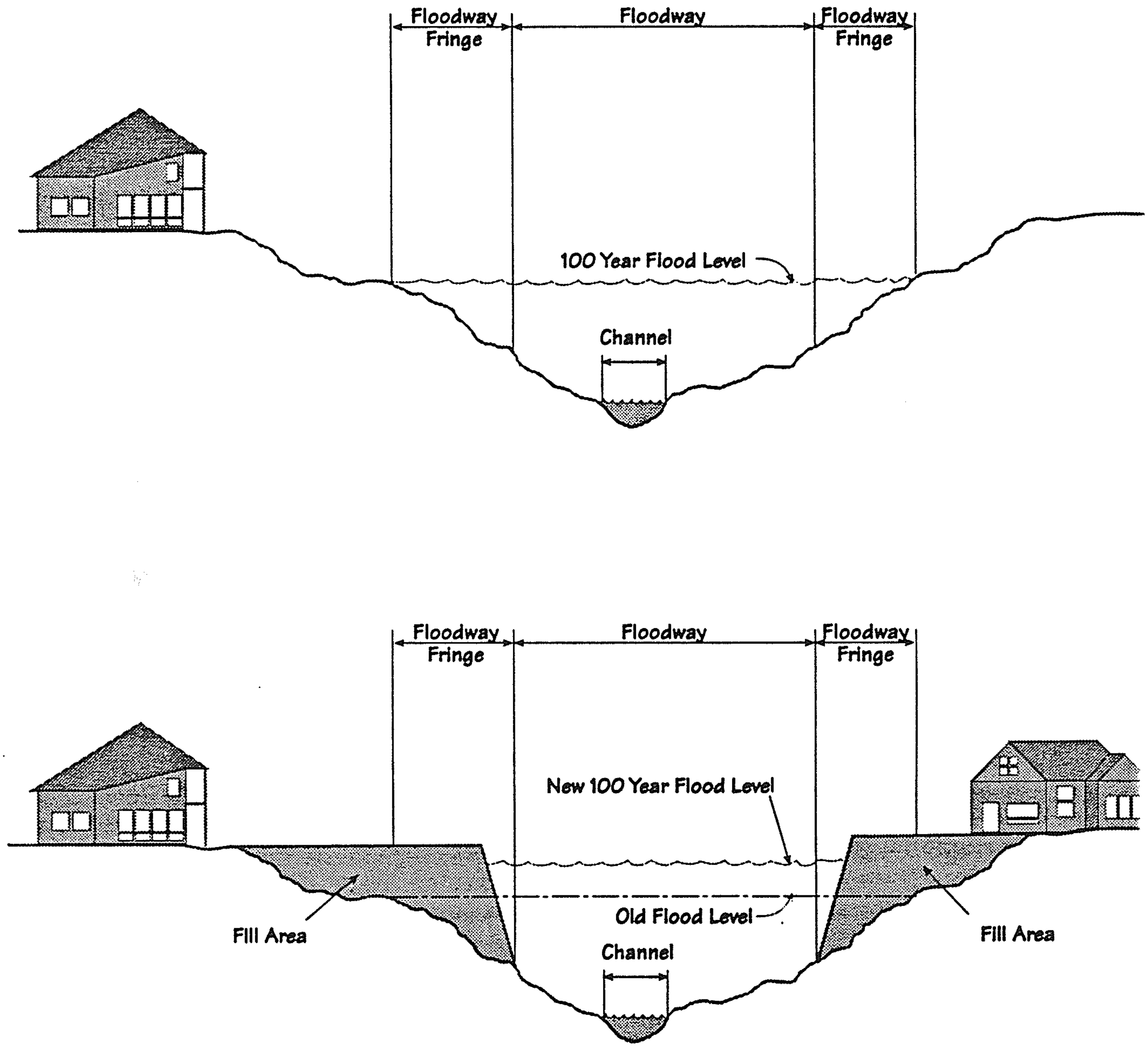
In the Johnson Creek watershed, a considerable amount of fill and development has occurred within the 100-year flood plain. Although each individual occurrence may have met the requirements under FEMA regulations, the cumulative effect has been to increase flood elevations to unacceptable levels because fill displaces floodwater storage which in turn increases local flood water levels and downstream peak flows.

Due to similar concerns that FEMA regulations may allow unacceptable increases in peak flows and flood elevations, the Unified Sewerage Agency (USA) of Washington County has already adopted modified flood plain design standards. Referred to as the "Balanced Cut and Fill Standard," USA requires that all fill placed on a parcel within the 100-year flood plain is balanced by an equal amount of soil removal from the 100-year flood plain on the same parcel. No net fill within the 100-year flood plain is allowed. Restrictions are placed on location, areal extent, and grade of the excavation and its depth in relation to the winter "low water" elevation. For each proposed "cut and fill," the location of the cut, its effectiveness for offsetting the amount of fill, and its environmental impacts need to be carefully considered. The balanced cut and fill rule would not apply to properties destroyed by fire, flood, or other similar cause.

Immediate implementation of a new rule similar to USA's would have minor effects in the Johnson Creek watershed except in the Lents-Powellhurst neighborhood. There are many undeveloped lots in the 100-year flood plain, as currently defined, in the Lents-Powellhurst neighborhood. A new "Balanced Cut and Fill" rule would make many of these lots unbuildable.

FIG 25

Flood Plain Before and After Filling Floodway Fringe



The 100-year flood plain in the Lents area was mapped by the Corps of Engineers as part of the 1980 Multnomah County Flood Insurance study. The mapping was based on a relatively crude hydraulic model of Johnson Creek. The more refined hydraulic model now available indicates that water surface elevations in a 100-year flood would not be as high as predicted by the Corps. In addition, filling that has occurred since 1980 has altered some of the drainage patterns in the area. It is now apparent that the 100-year flood plain at Lents is smaller than predicted by the Corps. Thus, to avoid unjustified restrictions on certain lots, the new "Balanced Cut and Fill" rule should not be imposed until the 100-year flood plain is remapped.

The cities and counties within the watershed will adopt a "Balanced Cut and Fill Standard," similar to USA's standard, to prevent further fill and development within a redefined 100-year flood plain. Until the flood plain is redefined, Portland will carefully review all proposals to build in the floodway fringe in the Lents area to ensure that the proposals will not increase flood water levels.

Action FM-2-3

Redefine 100-year flood plain.

To change the 100-year flood plain it is necessary to file an application with FEMA. The hydrologic and hydraulic information that is the basis for the change must be detailed and must follow a prescribed format. The cities and counties in the watershed will conduct the necessary studies and request changes in the 100-year flood plain. The changes are most urgent in the city of Portland because many properties lie within the 100-year flood plain in that jurisdictions.

Simply remapping the flood plain in the Lents-Powellhurst area could have considerable economic benefits. It is likely that some homes and unbuilt lots will no longer be in the 100-year flood plain. This will result in reduced insurance costs and appreciation in property values.

Action FM-2-4

Establish channel maintenance practices handbook.

The proposed flood management facilities will only be effective if the hydraulic capacity of the creek is maintained. Channel maintenance practices must be designed to meet the multiple objectives of the RMP: flood management, water quality improvement, and fish and wildlife habitat improvement. In order to achieve a reasonable balance between these needs, channel maintenance needs to be performed carefully.

The principle of conducting maintenance based on performance is that maintenance will not be required as long as adequate channel capacity is maintained. For each section of Johnson Creek, a target range of channel capacities, with an upper and lower limit, will be determined using HEC-2 (the hydraulic model). The lower limit will be based on potential flood damages; the upper limit on compatibility with fish and wildlife habitat. Maintenance will be performed on a section of the creek when the hydraulic capacity reaches the lower limit of the target range. Channel maintenance will be limited to only those low impact practices required to achieve the upper limit of the target capacity range. The section then will be allowed to evolve and mature naturally until the lower limit of the target capacity range is again reached.

An evaluation of channel performance will be conducted annually to determine when and where channel maintenance is necessary. The annual inspection team will include a hydrologist, an ecologist, wildlife and fisheries biologists, and a representative of the WMO. The annual evaluation will consist of updating the channel cross-sections in HEC-2 with visual observations (to update estimated roughness) and surveying significant sediment deposits. The photographs of each typical section taken by the surveyors during the summer of 1993 will be useful for updating the estimated roughness of each section. Based on the updated cross-sections, HEC-2 will be used to determine the current capacity of each section of the creek. The schedule for channel maintenance will be determined in consultation with the fisheries and wildlife biologists to minimize disturbance during important migratory or nesting seasons for fish and wildlife.

Where unacceptable decreases in hydraulic capacity of the creek have been identified, channel maintenance will be conducted according to the following guidelines:

1. Labor intensive methods will be used to thin and remove vegetation and to remove channel obstructions.

2. The use of herbicides for vegetation management will be minimized.

3. Riparian trees on the top of both banks will be allowed to grow to maturity to provide maximum shading of the creek channel and to reduce the density of understory vegetation.

4. Sediment removal will be performed only when thinning or removal of vegetation is insufficient to reach the upper range of the target channel capacity. Access to the creek channel, if needed, will be made from the north bank to minimize destruction of shading. Access points will be a maximum of 25 feet wide. Replanting of the disturbed vegetation with native species identified in Actions FW-2-1 and FW-2-2 in the Fish and Wildlife Habitat Improvement Plan Element will be required. If direct crossing of the creek channel occurs, the creek bed will be repaired based on standards provided by the fisheries biologist.

5. Routine maintenance will be limited to the removal of inorganic debris and garbage.

Initial costs for channel maintenance based on performance criteria will be higher than traditional channel maintenance practices, however, the long-term goal is to significantly reduce costs associated with channel management. To reduce costs associated with the above practices, vegetation management and routine removal of debris and garbage will be coordinated with volunteer efforts as described in Watershed Stewardship Plan Element, Action WS-2-3 (Support Volunteer Creek

Improvement Projects). The cities and counties could provide the equipment and means of disposal while the volunteers could perform the labor.

An intergovernmental committee will be established to develop a channel maintenance practices handbook for the watershed.

Action FM-2-5

Maintain channel according to channel maintenance practices handbook.

The jurisdictions within the watershed will adopt the channel maintenance practices handbook developed in Action FM-2-4. They will also request private landowners to maintain the channel on their land in accordance with the handbook or provide the cities and counties with easements so that the latter can maintain the channel.

Action FM-2-6

Establish emergency response team and procedures to minimize flood damage.

During the flood event which occurred on February 24, 1994, the City of Portland provided sand and sandbags to residents in the Lents and Powellhurst neighborhoods for use in protecting their homes and businesses from floodwater. Although the sand and sandbags were helpful, delivery was delayed due to an uncertain decision-making process and the need for mobilization time. In order to speed up the response time during future flood events, a multi-jurisdictional emergency response team will be organized. During a flood event, the emergency response team will coordinate the activities of city or county personnel.

Specific procedures will be developed for the emergency response team. The emergency response plan could include:

- Prompt notification of potential flood conditions for residents in flood prone areas (e.g., announcements on local radio stations, police PA announcements).
- Storage of materials for emergency response near flood-prone areas for immediate availability (e.g., sand and sandbags for temporary floodproofing of homes and businesses).
- Closure of flooded streets by police to prevent joyriding in four-wheel drive vehicles which increases damage to flooded properties.

Action FM-2-7

Acquire properties vulnerable to frequent flooding as they become available.

Current thinking in engineering and planning circles is that construction within the 100-year flood plain should be avoided if possible. This approach reduces the risk of flood damage and avoids the need for construction of expensive and environmentally damaging flood reduction facilities. It is the approach adopted by the City of Gresham, where the bulk of the 100-year flood plain is in public ownership and construction within it is prohibited. Because the westerly portions of the watershed were developed

many years ago, they reflect an earlier planning philosophy that allowed development in the flood plain and assumed that residents would either tolerate periodic flooding or that any problems could be corrected by drainage improvements.
Currently there are about 2,000 homes and businesses in the 100-year flood plain of Johnson Creek downstream of S.E. 158th Avenue. (The number may be reduced somewhat when the 100-year flood plain is redrawn as discussed in Actions FM-2-3 and FM-2-4.) The measures proposed in Action FM-2-2 of this plan will greatly reduce the vulnerability of existing structures to frequent flooding. However, for several reasons, it may be in the public interest to gradually acquire land and property within the flood plain. Public ownership of the flood plain would allow the demolition of existing structures and the setting aside of the land for flood conveyance purposes. It would also allow a more comprehensive restoration of wildlife habitat within and adjacent to the riparian corridor. Furthermore, the recreational value of the Springwater Corridor Trail would be enhanced by its proximity to more natural areas.

The Johnson Creek Corridor Committee has decided against condemnation as a means of implementing the RMP. Acquisition of property by public agencies within the flood plain will only be considered where there is a willing seller. Properties most vulnerable to flooding, that is, those within the 10-year flood plain, should be given the highest priority for acquisition. Properties acquired by public agencies in residential neighborhoods should be properly managed to avoid neighborhood blight as a result of unoccupied property. Eventually, when sufficient property has been acquired, the flood plain could be restored to a natural condition.

FISH AND WILDLIFE HABITAT ENHANCEMENT PLAN ELEMENT

INTRODUCTION

Waterways play a key role in the natural environment. The number of species found in and around rivers and streams far exceeds those found in the neighboring uplands. Stream corridors and associated uplands contain a diversity of micro-environments that provide habitat for birds, mammals, reptiles, amphibians and fish. Some of these species live permanently in the stream corridor while others visit it periodically for food, water, and cover. Because of the stream corridor's importance to fish and wildlife, its pollution or degradation can have a disproportionately serious effect on the ecology of an entire watershed. One of the primary goals of the RMP is to improve fish and wildlife habitat in the Johnson Creek corridor within the broader context of watershed-wide habitat improvement.

Development of the Johnson Creek watershed has had a profoundly adverse effect on the creek system, the riparian corridor, and associated uplands. The downstream or lower reaches of the creek channel were rock-lined in the 1930s to reduce flooding. The rock-lining project not only destroyed streamside vegetation, but also confined the stream within a channel eliminating its ability to wander within the floodplain and destroying the aquatic and riparian habitats created by the stream's sinuosity. Although lack of maintenance of the channel has allowed some vegetation to become established on the streambanks, it is far from a fully functional natural environment. Clearing and development of upland areas have reduced the extent and value of wildlife habitat, accelerated soil erosion and diminished summertime stream flow. The stream itself has been subject to siltation and water pollution limiting its value as habitat for fish and other aquatic life.

Despite these great changes, Johnson Creek and its watershed remain important for wildlife. Enough streamside vegetation exists to provide a corridor for wildlife movement; a remnant salmonid fish population still persists; beaver flourish and a few mink inhabit the least developed stream reaches; and frogs and salamanders take advantage of side channels and ponds. In the uplands, forested buttes continue to provide homes for birds and mammals. However, it is not clear whether what remains can be preserved in the face of continuing development pressures. Without decisive action the wildlife habitat value of the creek corridor and uplands is likely to slip away, bit by bit, as new homes displace natural areas. The purpose of this element of the RMP is to change this trend, to stop the progressive deterioration and loss of wildlife habitat and to begin its gradual restoration.

Wildlife habitat enhancement provides benefits to humankind as well as wildlife. Shady riparian corridors provide a quiet place for passive recreation. Forested uplands lower ambient air temperatures and provide privacy for people living nearby. Tree and shrub roots stabilize steep slopes and reduce soil erosion and landslide potential. Wetlands filter pollutants from stormwater runoff and allow flood waters to spread across the flood plain without causing damage. And many people enjoy the opportunity to observe wild birds and animals close to home.

A three step process was used to develop the fish and wildlife habitat enhancement element of the RMP. First, an assessment was made of the current condition of fish and wildlife habitat within the watershed; next, the factors that limit the value of the habitat were identified and analyzed; and finally, a plan was developed to improve habitat quality. The terrestrial and aquatic environments, although obviously functionally-linked, are discussed separately below.

VEGETATION AND WILDLIFE

Vegetation, wildlife habitat and wildlife populations in the Johnson Creek watershed have been greatly altered since the beginnings of European settlement in the mid-nineteenth century. Extensive old growth coniferous forests were cut for timber and the fertile lowlands cleared for agriculture. Later, small residential communities were established along a commuter railroad, ultimately growing to form the present urban and suburban communities. Today, the watershed is a mosaic of agricultural lands, urban and suburban landscapes, upland forest, riparian woodland and wetlands. Remnants of pre-development vegetation are rare and consist mainly of isolated mature trees scattered throughout the watershed. Vegetation in undeveloped areas is primarily at a relatively early stage of recovery from disturbance. It remains far from the condition that might prevail in a stable, undisturbed natural vegetative community.

HISTORIC LANDSCAPE AND WILDLIFE

Prior to European settlement of Multnomah and Clackamas counties in the mid-19th century, the landscape was a mixture of terrestrial and aquatic habitats including upland and wetland forests, prairies and shrublands, creeks, rivers, and marshes. The Johnson Creek watershed was dominated by extensive stands of mature and old growth conifer and mixed conifer-deciduous forests. Overstory trees in the uplands included western hemlock, Douglas-fir, grand fir, western red cedar in the wetter sites, big-leaf maple, and oaks on south-facing slopes. Vegetation occurred in several layers and included young conifer trees (mostly hemlock and cedar which are shade tolerant); shrubs, such as hazel, vine maple, rose, and huckleberry; and herbaceous plants, such as oxalis, bunchberry, inside-out flower, fringe cup, and others. Where floods or fire had formed natural openings in the forest canopy, Douglas-fir, big-leaf maple, huckleberry, salal, thimbleberry, and bracken fern would have been the likely early colonizers. Red alder, big-leaf maple, willows, red-osier dogwood, vine maple, salmonberry, and sword fern would have colonized the riparian areas providing nutrients and soil for the conifer stands that would succeed them.

The broader lowland areas, typically defined in modern terms as the 100-year return period floodplain, supported black cottonwood forests, which often included dense understories of willows. Oregon ash/slough sedge wetland forests were also found in the flatter streamside areas where water was seasonally perched and flows were sluggish.

Early survey maps show an extensive marsh system located along the lower three miles of Johnson Creek and throughout the Crystal Springs basin. The marsh system was likely a mixture of cover types with skunk cabbage wetlands in places, scrub/shrub willow habitat, cottonwood/willow stands, and open water. The marsh habitat likely supported rich and varied wildlife populations. Abundant insects provided a prey base for amphibians (spotted and red-legged frogs), reptiles (western pond and painted turtles), and resident and anadromous fish, such as cutthroat trout, sculpins, salmon and steelhead. Ducks and geese nested and overwintered in these food rich habitats, and predators such as fox, coyote, and raccoon would hunt there. Marshes and wetland forests likely existed in other flat areas such as the broad floodplain area south of Powell Butte.

Trees killed by lightning or disease or other natural causes would fall into creeks and wetlands providing instream protective cover for fish and egg laying habitat for frogs and salamanders. Downed logs within the forests provided habitat for insects and salamanders, denning places for foxes and bobcat, and foraging places for pileated woodpecker and raccoons. Standing dead trees provided cavities for nesting woodpeckers and other birds, insects for wildlife food, and perches for large birds of prey, such as red-tailed hawk and bald eagle.

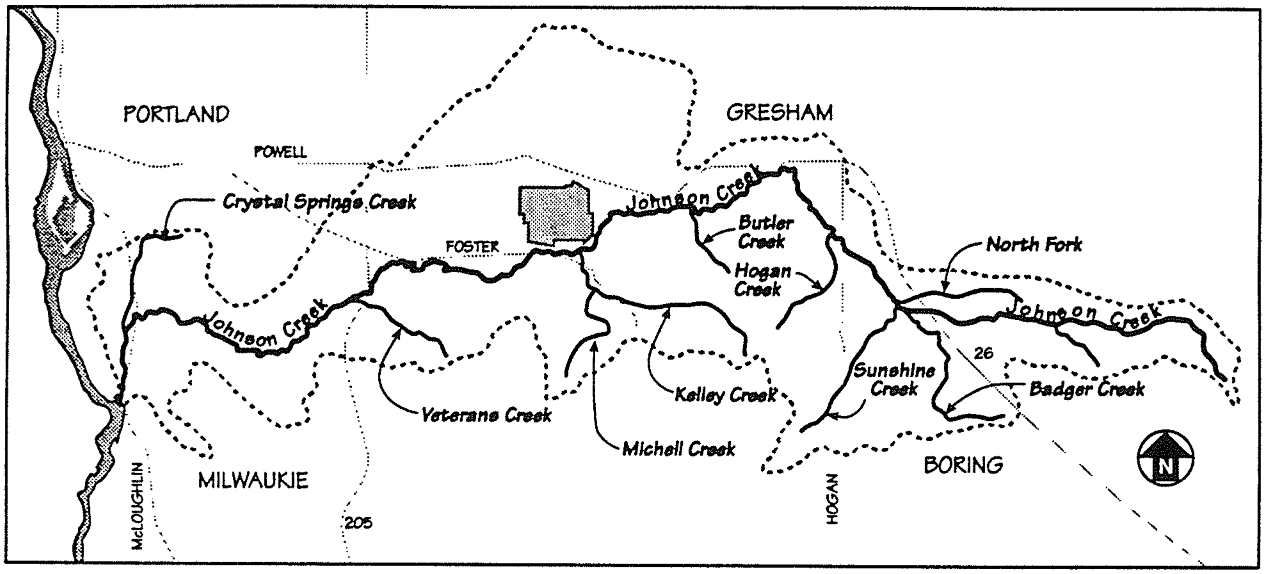
The mixture of terrestrial and aquatic habitats within the watershed supported the necessary functions of reproduction, rearing, territory, and travel for a variety of wildlife species. Bear, elk, deer, muskrat, beaver, otter, mink, cougar, bobcat, gray wolf, salmon, steelhead, cutthroat trout, and lamprey probably all existed in the watershed prior to 1900. The first habitats to be lost were timbered lands, cleared for shipping and farming. Creeks and marshes were initially avoided by the early European settlers because they lacked the technology to drain them. Consequently, these habitats were still plentiful until about 1920. By the mid-1930s, most of the marsh land within the watershed was drained for housing and agricultural development. Of the estimated thirty or more large and small creek systems and their attendant marshes identified by the early surveyors within Multnomah County, less than a dozen still remain in an above-ground, free flowing or partially free flowing state.

EXISTING VEGETATION AND WILDLIFE

Several natural resources surveys of Johnson Creek have been made in the last five years. They include wildlife and vegetation inventories to determine the presence of local and migratory wildlife and to identify habitat types. The surveys were conducted for METRO's Greenspaces Program and for the City of Portland Planning Bureau, among other jurisdictions. They, together with new surveys conducted as part of the RMP process, provided the informational basis for the description that follows (see Technical Memorandum No. 7 for a complete description of survey methods and results). A map of the creek and its major tributaries is shown in Figure 26.

FIG 26

Johnson Creek and Tributaries



Currently, streamside, or riparian, vegetation along Johnson Creek and its tributaries, is dominated by red alder, big leaf maple, western red cedar, and hawthorn with black cottonwood, Oregon ash, and willows in the wetter sites. Douglas-fir is common in the uplands adjacent to the creek. Common native shrubs include snowberry, elderberry, Indian plum, hawthorn, and red osier dogwood, but introduced species, such as Himalayan blackberry and holly, overwhelm natives in many sections of the creek. Herbaceous vegetation includes native species such as lady fern, sword fern, trailing blackberry, small-fruited bulrush and introduced species such as English ivy, thistles and various grasses. Lawns and crops often extend to the creek bank. Some wet areas have been colonized by the very invasive non-native reed canary grass.

MAINSTEM OF JOHNSON CREEK

Long sections of the mainstem of Johnson Creek from its mouth at the Willamette River to S.E. 158th Avenue were rock-lined in the 1930s. The rock-work has not been maintained, but remains in good condition, for the most part. Although vegetation has grown over and through it in many places, the rock-work continues to exert a profound influence on creek bank vegetation.

From its mouth to the S.E. Tacoma Street bridge at river mile 1.6, the creek flows through densely developed industrial, commercial and residential areas. In some sections, riparian vegetation is completely lacking, having been replaced by buildings or parking lots. Where trees exist, the remnant riparian forest is dominated by red alder saplings with few shrubs. Himalayan blackberry occurs as a dominant shrub within forested habitat and in monocultural stands where trees are wholly lacking. Stream shade is limited and the creek corridor is subject to much human disturbance. A short section of creek, near the confluence with Crystal Springs Creek and within Johnson Creek Park, is not rock-lined.

Just east of the S.E. Tacoma Street Bridge, the creek enters a lightly-developed canyon which includes Tideman Johnson Park at its easterly end. Most of this section of the channel is not rock-lined. The corridor of riparian and upland forest is broader here and dominant trees include Douglas-fir, western red cedar, big-leaf maple, with a shrub layer of both native and non-native species. Native herbaceous (non-woody) plants also exist in these broader forested areas and include such species as piggyback plant, spring beauty, and ducksfoot.

Upstream of S.E. Johnson Creek Boulevard at river mile 3.2, the creek traverses an area of mixed residential, commercial and industrial land uses that extend to Interstate 205 at river mile 6.4. Although the area is less densely developed than the downstream reaches, the creek is largely bordered by landscaped yards, parking lots and buildings. Vegetation is generally sparse, shade is lacking and the banks of the creek are almost continuously rock-lined. There is, however, a small forested area adjacent to the creek at S.E. 86th Avenue.

East of Interstate 205, there is a greater variety of habitat types. Just east of the highway, at the partially-developed Freeway Land Company site, habitats include emergent wetland, upland shrub/scrub and wetland and upland forests. Native trees, shrubs, and herbs are present together with the ubiquitous Himalayan blackberry, in both open and forested areas. The creek banks themselves are covered with blackberry and willow. East of the Freeway Land Company site, the creek meanders through a flat residential area where the riparian corridor is narrow and bordered by landscaped yards.

At S.E. 112th Avenue (river mile 8.1) the creek enters a canyon where the tree canopy broadens and the creek banks are not rock-lined. Although trees are numerous in the canyon, lawns and cleared areas still exist in the understory. Dominant trees here include large and older western red cedar, big-leaf maple, western hemlock, grand fir, and larger red alder. Native plants are fairly common, interspersed with introduced landscaping trees such as ornamental cherry. Snag trees, suitable for hole-nesting birds, are present and the creek is joined by a number of small feeder streams that connect the riparian corridor to other densely-vegetated uplands. The canyon extends through Leach Botanical Gardens to near the intersection of S.E. Foster Road and Barbara Welch Road. From this intersection to S.E. 158th Avenue, the creek follows S.E. Foster Road and the northerly toe of a densely-vegetated hillside. Rural homes, some on large lots with pastures, border this section of the creek. Although riparian trees are numerous, much of the understory has been cleared. This section of the creek is the last of the rock-lined sections. Creek banks are largely natural upstream of S.E. 158th Avenue (river mile 11.3).

Upstream of Johnson Creek's confluence with Kelley Creek at river mile 11.4, the valley bottom between Powell Butte and the highlands to the south becomes wider. The creek passes through an area of large rural lots and small farms. In some places, upland shrub/scrub and wet meadow habitats exist, vegetated by native willows and a mixture of native and non-native grasses and flowering plants. Himalayan blackberry and reed canary grass are the non-native dominants in these habitats. Pastures of non-native grasses extend to the top of the creek bank in some locations. As a whole, the area lacks structural diversity and, consequently, its wildlife habitat value is low.

From Jenne Road at river mile 12.0 east to Highland Road at river mile 13.0, the mainstem creek corridor passes through or near several types of habitats. At river mile 12.0, the creek corridor consists of a narrow band of sapling alder trees with scattered shrubs of wild rose and Himalayan blackberry with open grassy areas to the creek. At the S.E. 174th Street crossing, the creek passes through upland shrub/scrub habitat and a wet meadow area. Himalayan blackberry dominates in both habitat types, but some areas possess native red osier dogwood and Pacific ninebark shrubs. Grasses include reed canary grass and other exotic plants. While this area may be dominated by several non-native plants, it is linked to the creek and other upland habitats in several directions, improving its overall value to wildlife.

From Highland Road at about river mile 13.0 to the Pleasant View Avenue crossing at river mile 13, streamside vegetation includes an upland forest of Douglas-fir and western red cedar that are mostly 60 to 75 years old. Some trees may be approaching 100 years of age. The shrub layer contains many native species, such as snowberry and Indian plum and is generally well developed, although Himalayan blackberry and English ivy exist throughout the area. At Cedarville Park, shrubs are mostly absent, but there are several snag trees which provide nesting and foraging habitat for birds.

From just east of the Pleasant View Street crossing to river mile 13.9, just beyond the mouth of Butler Creek, the streamside vegetation changes to a wetland forest consisting mostly of 15- to 20-year-old alder and extensive stands of Himalayan blackberry. From here upstream to Towle Road at river mile 14.8, the creek corridor is vegetated by an upland forest of 60-year-old alder with some cedars. This area of the Johnson Creek riparian corridor is linked to other upland habitats and small feeder streams on the south side of the creek.

From Towle Road to about river mile 15.3, both sides of the creek are vegetated by upland shrub/scrub habitat which is dominated by Himalayan blackberry. The area is very disturbed and weedy with little connection to other habitats. Upstream of river mile 15.3, the riparian vegetation changes first to upland meadow and then to wetland forest that extends to the east end of Gresham Main Park. The upland meadow consists of Himalayan blackberry and fescue grass, with reed canary grass in localized wet spots. It appears to be a former pasture and is bordered by a red osier dogwood/willow/Himalayan blackberry wetland forest. This forest has a moderate wildlife habitat value because it has not recently been disturbed. Its value is increased by its linkage to the meadow and to an upland forest strip to the south of the creek.

At Gresham Main Park (river mile 16.1), the creek swings southeast around the toe of Walter's Hill and follows the Springwater Corridor Trail to Regner Road at river mile 16.9. The vegetation along Johnson Creek and the Springwater Trail at Walter's Hill provides excellent nesting and foraging habitat for warblers, flycatchers and other birds that migrate from the tropics. The site is also connected to upland forested habitat which is vegetated mostly by big-leaf maple, Douglas-fir and alder with a shrub layer of hazelnut and blackberry. Wildlife habitat value is high because of the native plant species diversity.

From Regner Road to the Telleford Road crossing at river mile 19.6, streamside vegetation is mostly closed canopy upland forest. The upland forest is dominated by alder and cedar 50 to 60 years old with salmonberry and swordfern present in the shrub and herbaceous layers. Snag trees are common in some areas and larger, older trees are scattered through the forest. A small area of wetland forest occurs within the upland forest at about river mile 18.5. The wetland forest consists primarily of Oregon ash interspersed with large cottonwoods. Wild rose and slough sedge are found in association with these trees.

East of Highway 26 at about river mile 20, the creek runs through agricultural lands which are principally used for grazing and nursery operations. From river mile 20.3 to Orient Road at river mile 22, the creek area is vegetated by a wetland forest dominated by alder and ash with some cottonwood. Generally, the shrub layer is underdeveloped and impacted by grazing. West of Orient Road to the headwaters, the riparian corridor is mostly vegetated by a closed canopy upland forest of alder, western red cedar, big-leaf maple, and Douglas-fir. For the most part, a well-developed shrub layer is lacking due to grazing or lawns extending to the stream bank. At Pleasant Home Road, the riparian corridor includes a wetland forest of alder and Oregon ash with a mix of blackberry and red osier dogwood in the shrub layer. The southern branch of the headwaters runs through a series of agricultural fields and nurseries. There is no riparian vegetation along this stretch of creek. Within the summer and fall of 1993, the cottonwood forest at the headwaters was logged.

■ CRYSTAL SPRINGS AND REED CREEKS

Crystal Springs Creek flows into Johnson Creek from the north at river mile 1.2. It, and its tributary Reed Creek, are fed by perennial springs. Crystal Spring Creek originates from springs within the Crystal Springs Rhododendron Gardens. Reed Creek originates from springs on the Reed College campus. Historically, the springs fed a marshy area, interspersed with uplands trees, that drained slowly to Johnson Creek via the two creeks. Today, the former wetlands are occupied by landscaped gardens, a lake, small farms and the Eastmoreland Golf Course. A dam on Crystal Springs Creek forms Crystal Springs Lake. The lake is shallow and offers little cover for fish or nesting habitat for waterfowl. It is surrounded by landscaped grounds and golf fairways. Downstream of the dam, Crystal Springs Creek crosses the golf course in a broad channel to its confluence with Reed Creek.

Reed Creek flows into Reed Lake which is surrounded by a remnant Douglas-fir and western red cedar forest. The lake is formed by a small dam. and provides prime breeding and rearing habitat for amphibians and salmonid fish. Downstream of the dam and upstream of S.E. 28th Street, the creek flows through a section of original creek channel where conifer and deciduous forest canopy and shrubs provide good cover and food for aquatic and terrestrial wildlife. After entering Eastmoreland Golf Course, the creek meanders through fairways to Crystal Springs Creek. Within the golf course, streamside vegetation along both creeks consists of introduced overstory trees, mainly weeping willow, with no developed shrub layer. Leaving the golf course, Crystal Springs Creek enters an area of homes on small lots. The riparian corridor is narrow with trees limited to exotic landscape species or entirely lacking. Wildlife habitat value is generally low for

Crystal Springs and Reed Creeks, with the exception of Reed Canyon where native vegetation still dominates and the creek and lake are well shaded.

■ KELLEY AND MITCHELL CREEKS

Kelley Creek joins Johnson Creek at river mile 11.4, near S.E. Foster Road and S.E. 162nd Avenue. Kelley Creek and its principal tributary, Mitchell Creek, are mostly vegetated by upland closed canopy forest consisting of Douglas-fir, western red cedar, big-leaf maple, alder, and black cottonwood. Shrub layer development is scattered in some areas with native plants dominating the stream corridor overall. Certain localities are dominated by Himalayan blackberry. Immediately east of Foster Road, there is an approximately one mile stretch of Kelley Creek which is an open canopied wetland forest dominated by cottonwood and alder with some very large (100') cottonwood trees. Generally, the wildlife habitat value is considered as low to moderate because of the mix of native and non-native vegetation, and a mostly reduced shrub layer resulting from residential lawns.

Mitchell Creek is a major tributary entering Kelley Creek from the east. Mitchell Creek is vegetated by an upland closed canopied forest dominated by 60- to 80-year old alder and cedar. Salmonberry and blackberry dominate the shrub layer and trailing blackberry dominates the herb layer.

Two unnamed tributaries enter Kelley Creek. The first tributary enters Kelley Creek just upstream of Mitchell Creek and is vegetated by an upland closed canopied forest dominated by Douglas-fir and cedar with blackberry making up the principal shrub component. Springs may be present along this tributary. The second unnamed tributary enters Kelley Creek at the Pleasant Valley School. This area appears to be an old meander of Kelley Creek and is dominated by a wetland forest of alder and ash with a mixture of native and non-native shrubs, including snowberry and blackberry. Springs may also exist along this tributary. Habitat value for both these unnamed tributaries is considered as medium because of the native/non-native mix and the encroachment of invasive plants.

■ BUTLER CREEK

Butler Creek enters Johnson Creek at river mile 13.9. Its headwaters are located on a forested hill south of Johnson Creek. The headwaters forest is composed mostly of alder and cedar with openings in the canopy where housing developments and lawns have cleared vegetation to creekside. Where it is forested, native plants remain, such as Oregon hazel and salmonberry in the wet areas. Swordfern dominates the herb layer. Several artificial lakes have been created on Butler Creek.

■ HOGAN CREEK

Hogan Creek enters Johnson Creek just east of the brick factory where Hogan Road and the Springwater Trail intersect (river mile 18.6). The creek corridor is generally forested and surrounded by a mosaic of agricultural lands and undeveloped upland forests. Forested areas are dominated by red alder and big-leaf maple, with Douglas-fir and other conifers present in the mid-reaches. At the headwaters, west of Hogan Road, the creek flows through a sand and gravel operation where the riparian corridor has been narrowed to an open canopy strip of deciduous and conifer trees. The Hogan Creek drainage still retains some larger blocks of upland and riparian forested habitat which are important for interior forest nesting birds and mammals.

■ NORTH FORK JOHNSON CREEK

The north fork of Johnson Creek enters the mainstem at about river mile 19.3. The riparian corridor is a narrow strip of forested land, primarily alders and maple, surrounded by rural housing and agricultural developments. Highway 26 separates the north fork riparian corridor from the mainstem, limiting opportunities for wildlife movement. Riparian habitat in the upper reaches is connected to a few forested areas and open pastures or meadows.

■ SUNSHINE CREEK

Sunshine Creek enters Johnson Creek near Telleford Road at river mile 20.6. The forest along the creek varies from wetland alder/willow woods to an upland alder-dominated forest. Blackberry is present in both forest types as a dominant shrub. Beaver sign is abundant and, according to local residents, beaver are very active within the creek.

■ UNNAMED TRIBUTARY AT SE 282nd AVENUE

This tributary to the mainstem Johnson Creek is located on the south side of Johnson Creek at 282nd and Stone roads. The area is vegetated by an upland closed canopied forest dominated by big-leaf maple and cedar. The shrub layer is lacking and swordfern dominates the herb layer.

■ UPLANDS

Upland habitats in the Johnson Creek watershed include small parcels of forest and other habitats that are located adjacent to, but outside, the creek corridors. Uplands also include larger blocks of habitat found in city and county parks (e.g., Tideman Johnson Park), the 86th Avenue forest, and the forested buttes east of Interstate 205, including Kelly Butte, Powell Butte, Jenne Butte, Mount Scott, the Willamette Cemetery hill, the Barbara Welch uplands, Walter's Hill, and the unnamed butte at the headwaters of Sunshine Creek (part of the Boring Lava Hills). The larger upland areas are mostly forested with 80-year old, second growth Douglas-fir, in association with big-leaf maple, red alder, western red cedar, grand fir, and western hemlock. Native shrubs and herbs are often present, but in the more developed areas, non-native trees and shrubs can be found. Small streams and ephemeral drainages within the uplands contribute to their overall wildlife habitat value. Some of the upland areas are directly connected to each other and to the Johnson Creek riparian corridor, allowing free movement of wildlife; others are not.

■ WETLANDS

Wetland habitats are scattered throughout the watershed, either connected to the creek or within the watershed boundary. These include remnant wet meadows at the Freeway

Land Company site, Beggars-tick Refuge, S.E. Brookside Drive, and at the north edge of Jenne Butte. Beggars-tick Refuge also includes emergent marsh. Wet meadows and emergent wetland areas are a mixture of wetland dependent species such as rushes and sedges, often associated with willows and having snag trees. Wet shrub/scrub habitat is located at Jenne Butte and eastward to Walter's Hill and is dominated by willow, alder, and in many cases, Himalayan blackberry. Wetland forests are located mostly in the upper watershed in agricultural lands. They occur north of the mouth of Butler Creek, along the north and east borders of Walter's Hill, and in a few scattered locations east of Highway 26. Wetland forests may be a combination of alder and ash trees, or the more rare Oregon ash/slough sedge habitat (one site is located at Palmblad Road).

Many wetland forests in the upper basin have been drained for agriculture or rural housing. Himalayan blackberry is also encroaching at the cleared edges of these forests and upland forests throughout the upper watershed. Habitat value for the wetland forests, especially those interspersed with upland forest and scrub/shrub habitats along Walter's Hill and into the upper tributary areas, is medium to high. The single most limiting factor for habitat value here is the lack of dead wood habitat for birds and amphibians.

■ WILDLIFE

Overall, the diversity of wildlife species in the watershed has been reduced since pre-European settlement. Large mammals which were once common, such as black bear, bobcat, cougar, wolf, fox, elk, and coyote either no longer exist within the watershed, are restricted to the upper basin, or their numbers are reduced. Black-tailed deer are likely the only large mammal that can be found in or near the remaining forested areas. Opossum, raccoon and skunk have learned to adapt to human development and remain common. Herpetofauna also show declines in species variety. The last record for spotted frog is dated sometime in the 1930s; red-legged frog exists in remnant wetland and creek habitat and the Pacific tree frog is likely the most plentiful amphibian today within the basin. Birds are the most abundant wildlife form living in urban and rural areas within the watershed. Although there is a marked decline in interior forest habitat (large continuous blocks of woodland), bird species that winter in the tropics, such as Swainson's thrush, flycatchers, and warblers, can still be found in sufficient numbers to sustain local breeding populations. During migration, and in winter, birds from higher elevations and more northerly latitudes can be seen. These include species such as evening grosbeak and varied thrush, which will frequent backyard feeders, and small raptors such as Cooper's hawks.

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FACTORS LIMITING WILDLIFE HABITAT VALUE

The wildlife habitat value of the Johnson Creek watershed has been greatly reduced by development. In this context, wildlife habitat is more than just vegetation. It includes rocks for sunning and cover, and suitable soils for harboring prey and creating dens. It includes trees in various states of decay, standing or down, which provide a home for insects and the opportunity for carving out cavities in which birds and small animals can roost, sleep, or raise their young. And it also includes decaying leafy debris that provides hiding places for salamanders and food for insects as well as the ingredients for future soils.

Many different factors influence and generally reduce wildlife habitat values. In order to devise a strategy for improvement, the most important factors reducing wildlife habitat values were identified, based on the results of field surveys and interpretation of aerial photographs. Important limiting factors include:

- A general lack of species and structural diversity within all habitat types in the riparian corridors (e.g., few tree species and no shrub layer).
- A narrow and degraded riparian corridor, often less than 20 ft wide, lacking in shrub layers and having thin (<30 percent) canopy closures.
- A lack of dead wood, either standing as snag trees, or down as woody debris.
- Limited connection or linkage between riparian habitats and upland habitats.
- Very limited interior forest habitat, defined as blocks of habitat of a size that would allow songbirds and other neotropical migrant species to have secure nesting territories (often defined as habitat blocks 600 feet from a road or break in tree canopy).
- Fragmentation of habitat, that is, breaks in vegetation that subject wildlife to predation and disturbance.
- Disturbance due to the proximity of housing, domestic animals, and recreational trails.
- Encroachment of non-native vegetation which out competes native species and reduces wildlife habitat value.
- Lack of habitat diversity, especially in the lower reaches.

The goal of wildlife habitat enhancement is to minimize the adverse effects of these limiting factors, and to maximize species and habitat diversity.

WILDLIFE HABITAT IMPROVEMENT STRATEGIES

Restoring wildlife habitats to their pre-development condition is obviously an unrealistic goal. Urban and agricultural development has produced irreversible changes in land use and vegetative cover. Further changes can be expected as the population of the watershed grows. A practical goal for an urbanizing watershed is to arrest, and perhaps reverse, the decline in wildlife habitat values that accompanies development. This goal can be accomplished by protecting valuable habitats that remain, enhancing the value of those that have been degraded, and restoring, to the extent practicable, native plant communities. This approach is both expedient and consistent with practices adopted elsewhere in the United States.

The fish and wildlife habitat improvement plan element sets out to minimize the effect of the factors, described earlier, that limit wildlife habitat value in the watershed. Effects of the limiting factors will be minimized by a combination of protection, enhancement and restoration strategies. Unique or very high value habitats, such as ash wetlands, will be protected. Protection could be accomplished by land purchase, conservation easements, zoning and development standards, management changes on public land, and cooperative management agreements with private landowners. Habitats for which protection would be the priority include areas that now possess the best habitat and support populations of native species of concern, floodplains, riparian corridors, wetland forest, meadows or marshes, interior forest habitat, and areas that link stream corridors with uplands and upland habitats to each other.

Enhancement would involve modifying existing habitat to increase its value to wildlife. Areas targeted for enhancement already have some value to wildlife which can be increased by judicious intervention. An example might be a riparian area with a mature canopy of large trees but where heavy livestock grazing has eliminated the shrub and herb layers. Limitation of livestock access to the stream corridor and replanting with natives shrubs would increase structural diversity and wildlife habitat value in the riparian area and in the associated aquatic habitat. Another example might be a wet area created when a stream was rerouted around a housing development. The wet area could be improved to become a fully functional wetland habitat.

Restoration would be applied to sites that have very little or no vegetation, or mostly non-native plants. Restoration would include revegetating a site with native trees, shrubs, and herbaceous plants to approximate the historic vegetative assemblage. Once planted, the vegetation would be allowed to succeed naturally over time. Other habitat components such as downed wood may be added during early planting phases to improve habitat value faster than normal succession. An example of restoration would be the replacement of the extensive monocultural stands of Himalayan blackberry prevalent in the lower reaches of the creek with native trees, shrubs, and grasses.

Obviously, enhancing wildlife habitat in the Johnson Creek riparian corridor will not always be simple. Both public and private landowners have uses for streamside lands that they may consider more important than wildlife habitat. In some cases, land uses incompatible with wildlife habitat extend to the very edge of the stream, severely limiting opportunities for wildlife habitat improvement. The rock-lining that occurred in the 1930s limits revegetation of the creek banks themselves. To succeed, habitat improvement efforts will have to be practical and will have to balance wildlife values with human needs.

The approach taken in this plan is to establish an improvement goal for each reach of the creek and its tributaries. The goal specifies the type of vegetation that would be desirable and the extent of revegetation that should occur in about 10 years, and then in 50 years. In establishing the improvement goals for a particular stream reach, various factors were taken into account including capacity of the channel to pass flood flows, probable historic vegetation type, presence or absence of rock-lining, orientation to the sun (where the creek runs east/west conifers would be planted on the south side to provide stream shade quickly), land ownership and the compatibility of adjacent land uses with a natural stream corridor.

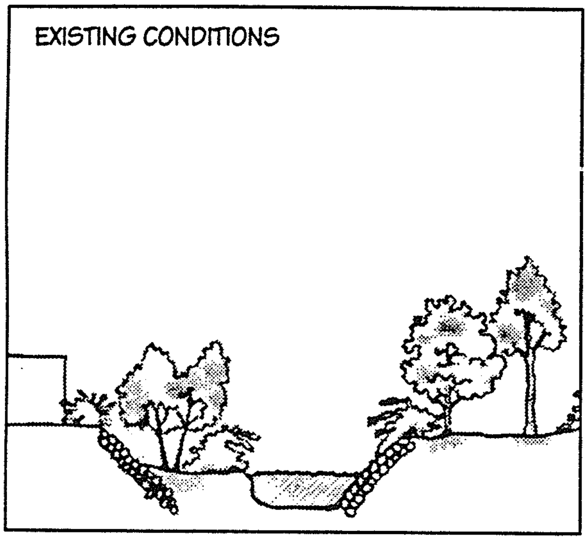
Figures 27 through 34 show the improvement goals for the riparian area in various reaches of the creek. The improvement goals are stated generally in the form of creek cross-sections. They cannot usually be attained uniformly through the designated creek reaches because of the natural variability of the channel form and encroachment of structures into the stream corridor. However, they do provide an overall framework for vegetation restoration within which planting plans for specific sites can be developed. Additional guidance on wildlife habitat improvements by river mile is included in Appendix B.

The revegetated sections would need to be maintained to ensure that adequate stream flow capacity was retained. (See discussion of channel maintenance practices in Action FM-2-4.) Trees that mature and become unsafe will be dealt with on a case-by-case basis. In some instances, trees may have to be cut down. Where possible, cut trees will be laid down in the upland area to provide denning and foraging habitat. Alternatively they could be secured in the stream channel or bank to provide cover for fish.

Restoration and enhancement goals for upland habitats, and wetland habitats not directly associated with the principal riparian corridors, will also focus on revegetation, especially for the larger habitat blocks and those areas that would provide linkages to other habitats. The most important upland and wetland habitats within the watershed may require protection by purchase, easement, or land management changes.

All habitat improvement projects will require specific site assessment, site plans, and evaluation and monitoring. Guidelines for site planning and attendant processes to be implemented under this plan can be found in Technical Memorandum No. 17.

FIG 27 Vegetation Restoration Goal - Millport Street

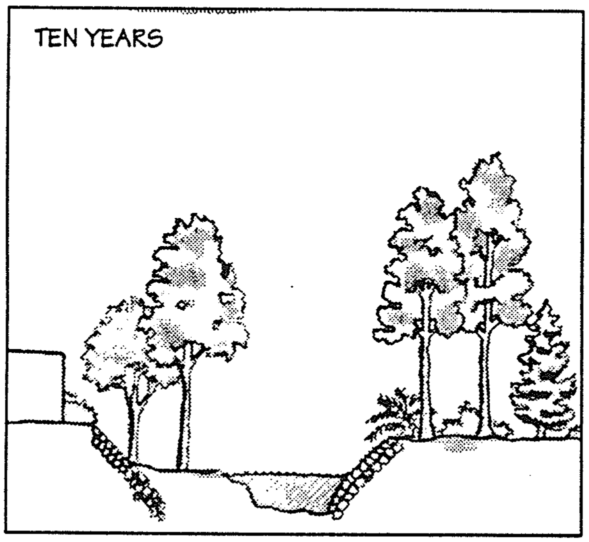


VEGETATION

- Tree layer is mostly sapling alder with 1) no understory shrub layer or 2) an understory of mostly Himalayan blackberry; trees and shrubs located on the banks and in the channel where sediments have been deposited.
- Small areas may have larger trees; in other areas there are only grasses and weeds with buildings or parking lots to bank edge.

PROPOSED PLANTINGS/TREATMENT

- Remove in channel vegetation to accommodate the minimum flood flow and bio-engineer the new bank to provide stabilization
- Add native shrubs and herbs to diversify habitat conditions; widen riparian area to accommodate additional vegetation, where possible
- Plant Douglas-fir seedlings or saplings in open areas to provide long-term shading and structure.
- Add big-leaf maple seedlings interspersed with alder to provide larger quick-growing trees for stream shading.

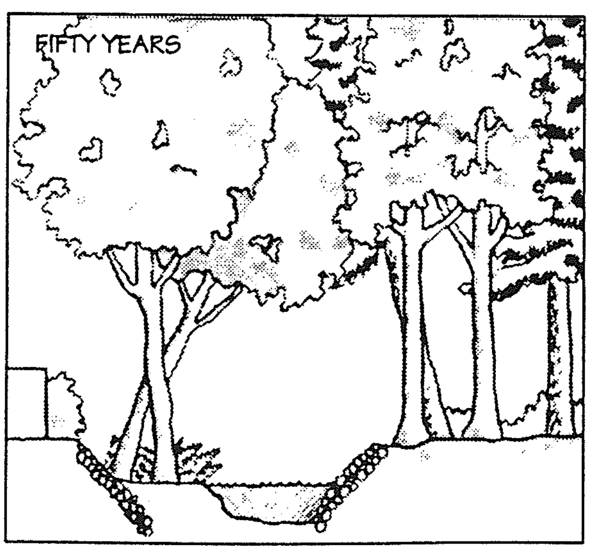


VEGETATION

- Alder saplings are now about 30-40 ft. tall providing better stream shade.
- Big-leaf maple are about 25-30 ft. tall with fairly open crowns.
- Douglas fir seedlings are now about 10-15 ft. tall adding to shrub layer structure.
- Shrub and herb layer should be well developed.

PROPOSED PLANTINGS/TREATMENT

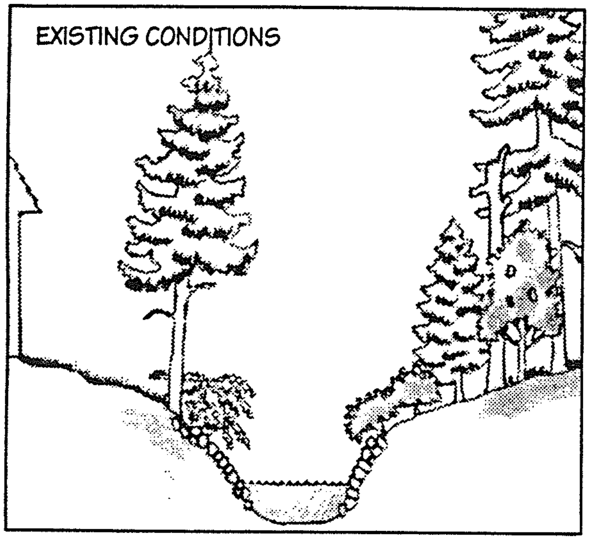
- Add western red cedar in appropriate areas.



VEGETATION

- Alder may be up to 130 ft. tall with well-developed crowns.
- Big-leaf maple will be about 50 ft. tall with crowns that shade over the creek.
- Shrub layer may be scattered due to additional shading from developed tree layer.
- Douglas-fir should be about 70-90 ft. tall with good sized crowns.

Vegetation Restoration Goal - Canyon Area FIG 28

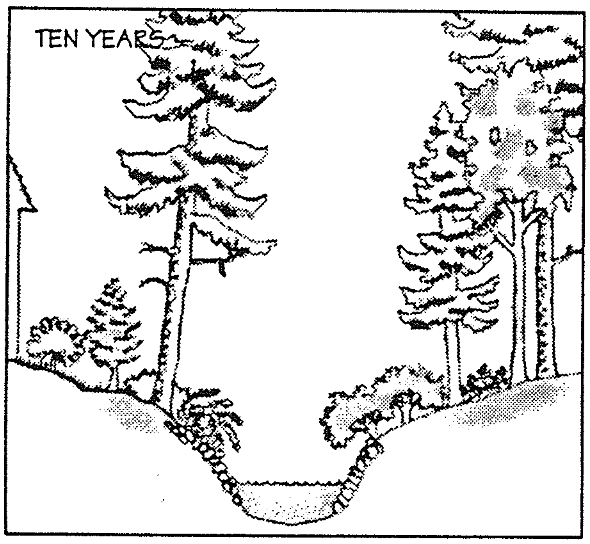


VEGETATION

- Suburban housing borders most creek areas with lawns and landscaping plants to creek
- Native tree layer in places with Douglas-fir trees 70-80 ft. tall, large western red cedar, and mature big-leaf maple
- Shrubs include native Oregon grape, salal, rose and others; Himalayan blackberry, English holly, and exotic weed species encroaching in some areas

PROPOSED PLANTINGS/TREATMENT

- Allow trees to succeed naturally
- Replace Himalayan blackberry and other exotic species with native shrubs
- Remove yard and other debris
- Avoid use of lawn chemicals; replace lawn at creekside with low shrubs to provide bank stability and habitat

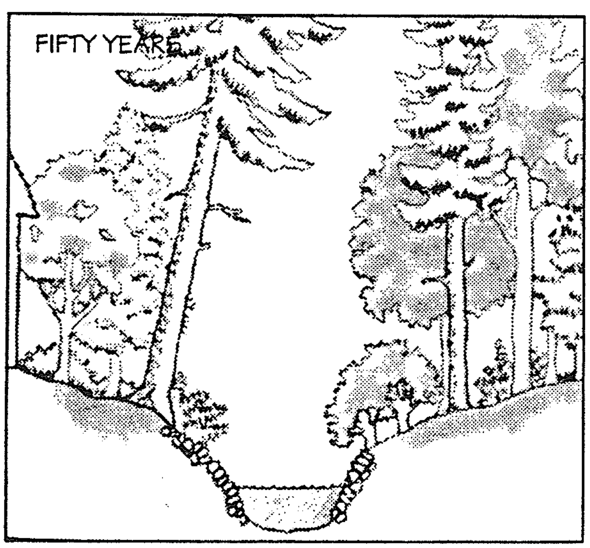


VEGETATION

- Shrub layer has become established in places; Himalayan blackberry still exists in areas not treated or has colonized into other areas in forest openings and along backyards
- Conifers (cedar and fir) have matured and may now be 80-85 ft. tall

PROPOSED PLANTINGS/TREATMENT

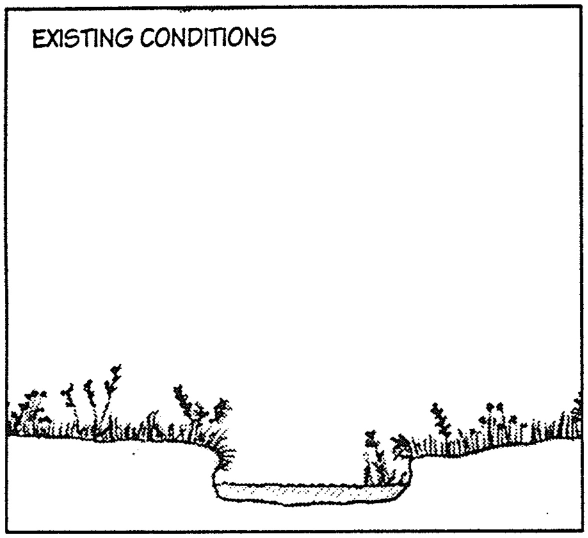
- Older or diseased trees that need to be cut down for safety or other reasons should be dropped in place within riparian zone to provide wildlife habitat
- Continue replacement of non-native shrubs and herbs and replant with natives



VEGETATION

- The forest is now composed of mature trees ranging from 50 to over 200 feet tall with mostly closed canopy which covers the stream providing shade and wildlife habitat
- The shrub layer is scattered and has thinned out in the more shaded areas but is mostly native species and is providing structural diversity to the habitat

FIG 29 Vegetation Restoration Goal - Agricultural/Rural Housing Areas (Upper Watershed)

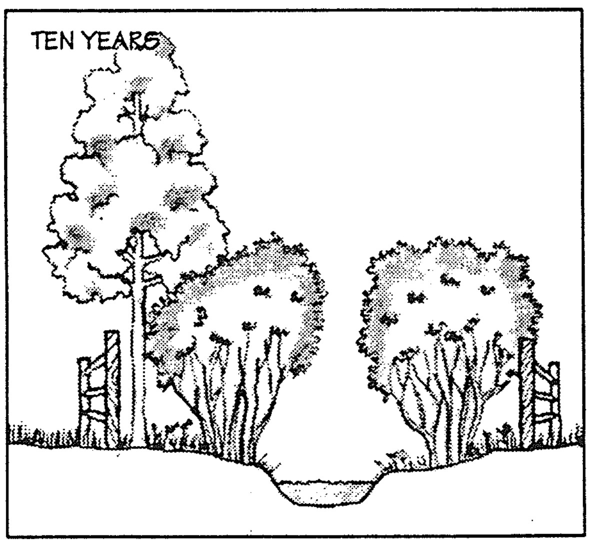


VEGETATION

- There is no tree layer but may be widely scattered willow or alder saplings in places; mostly pasture grasses with some scattered sedges or rushes in seepy areas
- The predominant land use is grazing with some hay fields; there is some rural housing with small pastures
- The stream channel may be severely undercut where cattle cross or loaf in the stream

PROPOSED PLANTINGS/TREATMENT

- Plant willow and alder seedlings or saplings
- Plant sedges and rushes in wet areas
- Fence riparian corridor to ensure re-establishment of riparian vegetation
- Avoid use of chemicals which may impact the aquatic environment

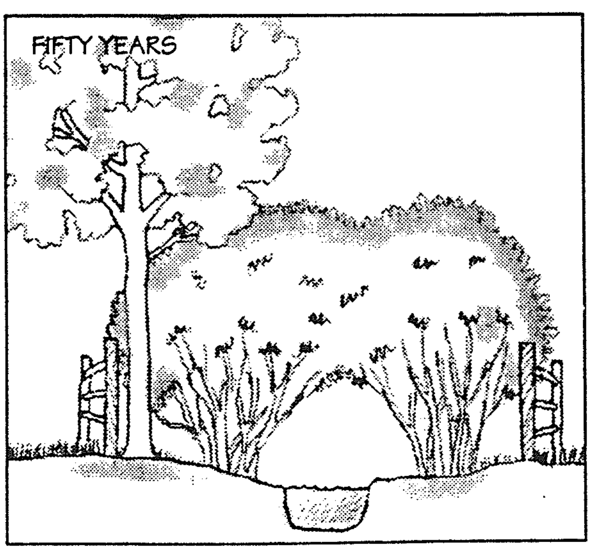


VEGETATION

- Alder seedlings now about 25 ft. tall; saplings about 40-50 ft. tall providing stream shade
- Willows will be about 8-10 ft. tall in dense clumps
- Stream channel may have some integrity and be narrow; flow may have become perennial

PROPOSED PLANTINGS/TREATMENT

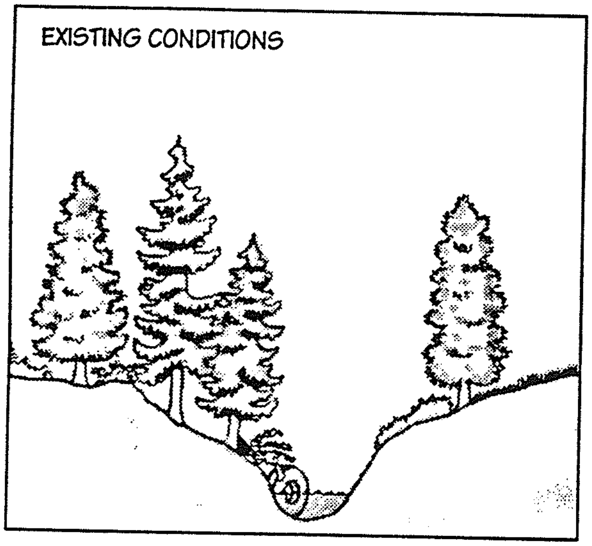
- Remove any exotic species, such as Himalayan blackberry that may be encroaching in riparian vegetation
- Allow plantings to succeed naturally; replant areas where initial plantings did not take or where new plantings are needed



VEGETATION

- Alder may be up to 130 ft. tall and willow should be at full growth, about 15 ft. tall in dense clumps; stream will be fully shaded
- Stream channel has narrowed and is deeper; there may be perennial surface flow

Vegetation Restoration Goal - Kelley and Mitchell Creeks **FIG 30**

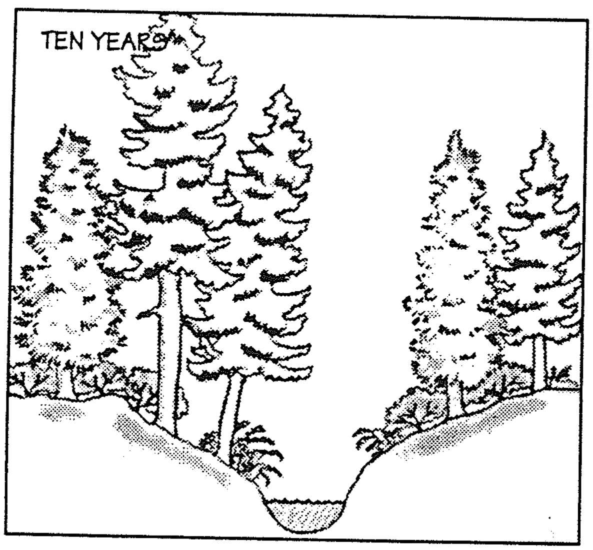


VEGETATION

- Creeks flow through natural channel of rock and mud; suburban housing and some rural housing borders creeks with lawn, pasture or landscaping to bank edge
- Native tree layer in places with Douglas-fir trees 70-80 ft. tall, large western red cedar, and mature big-leaf maple
- Shrub layer is mostly native plants with encroachment of lawn grasses and blackberry
- Creeks have yard and other debris in stream channel

PROPOSED PLANTINGS/TREATMENT

- Allow tree canopy to succeed naturally. Plant native trees in areas where they are lacking
- Replace Himalayan blackberry and other exotic species with native shrubs
- Remove yard and other debris
- Avoid use of lawn chemicals; replace lawn at creekside with low shrubs

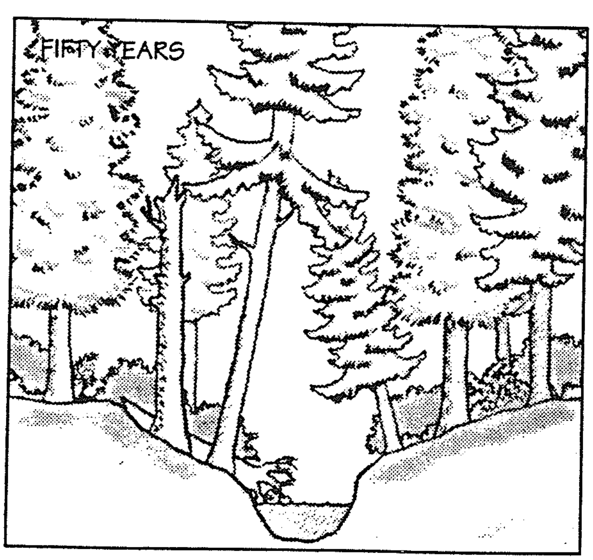


VEGETATION

- Tree canopy will fill in as native trees mature
- Natural succession of forest may occur as native plants seed area where exotics have been removed

PROPOSED PLANTINGS/TREATMENT

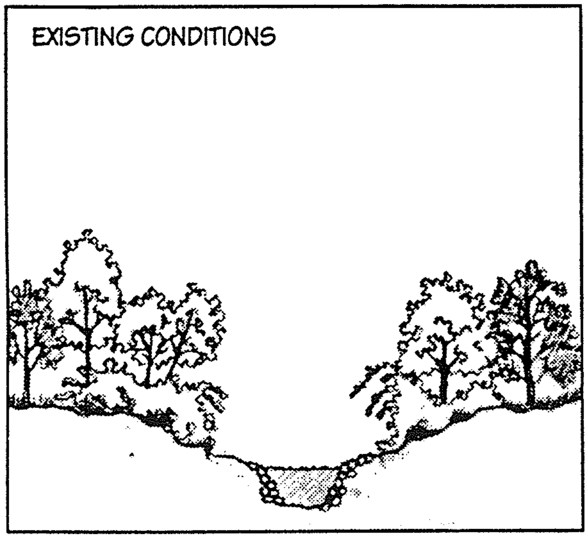
- Where needed control exotic plants and replant with native species. This process will be repeated as needed to establish native plants



VEGETATION

- Over time large trees will die and either remain standing as snags or fall as downed logs providing dead wood habitat for several species of wildlife, including mammals and amphibians. If exotic plant encroachment has been controlled, the forested habitat will likely reflect historic vegetative characteristics

FIG 31 Vegetation Restoration Goal - Bell Station

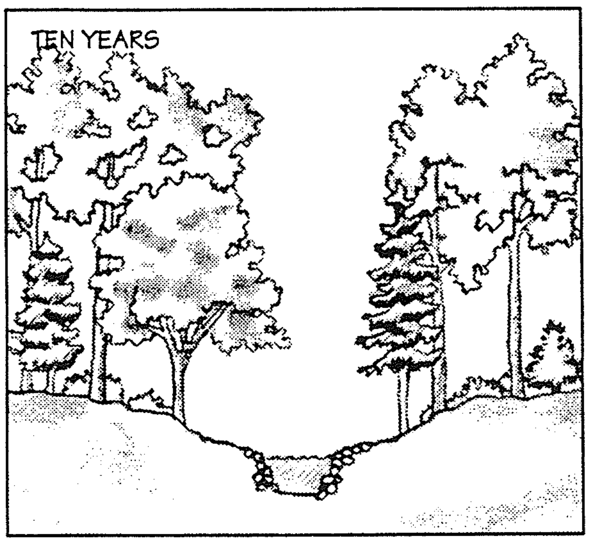


VEGETATION

- Stream bank is mostly rock walls with sapling and larger alder trees along upper banks and in channel where sediments have been deposited on one bank
- Shrub layer is mostly Himalayan blackberry
- Exotic grasses dominate herb layer

PROPOSED PLANTINGS/TREATMENT

- Remove in channel vegetation to accommodate the minimum flood flow goal and bio-engineer the new bank to provide stabilization
- Allow existing alder to succeed naturally and plant additional alder to increase tree layer; widen riparian area to accommodate more vegetation, where possible
- Plant Douglas-fir seedlings in open areas or, where necessary, clear small areas, for these trees
- Plant big-leaf maple saplings close to the creek to provide stream shade
- Begin removal of Himalayan blackberry

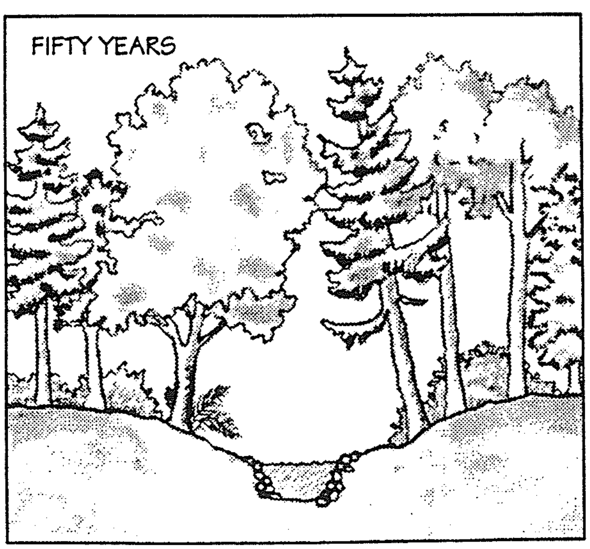


VEGETATION

- Alder are about 30-40 ft. tall providing good shade at leaf on
- Big-leaf maples now average about 25-30 ft. providing shade and vegetative structure
- Douglas-fir saplings are now about 10-12 ft. tall
- Where shade has increased, Himalayan blackberry may be reduced

PROPOSED PLANTINGS/TREATMENT

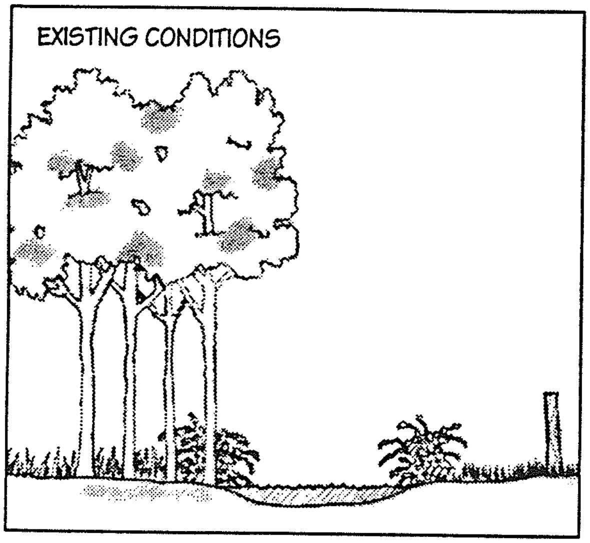
- Remove blackberry roots and plants and revegetate with native shrubs
- Add western red cedar, grand fir, and western hemlock where appropriate to increase overstory tree canopy and shade value for creek



VEGETATION

- Big-leaf maple and alder have matured and range from 50 to 130 ft. tall respectively, providing good shade to stream and shading out Himalayan blackberry where it was once established
- Douglas-fir and other conifers are now 40-50 years old and stand anywhere from 50-80 ft. tall. The forest shows good diversity both vegetatively and structurally
- Shrub layer is scattered having thinned out in the more well shaded areas
- The stream is 70-100% shaded at noon

Vegetation Restoration Goal - Wetland and Forests Found in Broader Floodplains **FIG 32**

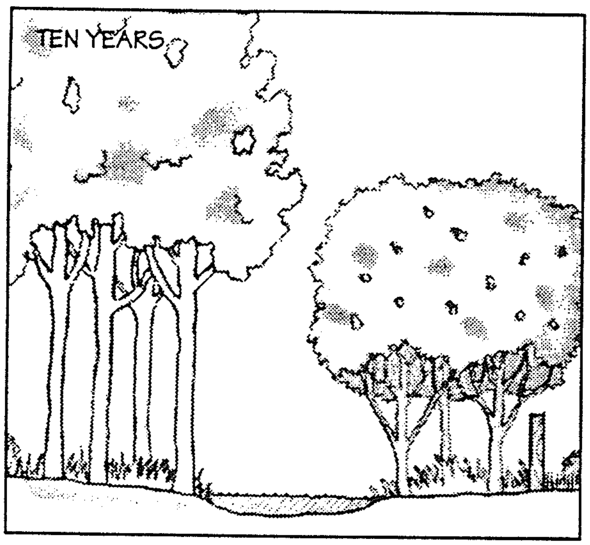


VEGETATION

- Dominant trees may be Oregon ash, red alder, or black cottonwood
- In cottonwood forests, willows may be the dominant shrub; in Oregon ash forests, slough sedge may be dominant and shrubs may be absent or along the periphery
- Often one bank is forested and the other bank is vegetated with exotic grasses or Himalayan blackberry, which may encroach into the wetland forest on the other bank
- Flow in these areas may spread out of the normal stream channel and into the broader floodplain and be sluggish

PROPOSED PLANTINGS/TREATMENT

- Remove Himalayan blackberry and other exotics
- Plant non-forested area with native trees and shrubs, including ash, cottonwood, alder, wild rose, willow and various rushes and sedges
- Where needed, fence riparian zone to protect existing forest and new plantings from livestock and human disturbance

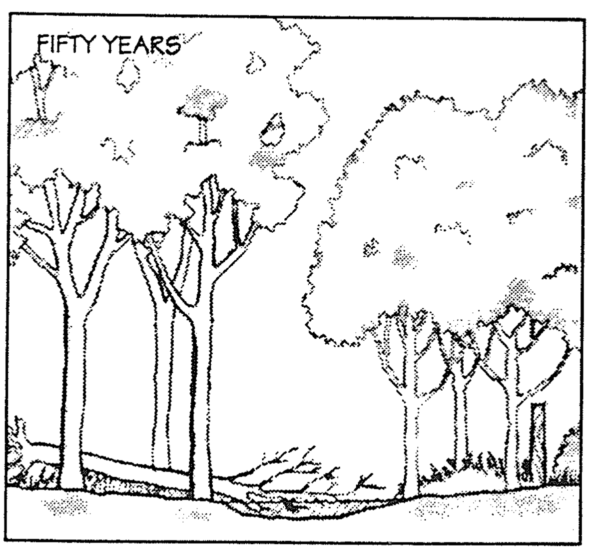


VEGETATION

- Alder may be about 30 ft. tall; ash about 15-20 ft. tall, and cottonwood about 30-35 ft. tall; willows and other shrubs will be well established as well as ground cover plants

PROPOSED PLANTINGS/TREATMENT

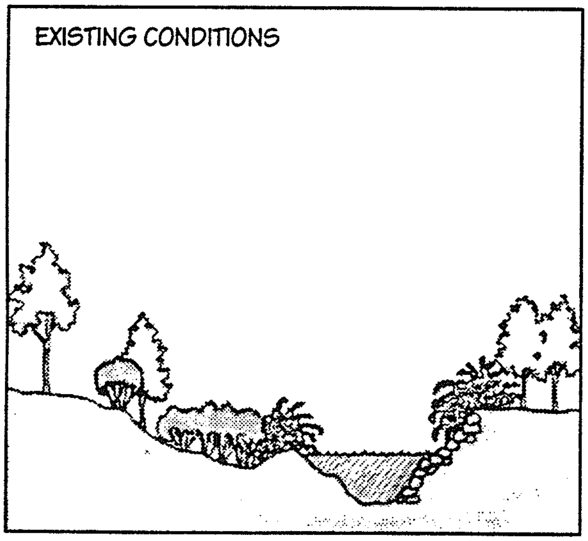
- Continue to remove exotic plants and maintain fences
- Replant where necessary or add new plantings where openings allow



VEGETATION

- Willow and other shrubs have reached maximum height
- Trees range from 40 ft. to 70 ft. tall, depending upon species present; some trees have already died and have fallen, providing habitat for fish and aquatic wildlife
- Slough sedge and other wetland plants dominate the ground layer and shrubs may be present where light penetrates the forest canopy or along the forest periphery
- The wetland forests are now providing areas that distribute flood waters, catch sediment, and support additional wildlife species

FIG 33 Vegetation Restoration Goal - Circle Drive

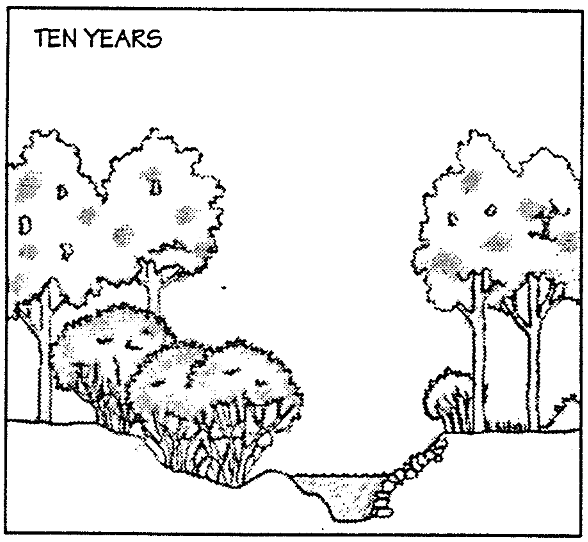


VEGETATION

- Willows have become established in sediment deposits within stream channel along one bank; scattered alder saplings are located within and adjacent to the willow and in established sapling stands on the opposite bank
- In some areas Himalayan blackberry dominates the shrub layer

PROPOSED PLANTINGS/TREATMENT

- Allow willow and alder to naturally succeed
- Add conifers in appropriate places on higher stream bank
- Begin to replace Himalayan blackberry with native shrubs and herbs

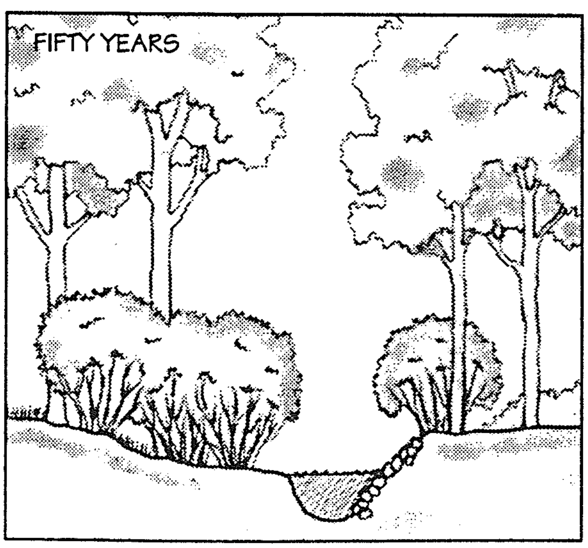


VEGETATION

- Willow remains in dense stands; alder have matured on both sides of the creek providing additional stream shade

PROPOSED PLANTINGS/TREATMENT

- Continue with removal of Himalayan blackberry and replace with native shrubs or trees
- Fence riparian area, if necessary, to ensure establishment of new vegetation



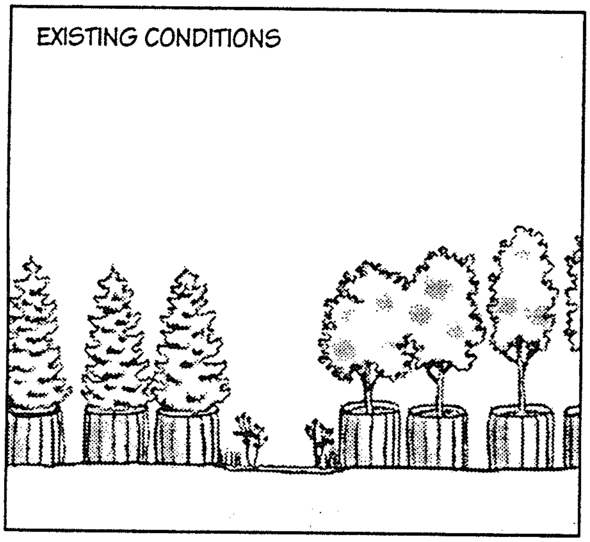
VEGETATION

- The sediment caught by willow shrubs has provided a new channel which is narrower and deeper than fifty years ago
- Douglas-fir trees are about 70-90 ft. tall and about 16-20 inches diameter at breast height providing large structure and stream shade

PROPOSED PLANTINGS/TREATMENT

- Continue to remove exotic plants and maintain fences
- Replant where necessary or add new plantings where openings allow

Vegetation Restoration Goal - Agricultural Areas and Container Nurseries FIG 34

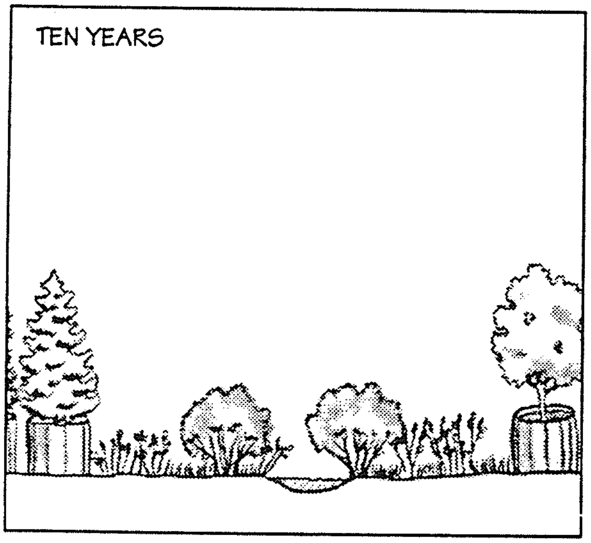


VEGETATION

- The creek shows no defined drainage but usually appears as a broad wet area in pastures or between containers
- Trees are absent; shrubs may include common rush or other rush type plant; ground cover is usually pasture grasses

PROPOSED PLANTINGS/TREATMENT

- Widen riparian area by setting back containers or fencing off livestock
- Plant wet area with shrubs, such as willow and wild rose, and other wetland types ground covers, such as rushes and sedges
- Where possible, in broader floodplain areas, plant alder and cottonwood trees to reestablish creek channels and provide stream cover
- Control pesticide use within riparian and adjacent areas

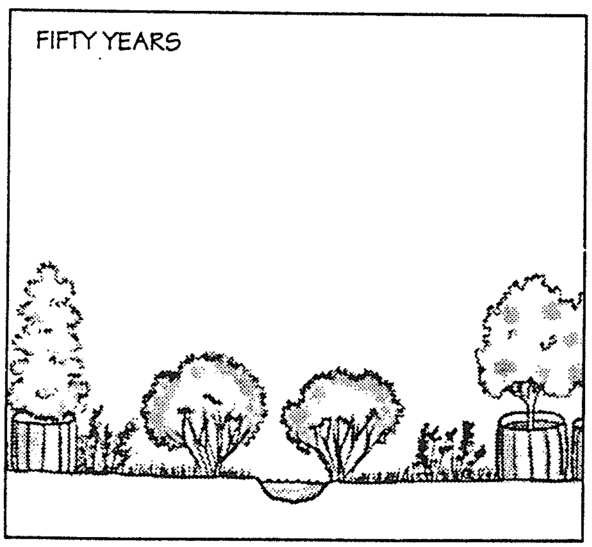


VEGETATION

- Trees may be 15-40 ft. tall and willows will be about 8-10 ft. tall
- Wetland plants should be well established, if area has been fenced to exclude livestock
- Stream channel has begun to form and may be only 6-8 inches wide; water flow has likely improved

PROPOSED PLANTINGS/TREATMENT

- Allow plantings to succeed naturally; plant or replant where necessary
- Continue to control pesticide use in and adjacent to riparian area



VEGETATION

- Trees. willows and other plants have achieved maximum growth and channel may be 6-10 inches deep

PROPOSED PLANTINGS/TREATMENT

- Protect area and allow to succeed naturally

PLAN OBJECTIVES AND ACTIONS

The objectives and actions summarized in Table 20 are designed to improve wildlife habitat. They are based on the the wildlife habitat improvement strategy described above, and include protection, enhancement and restoration components.

Certain actions elsewhere in the RMP may result in some minor loss of wildlife habitat. Principal among them is the construction of on-stream detention basins for flood reduction. Some wetlands will be lost as a result of dam construction. Because the losses are expected to be small (less than five acres), the wildlife habitat enhancing actions in this plan element are expected to more than compensate for the losses.

Objective FW-1.
Protect Existing Wildlife Habitat

Action FW-1-1.
Protect critical wildlife habitats.

Certain lands in the watershed are particularly important as wildlife habitat. Examples are remnants of vegetation that existed before European settlement, lands that connect the riparian corridor with adjacent uplands, lands that abut spawning and rearing habitat for native fish, habitat types under-represented in the watershed, such as forested and emergent wetlands, seeps and springs, and the habitats of special status plants or animals. The protection of these lands may be best accomplished by acquiring them, obtaining conservation easements or executing land management agreements with landowners.

A list of general candidate sites for protection has been compiled as part of the RMP. A special purpose wildlife habitat subcommittee of the WMO will develop the list in more detail, assign priorities and devise protection strategies. (See Action WS-1-4.) Because funds for public land acquisition are always limited, it may be desirable to protect wildlife habitat as much as possible by conservation easements and management agreements rather than by outright acquisition.

In May, 1995, Metro is seeking voter approval to sell bonds to finance the public purchase of open space throughout the Portland metropolitan area. The Open Space, Parks and Streams Bond Measure asks voters to approve the expenditure of $135.6 million to acquire, protect and improve valuable lands for fish and wildlife habitat, as well as for recreational opportunities. If approved, this measure will protect and preserve over 6,000 acres of open space. Funds will be used to acquire stream corridors, critical wildlife habitat and land near existing parks and trails, to create and improve trail corridors, and to increase opportunities for walking, jogging and biking.

Eighty-nine projects are proposed, 14 of which lie within the Johnson Creek watershed. Approximately 340 acres would be acquired in the Johnson Creek watershed at the locations listed in Table 21. About one-half of the proposed acquisitions would benefit fish and wildlife.

TABLE 20
Wildlife Habitat Enhancement Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective FW-1. Protect Existing Wildlife Habitat (JCCC Goals 2, 4, and 12)				
Action FW-1-1. Protect critical wildlife habitats	Cities, Counties, Land Trusts	Not estimated	Not estimated	A
Action FW-1-2. Protect other existing wildlife habitats through land use regulation[1]	Cities, Counties, Land Trusts	Included in Action WS-3-1	Included in Action WS-3-1	A
Objective FW-2. Enhance and Restore Streamside Vegetation (JCCC Goals 2, 4, and 12)				
Action FW-2-1. Enhance and restore riparian corridor on public lands	Cities and Counties (one-time cost)	$400,000 (one-time cost)	$400,000	A
Action FW-2-2. Enhance and restore riparian corridor on private lands[2]	Private property owners	$1,400,000 (one-time cost)	$1,400,000 (one-time cost)	A
Action FW-2-3. Provide artificial habitat structures	Cities, Counties, Private property owners	Minor Not estimated	Minor Not estimated	B
Action FW-2-4. Connect upland and wetland habitats with riparian areas	Cities, Counties, Private property owners	Not Estimated	Not Estimated	B
Objective FW-3. Enhance and Restore Uplands and Wetlands Outside Creek Corridor (JCCC Goals 2, 4, and 12)				
Action FW-3-1. Enhance and restore publicly-owned uplands	Cities and Counties	Not estimated	Not estimated	B
Action FW-3-2. Enhance and restore privately-owned uplands	Private property owners	Not estimated	Not estimated	B

NOTE:

1 Related actions: WS-3-1, WS-3-2, and WS-3-3
2 Cost estimate assumes basic revegetation with small native plants. Property owners may choose to spend more to accelerate achievement of mature landscaping.

TABLE 21
Proposed Open Space Projects in the Johnson Creek Watershed

Project Name	Description
East Buttes and Boring Lava Domes	Regional Greenspaces target area, approximately half of which lies in Johnson Creek watershed (275 acres)
Butler Creek Greenway Trail, Gresham	Soft surface trails, bridge over Johnson Creek
Crystal Springs Rhododendron Garden, Portland	Acquisition of adjacent land in Southeast Portland (3 acres)
Hogan Cedars	Acquisition along Johnson Creek near Tellford Road/Springwater Corridor (16 acres)
Johnson Creek Corridor, Portland	Acquisition of greenspace along creek in Southeast Portland
Kelly Creek Greenway, Gresham	Acquisition of 4.5 acres, soft surface trails
Leach Botanical Garden, Portland	Acquisition of adjacent land in Southeast Portland (5 acres)
OMSI to Springwater Corridor, Portland	Trail heads and trail improvements on east bank of Willamette River
Powell Butte, Portland	Habitat restoration, improvements in Southeast Portland (20 acres)
Springwater Corridor Trail, Gresham	Trail heads, trail construction, information center, native vegetation plantings
Springwater Corridor, Portland	Trail heads and trail improvements in Southeast Portland
Ardenwald to Springwater Corridor, Milwaukie	Construct trail to connect Ardenwald area to Springwater (10 acres)
Milwaukie Waterfront	Acquire about 2.5 acres at the confluence of Johnson Creek and Willamette River
Springwater Corridor Trail	Land acquisition to complete trail near Boring (2 acres)
Springwater Corridor, Milwaukie	Acquire land between Johnson Creek and the Springwater Trail (2 acres)

Action FW-1-2.
Protect other existing wildlife habitats through land use regulation.

All wildlife habitat in the Johnson Creek watershed, other than the critical habitat referred to above, should be protected. However, it is recognized that communities in the watershed expect to have to accommodate more homes and businesses as the

Portland Metropolitan area grows. As development proceeds, open and agricultural lands will be converted to urban uses. Cities and counties will decide which lands are to be developed as part of their comprehensive planning process. Cities and counties should consider the value of wildlife habitat as part of their decision-making process (see Objective WS-3).

Objective FW-2.
Enhance and Restore Streamside Vegetation along Johnson Creek and its Tributaries.

Action FW-2-1.
Enhance and restore the riparian corridor on public lands.

On the 25-mile long mainstem of Johnson Creek about 4.2 miles, or about 17 percent, are publicly owned, that is, owned by city, county, state, or federal governments. Many of the publicly owned sections are located at road crossings and are very short. Longer sections are at Johnson Creek Park, Eastmoreland Golf Course, Tideman Johnson Park, the floodplain area west of the creek near S.E. 45th Avenue, S.E. Brookside Drive, Leach Botanical Garden, most of the riparian corridor within the city of Gresham, including Gresham Main Park. The riparian corridor within public parks will be enhanced or restored to the maximum degree that is compatible with other park uses and other elements of the RMP. The riparian corridor is defined as the corridor within which vegetation, adopted to streamside conditions, grows. Its width varies depending on topography. The cross-sections shown in Figures 27 through 34 will serve as a guideline for development of individual enhancement and planting plans. Removal of non-native plants is a common element of all cross-sections. Many areas in parks possess mature native trees, such as Douglas-fir, but lack shrubs, or have an understory of Himalayan blackberry. These areas will be enhanced by the removal of the blackberries and their replacement with native plants, such as rose or Oregon grape, and by the addition of a herbaceous layer of native wildflowers and groundcovers.

In the more developed parks, Johnson Creek Park, Westmoreland Park, and Gresham Main Park, for example, the need to accommodate active recreational uses within a relatively small area may preclude full restoration of the riparian corridor. As an alternative, a portion of the creek corridor could be reserved as wildlife habitat and active recreation limited to areas where banks have been hardened to allow direct public access. More comprehensive riparian restoration could occur at Eastmoreland Golf Course and Tideman Johnson Park. Within Leach Botanical Garden the creek corridor already has considerable value as wildlife habitat, so improvements would be minor. At S.E. Brookside Drive a 13-acre parcel, on the south side of Johnson Creek, owned by the City of Portland,will be developed as a natural park and wildlife refuge, that also provides storage for flood waters (see Action FM-2-2). The riparian and upland portions of the parcel will be largely restored to a natural condition, while other portions of the site will be excavated to form wetlands that also serve as flood storage. Riparian improvements in the Lents area would be coordinated with Metro's and Multnomah County's plans for management of Beggars-tick Refuge. (Beggars-tick Refuge is owned by Multnomah County and managed by Metro.)

It will be especially important to move forward rapidly with wildlife habitat restoration and enhancement of publicly-owned streamside lands, because these areas can then serve as an example to private property owners. It will be difficult to persuade private property owners to restore their streamside lands to a natural condition if adjacent public lands are not similarly managed. As a first step, management plans will be prepared for all public lands that include wildlife habitat protection and enhancement as a goal of management.

Action FW-2-2.
Enhance and restore riparian corridor on private lands.

Private land owners will be encouraged to enhance and restore the riparian corridor within their lands. Again Figures 27 through 34 provide a general guide for management. Compliance with this action will be purely voluntary, although some jurisdictions already place some limits on environmentally-sensitive private lands as discussed under Objective WS-3.

The Johnson Creek Corridor Committee has developed a handbook for streamside property owners that provides advice on landscaping in areas adjacent to the creek. The WMO will maintain a library of materials on the same topic and will also be able to provide limited technical assistance to landowners. The WMO will develop a program to inform private land owners of the advantages of natural landscaping. This program will be coordinated with Oregon Fish and Wildlife's "naturescaping" program and may use some of the same informational materials.

Action FW-2-3.
Provide artificial habitat structures to supplement existing habitat or to provide short-term habitat components within improved habitats.

Some areas lack certain life requisites for particular wildlife species. For example, a wooded area may have large older trees, but no dead trees or snags because they have been removed for safety reasons. In other areas with similar habitat attributes, for example a large public park with areas away from trails, dead trees may be left standing to provide natural cavities. Until such dead trees become available, nest boxes would provide short-term habitat for these cavity users. Other artificial habitat structures that could be installed include nesting platforms and bat boxes.

Action FW-2-4.
Connect upland and wetland habitats with riparian areas and other upland or wetland habitats by protecting, restoring, or enhancing native vegetation in potential connective corridors.

Connecting various habitat types by means of riparian or upland corridors can enhance overall wildlife values by providing secure travel and dispersal. Dispersal of juveniles and adult wildlife species allows for genetic exchange, which is necessary to maintain healthy wildlife populations. Mammals and herpetofauna are the most impacted by fragmentation of habitats. Populations that become isolated eventually will die out because of inbreeding or normal population declines. Riparian corridors make excellent avenues for wildlife movement but they need to be connected to uplands and other riparian areas. The value of connecting habitats should be recognized in efforts to protect wildlife habitat by acquisition or land use regulation (See Objective FW-1, above, and Objective WS-3).

Objective FW-3
Enhance and Restore Uplands and Wetlands outside the Creek Corridor

Action FW 3-1.
Enhance and restore publicly-owned uplands and wetlands outside creek corridor.
Upland and wetland areas that are located outside of the riparian area and are currently publicly-owned, in whole or part, include Westmoreland Park, Eastmoreland Golf Course, Tideman Johnson Park, Beggars-tick Refuge, the S.E. Brookside Drive parcel, Bundee Park, Cedarville Park, Powell Butte, and in Gresham, south of the PGE Station, near the 7th Street bridge crossing, Gresham Main City Park, and parts of Walter's Hill.

Restoration and enhancement projects for upland and wetland areas, will include the removal of non-natives and the planting of native trees, shrubs, and herbaceous vegetation. Priority areas for revegetation will include buffer and linkage areas between riparian zones and upland habitats. Upland habitats that contain small streams will be an early target for improvement because they are likely to be used by the greatest number of wildlife species.

Before improvements can begin, site-specific enhancement and restoration plans will need to be prepared. General improvement prescriptions for publicly-owned uplands follow. They provide a framework for development of detailed plans.

Eastmoreland Golf Course and Westmoreland Park should be revegetated to include shrub areas between overstory trees, where this will not impede other park uses. Habitat at Tideman Johnson Park should be improved by the addition of native shrubs and herbs to provide additional cover and breeding habitat. Requiring dogs to be on a leash will reduce damage and disturbance to wildlife habitat. As noted above, Portland's fifteen-acre parcel at S.E. Brookside Drive should be developed as a natural park and wildlife refuge. This will involve regrading and revegetating all of the parcel except the riparian corridor. Past filling of the parcel has produced an unnatural topography. Lowering the surface elevation of portions of the site will allow expansion of the existing wetlands and will also increase flood storage in this flood-prone area.

Beggars-tick Refuge, a 20-acre marsh and wildlife refuge is the subject of a management plan which is being implemented by Multnomah County. At Powell Butte, vegetative diversity should be maintained and additional wildlife habitat provided by the addition of dead wood and replanting with shrubs along its south slope. At Bundee Park, the north bank upland area should be revegetated and unwanted exotic vegetation removed. The area should then be allowed to succeed naturally.

In general, shrubs and herbs should be planted under trees in the buffer area between the creek and the nearby open uplands.

Action FW-3-2.
Enhance and restore privately-owned uplands and wetlands outside the creek corridor.
Private landowners will be encouraged to enhance and restore upland and wetland habitats within their property boundaries. Land developers will also be encouraged to design housing projects and other developments that include retention, restoration, or enhancement of wildlife habitat and the amenities that it provides.

Areas within the watershed that are included in this action are: Freeway Land Co. (Smurfit) site, the springs that feed Beggars-tick Marsh, the wet meadow and shrub/scrub habitat north of Jenne Butte, forested wetlands that run along the base of Walter's Hill, Walter's Hill complex, the Barbara Welch uplands, the Boring Lava Hills and East Buttes (south of Kelly Butte and Powell Buttes, Jenne Butte, etc.), Mt. Scott, the Willamette Cemetery Hill, and all vegetated areas around seeps and the smaller drainages. Some of these areas, such as wetlands and interior forest habitat, may also need protective measures, as determined by the various jurisdictions, to ensure improved long term habitat value.

The buttes and other large blocks of upland forest habitat need to retain continuous and large blocks of habitat or vegetative cover. This will be accomplished through environmentally-sensitive development, revegetating areas deficient in native plants, and allowing existing high quality habitat to succeed naturally. Within the more developed areas, e.g., Willamette Cemetery, riparian zones and buffer areas should be planted with shrubs to provide continuous cover for wildlife.

Fish

Nothing is known about fish populations in Johnson Creek before European settlement. It seems likely, however, based on comparisons with less-disturbed streams in the lower Willamette watershed, that Johnson Creek supported runs of steelhead trout, sea-run cutthroat trout, coho and chinook salmon. Conditions for these fish declined after the watershed was settled, logged, and converted to agricultural and urban uses. Channelization of much of the creek by the Works Progress Administration in the 1930s, and the use of the creek for wastewater disposal, further exacerbated already deteriorated conditions. Water quality in the creek has probably improved somewhat in recent years. Currently, Johnson Creek contains many small non-game fish, but only a remnant of the historic salmonid runs.

One of the goals established by the JCCC is to restore and maintain good quality aquatic habitat that will support native resident and migratory fish. In general, restoration of conditions that will support migratory fish, in this case salmonids, will also create habitat for resident fish species. Salmonids tend to be more sensitive to environmental change than most fish species and are a good indicator of overall environmental health. Consequently, the discussion below, and the RMP itself, focuses on the restoration of salmonid runs. This focus is further reinforced by the considerable community interest in salmonids, which reflects the importance of salmon in the culture of the Pacific Northwest.

CURRENT STATUS OF FISH AND FISH MANAGEMENT PRACTICES

Information on fish in the Johnson Creek watershed is based on several surveys, fish kill reports and occasional observations made by residents and wildlife agency personnel. The most detailed and current information was gathered by the City of Portland in 1992, and by Oregon Department of Fish and Wildlife and volunteers in 1993.

The fish community of Johnson Creek is presently numerically-dominated by redside shiner and reticulate sculpin. Speckled dace are also widely distributed in the watershed. Redside shiners and speckled dace are members of the minnow family that rarely exceed 3-inches in length. The reticulate sculpin is a similarly sized bottom fish. All three common fishes, but particularly the sculpin, are tolerant of varying environmental conditions. The sculpin can survive in temperatures as high as 30° Celsius.

Single coho and chinook juveniles and small numbers of juvenile steelhead and cutthroat trout were identified during the 1992 and 1993 surveys. No adult salmonids were found during these surveys. Oregon Department of Fish and Wildlife personnel and residents both report sightings of adult salmonids in recent years, including coho salmon, chinook salmon, cutthroat trout and steelhead. Angling records indicate that a few steelhead and coho salmon were caught most years during the 1970s and 1980s. A single spawning steelhead was observed in March 1994, a few hundred feet upstream of Johnson Creek's confluence with the Willamette River.

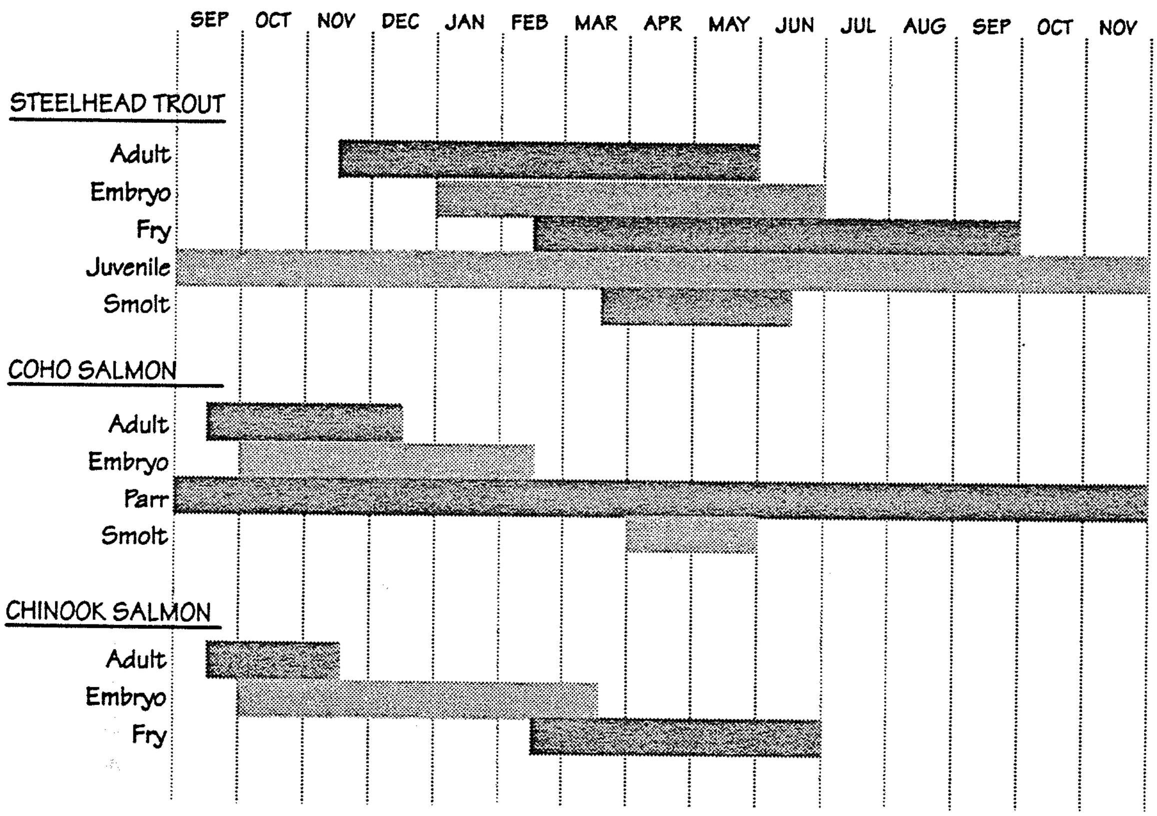
At the present time, Johnson Creek fisheries are not being managed to re-establish native fish stocks, although that is one of the goals of a fisheries management plan being developed by Oregon Department of Fish and Wildlife. Hatchery strains of coho salmon and steelhead are incubated in hatch boxes and released as fry into Crystal Springs Creek (since 1981) and into the lower 2 miles of Johnson Creek (since 1991). In addition, Oregon Department of Fish and Wildlife has released substantial numbers of hatchery-reared juvenile fall chinook salmon during the last few years. A "put and take" rainbow trout fishery also is maintained through spring stockings of hatchery-reared catchable rainbow trout downstream of S.E. 82nd Avenue. Trout angling is allowed from late April through 31 October with a bag limit of five fish; salmon and steelhead angling is allowed throughout the year with a bag limit of two fish.

LIFE STAGES OF SALMONIDS IN JOHNSON CREEK

Different salmonid species use Johnson Creek during different parts of their life cycle. Figure 35 shows when different life stages of steelhead, coho and chinook salmon are, or could be, in Johnson Creek. Winter-run adult steelhead return to spawn in Johnson Creek from mid- November through May. There appear to be two separate runs of winter steelhead peaking in January and February and again in April and May. Spawning female steelhead dig depressions, or redds, in the bottom gravel. Eggs are deposited in the redds and usually hatch in 35 to 50 days, depending on water temperature. After hatching, the trout fry remain in the gravel for two to three weeks. Eggs or fry could be present in the gravel from December to July. Three to four months after leaving the gravel, fry reach a

FIG 35

Periods of Occurrence of Various Life Stages of Fish in Johnson Creek.
Shaded Areas Represent Period of Residency of Life Stage in Johnson Creek.



length of about one and one-half inches and become juveniles. Juveniles probably remain in the stream for one to two years before undergoing the physiological transition necessary to allow them to migrate to salt water. At this stage they are referred to as smolts. Steelhead remain in the ocean for one to four years before returning to spawn.

Coho salmon in North America typically migrate upstream in a single fall run. Entry into freshwater usually begins when the first winter rains swell stream flow. Adult coho salmon have been observed in the lower reaches of Johnson Creek and in Crystal Springs Creek from late September through early November. Eggs hatch in 45 to 55 days and fry emerge from the gravel about 25 days later. Eggs or fry could be in the gravel between October and March. Fry attempt to establish territories and remain in the stream as juveniles (parr) for one to two years before becoming smolts. Smolts migrate downstream to the ocean. The survivors return to spawn after spending about 18 months in salt water.

Chinook salmon have the most diverse life history of all Pacific salmon. There are many different races of chinook with their own individual characteristics. A particular race of fall chinook, referred to as the "tule" have historically spawned in Johnson Creek. Tules generally remain in the ocean or estuary until nearly mature. By the time they migrate upstream to their spawning grounds, they are dark in color and their flesh has lost most of its oil content. Chinook salmon probably enter Johnson Creek to spawn from mid-September through October. Fry emerge from the gravel in January and February. They only spend a few weeks in the vicinity of the spawning grounds before beginning their seaward migration. Most chinook salmon fry have left freshwater by June. Chinook spend two to four years in the ocean before returning to spawn. Thus, unlike steelhead and coho salmon, tule chinook salmon are only resident in Oregon streams for a few months.

The other salmonid species present in Johnson Creek is the coastal subspecies of cutthroat trout. The coastal subspecies has both sea-run and resident forms. Although it is possible that both forms occur in Johnson Creek, no recent documentation of the sea-run form has been found. Data from electrofishing surveys conducted in 1992 and 1993 indicated that cutthroat trout are present in low numbers throughout the mainstem of Johnson Creek and are more abundant in the small headwater tributaries. Fry and juvenile life stages were found primarily in small tributary streams, although a few juveniles where found in the mainstem in the vicinity of Gresham. Coastal cutthroat trout spawn from late December through February. The spawning behavior is similar to that of other salmonids, except that the densities of spawning fish are lower and spawning occurs in much smaller streams. Spawning occurs in riffles in coarse (walnut-size) to pea-size gravel. Most cutthroat fry emerge from the gravel by mid-April, but the time of emergence varies depending on the spawning date and the water temperature. Resident forms of coastal cutthroat typically remain in, or relatively close to, their natal streams. Juvenile sea-run coastal cutthroat trout often spend a year in the small headwater streams and then move downstream into larger streams for the remainder of their freshwater residency. They may live in these larger streams for 2 to 9 years before migrating to the ocean. In Washington and Oregon most sea-run cutthroat trout migrate after three years of freshwater residence. Little is known about their life in the ocean, but it is believed they generally stay close to their home stream. Ocean residence ranges from a few months to one or two years.

FACTORS LIMITING FISH HABITAT VALUE

The adverse effect of development on fish habitat is well understood. Natural streams exist in a state of dynamic equilibrium with their watersheds. Migratory salmonids evolved to take advantage of the characteristics of the rivers and streams of the Pacific Northwest. When development occurs the dynamic equilibrium between stream and watershed is disturbed. When a watershed is logged, large quantities of silt are often discharged into streams. The silt blankets the gravels that salmonids use to spawn. The loss of cover along stream channels increases water temperatures to injurious levels and facilitates predation of young fish. Discharge of urban wastewaters introduces materials into the stream which are toxic to fish and the invertebrates they feed upon. Although these effects are well understood conceptually, it is still necessary to analyze the factors that actually limit fish populations in a given situation. Based on the analysis of limiting factors, a strategy for improvement can be developed.

A systematic approach to analyzing the factors that limit fish populations has been developed by the U.S. Fish and Wildlife Service. It is referred to the habitat suitability index

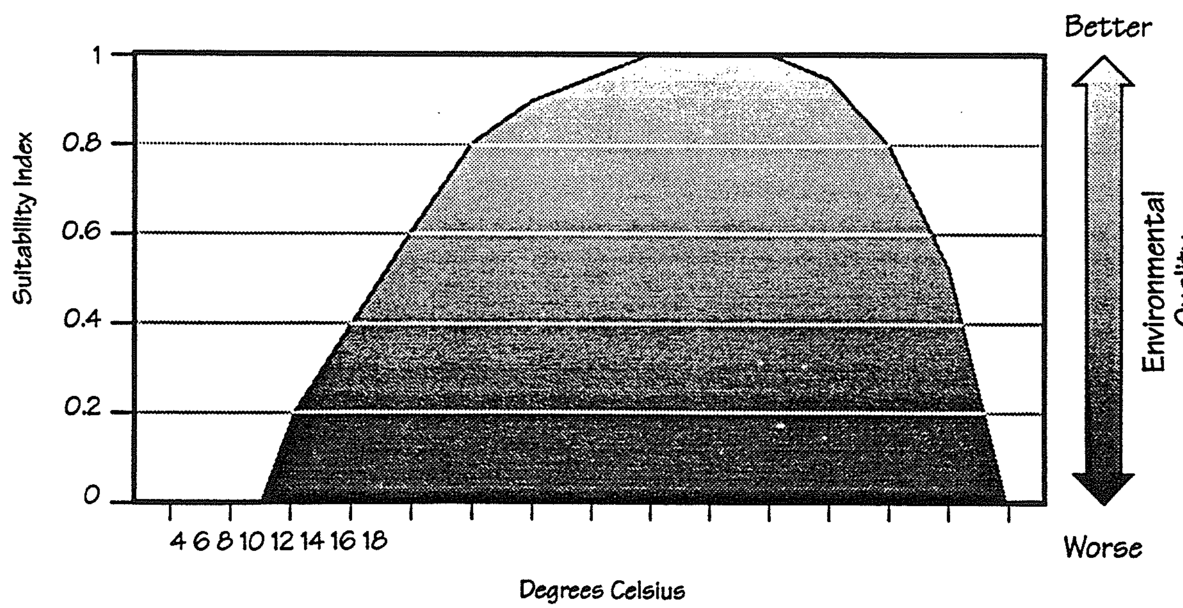
(HSI) method. A modification of the HSI method was used by Ellis Ecological Services, the fisheries consultant for the RMP, to analyze conditions for steelhead trout, coho salmon and chinook salmon in Johnson Creek and its tributaries. The analysis is summarized below. It is described in full in Technical Memorandum No. 16.

The HSI method depends on a thorough understanding of the environmental conditions suitable for fish during different stages of their lives. Habitat suitability indices have been developed by the Fish and Wildlife Service for each salmon and steelhead life stage and each environmental characteristic. The indices are based on many years of field and laboratory studies. A typical habitat suitability index is shown in Figure 36. The figure shows the habitat suitability index for water temperature during upstream migration of steelhead. It indicates that the ideal water temperature is between 12°C and 14°C; ideal conditions correspond to a suitability index of 1. If water temperature is less than 12° or greater than 14°, conditions for migrating steelhead are less-than-ideal and the suitability index drops below 1. Index values below 0.3 indicate very unfavorable conditions for fish.

Habitat suitability indices have been developed for a number of environmental factors known to influence salmonids. The factors include water temperature, dissolved oxygen content, depth of flow in the main channel, velocity of flow, extent of shading of the water surface, composition of the bottom of the channel, the ratio of pools to riffles, the size of pools and the availability of food. Ellis Ecological Services obtained information on each of the environmental factors for Johnson Creek and compared then to the habitat suitability indices. The results are summarized in Figure 37, which compares the number of limiting

FIG 36

Habitat Suitability Index - Maximum Temperature During Upstream Migration of Steelhead Trout

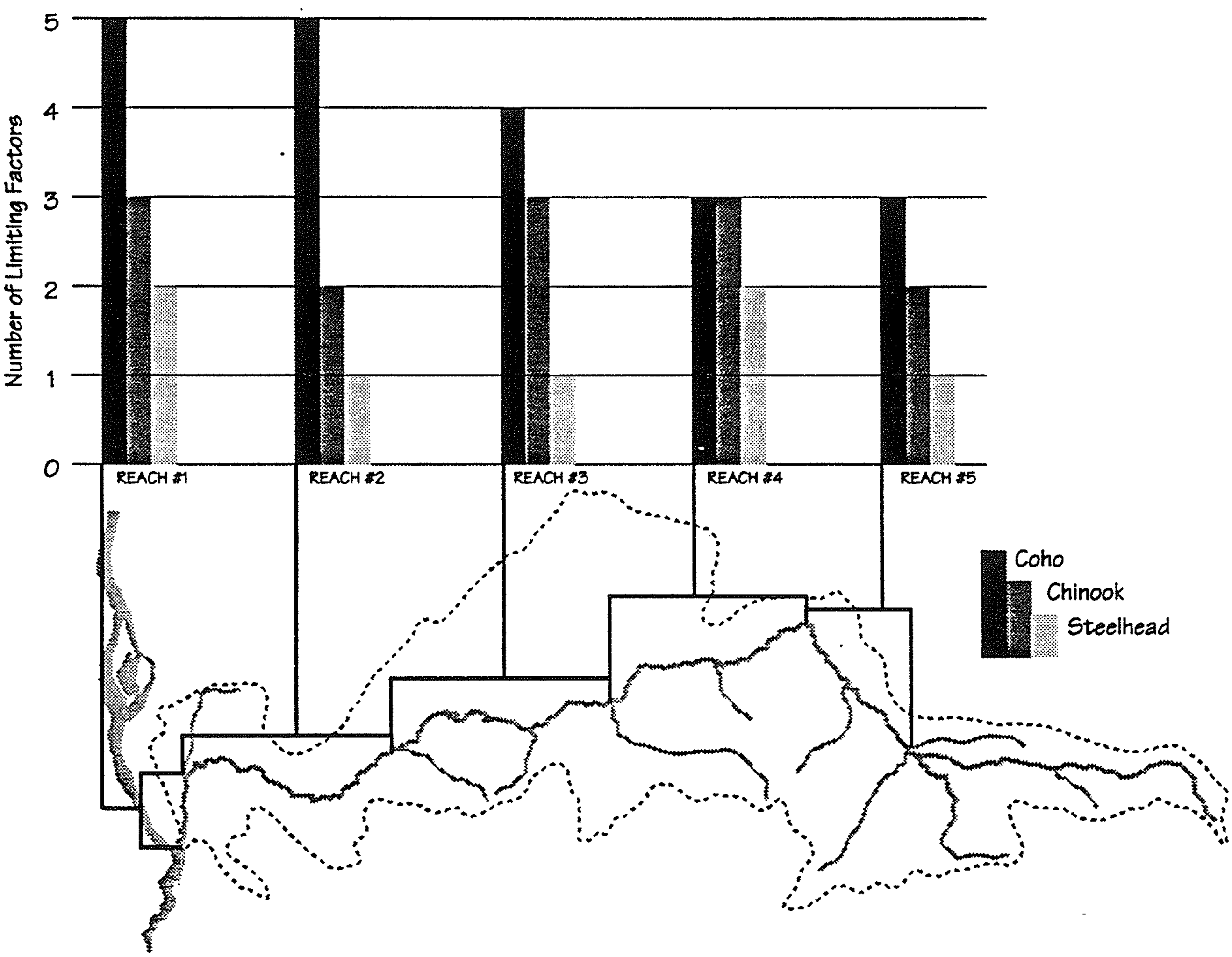


factors for each species for five reaches of the stream. Reach 1 extends from the mouth of Johnson Creek to the confluence with Crystal Springs Creek. Reach 2 extends from Crystal Springs Creek to the Johnson Creek/Veteran's Creek confluence near S.E. 96th Avenue. Reach 3 extends from Veteran's Creek to the Johnson Creek/Kelley Creek confluence. Reach 4 extends from Kelley Creek to the Main City Park in Gresham. Reach 5 extends from the park to the Johnson Creek/Sunshine Creek confluence.

It is apparent from Figure 37 that current conditions in Johnson Creek are considerably more favorable for steelhead trout than for coho salmon. Habitat suitability for chinook salmon is intermediate between that for steelhead and coho salmon. Limiting factors for each species are described below.

FIG 37

Limiting Factors for Salmonids



STEELHEAD TROUT

Juvenile steelhead were collected in the 1992 surveys in Reaches 1, 2 and 3 and in Crystal Springs and Kelley Creek. Several sightings of adult steelhead in the vicinity of Gresham (Reach 5) have been reported in the last 15 years.

Low flow conditions in the summer and fall are a major limiting factor for steelhead, except in Reach 1 below the Crystal Springs confluence. Crystal Springs Creek, as its name suggests, is fed by springs and has a fairly constant year-round flow of about 18 cubic feet per second. Although steelhead habitat is considerably less than optimum in Reach 1, juveniles are more abundant in this reach than elsewhere in the watershed. Unfavorable factors for steelhead in Reach 1 include lack of pool habitat, instream cover, spawning substrate and riparian shading and high water temperature during smolt development. The physical habitat limitations are probably more important than the somewhat elevated temperatures during the smolt development period.

If summer low flow conditions can be improved, Reach 2 has potential as steelhead habitat because it has gravel areas suitable for spawning and some summertime inflow from springs. Reach 5 has good riparian cover in most areas and better instream cover than most other reaches. It suffers from high fines content in the substrate that may make it unsatisfactory for spawning and has a low density of food organisms. It is not known why food organisms are scarce in this reach but it could be related to pesticide residues in the sediments. The pesticide residues probably originate in runoff from the agricultural areas in the upper watershed.

Reach 3 has a relatively shallow gradient, and slow-moving water and depressed dissolved oxygen levels in the summer and fall. Reach 4 suffers from the same limitations but, in addition, the pool to riffle ratio is excessive.

CHINOOK SALMON

One juvenile chinook salmon was collected from Reach 1 during the 1992 surveys and several juveniles were collected from a short reach of Crystal Springs Creek in 1993. No other recent sightings of chinook have been reported. Because chinook salmon had not been stocked in the creek prior to the surveys, the juvenile fish are assumed to have been produced by naturally spawning adults.

Low flow upstream of the Johnson Creek/Crystal Springs Creek confluence is a major limiting factor for fall chinook. During most years, low flows prevail on the mainstem of Johnson Creek throughout the normal spawning period for fall chinook salmon. The combination of low flow and beaver dams usually prevent chinook from migrating up Johnson Creek beyond the confluence with Crystal Springs. In addition, fall chinook show a preference for spawning and rearing in large streams, and would likely only use the lower reaches of small streams like Johnson Creek. Thus, it is doubtful whether chinook would use the upper reaches of Johnson Creek even if access was no longer denied.

A limiting factor for chinook throughout the stream is the ratio of peak stream flow to average stream flow. Large peak flows in the winter coincide with the residence period for chinook embryos which are vulnerable to bottom scouring and washout.

■ COHO SALMON

One juvenile coho salmon was collected during the 1993 surveys just downstream of Gresham. No stocking of coho salmon has taken place in the upper watershed so it appears some natural reproduction is occurring. Several adult coho salmon were observed in Crystal Springs Creek in October 1993 and juveniles were collected in the 1992 and 1993 surveys. Coho salmon have been routinely stocked in Crystal Springs Creek since the early 1980s. Stocking is probably the source of the fish observed in 1992 and 1993.

A relatively large number of factors limit the success of coho salmon in Johnson Creek. High summer water temperature is a major limiting factor in all five reaches of the creek. Average maximum temperatures are at least 5°C above acceptable summer rearing temperatures in all reaches.

Limiting factors for coho salmon decrease in an upstream direction. This is not surprising in that coho salmon prefer to spawn and rear in smaller headwater streams. Considering the number of limiting factors, it is very doubtful that the lower reaches of Johnson Creek can ever be made suitable for coho rearing. Reach 5 is the only mainstem reach with potential to support juvenile coho salmon. If coho salmon runs are to be developed in the Johnson Creek watershed, rearing habitat will have to be provided in off-channel spring-fed ponds, small headwater streams or within the cooler waters of Crystal Springs Creek.

■ CUTTHROAT TROUT

Limiting factor analyses were not conducted for cutthroat trout. However, a number of probable limiting factors were identified based on the habitat information developed for the various reaches of Johnson Creek and published habitat requirements of cutthroat trout. Lack of cover in the form of overhanging banks, root wads, logs, debris jams and other instream structure can be a limiting factor for adult cutthroat trout. Such cover is in short supply throughout much of the mainstem of Johnson Creek and may limit the carrying capacity for adult fish. High summer water temperature is another factor that could potentially limit the abundance of cutthroat trout. Habitat suitability for cutthroat trout drops off sharply at water temperatures above about 18°C. Water temperatures throughout most of mainstem Johnson Creek often exceed 18°C during the summer. Since cutthroat trout spawn during the winter, water temperature during incubation is probably not a problem. However, the condition of the spawning substrate could be limiting in many of the headwater tributaries. Heavy siltation of the beds of many of the Johnson Creek tributaries has been observed. Silt deposits on spawning gravel limit water circulation around incubating embryos, which results in insufficient oxygen supply and poor survival. Access to spawning habitat could also be a potential limiting factor for cutthroat trout, particularly the sea-run form. Many of the small headwater tributaries that contain spawning habitat are inaccessible to upstream migrating adults due to dams and improperly-designed culverts. Barriers to upstream migration in small headwater streams could also be a limiting factor during the summer. Cutthroat trout in other streams have been observed to seek out cooler tributary streams when their resident stream becomes too warm. If barriers exist on some of the cool tributary streams to Johnson Creek, trout residing in Johnson Creek may be unable to find areas of refuge from the high summer temperatures. Comprehensive surveys of migration barriers on tributaries to Johnson Creek have not been conducted.

FISHERY ENHANCEMENT STRATEGY

One of goals established by the JCCC is to restore and maintain a salmonid fishery in Johnson Creek. The JCCC, in agreement with the views of the Oregon Department of Fish and Wildlife and Oregon Trout, believes that long-term artificial propagation of fish is undesirable, and that the goal of the RMP should be the restoration of wild, native salmonid fish stocks. The overall strategy for fishery restoration is to take those actions that will restore and enhance native salmonid runs in Johnson Creek as rapidly, efficiently and inexpensively as possible.

Native wild fish, by definition, are direct descendants of populations that were indigenous to Johnson Creek, prior to settlement of Oregon by non-native Americans and Europeans. The Oregon Department of Fish and Wildlife is in the process of developing a management plan for Johnson Creek fisheries that will focus on re-establishment of native fish stocks. However, no information regarding the genetic composition of existing salmonid populations in Johnson Creek has been developed. Due to the close proximity of Johnson Creek to the migratory pathways of relatively large runs of salmon and steelhead to the Clackamas and Willamette River systems, straying of returning adults from these runs probably contributes significantly to the existing Johnson Creek salmon and steelhead runs. Johnson Creek also has been stocked over the years with hatchery strains of coho, fall chinook salmon, and steelhead trout. The wild (naturally-spawning) fish presently in the system could be the progeny of native fish, or the progeny of hatchery-reared fish, or hybrids. Additional studies are proposed to determine the relative contribution of hatchery-reared fish to the remaining Johnson Creek salmonid populations and to begin to determine whether any remnants of the native stocks of anadromous salmonids still remain in the creek. Once this information is developed, it will be possible to determine whether to build on existing stocks or whether closely related native stocks from nearby systems (e.g., the native population of late spawning coho salmon in the Clackamas River) can be used for re-establishment of the anadromous salmonid runs.

Re-establishment of native salmonid runs in Johnson Creek and its tributaries will not be feasible without a substantial improvement in existing habitat conditions. Consequently, the JCCC seeks to re-establish and maintain high-quality aquatic habitat that will support naturally-reproducing salmonid populations. Salmonids tend to be more sensitive to environmental change than many fish species and are a good indicator of overall environmental health. In general, restoration of conditions that will support anadromous salmonids also will create habitat for native resident fish species. The focus on salmonid habitat is consistent with the expressed interests of the community and reflects the importance of salmon in the culture of the Pacific Northwest.

As noted earlier, existing conditions are more favorable to steelhead than to the two salmon species; and more favorable to chinook than to coho salmon. Thus, the priorities for restoration should be first, steelhead trout; second, chinook salmon; and third, coho salmon. This does not imply that the habitat rehabilitation program should focus on one species at a time. Rather it simply indicates which species are most likely to respond positively to the fewest number of habitat improvements.

The overall strategy for fish habitat restoration has three major components. The first component involves gradually restoring the creek to a more natural, salmonid-friendly condition. Improvements of this sort will take many years and can only be expected to improve the salmonid populations in the long term. The second component of the strategy is to make some immediate physical improvements to fish habitat which will produce benefits within a year or two. The third component involves taking advantage of any opportunities for habitat improvements that arise as a result of streamside construction or other activities unrelated to the RMP. Each component of the fish habitat enhancement strategy are discussed below.

■ LONG-TERM IMPROVEMENTS TO FISH HABITAT

In the long term, the best way to improve the creek for salmonids is to return the creek to as natural a condition as is possible in an urban or urbanizing environment. This can be accomplished by revegetating the riparian corridor, by controlling water pollution and excessive soil erosion, by maintaining a minimum flow in the low flow months and by allowing the creek some freedom to move within its banks. Revegetation of the riparian corridor, discussed at length earlier, would benefit fish by increasing shading and decreasing water temperature. The mature riparian forest would also supply the stream with woody debris, providing cover for fish. Revegetation of the creek corridor is addressed in Objective FW-1.

The continued existence of fish, including salmonids, in Johnson Creek reflect that water pollution has been controlled to some degree. The pollution prevention element of this plan seeks to further reduce sources of pollutants entering the creek. Of particular concern from a fisheries point-of-view is the need to control the discharge of fine sediment to the creek. Excess fine sediment covers spawning gravels and makes them inaccessible to fish. Creek bottom materials in the upper reaches of the watershed contain a high percentage of fine sediment, which probably reaches the creek in runoff from agricultural areas. Under predevelopment conditions, the native forest largely held the soil in place. Now much of the vegetation has gone and the surface of the soil is disturbed frequently, making it very vulnerable to erosion. Objective PP-3 addresses the control of pollution from agricultural lands.

Low flow during the late summer and early fall is a critical limiting factor for fisheries. Low summer flow is caused by diversions from the stream for irrigation and alterations in watershed hydrology attributable to development. Before development a greater proportion of rainfall percolated into the ground than it does today. Summertime flow is sustained by groundwater. Objective FW-3 addresses the need to maintain a minimum flow in the creek year-round in order to support aquatic life.

Much of Johnson Creek is confined within a rock-lined channel. This prevents the creek from evolving naturally, eroding banks, building bars and altering its course over the years. The lack of a natural, dynamic stream channel reduces the diversity of habitats for fish and fish food organisms. Allowing the creek a degree of freedom to move within its flood plain would benefit the fishery. Objective FW-4 addresses this issue.

Although the RMP seeks to make Johnson Creek function more naturally than it does today, it would be unrealistic to expect that it can be returned to its predevelopment state. The creek will remain largely an urban waterway; compromises will always have to be struck between the desire for a natural channel and the need to minimize flood hazard. As a result of these compromises, Johnson Creek will have to be actively managed. Natural forces cannot be allowed to take their course unhindered. Intervention is necessary to prevent flooding and some of the actions taken will be deleterious to fish and wildlife. Compensatory management actions will be needed to tilt the scale back in favor of fish and wildlife. Unlike a stream in an undeveloped watershed that creates fish habitat as it evolves, Johnson Creek will have to be actively managed to create and maintain fish habitat.

■ SHORT-TERM IMPROVEMENTS TO FISH HABITATS

A number of actions can be taken that will improve fish habitat immediately. In Reach 1 the lack of deep pool habitat, in-stream cover and suitable spawning gravel is a limiting factor for steelhead and chinook. Pools can be created artificially using a number of different techniques. Instream cover can be increased by adding large rocks and secured logs to the stream channel. The increased channel complexity produced in this way will naturally result in improved retention of gravel suitable for spawning. Gravel recruitment can be further increased by directly adding suitable gravel in strategic locations.

In Reach 2, lack of pool habitat and suitable spawning gravels are limiting factors for steelhead. Pools could be created artificially in this reach. Gravel accumulation could be accelerated by removing the rock walls on the outside of bends. This would allow gravel bearing strata to be eroded naturally. Obviously this approach would only be applicable where bank erosion poses no hazard. Alternatively suitable gravel could be added directly to the stream channel. Steelhead success in Reach 2 is also limited by summer low flow. Some habitat improvement might be obtained by artificially creating meanders in the low flow channel. The meanders would lengthen the channel and deepen it by concentrating flow rather than spreading it across the entire channel. These improvements could also allow chinook salmon to better access the lower part of Reach 2.

Options for coho salmon habitat enhancement include improvement of winter refuge habitat and creation of off-stream rearing ponds. Reach 5 offers the best opportunity for development of alcoves and protected side channels for winter refuge. Sections of Reach 5 have a relatively broad, well forested flood plain, where high quality off-stream refuge habitat could be constructed. Reach 5 is also a preferred reach because it is the closest mainstem reach to the headwater tributaries where most of the coho salmon spawning and rearing habitat is located. Juvenile fish moving downstream out of the headwater streams could readily find refuge areas along Reach 5. Opportunities for development of refuge habitat in reaches further downstream may also exist, particularly in relatively undeveloped Reach 2.

Construction of off-stream rearing ponds for year-round rearing of juvenile coho may be possible at a few locations in the Johnson Creek watershed. These ponds would be constructed along small spring-fed tributaries with sufficient flow to maintain cool water conditions throughout the summer. The ponds would be located close to potential spawning areas so that small juvenile fish, in their first summer of life, would be able to access the ponds. The ponds would substantially increase rearing habitat for coho in the watershed. Water temperature and flow in the spring-fed tributaries are more suitable for year-round rearing than in the mainstem of Johnson Creek.

The best opportunity for improving runs of coho salmon in the Johnson Creek watershed is habitat enhancement in Crystal Springs Creek. Crystal Springs Creek has a constant flow of cool spring water and has consistently supported a small run of coho salmon for several years. This is despite the fact that fish habitat is severely degraded. The section of Crystal Springs Creek that flows through the Eastmoreland Golf Course is wide and straight and its bed is laden with silt. Reconstruction of the channel in this area would provide habitat for coho and steelhead. The channel could be narrowed and a number of tight meanders constructed to create a diversity of pool and riffle habitat. The new channel configuration should allow gravel beds to be kept free of silt naturally, although it may be desirable to mechanically remove already-accumulated silt from this reach of Crystal Springs Creek when the channel modifications are made.

Many of the enhancements described above will also benefit cutthroat trout. Removal of barriers to upstream migration in the small tributary streams is probably the best short-term habitat improvement that could be provided for cutthroat trout.

■ SUPPLEMENTARY FISH HABITAT IMPROVEMENT OPPORTUNITIES

As development along streams continues, opportunities to include fish habitat improvements as part of development should be taken. In some cases where public or private developments encroach on the stream corridor mitigation measures may be necessary. Potential mitigation measures might include construction of side channels for juvenile fish rearing or in-stream structural improvements. Opportunities of this kind will be identified as part of the WMO's review of development proposals (Action WS-3-3).

Citizen interest in fishery restoration is high. Individuals or groups should be encouraged to undertake small-scale habitat improvement projects throughout the creek. Some projects could serve as educational tools or demonstrations of new techniques. These types of citizen-initiated projects should be coordinated with other fish habitat improvements occurring in the watershed (see Action FW-2-1).

PLAN OBJECTIVES AND ACTIONS

Objectives and actions, most of which are associated with short-term improvements to fish habitat, are shown in Table 22. Recommended short-and long-term improvements are listed, by reach, in Table 23.

OBJECTIVE FW-4.
Improve Habitat to Foster the Reestablishment of Self-sustaining Native Salmonids and other Desirable Fish Stocks.

Successful reestablishment of naturally-reproducing wild salmonid populations in Johnson Creek will require the implementation of a carefully designed management plan coupled with both short-term and long-term habitat enhancement programs. Oregon Department of Fish and Wildlife has the responsibility for development of the management plan. Development of the plan is underway, but new information is needed regarding the present composition (wild versus hatchery-reared) of the remnant salmonid runs before it can be completed.

As noted above fish habitat restoration has long-term and short-term components. The long-term components are intended to gradually recreate a stream environment that is well-suited to native salmonid fish over a period of 5 to 50 years. Objectives FW-1, FW-3 and FW-4 and many of the actions in the other plan elements are designed to bring about such a result. The actions included under this objective, Objective FW-2, are designed to produce an immediate improvement in fish habitat (that is, within 5 years), and to obtain the information necessary to complete a plan for restoration of native fish stocks.

Action FW-4-1.
Complete fisheries management plan for Johnson Creek.

The Oregon Department of Fish and Wildlife is responsible for developing a fisheries management plan for Johnson Creek. It will address artificial propagation and angling regulations. Information gathered under Actions FW-2-5 and FW-2-6 will provide the basis for plan development with respect to reestablishment of a native salmonid fishery.

Action FW-4-2.
Develop off-channel rearing ponds and refugia for coho salmon and other fish.

The limiting factor analysis for anadromous salmonids (Technical Memorandum No. 16) revealed that summer water temperature conditions in mainstem Johnson Creek are well above the levels considered suitable for rearing of juvenile coho salmon. Headwater tributaries and spring fed pond habitats are the only areas in the watershed where suitable rearing temperature conditions are presently found. Most of the headwater tributaries suffer from moderate to severe sediment deposition, low summer flow and from a general lack of overwintering habitat (deep pools or off-channel backwater areas). Improvement of rearing conditions in the tributary streams will be a

TABLE 22
Fish Habitat Enhancement Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective FW-4. Restore Salmonid Fish Habitat (JCCC Goals 2 and 4)				
Action FW-4-1. Complete fisheries management plan	Oregon Department of Fish & Wildlife	Already budgeted	0	A
Action FW-4-2. Develop off-stream rearing ponds and refugia for coho salmon	City of Portland and private landowners	$100,000 (one-time cost)	$100,000 (one-time cost)	B
Action FW-4-3. Construct in-stream habitat improvements[1]	Cities, Counties, WMO, Volunteers	$140,000 (one-time cost)	$140,000 (one-time cost)	A
Action FW-4-4. Construct a trap for upstream migrating salmonids	Volunteers/Oregon Dept of Fish & Wildlife	$5,000 (one-time cost)	$5,000 (one-time cost)	A
Action FW-4-5. Construct a trap for downstream migrating salmonids	Volunteers/Oregon Department of Fish and Wildlife	$5,000 (one-time cost)	$5,000 (one-time cost)	B
Action FW-4-6. Protect habitat for cutthroat trout	WMO	Included in WS-1-4	0	B
Objective FW-5. Maintain a Minimum In-Stream Flow (JCCC Goals 2 and 4)				
Action FW-5-1. Update information on water rights and active diversions	WMO/Oregon Water Resources Department	$25,000 (one-time cost)	$25,000 (one-time cost)	A
Action FW-5-2. Eliminate illegal diversions	Oregon Water Resources Department	$20,000 (one-time cost)	$20,000 (one-time cost)	A
Action FW-5-3. Establish and obtain rights to minimum in-stream flow	Oregon Departments of Water Resources and Fish and Wildlife	Not estimated	Not estimated	A
Action FW-5-4. Obtain water to meet in-stream flow[2]	WMO	$25,000 (one-time cost)	$25,000 (one-time cost)	A
Action FW-5-5. Investigate potential sources of supplemental water	WMO	$25,000 (one-time cost)	$25,000 (one-time cost)	B
Objective FW-6. Protect and Restore Natural Stream Processes				
Action FW-6-1. Promote low environmental impact road crossing[3]	Cities and Counties	Not estimated	Not estimated	B

NOTE:

1 Related actions: FW-2-1 and FW-2-2.
2 Estimate only includes investigation cost
3 Minor costs would be associated with environmental features

TABLE 23
Fish Habitat Improvements by Streams Reach

Reach	Short-term Improvements	Long-term Improvements
1	In-stream structure, creek clean-up	Riparian corridor revegetation
2	Off-stream refugia, clean-up	Riparian corridor revegetation, control of urban runoff
3	Creek clean-up	Riparian corridor revegetation, natural channel formation, control of urban runoff
4	Creek clean-up	Riparian corridor revegetation, natural channel formation, control of urban runoff
5	Off-stream refugia	Riparian corridor revegetation, control of siltation
Crystal Springs Creek	In-stream structure, creek clean-up	Riparian corridor revegetation
Other Tributaries	Removal of barriers to fish movement	Riparian corridor revegetation, control of siltation

long-term process that will require control of sediment input, bank stabilization, improved summer flow conditions and enhancement of the riparian vegetation corridors.

In the interim, opportunities for production of coho salmon will be limited to a few locations where the juveniles can utilize spring-fed pond environments for year-round rearing. Coho salmon planted in appropriate pond environments in other areas have been shown to grow rapidly and have relatively high survival in comparison to those stocked into stream environments. Our surveys of the Johnson Creek watershed indicate that a few existing ponds and several pond sites could be developed for year-round rearing of juvenile coho salmon. However, because the RMP goal is a self-sustaining native fishery, only those pond sites which can be used by naturally produced coho will be developed. Consequently, the proximity of existing or potential spawning habitat will be a criterion for pond development. The off-stream rearing ponds will need to be connected to the creek by unobstructed outlet channels. There will need to be sufficient flow in the outlet channel to allow juvenile fish access to the ponds year-round. Initially, some artificial propagation probably will be required to establish runs to these sites. Any such stocking will be conducted in accordance with the long-term goal of re-establishing native fish runs.

The criteria for an appropriate rearing pond environment include: (1) perennial springwater input in sufficient volume to maintain summer water temperatures below 18°C and preferably below 15°C, (2) dissolved oxygen concentrations near saturation, (3) absence of other fish predators and/or competitors, (4) an abundant natural food supply, and (5) cover. A few existing spring-fed ponds, where temperature conditions may be satisfactory for annual rearing of coho salmon juveniles, have been identified in the upper watershed. Other suitable ponds may be present in the watershed, but have not yet been identified. Most of these ponds are on private property and will require landowner cooperation for their use. Some of the ponds would require modifications to their outlets to allow juvenile coho access and egress. Temporary draining of some ponds may be necessary to remove unwanted fish species, to remove accumulations of sediment or to allow excavation for additional depth. Enhancement of cover conditions also would be necessary in most of the ponds. Figure 38 shows a cross-section of a coho rearing pond with the physical features recommended for food production and protection from predators.

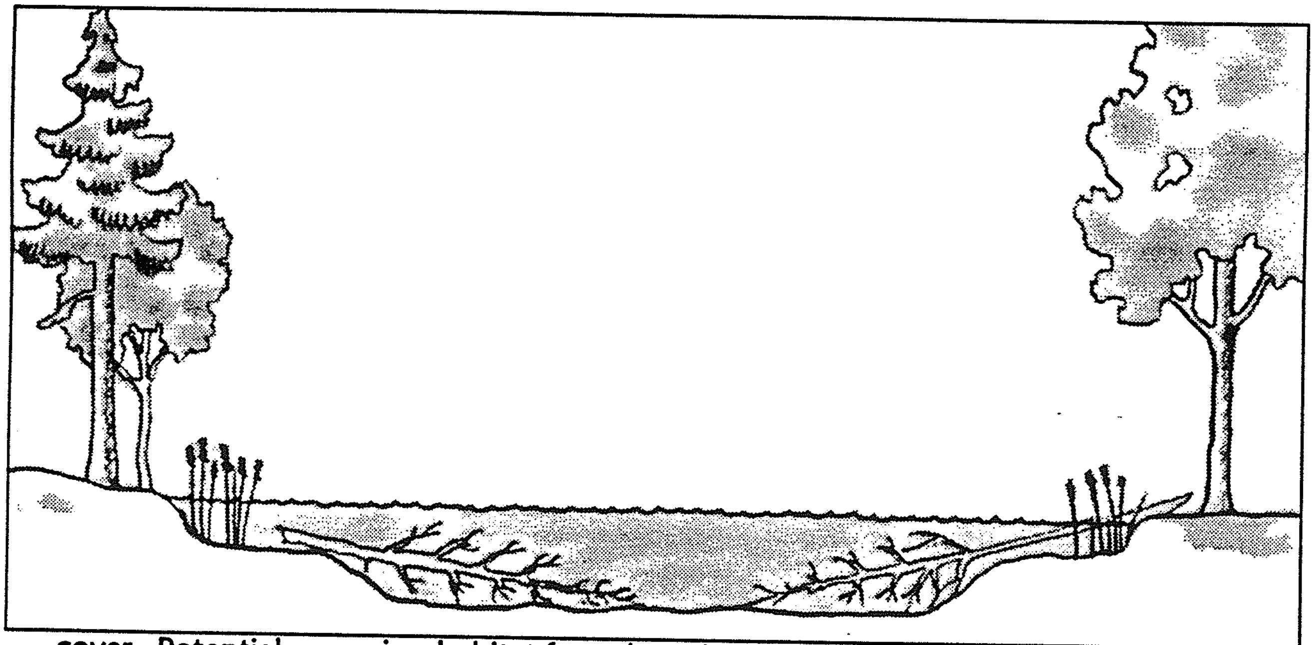
The most promising known sites for coho rearing are in the upper watershed, although there may be additional as-yet-unidentified sites further downstream. Several downstream pond sites in the vicinity of Tideman-Johnson Park were considered, but, while they may be suitable for coho rearing, they lack adjacent spawning habitat, and thus could not support a self-sustaining run of fish.

Two of the sites considered could be developed as refuges for fish, amphibians and other life forms that prefer the kind of quiet backwaters that are rare along Johnson Creek. One of the sites is located on undeveloped publicly-owned land, just upstream of Tideman-Johnson Park. A series of small, interconnected ponds similar to Figure 38 would be excavated and connected to the creek by a channel allowing fish movement year-round. The water table at this location is at the surface and a number of springs and seeps enter the area from higher ground to the north. It is likely that sufficient groundwater flow would be intercepted by the ponds to keep the ponds cool and to provide a small outflow to smolts to Johnson Creek. It is noteworthy that the site is located in an area of the Springwater Trail corridor that has a variety of interest points for visitors (e.g., WPA fish ladder and rock work, Springwater trail head, etc.). The development of a fish refuge area would be an additional point of interest (see Figure 45). The other site lies south of Tideman-Johnson Park on property owned by a JCCC member willing to devote a portion of the site to a pond or fish refuge area.

In addition to off-stream pond development, Crystal Springs Lake, adjacent to the Eastmoreland Golf Course, is being considered for coho rearing. Crystal Springs Lake receives a large input of spring water and may be cool enough (at least in the immediate area of the spring inputs) to support coho juveniles throughout the year. Temperature data are not available for Crystal Springs Lake and would be collected prior to any attempt to establish rearing in the lake. Crystal Springs Lake is shallow and presently has little cover that would allow juvenile coho to escape predators, such as fish eating ducks, blue heron, and kingfisher. Underwater brush piles and/or trees with branches would need to be placed at various locations throughout the lake to provide

FIG 38

Cross Section of Typical Coho Rearing Pond



cover. Potential spawning habitat for coho salmon is available where the springs enter the lake. Currently, movement of fish in and out of the lake is blocked by a small dam at the lake outlet. A short fish ladder at the outlet would permit access and possibly allow the establishment of a naturally reproducing run of coho salmon. Reed Lake, on the Reed College campus, is spring-fed and also may have potential as coho rearing habitat, if water temperatures are suitable and access problems can be solved.

Action FW-4-3.

Construct in-stream habitat improvements.

In addition to the off-channel ponds discussed in FW-4-2, the limiting factor analysis (Technical Memorandum No. 16) indicated that Reach 1 (lower mile of Johnson Creek) and sections of Crystal Springs Creek could benefit in the near-term from instream habitat enhancement. The other reaches of mainstem Johnson Creek suffer from problems associated with low summer flows, high water temperatures and excessive sediment inputs that should be controlled before extensive instream habitat enhancement is considered.

REACH 1 OF JOHNSON CREEK.

In Reach 1, quality of pool habitat and high water temperatures during smolt development were identified as limiting factors. Most of the pool habitat in Reach 1 is shallow and contains little cover. This condition is largely due to the channel straightening and bank rocking done during the 1930s by the WPA as a flood control measure. The lower end of Johnson Creek historically meandered over a wide flood plain and undoubtedly had a much more complex channel structure. Re-establishment of some of the complex habitat structure needed to support anadromous salmonids can be accomplished through the use a variety of in-channel habitat structures that are designed to modify the low flow channel characteristics. In designing the instream habitat enhancements a balance had to be achieved between optimization of fish habitat and flood control. Therefore, the intensity of habitat enhancement proposed is lower than would be recommended, if flooding was not a concern.

A variety of in-stream structures are recommended to create additional pool habitat and increase channel complexity. All of the structures recommended are low in profile and are designed to minimize the accumulation of debris that could increase the chance of flooding. The structures include the following:

- Rock single-wing deflectors
- Rock double-wing deflectors
- Digger logs
- Boulder/root wad combinations
- Boulder clusters
- Single boulder placements

Preliminary selection of locations for these structures was accomplished by walking Reach 1 and noting areas that appeared to be appropriate for each treatment. Before the final location of the enhancement structures is determined, additional survey work will be required to evaluate their potential effects on flood sensitive areas, potential impacts on stream bank stability and access for heavy equipment. A general description of each of the improvements and their purpose is provided below. Locations of improvements in Reach 1 are shown in Table 24.

TABLE 24
Location of Fish Habitat Improvements in Reach 1

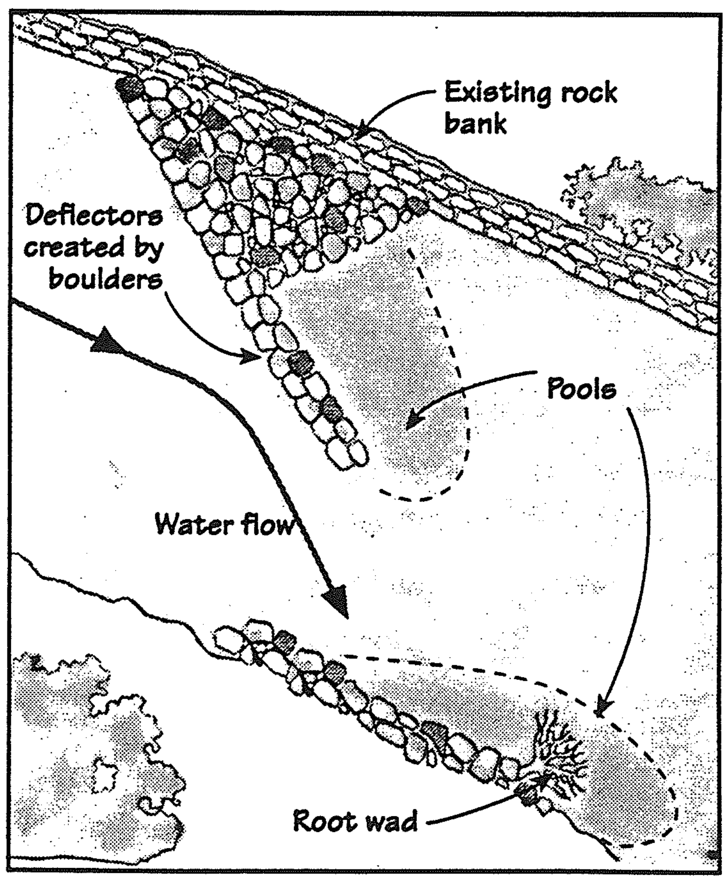
Type of Improvement	No.	Location (River Miles)
Single-wing flow deflectors	24	0.20, 0.29, 0.31, 0.32, 0.50, 0.53, 0.61, 0.62, 0.63, 0.67, 0.70, 0.76, 0.79, 0.,82, 0.91, 0.93, 0.95, 0.96, 0.98, 1.00, 1.09, 1.13, 1.23, 1.24
Double-wing flow deflectors	2	0.59, 0.84
Digger log	3	0.38, 0.55, 0.87

Flow deflectors (Figure 39) are recommended to create a meandering flow pattern in the low flow channel. Pools are created where the deflected water strikes the opposite bank and to some extent on the downstream side of the deflector. Through the use of a series of deflectors the low flow channel can be forced to meander back and forth across the straightened existing channel, creating a series of riffles, runs and pools where only shallow riffle and run habitat presently exists. Deflectors also tend to trap gravel and increase the amount of spawning substrate. Both rock and log deflectors have been used in stream habitat enhancement work. However, minimizing the use of logs for enhancement of Reach 1 is recommended due to the concern for potential wash out of the structures and the effect a resulting log jam could have on flooding.

Rocks used for constructing the upstream edge of a wing deflector should be large enough to protrude 8 to 18 inches above the water surface during low flow conditions. Rocks 18 to 24 inches in diameter with about 1/3 of their diameter keyed into the streambed are recommended for construction of the primary deflector wing. To be effective the deflectors should narrow the low flow channel by as much as 70 to 80 percent. The deflector wing should be placed at an angle of 30° to 35° to the stream bank. The purpose of the deflector is to guide the water rather than block it. It is important to fill the downstream side of the wing deflector with rock as shown in Figure 39. This configuration directs overtopping water away from the bank and reduces the potential for bank erosion at the base of the deflector. Where possible, the single-wing deflectors will be located to direct water toward natural cover such as complex root mats that have developed from trees growing along the low flow stream channel. The force of the water directed toward these areas will cause under cut bank habitat with overhanging roots which can be used as cover by juvenile salmonids.

FIG 39

Single-Wing Deflectors Constructed of Boulders



Where natural cover is not present, large boulders with root wads attached by cable can be placed on the bank opposite the deflector and provide complex habitat similar to natural cover.

In areas of Reach 1 where single-wing deflectors are not appropriate due to concerns for bank erosion or other channel constraints, double-wing deflectors are recommended (Figure 40). Double-wing deflectors concentrate the water in a narrow channel and cause scouring to occur near the downstream apex of the deflector in the center of the stream. Placement of large boulders immediately downstream of a double-wing deflector is recommended to add additional complexity to the channel and to create additional small pools for rearing juvenile salmonids.

Installation of several digger logs is recommended to create additional pool habitat in the alluvial bottom material present throughout most of Reach 1. Digger logs create pools by increasing the water velocity in the area of the log which results in removal of alluvial gravel and rubble deposits underneath and somewhat downstream of the log (Figure 41). A natural digger log, created by the roots and partial trunk of a large fallen tree, is located in the upper end of Reach 1 and has created one of the few deep pools in the reach. Additional digger logs could be established by burying approximately eight to ten feet of an 18-24 inch diameter log into the stream bank and extending the

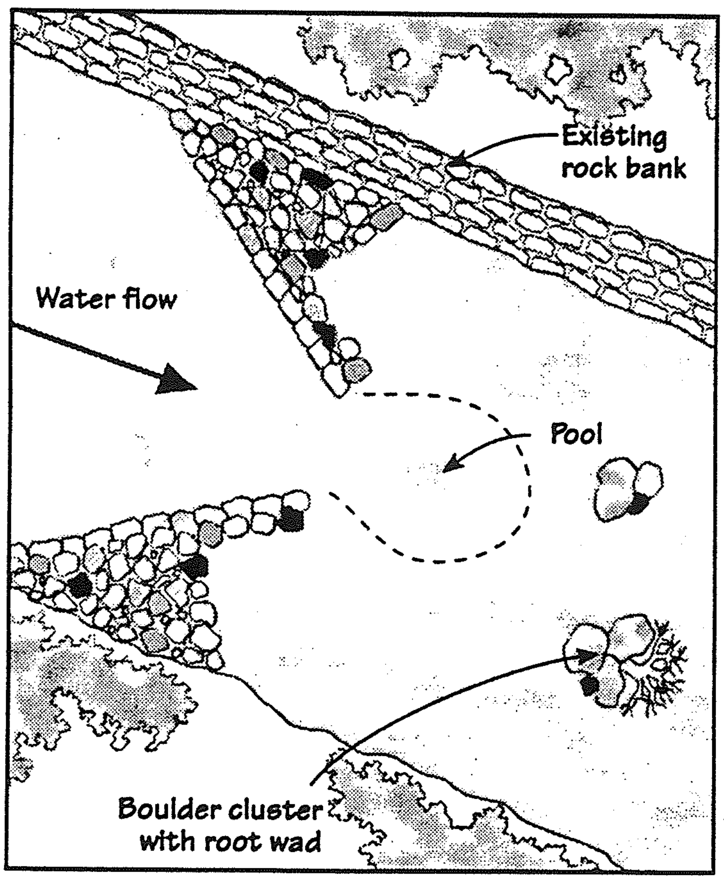
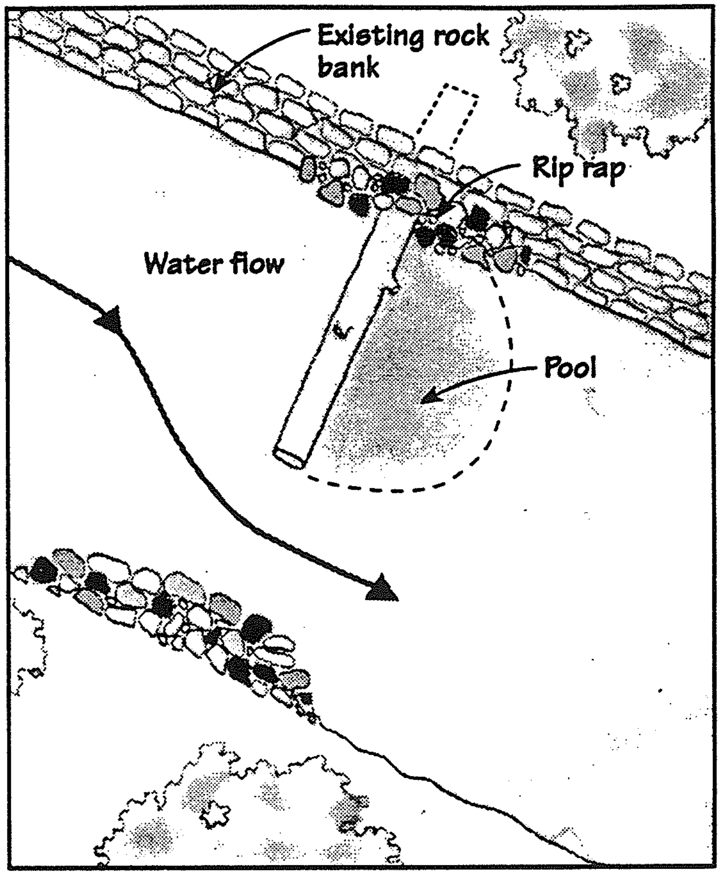


FIG 40

Double-Wing Deflectors Constructed of Boulders

FIG 41

Pool Created by Placement of Digger Log



exposed portion approximately one half the distance across the channel at the level of the substrate surface. These structures work best where the channel is relatively narrow. Placement of several large boulders on the opposite bank would constrict the low flow channel and increase the efficiency of the digger log. As indicated in Figure 41, large rocks should be placed around the log in the area where it enters the bank and the continuity of the existing rock wall should be reestablished above the log to prevent erosion. Digger logs have a low profile in the stream channel and do not accumulate debris that could influence flood capacity of the channel. A fan of gravel suitable for spawning is often created immediately downstream of the pool created a digger log. Three of these structures are recommended for Reach 1.

Placement of large boulders both individually and in clusters is another enhancement technique that is recommended for improving rearing conditions in shallow riffle and run habitats. Boulders provide cover and midchannel feeding areas for juvenile salmonids. The turbulence around boulders creates small pools which provide shelter from high water velocities. Clusters of three large boulders generally provide more structural diversity and cover than single boulder placements. However, both single boulders and boulder clusters can be effective, if properly located in the channel. Boulders 2.5 to 3.5 feet in diameter are recommended for Reach 1. A typical placement pattern, including both clusters and single is boulders, is shown in Figure 43.

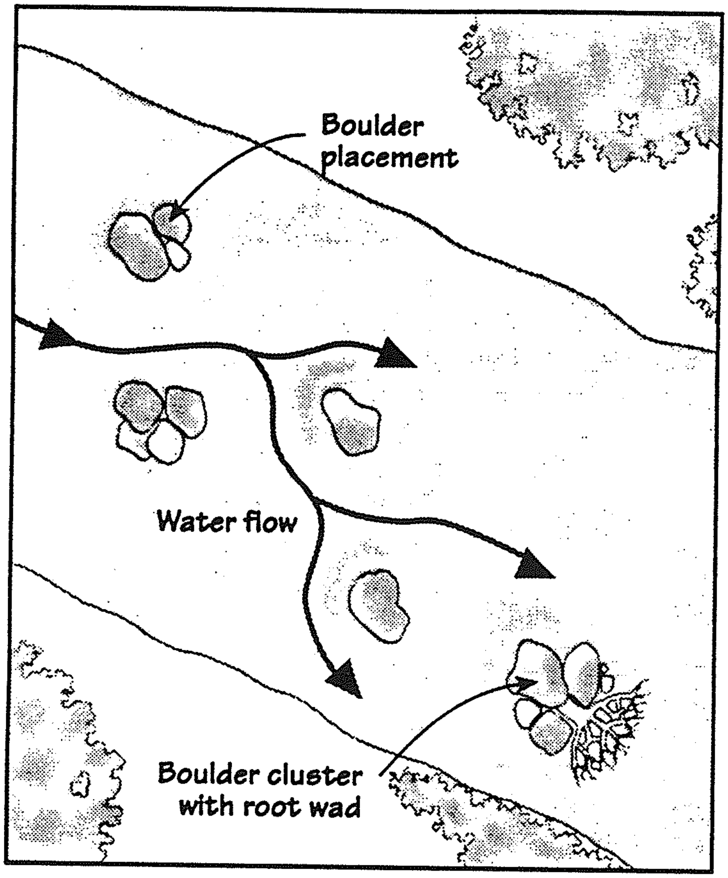


FIG 42
Boulder Clusters

Root wads provide excellent cover for juvenile salmonids and will be used in conjunction with boulder clusters at selected locations in Reach 1 (e.g., Figures 39, 40, and 42). Root wads tend to be scour structures in the channel and keep bed load from accumulating around boulders. However, root wads need to be tightly cabled to boulders to avoid floating up during high flow periods or their effectiveness as cover elements diminishes significantly.

CRYSTAL SPRINGS CREEK
The limiting factors in Crystal Springs Creek appear to be associated with channel straightening and widening that has occurred throughout most of it length. Due to the low gradient and relatively constant flow conditions in Crystal Springs Creek most of the substrate is blanketed with a thick layer of fine silt. Electrofishing surveys indicated that juvenile salmonids were only present in areas where water velocities are sufficient to scour the sediment and expose gravel and rubble substrate. To remove silt accumulations water velocity over the substrate needs to be substantially increased. This can be accomplished by narrowing the stream channel and creating tight meanders that create numerous scour points in the channel. Installation of a series of single-wing rock deflectors (Figure 43) is recommended as the appropriate treatment to create the desired habitat conditions. The best location for such treatment is on the Eastmoreland Golf Course. Because flow conditions are nearly constant year round in Crystal Springs Creek the rock deflectors could be covered with topsoil and revegetated

with shrubs and grasses. Sediment would gradually fill in on the downstream side of the deflectors and also could be revegetated. The end result would be a much narrower meandering stream channel with much improved conditions for steelhead trout and coho salmon rearing and spawning.

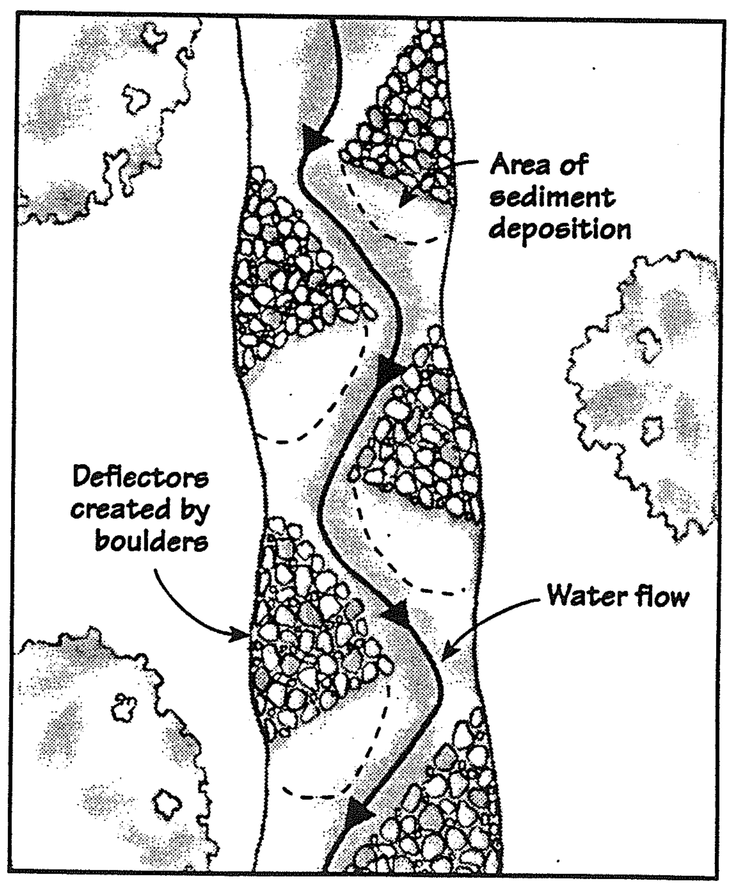
A small pond that has become filled with silt is located just upstream of the enhancement reach on Crystal Springs Creek. Dredging of the pond is recommended prior to installation of habitat enhancement structures. Deepening of the pond will reactivate its sediment trapping capabilities and may provide suitable rearing habitat for juvenile coho salmon.

UPPER WATERSHED

Although conditions for salmonids are poor in the upper watershed, modest measures will be taken to improve habitat for cut-throat trout and other resident fish species. Efforts will focus on restoring and enhancing fish passage into underutilized habitat in tributaries and side channels. Kelley Creek and the North Fork of Johnson Creek offer opportunities for this type of habitat enhancement.

FIG 43

Crystal Springs Creek Improvements



Action FW-4-4

Construct and maintain a trap for upstream migrating adult salmonids in lower Johnson Creek.

Assessment of the relative contribution of wild and hatchery fish to the anadromous salmonid runs in Johnson Creek can be achieved by trapping upstream migrating adults on their spawning runs. From examination of adult fish it is possible to determine whether they have reared in a hatchery or are wild fish that have reared in a natural stream environment. If it is determined that the spawning runs are comprised primarily of wild fish or a mixture of wild and hatchery fish, the trap could be used to collect wild fish for hatchery augmentation (if deemed appropriate by Oregon Department of Fish and Wildlife) and for the selective release of wild fish to upstream spawning areas. If it is found that one or more runs are dominated by hatchery fish, selection of an ecologically suitable donor stock(s) from another nearby watershed would probably be necessary to initiate re-establishment of natural reproduction.

In addition to distinguishing between wild and hatchery fish, an adult trap will also provide information on the timing of upstream migration. Differences in the timing of spawning runs can sometimes be used to separate hatchery stocks from native stocks. For example, there appear to be two distinct runs of adult steelhead in Johnson Creek. The earlier spawning run could represent fish of hatchery origin whereas the late spawning fish could be a remnant of the native steelhead stock.

A trap to capture most of the adult salmonids moving upstream in Johnson Creek, above approximately river mile 2, will be constructed in the existing fish ladder near 45th Street. Except during flood events, all of the salmon and steelhead moving upstream beyond river mile 2 must pass over the fish ladder. Oregon Department of Fish and Wildlife will provide a trap design that has worked effectively in similar locations on other streams. The trap will have a lid that can be locked to prevent unauthorized removal of fish from the trap. Schedules for trap operation and maintenance will be determined by the WMO fisheries subcommittee.

Data collected at the trap will include at least the following: 1) species, 2) presence of fin clips, 3) evidence of dorsal finray deformities indicative of hatchery reared fish, 4) approximate length, 5) sex, 6) stage of maturity, 7) any evidence of disease, 8) scale samples, 9) date and time of observations, and 10) name(s) of data collector. Handling of the fish will be kept to a minimum. All volunteer trap operators will be trained by a Oregon Department of Fish and Wildlife fisheries biologist. Data collected by the operators will be submitted to the WMO fisheries subcommittee for compilation and then forwarded to Oregon Department of Fish and Wildlife for review and analysis.

It is expected that at least three years of trapping will be required to obtain sufficient information on species, numbers of fish, hatchery fish versus wild fish ratios, and run timing to provide meaningful input into the fisheries management plan. Depending on the results of the trapping operations, it may be determined that continuation of trapping will be required for additional years. If volunteer trap operators cannot be recruited, it may be necessary to provide some minimum level of funding to insure that reliable trap operators are available.

Action FW 4-5.

Construct and maintain a trap for downstream migrating salmonids in lower Johnson Creek.

Information on the species, numbers, and timing of downstream migrants in Johnson Creek is needed to assess the status of natural production in the upper watershed. By continuing the downstream trapping program over time an assessment can be made of the effectiveness of upstream habitat improvements and the overall fisheries management plan. A trap for downstream migrating juvenile salmonids will be installed and operated in lower Johnson Creek. The trap will be located at the fish ladder in close proximity to the adult upstream trap. Oregon Department of Fish and Wildlife has a trap design which should work at the fish ladder. The trap will be operated on a set schedule that will allow estimation of total number of downstream migrants. Refinement of the sampling schedule will occur after the first year of operation. A water velocity meter will be installed in the mouth of the downstream trap to allow calculation of volume of water sampled. The volume sampled by the net will be compared with the total stream volume passing the net during the sampling period to estimate the percentage of the stream volume sampled. This value will be used to estimate the total number of downstream migrants passing the sampling location during the sampling interval.

Fish captured in the trap net will be identified by species, enumerated and released to continue their downstream migration. Handling of the fish will be kept to a minimum. The trap operators will be trained by an Oregon Department of Fish and Wildlife fisheries biologist. It is anticipated that the same operators that man the upstream migrant trap will also be responsible for the maintenance and operation of the downstream trap. Data collected by the operators will be submitted to the WMO fisheries subcommittee for compilation and then forwarded to Oregon Department of Fish and Wildlife.

Sampling will be conducted for several consecutive years (at least three) at the beginning of the downstream migration study. After it is determined that an adequate baseline has been established to describe existing conditions, future sampling will occur less frequently, perhaps at 5-year intervals. These latter estimates will be used to document long-term changes in the capacity of the watershed to produce salmon and steelhead smolts.

Action FW-4-6

Protect habitat for cutthroat trout

The measures included in the RMP to improve habitat for migratory fish will also benefit resident fish. Some special measures may be needed, however, to ensure that cutthroat trout populations are maintained at current levels or increased. As a first step, the fisheries subcommittee will devise a method for initially inventorying and then monitoring cutthroat trout populations. Based on the results of monitoring it may be necessary to supplement the RMP by adding actions to specifically protect cutthroat trout.

Objective FW-5.
Maintain a Minimum In-stream Flow.

One of the most severe limiting factors for all salmonid species in Johnson Creek is low stream flow in the mainstem upstream of Crystal Springs Creek in the late summer and early fall. Low flow also degrades water quality. Decreased flows can cause water temperatures to rise and dissolved oxygen levels to fall. Excessive aquatic plant growth may occur in stagnant pools and any spills or pollutant discharges have a disproportionately adverse effect when little dilution is available.
Low summertime flow in Johnson Creek, upstream of Crystal Springs Creek, probably occurred even before development as a result of the occasional extended dry period. The condition has been exacerbated by hydrologic changes in the watershed resulting from development and by diversion of water for irrigation and other purposes. Three possibilities were examined to reverse the decline in summertime flow: alteration of the watershed's hydrologic characteristics, providing a supplementary water source during the summer, and curbing water diversions. Reducing diversions appears to be the most promising.

■ HYDROLOGIC CHANGES

Prior to development the watershed was largely forested. Much precipitation was intercepted by the forest canopy and the carpet of organic matter on the forest floor, and accumulated in small ponds and wetlands. Some of this water was used by the native vegetation and some percolated into the ground where it served as a source for streamflow during the dry summer months. In the post-development condition a larger proportion of precipitation runs off immediately to stream channels, increasing wet weather peak flows and reducing groundwater recharge. It is doubtful that much can be done to alter this trend. The creation of percolation basins as part of new development could increase groundwater recharge somewhat. Increasing the numbers of trees in the urban area could increase interception by foliage and reduce runoff rates but it is doubtful that it would have much effect on percolation rates. Substantial increases in groundwater recharge, and consequently summertime flow, would not occur unless the watershed was returned to its former forested condition, obviously a practical impossibility.

■ SUPPLEMENTARY WATER

Summertime creek flow could be increased by release of stored water or water from another source. A portion of the wintertime storm flow could be stored in reservoirs in the upper watershed and released during the summer months. As part of the flood management plan element, several detention reservoirs with a total storage capacity of 400 acre-feet are proposed. As proposed the detention reservoirs would normally be dry. They would only retain water during large storms. These reservoirs could be designed to have a dual purpose; flood control, and storage of water in the spring for later release during the summer low flow period. The proposed reservoirs, modified to store and release water, could provide a supplementary flow of 2 to 3 cfs for two months in the summer. The construction of additional reservoir storage, beyond the currently proposed 400 acre-feet, would probably involve the displacement of homes and businesses.

The idea of dual purpose reservoirs was rejected for several reasons. Dual purpose reservoirs would permanently inundate large upstream areas and destroy any wetlands present (creek channels are classified as wetlands). Wetlands are regulated by the U.S. Army Corps of Engineers and the Oregon Division of State Lands. Because single purpose flood detention reservoirs would destroy a much smaller area of wetlands than dual purpose reservoirs it is likely that construction permits would be more simple to obtain.

Dual purpose reservoirs would be more expensive to build and operate than single purpose reservoirs. Once built, single purpose reservoirs would function passively. They would work when needed without human intervention. Dual purpose reservoirs, on the other hand, would need to be actively managed. The outlet of the reservoir would be equipped with gates or valves. At some time in the spring an operator would have to decide that the reservoir's winter time flood detention function had been fulfilled, and that the gates should be shut to store water for later release. As a reservoir begins to fill in the spring, it would become unavailable for flood.

Water stored in the reservoirs would be subject to solar heating. Because elevated summertime water temperatures in Johnson Creek is a problem for salmonid fish, the release of warm water from the reservoirs might not be helpful. It may be possible to reduce the problem of heated water releases by drawing from the bottom of the reservoirs but the effectiveness of this approach is limited by the shallowness of the reservoirs.

Another serious disadvantage of the dual purpose reservoirs is that they would have an unappealing appearance. After holding water for several months they would be drawn down over the summer to reveal muddy expanses of dead vegetation. Obtaining public, and particularly neighborhood, acceptance of dual purpose reservoirs would likely be more difficult than for the less visually-intrusive flood detention reservoirs.

Rather than construct dual-purpose reservoirs, it may be more practical, although expensive, to construct separate reservoirs for flood storage and for summer flow augmentation. This would avoid the potential loss of flood storage in the spring. However, the permitting and public acceptance problems noted above would remain.

Other potential sources of supplemental water could be deep wells or releases from the Bull Run watershed. Nurseries in the upper basin obtain some of their water supplies from deep wells. Water from a similar source could be used to supplement Johnson Creek flows. The Bull Run aqueduct terminates at Powell Butte on the north side of Johnson Creek. Occasionally excess water is released from the terminal reservoirs to the creek. Planned releases could be made to supplement Johnson Creek flow.

CURBING DIVERSIONS

Under Oregon law, all water is publicly owned. With some minor exceptions, farmers, factory owners or other users must obtain a permit or water right from the Water Resources Department to divert and use water. A water right is a type of property right and is attached to the land where it was established. If the land is sold, the water right goes with the land to the new owner. Landowners with water flowing past or through their property do not automatically have the right to divert the water without state permission.

As in most western states, Oregon water law is based upon the "prior appropriation" doctrine. Under this doctrine, rights for withdrawal of water are given priority based on the date they were acquired. During shortages, earlier permittees receive water while more recent permittees may not. In Oregon, the appropriation doctrine has been law since 1909 when passage of the first unified water code introduced state control over the right to use water. Before then, water users had to depend on themselves or local courts to defend their rights to water.

A water right is valid as long as it is used beneficially at least once every five years. After five consecutive years of non-use, the right is considered forfeited. Some uses of water do not require water rights. These are called "exempt uses." Exempt uses of surface water include the landowner's use of a spring which, under natural conditions, does not form a natural channel and flow off the property where it originates. Stock watering is also exempt if it is directly from surface sources where there is no diversion or other modification to the source. Water diversions for egg incubation projects under the Oregon Department of Fish and Wildlife's Salmon and Trout Enhancement Program (STEP) are also exempt.

Quite commonly streams become over appropriated; that is, permits are issued for water diversions that exceed the flow available at certain times. When this occurs the Oregon Water Resources Commission closes the stream to further appropriation. On May 25, 1966, Johnson Creek and its tributaries, except Crystal Springs Creek and tributaries with flows in excess of 10 cubic feet per second, as measured at their mouth, were withdrawn from further appropriation, except for protection of fish and minor power development. Appropriation and storage are allowed on Johnson Creek tributaries, but not on the main stem, from December 1 through June 1 of each year (ORS 538.170).

During the summer, water is diverted from Johnson Creek and its tributaries for irrigation and livestock watering. Sixty nine permits to divert water from Johnson Creek and its tributaries have been issued by the Oregon Department of Water Resources. Permitting procedures make it difficult to determine current levels of water diversion and use. Permits do not have expiration dates and permit holders do not always notify the Water Resources Department when they discontinue water use. It is not known how many of the 69 permits actually represent current water users on the creek. According to the Water Resources Department's watermaster, there may also be many additional water users on Johnson Creek who are withdrawing water without a water right.

The first step in a program to increase summertime flow in Johnson Creek is to develop a complete and accurate picture of current water rights and actual diversions. Some of the diversions occurring today may be illegal. Elimination of illegal diversions could return some flow to the stream.

The second step is to establish rights to in-stream flow. Historically water rights were only given for what were regarded as beneficial uses — maintaining in-stream flow for fish and wildlife was not regarded as a beneficial use. Now rights to water for in-stream flow are issued by the Water Resources Department, but can only be held by the state. The Oregon Department of Fish and Wildlife often files for rights to in-stream flow. They have done so for Johnson Creek and Crystal Springs Creek but in-stream rights have not yet been granted.

Even if in-stream water rights are granted this will not guarantee that the desirable minimum flow in the creek will be maintained. In-stream water rights, like all of Oregon's water rights are subject to the prior appropriation doctrine. Water rights issued prior to the in-stream rights cannot be curtailed in time of shortage to meet the in-stream right. On an over-appropriated stream like Johnson Creek prior rights may still dewater the stream in dry years. Because of this it may be necessary to buy, lease or receive as a gift prior water rights in order to be able to maintain the desired minimum in-stream flow.

Action FW-5-1.
Update information on water rights and active diversions.

With the assistance of the Water Resources Department, the current list of withdrawals in Johnson Creek will be updated, withdrawals will be quantified, and a concise, easily-readable list of current water rights prepared. Water rights for existing impoundments will also be reviewed.

Action FW-5-2.
Eliminate all illegal diversions.

Many people who live adjacent to streams may not be aware that they need a water right to withdraw water. As a result illegal withdrawals occur even when there is no intent to break the law. Preparation and distribution of a current water rights list for Johnson Creek and its tributaries, along with a map clearly locating each withdrawal, would enable citizens to identify illegal withdrawals. Since water rights inspections by the water master are almost exclusively in response to complaints registered in the Water Resources Department office, this heightened citizen awareness would complement his efforts to control illegal withdrawals. In addition, citizens could assist agencies and the WMO in efforts to educate streamside landowners about water rights, and the need for and benefits of instream flow.

Action FW-5-3.
Establish and obtain rights to a minimum in-stream flow.

Until 1955, Oregon water law did not recognize in-stream flow as a beneficial use of water. In that year the legislature allowed, by administrative rule, the establishment of minimum streamflow levels for fish and wildlife and for pollution abatement. Over the next 32 years minimum flows were set for most large streams and rivers. No minimum flow was established for Johnson Creek or its tributaries. Minimum streamflows set by the state in this way did not enjoy the same legal status as water rights. In times of shortage the Water Resources Commission could waive the minimum in-stream flow in favor of water rights that were granted after the establishment of the minimum flows. As a result the state's minimum streamflow administrative rule was not very effective in protecting in-stream water uses.

In 1987, legislation was passed to strengthen the protection of in-stream water uses. The Instream Water Rights Act allows in-stream water uses to be regulated in the same way as other water uses. Water rights are now granted for in-stream flows and the rights have the same legal status as any other water right. In-stream rights can no longer be curtailed in favor of junior appropriative rights.

Under the new legislation, instream water rights can be created in three ways. Existing minimum streamflows under the 1955 administrative rule can be converted into water rights. Three state agencies, the Oregon Departments of Fish and Wildlife, Environmental Quality and Parks and Recreation, may apply to the Oregon Water Resources Department for new instream water rights. Private rights to water can be transferred permanently to in-stream use. or leased temporarily for the same purpose.

Only the last two methods are applicable to the RMP because no minimum flow was set for Johnson Creek under the 1955 administrative rule.

On April 30, 1991, the Director of the Oregon Fish and Wildlife Department applied for instream water rights for Johnson Creek and Crystal Springs Creek. The quantity of water requested on Johnson Creek varies from 4 to 25 cubic feet per second (cfs), and from 10 to 15 cfs in Crystal Springs Creek. The applications underwent technical review by the Oregon Water Resources Department, and the results were released for public review until March 11, 1994.

According to ODFW, the Water Resource Department's technical review recommended that the instream water rights be reduced in Crystal Springs from 10 cfs to 0.1 cfs in September, and from 15 cfs to 3.65 cfs in February. The Water Resources Department agreed with the application amounts on Johnson Creek. ODFW submitted comments disagreeing with the accuracy of the technical review process for the Crystal Springs analysis. No in-stream water rights have been granted yet for either stream.

If ODFW's original application for rights to 10 to 15 cfs in Crystal Springs Creek is granted, then in-stream flow, sufficient to meet the needs of aquatic life, will be protected from later appropriation. This is because there is currently enough unappropriated flow in Crystal Springs Creek to fulfill the in-stream rights. ODFW should continue to press for its application for 10 to 15 cfs. Johnson Creek, on the other hand, is fully appropriated and so there is no water available to fulfill the new in-stream water rights. Unless water becomes available the state's ownership of in-stream rights will not provide a minimum flow for aquatic life.

Action FW-5-4.
Obtain water to meet in-stream minimum flows.

Because Johnson Creek is fully appropriated, almost the only way to obtain more water for in-stream uses will be to buy, lease or receive as a gift existing water rights, as allowed under the provisions of the 1987 Instream Water Rights Act. Water rights transfers of the kind contemplated in the Act are in their infancy in Oregon. WMO will investigate the feasibility of executing transfers of water rights on Johnson Creek.

A second avenue for obtaining in-stream flow has been opened by recent state legislation. A new law attempts to encourage investment in more efficient use of water while obtaining water for in-stream uses. If a water right holder implements an approved water conservation plan the holder is allowed to keep a portion of the water saved. Seventy percent of the water saved this way is allocated to the permit holder and the remaining 25 percent is allocated to the state. However, according to Water Resources Department staff, permit holders have shown little or no interest in the new law. Amendments to the law have recently been proposed which would make it easier for water rights holders to participate in this conservation program.

It may also be possible to increase summer time base flow by requiring existing property owners to route all or part of their stormwater runoff to sumps or percolation ponds. This will increase groundwater storage and perhaps increase the amount of groundwater available to supply surface streams in the dry season.

Action FW-5-5.
Investigate potential sources of supplemental water.

In the event that insufficient stream flow can be obtained via the water rights process, then supplementary water sources will be investigated. Possibilities include modifying the proposed dry detention basins to provide storage for stream flow augmentation, construction of additional reservoirs dedicated to stream flow augmentation, deep wells in the upper basin or releases of water from the Portland water supply system. The first two possibilities are considered superior to the latter two because they would provide water from the Johnson Creek watershed. Water from a different source, groundwater or water from the Sandy River watershed, may make enhancement of the native fishery more difficult. Migratory fish use the unique characteristics of their native stream to locate their spawning grounds. Also, there is a moratorium on well drilling in the upper watershed and Portland's water is chlorinated; it would have to be dechlorinated before it is released to a stream. The dry detention basins would be constructed in a way that would not preclude the future possibility of conversion to multiple use. Also, the WMO will keep abreast of scientific developments concerning the use of shallow aquifers for stormwater disposal and deep aquifers for regional water supply.

Objective FW-6.
Protect and Restore Natural Stream Processes.

As noted earlier, the lack of natural stream evolution processes reduces the fish habitat value of Johnson Creek. The gradual erosion and deposition of eroded bank materials and the periodic accumulation of downed trees and shrubs in the stream channel are some of the processes that benefit fish. Although human intervention in these processes is necessary in some reaches of the creek in order to prevent flooding or destabilization of stream properties, it is not necessary or can be curtailed in less developed areas. For example, in Leach Botanical Garden or the publicly-owned stream reaches downstream of Gresham, natural processes could be allowed to take their course. An exception is that any large downed trees left in the stream channel will need to be secured to prevent fouling of downstream bridges during floods.

The general philosophy of this objective is embodied in several parts of the RMP which seek to maintain Johnson Creek in as natural a state as possible within an urban and urbanizing environment. Objective FM-1 seeks to prevent increases in downstream peak flow as a result of upstream development. Objective FM-2 seeks to reduce flooding in vulnerable areas without replacing natural creek reaches with a lined channel, or destroying wildlife habitat during creek maintenance activities. Objective FW-2 seeks to restore native vegetation along the creek banks.

Action FW-6-1.

Promote low environmental impact road crossings.

There are many existing road crossings of Johnson Creek and its tributaries. As the watershed develops it can be expected that existing crossings will need to be rebuilt, as roads are widened, and new crossings will become necessary. The new and rebuilt crossings will incorporate features that allow the creek channel to remain in as natural a state as possible. For example, crossings should not pose a barrier to the movement of fish or wildlife, a natural channel bottom should be retained, and the interruption in the canopy of riparian vegetation should be minimized.

WATERSHED STEWARDSHIP PLAN ELEMENT

INTRODUCTION

The watershed stewardship plan includes a variety of actions designed to protect and enhance environmental quality while encouraging wise human use of the watershed's natural resources. It differs from the previous three plan elements in that it does not target a particular aspect of environmental quality. The actions contained in the watershed stewardship plan are designed to improve the watershed as a whole, or integrate environmental improvement with other human interests. The actions build on past, and complement current, watershed stewardship efforts by local governments and citizen groups.

The stewardship plan element addresses four aspects of watershed management; management institutions, land use regulation, recreation, and protection of cultural resources. It also addresses measuring progress toward RMP goals.

Existing institutional arrangements for environmental management are not well-suited to implementing all aspects of the RMP. The RMP contains about 60 actions; some would be taken by public agencies and others by private parties or non-governmental organizations. The existing institutional arrangements need to be modified to improve coordination between public agencies in the watershed and to provide a vehicle for greater involvement of citizens and private organizations in decision-making and creek improvement projects.

Cities and counties have the responsibility for regulating land use. Their goal is to reconcile the economic need for growth with the desire to protect natural resources and retain an attractive living environment. Some adjustments to current land use regulations are needed to achieve this goal in the Johnson Creek watershed.

One of the JCCC's goals is to ensure that recreational opportunities exist in the creek corridor. The fact that the Springwater Corridor Trail parallels much of Johnson Creek provides opportunities and challenges. The trail offers hikers, cyclists and equestrians access to a enhanced creek corridor. On the other hand, access can lead to conflicts between human use and wildlife habitat values. The RMP seeks to balance public access and protection of natural resources.

Another of the JCCC's goals is to protect the watershed's cultural heritage. Properly protected and interpreted, cultural relics can aid understanding of man's influence on the watershed and its natural resources. They also add interest to the Springwater Corridor Trail.

Finally, the watershed stewardship element addresses the need to continuously monitor progress with the RMP. It cannot be expected that implementation of the RMP will occur flawlessly. Life is unpredictable and circumstances change. While the RMP establishes an ultimate goal, the route to the goal may need to be modified. Progress needs to be monitored so that successful approaches to creek improvement are recognized and capitalized upon. Less successful approaches can be modified or dropped.

Watershed Management Institutions

Traditionally, environmental management has been the responsibility of local governments. Citizens have relied on local government to make land use decisions, to dispose of solid and liquid wastes safely, to provide parks, and protection from flood waters. For much of this century, local governments alone decided whether, and how much, they should invest in environmental protection measures. Their decisions were as varied as the views of their electorates. However, in the last twenty years, local governments have increasingly performed their environmental management function within a regulatory framework established by state and federal governments. To a considerable degree, local governments now simply decide how best to comply with regulations imposed by state and federal governments. Citizens' responsibilities have been largely limited to paying the taxes necessary to support government. In most cases, this has worked satisfactorily and will continue in the future. However, as we move toward environmental management on a watershed basis, some reexamination of the division of responsibility between local government and citizens is necessary. In addition, it is worth examining the related issue of watershed boundaries and their lack of coincidence with the boundaries of local governments.

THE CHANGING ROLE OF CITIZENS AND GOVERNMENT IN WATERSHED MANAGEMENT

Watershed or basin plans were prepared all across the United States during the 1970s. These watershed plans were a requirement of the amended federal Water Pollution Control Act passed by the Congress in 1972. The huge investment in water pollution control made by cities and industries in the 1970s and 1980s was based on these watershed plans. As the nation begins to consider developing a second generation of watershed plans, it is worth examining the characteristic features of the earlier plans. Watershed plans in the 1970s were:

- Prepared by units of state government
- Focused on large, easily identified pollutant sources – point sources
- Dependent on regulatory action as the way of ensuring implementation
- Only peripherally involved citizens and stakeholders

The new generation of watershed plans, of which the Johnson Creek RMP is an example, are structured differently to succeed in an altered environment. The new plans focus on the control of diffuse sources of pollution – non-point sources. Their implementation will involve thousands of corrective actions taken by cities and counties, landowners, other stakeholders and private citizens, rather than a handful of major projects implemented by cities or industries. Because of the diversity of the corrective actions, many more individuals are involved in plan development and implementation than were involved in the 1970s. The RMP and other similar watershed plans are:

- Prepared by stakeholder groups organized as watershed councils or committees
- Focused on diffuse or non-point source pollutants but comprehensively address all aspects of watershed health
- Dependent on largely voluntary commitments by local governments and citizens to implement the plan
- Dependent on citizens and stakeholders in a partnership with local governments
- Encouraged, but not mandated, by federal or state law

Implementation of watershed plans prepared in the 1970s was largely the province of governments and large industries. The watershed plans of the 1990s will be implemented by citizens, citizens groups, businesses large and small, and governments. New institutions will be needed to deal with the complexities of a more participatory form of environmental management.

WATERSHED AND INSTITUTIONAL BOUNDARIES

There is an overwhelming logic to environmental management on a watershed basis. It is impossible to effectively manage stream water quality or fish habitat without exercising some control over land use in the stream's watershed. Flood control in the lower reaches of the stream is unlikely to be effective if it is not linked to controls on development in the upper watershed. However, this logic is rarely reflected by the boundaries of existing institutions of government because they have been shaped by social and economic, rather than environmental, factors. The Johnson Creek watershed is typical in that its boundaries contain parts of two counties and four cities. None of the city and county boundaries coincide with watershed boundaries.

A further complicating factor is that the responsibility for certain aspects of watershed management lies with state and federal agencies rather than local government. These agencies are organized on a regional or statewide basis. Again, their jurisdictional boundaries do not coincide with watershed boundaries.

The lack of coincidence between watershed and institutional boundaries has several disadvantages. Most important is the division of responsibility between several units of government. Divided responsibility tends to inhibit action and increases the need for coordination between agencies. Another disadvantage is the fact that no agency has Johnson Creek as its first priority. Many government agencies have some responsibility for the Johnson Creek watershed but their attention is spread over a larger area. The current division of responsibility for environmental management in the watershed is shown in Table 25.

TABLE 25
Current Management and Regulatory Responsibilities in Johnson Creek Watershed

Direct Management Responsibilities	
Land Use	Cities and counties
Sewerage	Cities, counties and special districts
Flood Control	Cities and counties
Fish and Wildlife	Oregon Department of Fish and Wildlife
Regulation	
Water Quality	Oregon Department of Environmental Quality and Oregon Department of Agriculture
Water Diversion	Oregon Water Resources Department
Wetlands	U.S. Army Corps of Engineers and Oregon Division of State Lands
Federal and state endangered and threatened species lists – also state species of concern list	U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Oregon Department of Fish and Wildlife

Bearing in mind the current, less than ideal institutional structure, the question obviously arises: how best to obtain the benefits of environmental management by watershed. Two basic approaches are apparent: the first would radically change the existing institutions of government to conform to watershed boundaries; the second would attempt to implement watershed management largely through existing institutions. The first of these approaches, while perhaps desirable theoretically, is a practical impossibility. Thus, the second approach is embodied in the RMP.

LAND USE REGULATION

One aspect of stewardship is the wise management of land to protect the watershed's natural resources. Regulation of land use is the responsibility of city and county government. City and county government land use regulation occurs within a framework established by state government. In 1973, the Oregon legislature passed a statewide land use planning law designed to control urban sprawl and the loss of open lands. The law established the Oregon Land Conservation and Development Commission which developed nineteen statewide planning goals. These goals provided a framework within which cities and counties prepare their comprehensive plans. City and county comprehensive plans are reviewed by the Land Conservation and Development Commission for compliance with the statewide planning goals.

It was assumed, in developing the RMP, that the watershed's future would be as currently envisaged in the city and county comprehensive plans. Although current land use designations may not be ideal from an environmental perspective, they have been arrived at through the normal democratic procedures of local government. The compromises that have been made to balance environment and economy represent the wishes of the majority. Thus, in general, the RMP treats current land use designations as a given. The only exception is in the area immediately adjacent to Johnson Creek and its tributaries where the RMP includes proposals that could lead to changes in land use designations.

Fourteen of the statewide planning goals apply to the Johnson Creek watershed. However, Goal 5 is the most relevant to the RMP. Goal 5 requires that cities and counties "conserve open space and protect natural and scenic resources." Each of the six local government units in the watershed has taken steps to comply with Goal 5, although their regulations vary widely from jurisdiction to jurisdiction (see Technical Memorandum No. 10). Portland has complied with Goal 5 by establishing environmental zones (E-zones) within which development is restricted. The E-zones are applied as a zoning overlay in areas with high natural resource values. E-zone boundaries were established based on the results of natural resource inventories. The Cities of Gresham and Milwaukie, and Multnomah and Clackamas Counties have adopted similar, but not identical approaches. Each jurisdiction's requirements are summarized in Table 26.

TABLE 26
Comparison of Land Use Restrictions in the Johnson Creek Watershed

	Sensitive Area Classifications		Riparian and Wetland Area Restrictions	
Jurisdiction	Open Spaces	Natural Areas	Buffer Widths	Transition Zones
Portland	Yes	Yes (Environmental Zone)	Determined by Natural Resource Area site-specific definition (Chapter 33.430)	25 feet
Gresham	Yes	Yes (Natural Resource District)	Natural Resource sites must be designated in environmental report (Vol. 4, Article III, Section 2.0554)	25 feet
Milwaukie	Yes	Yes (Natural Resource Overlay Zone)	Defined in Zoning Ordinance Section 322.2 for riparian, wetland and habitat areas	"Adequate" development setback required (Section 322.7)
Happy Valley	No	No	No	No
Multnomah Co.	Yes	Yes (Significant Environmental Concern District)	100 feet from the normal high water line, or FEMA 100-year floodplain	No
Clackamas Co.	Yes	Yes (Significant Natural Area)	Maximum of 150 feet; defined in Development Standards, Section 1002.05, part B	25 feet

It is not clear how effective the zoning regulations are in actually protecting natural areas along the creek. There is probably considerable variation from jurisdiction-to-jurisdiction. Portland's E-zone regulations provide a high level of protection to the creek, particularly from new development. When a developer proposes to build within an E-zone, a detailed permit application must be filed. The permit application is subject to scrutiny by city staff before a permit is granted. However, it is likely that many small creekside land owners do not understand the regulations. The fact that the cutting of large trees or modification of stream banks require E-zone permits may not be widely known or accepted. In general, minor violations of the E-zone regulations are not pursued by the city unless complaints are made.

Although the regulations applied to the rural areas appear weaker than those for the more urban parts of the watershed, they probably provide the creek a reasonable level of protection from the effects of major new development. Proposals to convert land from agricultural uses to housing subdivisions undergo a rigorous environmental review. On the other hand, agricultural land owners are relatively free to manage their land as they wish, even if it adversely affects the creek. When agricultural land owners make changes on their property that could affect the creek, removal of riparian vegetation for example, no permits are required. DEQ and the Oregon Department of Agriculture exercise some control over agricultural practices that adversely affect water quality, but restrictions do not extend to land use practices that may damage wildlife habitat if the practices do not substantially affect water quality.

Recreation

Currently, there are 49 developed parks and recreational facilities within the Johnson Creek watershed. The parks are managed by four public park providers, the Cities of Portland, Milwaukie, Gresham, and North Clackamas Parks and Recreation District. A few recreational facilities are privately-owned. The total area of parks and recreational facilities is 1,023 acres. State guidelines indicate that, for the projected 1995 watershed population, there should be between 1,500 and 2,700 acres of open space accessible to the public. Without the acquisition of additional land for parks, the open space deficit will increase as the population of the watershed grows.

A key recreational facility in the Johnson Creek watershed is the Springwater Corridor Trail. The Springwater Corridor, which occupies a former railroad right-of-way, parallels Johnson Creek for much of its length. The Springwater Corridor Trail acts as an accessway to other parks and recreational facilities, 18 of which lie adjacent to, or within a short distance, of the trail. The 18 parks and recreational facilities close to Johnson Creek and the Springwater Corridor are shown in Table 27.

The Springwater Corridor extends more than 16 miles from S.E. McLoughlin Boulevard in Portland to the community of Boring and beyond. The corridor is part of a former railroad right-of-way that extends from Portland to Cazadero, on the Clackamas River. The railroad was built in 1903 to provide passenger service to suburban communities east of Portland,

and access to several dam sites on the Clackamas River. Transmission lines along the corridor conveyed hydroelectric power, generated at the dams, back to Portland. The railroad enjoyed its greatest success around 1910. After the First World War, patronage declined as automobiles became popular. In 1932, service on the line between Boring and Cazadero was terminated, and the right-of-way purchased by the State of Oregon. In 1958 all passenger service ended. Freight service continued until 1989, when the remainder of the right-of-way was purchased by the Oregon Department of Transportation and its ownership transferred to the City of Portland. The City of Portland may use the property, but must keep the corridor intact and available for future rail use, should the need arise. The corridor continues to be used for the transmission of electrical power.

Planning for recreational use of the corridor began in 1991. The Springwater Corridor Master Plan was published in November 1992. The plan includes a trail running the full length of the corridor from McLoughlin Boulevard to Boring and beyond. A multi-purpose hard-surface trail will run approximately 13 miles from McLoughlin Boulevard to the eastern outskirts of Gresham. A soft surface trail suitable for hikers will continue to Boring. A separate equestrian trail will run from near Tideman Johnson Park to Boring. Eight trailheads are proposed along the corridor. Three trailheads will be located in Portland near S.E. 45th Avenue, near Interstate 205 and at S.E. 136th Avenue. Four trailheads will be in Gresham at Linneman Junction, 10th Street, Main City Park and Hogan Road. The most easterly trailhead will be in Boring. The S.E. 45th Avenue, 10th Street and Boring trailheads will accommodate equestrians.

TABLE 27

Parks and Recreational Facilities Near Johnson Creek

Park	Park Type	Ownership	Acreage
Main City Park	Community	Gresham	17.5
Johnson Creek Park	Neighborhood	Portland	2.9
Leach Botanical Garden	Garden	Portland	5.0
Eastmoreland Golf Course	Golf course	Portland	149.6
Westmoreland Park	Community	Portland	46
Powell Butte	Open space	Portland	569
Beggar's Tick Marsh	Open space	Multnomah County	10.1
Butler Creek Greenway	Open space	Gresham	23.8
Johnson Creek Open Space	Open space	Gresham	28.9
Regner Road	Open space	Gresham	8.7
Tideman Johnson Park	Open space	Portland	6.0
Bundy Park	Undeveloped	Portland	3.7
Club Paesano	Picnic facilities	Non-profit corporation	11.2
Eastmoreland Tennis Club	Tennis club	Private	6.2

The Springwater Corridor Trail and Johnson Creek complement each other perfectly. An enhanced Johnson Creek will make use of the trail more pleasurable by providing a more scenic setting, and opportunities for wildlife observation and environmental education. The trail will provide managed public access to portions of the creek. The actions contained in the RMP are designed to promote complementary improvements to the creek and trail.

Cultural Heritage

Limited surveys of cultural resources have been conducted in the Johnson Creek watershed. A single prehistoric archeological site, near the headwaters of Crystal Springs Creek, is formally recorded, but local residents report finding arrowheads and other artifacts along the main stem of Johnson Creek for many years. A predictive model developed for the Portland Bureau of Parks and Recreation indicates that about 40 prehistoric archeological sites can be expected to be found if a watershed-wide survey is conducted.

Two historic archeological sites in the watershed have been documented. They are old bridge footings at Tideman Johnson Park and near the existing covered Cedar Crossing bridge. Forty-four historic structures have been identified, but only a few are located near the creek. They include rockwork constructed by the Works Progress Administration, including the waterfall and fish ladder near S.E. Harney Street, the S.E. Tacoma Street bridge, the Bell Station store, Leach Botanical Garden, Linneman Railroad Station and the Gresham Pioneer Cemetery.

Plan Objectives and Actions

The watershed stewardship plan is organized as a series of objectives and actions. The objectives are general statements of intent based on the goals established by the Johnson Creek Corridor Committee. The actions are the specific programs and practices necessary to achieve the objectives. Table 28 lists the objectives and actions, identifies the party responsible for each action, and includes an estimate of the cost of each action.

OBJECTIVE WS-1
Establish Institutional Infrastructure for Long-term Watershed Management.

Establishment of the institutional infrastructure necessary to implement the RMP is critical to the plan's success. Without the right institutional infrastructure the RMP is likely to share the fate of many other well-meant plans – dust-gathering on a forgotten shelf. Because the actions proposed in the RMP are so diverse, they cut across the turf of many existing agencies. No single existing institution has a mandate for comprehensive planning of the Johnson Creek watershed, or the authority to implement the RMP on its own.

TABLE 28
Summary of Watershed Stewardship Plan Element

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective WS-1. Establish Institutional Infrastructure for Long-Term Watershed Management				
Action WS-1-1. Establish permanent watershed management organization	JCCC	$20,000 one-time cost	$20,000 one-time cost	A
Action WS-1-2. Obtain stable funding source for watershed management organization	JCCC	$20,000 one-time cost	$20,000 one-time cost	A
Action WS-1-3. Operate watershed management organization[1]	WMO	$100,000 annual cost	$100,000 annual cost	A
Action WS-1-4. Establish special purpose subcommittees.	WMO	Included in Action WS-1-3	Included in Action WS-1-3	B
Objective WS-2. Foster Development of a Watershed Stewardship Ethic (JCCC Goals 6, 8, 9, and 11)				
Action WS-2-1. Establish a Johnson Creek information clearinghouse and library	WMO	Included in Action WS-1-3	Included in Action WS-1-3	B
Action WS-2-2. Maintain a program of ongoing communication with watershed residents	WMO	Included in Action WS-1-3	Included in Action WS-1-3	A
Action WS-2-3. Support volunteer creek improvement projects	WMO	Included in Action WS-1-3	Included in Action WS-1-3	A
Action WS-2-4. Provide technical assistance to privately-funded creek improvement projects	WMO	Included in Action WS-1-3	Included in Action WS-1-3	B
Action WS-2-5. Develop a proactive program of public education about watershed issues and regulations	WMO, cities, counties, state and federal agencies	Included in Action WS-1-3	Included in Action WS-1-3	B
Objective WS-3. Increase Creek Protection Through Land Use Regulation and Incentives (JCCC Goals 8 and 11)				
Action WS-3-1. Coordinate community plans, zoning and development standards to provide protection to all reaches of creek[2]	Cities and counties with the advice of citizens and stakeholders	$30,000 (one-time cost)	$30,000 (one-time cost)	B

NOTE: 1 See Tables 29 and 30 for a detailed budget for WMO
2 Restrictions on development could impose lost opportunity costs on landowners

TABLE 28
Summary of Watershed Stewardship Plan Element (Continued)

Objectives and Actions	Implementing Agency/ Responsible Party	Estimated Cost of Action	Portion of Estimated Annual Cost of Action Attributable to JCRMP	Priority
Objective WS-3. Increase Creek Protection Through Land Use Regulation and Incentives (JCCC Goals 8 and 11) (continued)				
Action WS-3-2. Provide incentives to private parties who manage lands in the public interest[3]	Cities and counties	Not estimated	Not estimated	B
Action WS-3-3. Review development proposals	WMO	Included in Action WS-1-3	Included in Action WS-1-3	A
Objective WS-4. Increase Recreation Opportunities in Creek Corridor (JCCC Goals 5)				
Action WS-4-1. Coordinate planning and management of Springwater Corridor Trail with Johnson Creek improvements	WMO, Portland and Gresham, counties and No. Clackamas Parks and Recreation District	0	0	B
Action WS-4-2. Integrate Minor cost to public agencies recreation facilities into creek improvements[4]	WMO, cities and counties	Not estimated	Not estimated	B
Objective WS-5. Preserve Heritage Values Within Watershed (JCCC Goal 7)				
Action WS-5-1. Prepare a comprehensive history of the watershed[5]	Volunteers	0	0	B
Action WS-5-2. Develop interpretive program for cultural resources[6]	Cities and counties	$20,000 (One-time cost)	$20,000 (One-time cost)	B
Action WS-5-3. Preserve cultural resources	Cities and counties	0	0	B
Objective WS-6. Evaluate Progress Toward RMP Implementation				
Action WS-6-1. Establish and implement comprehensive monitoring and evaluation program	WMO Volunteers	Establishing program included in Action WS-1-3 Implementation will cost $50,000 annually.	Establishing program included in Action WS-1-3	A
Action WS-6-2. Prepare annual "state-of-the watershed" report	WMO	Included in Action WS-1-3	Included in Action WS-1-3	

NOTE:
3 Could result in some loss of property tax revenues
4 Minor cost to public agencies
5 Small printing cost might be donated by corporate sponsor
6 Cost assumes two exhibits in Portland

Several institutional models for watershed management were considered by the JCCC and its task groups. A common feature of the institutional models considered is that they all assumed that decision-making authority would remain where it is today. The creation of a new body with statutory authority was deemed to be both unnecessary and impractical. The existing decision-making bodies, cities, counties and state and federal agencies, should continue to make and implement public policy. Any new committees or non-governmental organizations would attempt to influence public policy by making recommendations to the existing decision-making bodies.

The model chosen by the JCCC is shown diagrammatically in Figure 44. It involves the creation of two new advisory bodies; a watershed management organization (WMO) with a very broad membership that includes all stakeholders in the watershed; and a watershed technical coordinating committee (WTCC) that includes staff members of the jurisdictions in the watershed.

Action WS-1-1

Establish watershed management organization and watershed technical coordinating committee.

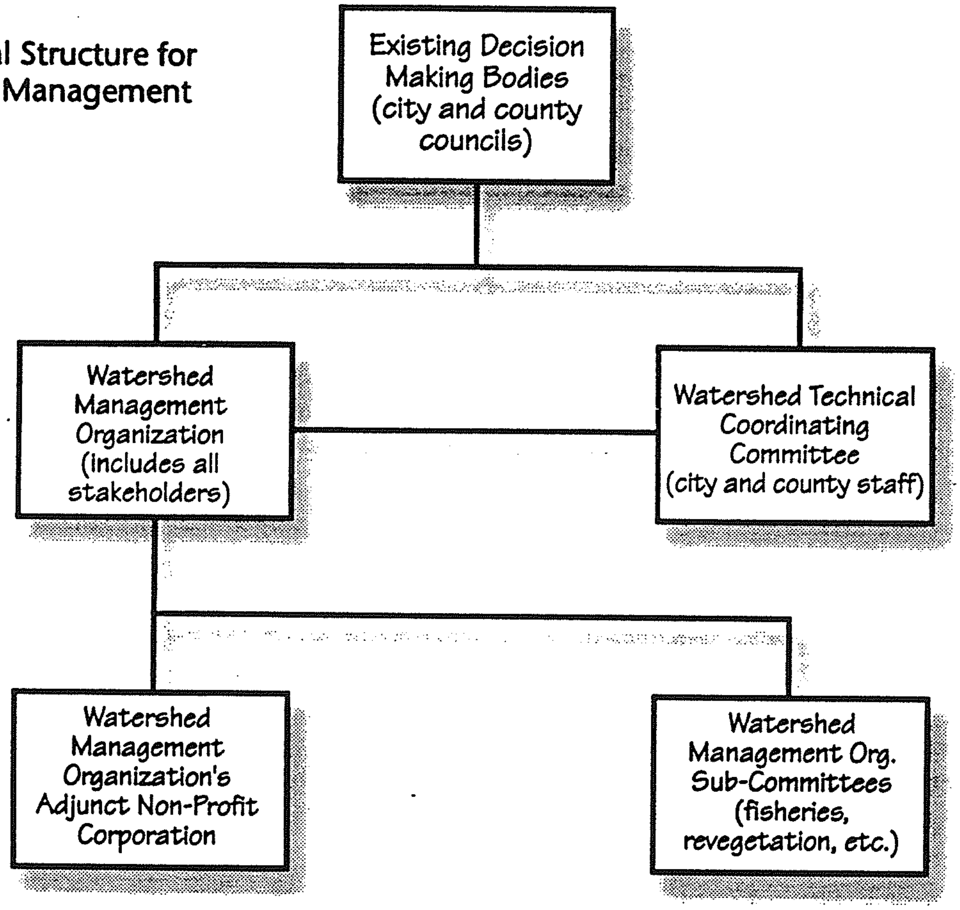
This RMP includes approximately 60 actions intended to protect and enhance the natural resources of the watershed while reducing the frequency of damaging floods. The actions fall into two categories, actions taken by private parties or non-governmental organizations, and actions taken by public agencies. Actions taken by private parties or non-governmental organizations might include development of a stewardship ethic by information dissemination and education, revegetation of privately-owned creekside lands, the organization of volunteers, and the coordination of creek improvement efforts. Actions taken by public agencies might include the construction and maintenance of flood reduction and water quality improvement facilities, revegetation of publicly-owned lands, and the adoption of various new regulations.

The formation of a new WMO is proposed to address the first category of actions. Functions of the WMO might include:

- Acting as an advisory body to existing decision-making bodies
- Continuing the watershed planning process
- Helping to resolve citizen's problems by serving as a liaison between government and the public
- Resolving conflicts between parties and addressing contentious issues
- Acting as a repository for watershed information, and a source of information on enhancement techniques
- Raising funds to further watershed management and enhancement
- Increasing public awareness of environmental matters by involving citizens in enhancement projects and educational programs
- Evaluating progress toward watershed management goals
- Acting as an advocate in support of watershed management goals
- Coordinating volunteer activities

FIG 44

Institutional Structure for Watershed Management



The WMO would have a broad membership including all stakeholders in the watershed. In this context, stakeholders means all individuals or groups that have an interest in the watershed. A stakeholder's interest might be that they own land, a home or a business in the watershed. Cities, counties and other units of government are stakeholders. So are government agencies with responsibilities for environmental management in the watershed, such as DEQ, ODFW, and WRD. The present structure of the JCCC is an example of this institutional model.

This institutional model has been embraced by the State of Oregon. In 1993, the state legislature passed HB 2215 which directed the Governor's Strategic Water Management Group (SWMG) to initiate a watershed management program. The program, as developed to date, focuses on large rural watersheds. So far, funds have been appropriated for work in two watersheds, the Grande Ronde and the South Coast/Rogue River. The first step in the state's watershed management process is to establish a watershed council. The state's guidelines for watershed councils correspond to the model chosen by the JCCC. Other successful watershed councils have also followed this institutional model; an example is the Nisqually River Council in Washington.

The key concept underlying this model is that watershed improvements can best be made by obtaining the prior agreement of all stakeholders. The advantage of this approach is that it capitalizes on the widespread desire to manage natural resources wisely. The WMO's political power would derive from its independence and its ability to present itself as a representative of all interests in the watershed. It would be most effective when the watershed improvements under consideration are not costly to private parties and are seen as advantageous to all – in common parlance, win-win situations. Although many valuable incremental improvements can be made in this way, it is an unfortunate fact of life that most watershed management issues involve both winners and losers. The broad stakeholder representation may result in paralysis and an inability to reach consensus when contentious issues are under consideration. Consequently, alternative decision-making processes may be needed to resolve stalemates.

The WMO will differ from typical "friends" groups such as Friends of Johnson Creek. Friends groups do not include official representatives of cities or counties or other government agencies and usually consist of like-minded citizens with the single goal of environmental improvement. Unlike the WMO, they do not need to balance environmental and economic considerations. They function as watchdogs over the activities of government agencies and private parties and may take positions opposing the activities of either. The WMO will be a public-private partnership that includes local government officials as well as all other stakeholders. It will seek to further the goal of environmental improvement by cooperation among stakeholders. However, because the WMO would not be a legal entity, it may choose to create an adjunct non-profit corporation or enter into an agreement with an existing non-profit corporation. Leach Botanical Garden or Friends of Johnson Creek, if it incorporates, could fill this latter role. Unlike the WMO, non-profit corporations can enter into contracts and receive tax-protected grants from private foundations. They could also serve as a land trust to facilitate preservation of sensitive areas.

The second category of actions in the RMP are already the responsibility of public agencies. The primary improvement needed is better coordination of public agency actions that affect the watershed. For example, current regulation of stormwater flows from new development is inconsistent in the watershed. All jurisdictions would benefit from coordinated regulations that better reflect the hydrology of the watershed (see Actions FM-1-1 and FM-1-2). The WTCC will provide the necessary coordination. The functions of the WTCC might include:

- Coordinating the construction and maintenance of physical improvements in the watershed
- Coordinating the drafting of hydrologic regulations for new development
- Coordinating the drafting of land use regulations to protect creekside natural resources

The WTCC would be made up of staff members of the six jurisdictions in the watershed. If possible, the individuals chosen by jurisdictions to be members of the

WTCC will also be chosen as the jurisdiction's representatives on the WMO. The WTCC would exchange information with the WMO.

Action WS-1-2

Obtain stable funding source for watershed management organization.

Regardless of its institutional structure, a WMO is unlikely to be successful without a stable funding source. Organizations that depend entirely on volunteers often falter because volunteers typically cannot make the organization their first priority. It is difficult to move programs forward consistently when each volunteer can only contribute a few hours each week. On the other hand, an organization that has a core of permanent, salaried staff, assisted by volunteers can be very effective.

Assuming that responsibility for building and maintaining flood control and water quality facilities remains with the cities and counties, a minimum funding level for the watershed organization would be $100,000 per year. Budget breakdowns are shown in Tables 29 and 30. An annual budget of this magnitude would support a small office in the watershed and the employment of a watershed steward. The office would include an administrative space, and space for a library and resource center. The funding for the watershed organization's core activities may come from the following sources:

- Grants and in-kind contributions from local, state and federal governments
- Grants from private foundations
- Contracts for service
- Gifts and donations

Local governments might provide assistance in two ways. They could assist the WMO by using their own staff to undertake some WMO functions or by providing office space and administrative support (in-kind contributions). Alternatively, local government may choose to fund a full-time staff person to be the watershed steward. The watershed steward would be employed by one of the public agencies but the cost of the position would be shared by some or all participating agencies.

TABLE 29

Watershed Management Organization Initial Annual Budget

Item	Estimated Cost
Staff	$ 70,000
Rent	$ 6,000
Telephone/Utilities	$ 3,000
Mail Printing	$ 12,000
Miscellaneous	$ 9,000
Total	**$100,000**

TABLE 30
Watershed Management Organization Budget Breakdown by Task

	Action	Budget
WS-2-1	Establish information clearinghouse and library	$ 5,000
WS-2-2	Maintain communication program	$ 15,000
WS-2-3	Support volunteer projects	$ 5,000
WS-2-4	Provide technical assistance	$ 5,000
WS-2-5	Develop public education program	$ 10,000
WS-3-3	Review development applications	$ 5,000
WS-6-1	Establish monitoring program	$ 10,000
WS-6-2	Prepare "State of Watershed" Report	$ 10,000
PP-1-1	Periodically review information on point source discharges	$ 3,000
PP-2-6	Periodically review information on stormwater discharges	$ 5,000
PP-3-3	Periodically review information on container nursery/CAFO compliance	$ 2,000
PP-3-4	Periodically review compliance with forest practice rules	$ 3,000
PP-4-1	Periodically review information on compliance with spill control rules	$ 4,000
FW-2-1	Establish fishery subcommittee	$ 3,000
FW-3-4	Obtain water rights for in-stream flow	$ 10,000
Misc.		$ 5,000
	TOTAL	**$ 100,000**

Action WS-1-3

Operate watershed management organization.

Successful operation of a watershed management organization depends on several principles: involvement of all affected interests; identification of a dedicated core group of interested people; local ownership of the management and enhancement of the watershed; identification of problems and solutions through a collaborative process; implementation, monitoring, and continual evaluation; supporting an ongoing forum for communication, cooperation, and problem solving; and closely linking the watershed management organization to existing, more formal decision-making processes.

Action WS-1-4

Establish special purpose subcommittees for fishery and wildlife habitat restoration.

Certain activities of the WMO will require specialized technical knowledge. For example, wildlife habitat restoration involves specialized knowledge of botany, plant propagation and wildlife biology. The WMO will form a wildlife habitat subcommittee with specialized knowledge or interest in these and other related disciplines. The subcommittee will review and comment on proposals for revegetation by public agencies and private parties. The subcommittee will also establish priorities for protection of critical habitats.

Similarly, fisheries management and habitat restoration involves specialized knowledge of fish and their habitat preferences. The WMO will establish a fisheries sub-committee. Oregon Department of Fish and Wildlife, which is the agency with direct responsibility for managing the state's fish resources, will be a key member of the subcommittee. All proposed fish habitat improvements, stocking, monitoring and surveying activities on Johnson Creek will be coordinated by the sub-committee. It will be important that any action taken is consistent with Oregon Department of Fish and Wildlife's yet-to-be-developed fisheries' management plan for Johnson Creek, and is coordinated with the Salmon and Trout Enhancement Program (STEP) administered by the department.

OBJECTIVE WS-2
Foster Development of a Watershed Stewardship Ethic.

Significant improvements to the watershed environment are unlikely to occur without the active participation, or at least awareness, of most residents and property owners. Thus, an important part of the plan is develop an awareness that all actions in the watershed are interconnected and that it is in everyone's interest to treat the watershed's natural resources with respect.

Action WS-2-1
Establish Johnson Creek information clearinghouse and library.

Although considerable information is available on Johnson Creek and its natural resources, it is located in many different places. Water quality and flow information are compiled by U.S. Geological Survey, DEQ and by the City of Portland. Fishery information is maintained by Oregon Department of Fish and Wildlife. Land use and natural area information is maintained by METRO. Many other entities also maintain files on Johnson Creek. The watershed could be managed more effectively if there were a single repository for data on the creek. This would not mean that other agencies would not maintain files on Johnson Creek, just that copies of all information would be maintained at a single.

A Johnson Creek library will be established and maintained by the WMO. The starting point will be the library of documents assembled by Woodward-Clyde during the RMP planning process. In addition to conventional hard-copies of relevant documents, the library will include electronic copies of all maps contained in the geographic information system (GIS) used in the RMP.

The WMO will also provide a watershed information and pollution prevention/reporting hotline for local residents. The hotline will provide information on: filling in the floodway, enhancement projects, erosion control, Springwater Corridor, nuisance control (rodents, insects, migratory birds, noxious weeds, etc.), public education programs, wildlife and fish issues and sightings, location of parks, trails and recreation opportunities, regulations for streams, ponds and wetlands, drainage and runoff regulations, water quality problems, WMO meetings, subcommittees and events, flooding problems, StreamWalk programs, safe uses of pesticides and fertilizers, and hazardous waste collection.

Action WS-2-2

Maintain communications with watershed residents.

The WMO will keep watershed residents informed about progress with the RMP and opportunities to participate in enhancement projects and special purpose subcommittees. The primary modes of communication will be a quarterly newsletter, and monthly WMO meetings.

Action WS-2-3

Organize and support volunteer creek improvement activities.

It is expected that volunteer activities will play an important role in implementing the RMP. Many small creek clean-up, bank and riparian corridor enhancement and fish habitat improvement projects will need to be implemented by volunteers. The WMO will be responsible for planning and organizing volunteer projects. The WMO will also maintain a registry of potential volunteers and volunteer organizations. An outreach program to schools, service clubs, scouts, etc., will be implemented to recruit volunteers. The WMO would coordinate activities with other groups with similar goals – the Springwater Corridor Steering Committee and the Friends of Johnson Creek, for example.

Action WS-2-4

Provide technical assistance to privately-funded creek improvement projects.

Most of Johnson Creek flows through privately-owned lands. Consequently, successful enhancement of the creek corridor will depend on the active participation of private land owners. The WMO will be responsible for providing technical information and guidance to landowners wishing to enhance natural vegetation on their property. If, for example, a property owner wishes to replace lawn extending to the creek bank with a more natural complex of vegetation, the WMO will assist in the development of a landscape plan, provide guidance on sources of native plants, and may be able to provide volunteer assistance with the construction.

The starting point for most property owners will be the streamside property owners guide developed as part of the RMP program. The WMO will update the guide periodically as new information becomes available. The U.S. Department of Agriculture, Natural Resources Conservation Service and local Soil and Water Conservation Districts provide technical assistance and information to agricultural landowners; the Oregon Department of Forestry provides similar assistance to forest landowners. The WMO will work with these agencies to provide coordinated landowner assistance. The WMO will also organize periodic workshops on creek bank revegetation and enhancement for streamside property owners.

Action WS-2-5

Develop and implement a public education program.

The WMO will develop and implement an education program designed to increase public awareness and understanding of the effects of various activities on the natural resources of the Johnson Creek watershed. This program will take advantage of existing sources of information and cooperate with other government and agency programs. Education activities might include:

- Lecture series at the WMO office describing the natural resources and history of the watershed
- Presentations to neighborhood groups and service clubs
- Material and informational support for cooperative teaching programs with schools, and school participation in other educational activities conducted by the WMO
- Workshops for streamside property owners
- Field trips to private properties that provide good examples environmentally-sensitive landscaping
- Information to new landowners in the watershed providing a full explanation of environmental regulations that apply to their property

OBJECTIVE WS-3

Increase Creek Protection Through Land Use Regulation and Incentives

In the past, largely unregulated growth and exploitation of natural resources in the Johnson Creek watershed have caused a wide range of environmental problems, including loss of habitat and natural areas, increased flooding, loss of recreational areas, and water quality impairment. By providing financial incentives to property owners who manage their lands in a way that protects the stream, and developing an effective, consistent set of regulations for natural resource protection, this trend can be reversed.

Action WS-3-1

Coordinate community comprehensive plans, zoning and development standards to provide similar protection to all reaches of creek.

The greatest need for change in land use regulation in the Johnson Creek watershed is the development of a consistent, watershed-wide set of standards for protection of natural resources. Each of the six jurisdictions in the Johnson Creek watershed has adopted varying approaches to the protection of natural resources. Although their policies are generally compatible, there is no consistent watershed-wide approach. The City of Portland's practice of using environmental zoning based on mapped natural resources could serve as a model for the watershed as a whole.

A task force comprised of land use planners from the six Johnson Creek jurisdictions, stakeholders, including JCCC members, and other interested citizens, will be convened to develop watershed-wide land use standards through coordination of all applicable community general plans. Its goal would be to develop standards within one year which will include:

- A consistent definition of natural resource areas to be applied watershed-wide
- Consistently-prepared maps of natural resource areas for the entire watershed
- Restrictions on development and other activities within mapped natural resource areas
- Establishment of a transition zone of at least 25 feet between the mapped natural resource areas and development, within which some restrictions on use would apply.

Because the new standards will take some time to develop and adopt, the JCCC considered providing some form of interim protection for streamside areas. Two possibilities were considered. The first possibility would involve immediately establishing a protected zone along the creek within which development would be restricted. The protected zone might extend 50 or 100 feet back from the top of the creek bank but would be arbitrarily defined instead of based on biological mapping. The second possibility would establish a similar protected zone, but, rather than impose immediate restriction on development in the zone, all development applications for lands within the zone would be reviewed by the WMO for compliance with the goals of the RMP.

The JCCC were unable to reach consensus on this action. The committee divided almost evenly into three groups: groups supporting the two approaches to interim protection discussed above and a third group favoring reliance on the standards developed by the multi-jurisdictional committee without interim protection measures.

Although some leeway should be given to owners of subdivided land, the establishment of protected natural resource areas and delineation of these areas on a map would greatly clarify regulatory requirements for land owners, developers and regulators. Land-use regulations which are easy to understand and apply would help re-establish an extensive vegetative cover along Johnson Creek, which is probably the most effective action that can be taken to enhance Johnson Creek and its tributaries.

Action WS-3-2

Provide financial and other incentives to property owners who manage natural resources in the public interest.

Protection of natural resources and the control of non-point source pollution rely heavily on volunteer commitments by local citizens. Although many citizens of the Johnson Creek watershed have shown great willingness to cooperate in actions to benefit the watershed, more incentives should be provided to encourage greater involvement.

Tax advantages exist for land owners who grant open space easements on portions of their property. Easements usually allow public access to natural resource areas, and therefore are not always desirable to all land owners. Sale of property to environmental organizations, such as the Nature Conservancy or the Wetlands Conservancy, obviously reduces property tax assessments. Special conditions can be included in the deed which allow continued use by the original land owner as long as they are alive. Land owners who provide public easements should be protected from liability claims resulting from accidents that occur on their property.

The State of Oregon's Riparian Tax Incentives Program provides state income tax reductions to land owners who establish and maintain riparian protection measures, such as fencing. However, the modest savings from this program do not provide an overwhelming incentive to reluctant land owners.

Additional financial incentives include cost-share programs through local, state and federal resource management agencies. Many programs are available through the Natural Resources Conservation Service, soil and water conservation districts and the Oregon Department of Agriculture for farmers to provide cost-share assistance for a wide range of agricultural Best Management Practices (BMPs), including fencing, providing watering supplies for livestock away from streams and revegetation. Programs are also available to forest land owners for BMPs such as wildlife habitat enhancement, reforestation, and preserving vegetative buffer strips next to streams.

The WMO could publicize these cost-sharing programs to land owners, facilitate contact between the land owners and agencies, and help land owners prepare cost-share applications. Serving a dual role as advocate for land owners and proponent for government programs would increase the chance of protecting and enhancing critical portions of the watershed.

Other ways to reward landowners for managing their lands for the public good include recognition in the media, and special awards. By publicly acknowledging conservation gains accomplished by private individuals, not only do the individuals gain recognition, their deeds and results are commended. This may lead to a stronger conservation ethic in the community. Each year, soil and water conservation districts give special recognition awards to farmers with outstanding conservation programs. The WMO could make similar awards to exemplary landowners from anywhere in the watershed, not only agricultural landowners. Outstanding landowners could be recognized at an annual banquet, could receive a plaque or other commendation, and a sign could be placed on their land recognizing their accomplishments.

Understandably, many land owners are unwilling to relinquish their private property rights or allow government interference in their enterprises, although their land management practices may be damaging a public resource. If good existing programs can be utilized, equitable new programs designed, and cooperation increased between agencies and between agencies and landowners, incentives should be able to increase the amount of voluntary conservation, and thereby improve the condition of natural resources in the Johnson Creek watershed.

Action WS-3-3
Review development proposals.

One of the key functions of a long-term watershed management organization would be to support an on-going forum for communication, cooperation and problem solving.

A subcommittee of the watershed management organization would be established to review proposed development projects. Developers and cities and counties would be encouraged to bring development proposals to the WMO subcommittee for review and comment. The subcommittee would meet at least monthly and would report directly to the WMO, which may choose to submit comments to the municipalities. The review procedure would allow proponents the opportunity to receive early public comment on their proposals.

OBJECTIVE WS-4
Increase Recreational Opportunities in Creek Corridor

Action WS-4-1
Coordinate planning and management of Springwater Corridor Trail improvements with Johnson Creek improvements.

Although construction of the Springwater Corridor Trail is well-advanced, some elements of the plan are not yet complete. All planning of new facilities such as trailheads or interpretive signage should be coordinated with the elements of the RMP to take advantage of linkages between the Springwater Corridor Trail and points of interest on the Johnson Creek, and other trails. Management of completed facilities should also be coordinated. Coordinated planning and management would be advantageous in the vicinity of S.E. 45th Avenue and Johnson Creek Boulevard and in the Lents neighborhood as discussed below.

Action WS-4-2
Integrate recreation facilities into creek improvements.

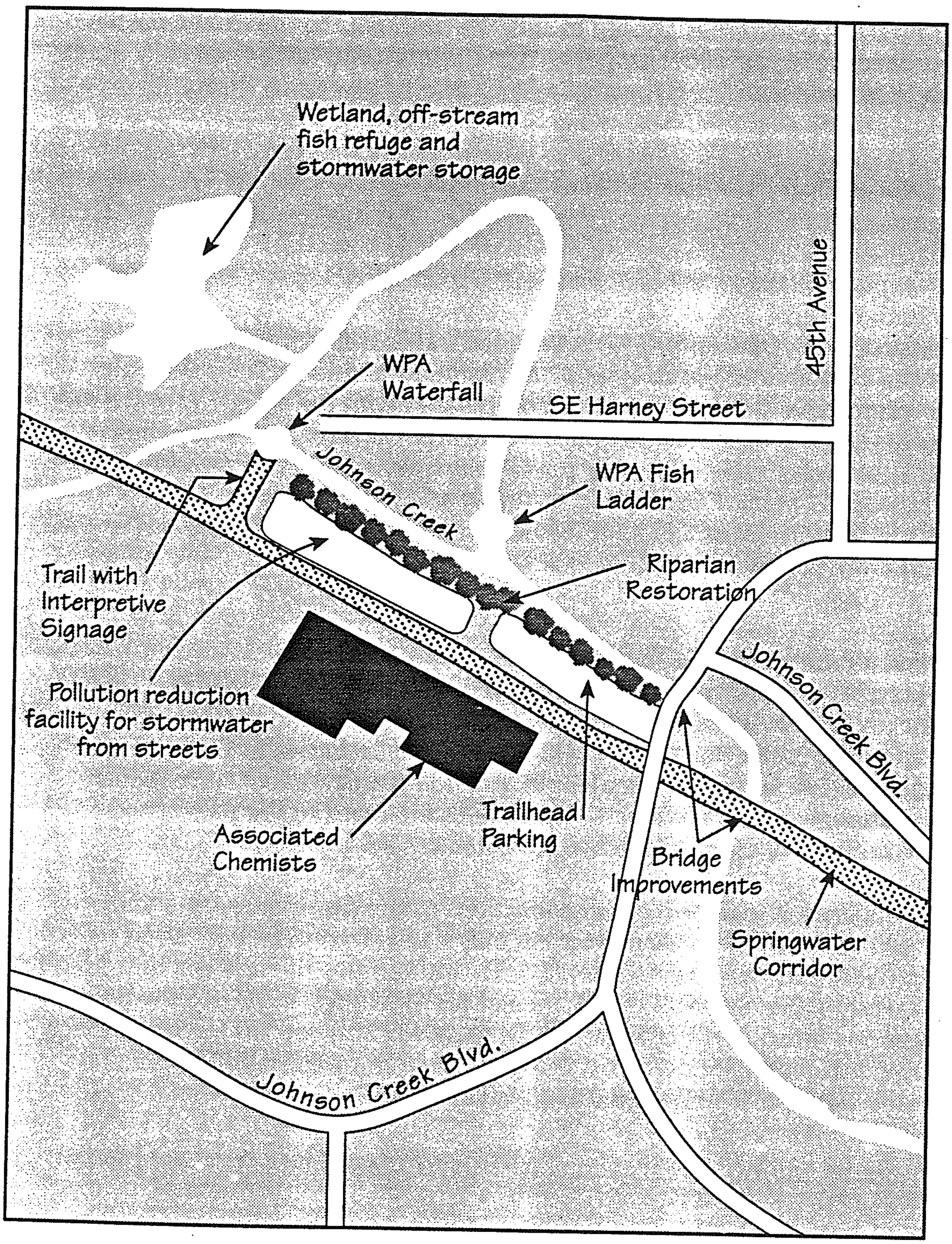
A number of recreation facilities will be integrated with other plan elements. These include trailheads for the Springwater Corridor near S.E. 45th Avenue (at Johnson Creek Boulevard), and near Foster Road and 104th Street. The Springwater Corridor roughly parallels Johnson Creek along its entire length, providing an excellent recreational component to the creek, and increasing exposure of the creek to the public, thereby increasing the number of citizens watching over the creek.

Trailheads will include at least two path connections to the Corridor. At the 45th Avenue and Johnson Creek Boulevard site, the trailhead will connect with short trails leading to the WPA waterfall (see Action WS-5-3). Interpretive signage will be added to this area to highlight the historical significance of the WPA sites, including the fish ladder near Harney Street and the waterfall. Signage will also explain the importance of the proposed fish rearing pond across the creek from the waterfall. The general layout of the multi-purpose facilities is shown in Figure 45.

The City of Portland Parks and Recreation Department intends for one of the Johnson Creek trailheads to be considered a "signature" trailhead. The signature trailhead will be advertised as the central entry point to the Corridor, and will be designed to welcome new users. This trailhead will be centrally located, i.e., as near to I-205 as possible. The Foster Road – 104th Street site seems to ideal for this purpose, and is already used as an informal "jumping-off point" for many trail users, even without

FIG 45

Multi-purpose Improvements at 45th Avenue and Johnson Creek Boulevard



formal designation as a trailhead, or paved parking spaces. A possible layout of future multi-purpose facilities at the site is shown in Figure 46.

OBJECTIVE WS-5
Protect Cultural Heritage Values.

Protection of cultural heritage values includes physically preserving known cultural resources and ensuring that currently unknown relics are not destroyed as the watershed develops. Protection of cultural resources is enhanced by public understanding of and interest in local history. The actions listed below seek to both preserve and increase appreciation of the watershed's cultural heritage.

Action WS-5-1
Prepare a popular history of watershed.

Considerable information is available on the history of the Johnson Creek watershed, but it is not summarized in a single publication. Interest in the watershed and its early development could be stimulated by writing a history designed for the general reader. The history would include a listing of all known cultural resources in the watershed, a compilation of oral historical accounts, old photographs, and instructions on a self-guided tour for visitors to the Springwater Corridor Trail. It could serve as the basis for a permanent exhibit and classes at the WMO's office (see Action WS-2-5). It would be prepared by volunteers, perhaps in association with Portland State University, or a similar educational institute.

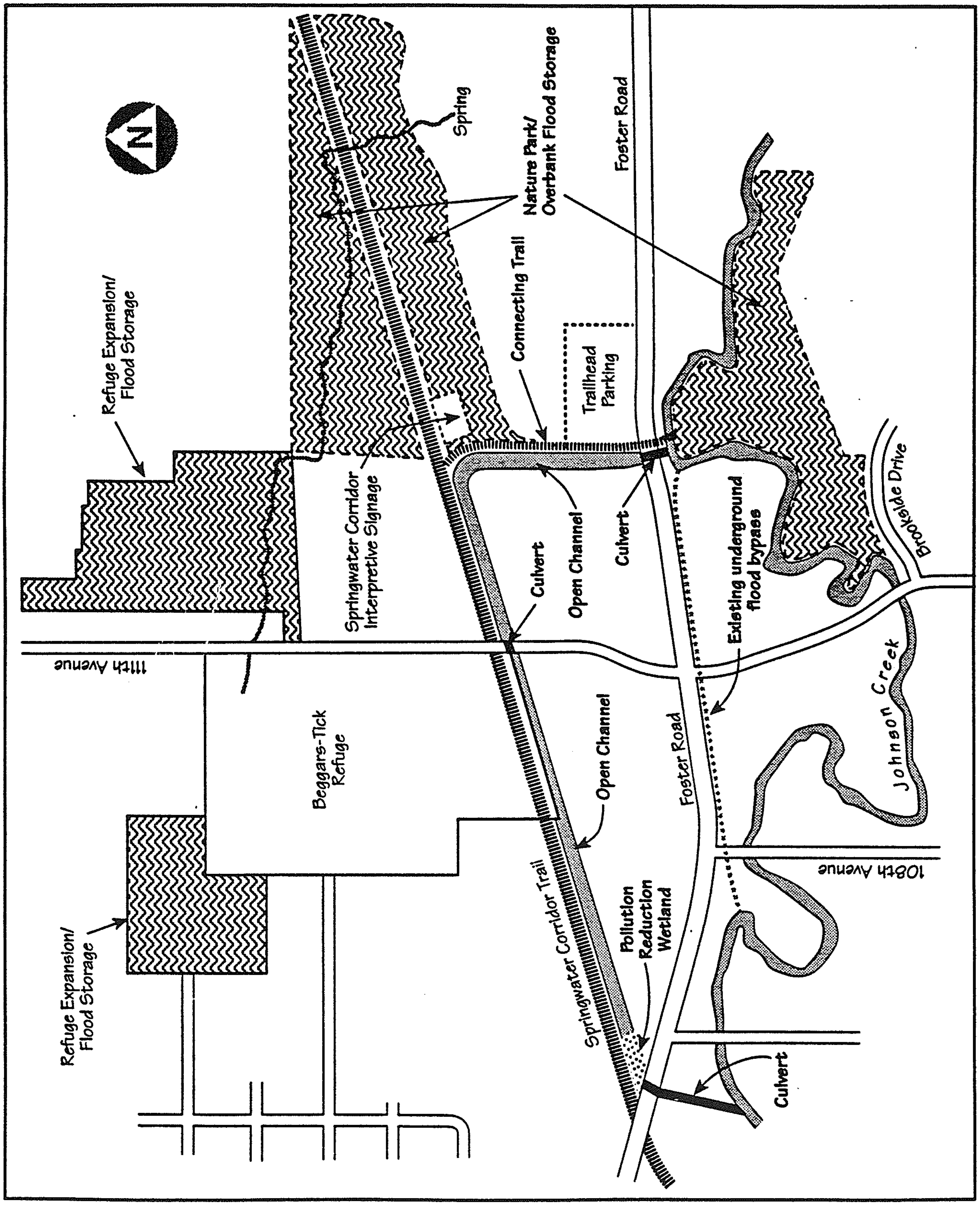
Action WS-5-2
Develop interpretive program for cultural resource.

The purpose of this program would be to increase access to and awareness of cultural resources in the watershed. The program would display historic information gathered in Action WS-5-1 on several interpretive signs. Signage would be coordinated with existing signage on the Springwater Corridor Trail. Possible exhibits are described below; others could be developed by the WMO.

The Works Progress Administration rockwork is of aesthetic and historic interest. Good examples of rockwork structures, a fish ladder and a waterfall, are located at Johnson Creek Boulevard and S.E. 45th Avenue. Currently the public has access to the waterfall, but the fish ladder is on private property. No explanatory signage is in place. Directional signage could guide users of the Springwater Corridor trailhead at Johnson Creek Boulevard to the waterfall. Interpretive signage could discuss the Great Depression of the 1930s and the role of the Works Progress Administration (WPA) in creating employment. In addition, a fish rearing pond will be built on the opposite side of the creek, and a sign could be added to explain the significance of this habitat addition (see Figure 45). In the Lents area, interpretive signage could describe the history of the Portland Traction Company railroad and the use of the Springwater Corridor for electrical power transmission.

FIG 46

Multi-purpose Improvements at SE Foster Road and 111th Avenue



Action WS-5-3

Preserve cultural resources.

Inventories of historic structures have been conducted for most of the Johnson Creek watershed except for Happy Valley. These inventories identified 44 historic structures or locations, two of which were listed in the National Register as of 1992 (Leach Botanical Garden, Bell Station Store). Other significant historic resources include Tideman Johnson Park, Cedar Crossing Bridge, Gresham Pioneer Cemetery, Escobar Cemetery, White Birch Cemetery, and the WPA rockwork.

Most of the historical inventories in the watershed focus on architecture rather than history, and attempt to document visually interesting resources. As a result, the historic resources identified in the surveys rarely reflect anything but architectural merit. For example, archaeological surveys have examined about 0.6 percent of the watershed, and only one prehistoric archaeological site, a stone tool manufacturing site located near the headwaters of Crystal Springs Creek, has been formally recorded in the watershed. Upstream of about S.E. 42nd, there are very few identified historic resources in the watershed, with the notable exception of Leach Botanical Garden and the urban cluster in Gresham.

Each municipality classifies and protects historic resources, and many historical sites which have been designated as significant may be eligible for the National Register. In particular, the bridges, waterfall, fish ladder, and embankments constructed by the WPA constitute an important ensemble of resources and should be nominated to the National Register. The WMO could help conduct thorough archaeological and historic surveys, and will work to ensure the preservation of identified sites. Particular care should be exercised in any channel changes that could occur near Leach Botanical Garden and the various pioneer cemeteries along Johnson Creek.

OBJECTIVE WS-6
Evaluate Progress Toward RMP Implementation.

It cannot be expected that the path toward enhancement of Johnson Creek will unfold exactly as envisaged in the RMP. Many of the RMP's provisions involve fundamental changes in the way an urban stream is managed. Some elements of the plan will probably be easier to implement than others. The RMP will need to be adjusted as information on the success and failure of various enhancement activities accumulates. Progress will need to be systematically monitored to provide an informational basis for modifying the RMP and its implementation.

Action WS-6-1

Establish and implement comprehensive evaluation program.

Measuring progress of implementation of a plan as diverse as the RMP will be complex. Some aspects of progress are more easily measured than others. It is recommended that the WMO form a technical subcommittee to devise an evaluation program that is both effective and can be accommodated within the WMO's budget. Some of the data gathering could be undertaken by other agencies such as ODFW and the cities, and existing data (including data gathered and analyzed during preparation of the RMP, and new data from state, federal and local agencies) would be utilized as much as possible. The evaluation program might include measurement of:

- In-stream water quality characteristics
- Numbers of spawning salmonids
- Vegetation surveys
- Other key indicator species
- Length of stream banks revegetated
- Numbers of bank enhancement projects
- Review of RMP implementation schedule and benchmarks

Some of these components can be measured and expressed numerically. Others can only be evaluated subjectively. The evaluation program should emphasize the former, whenever possible.

Developing an evaluation program is technically complicated. Implementing it is labor-intensive and expensive. The WMO will work with other jurisdictions to devise a program that obtains the greatest quantity of useful information at a minimum cost. It will also be designed to dovetail with the monitoring programs being conducted by Portland, Gresham, and Clackamas County as part of their stormwater management plans. The U.S. Geological Survey is also collecting water and sediment quality information on Johnson Creek. Additional information on possible components for a water quality monitoring plan are described in Technical Memorandum No. 18.

To the maximum extent possible, volunteers will be used to collect monitoring data. Since September 1992, a volunteer group, the "Johnson Creek Dippers," has been measuring water quality monthly at 12 locations in the creek. This volunteer program will continue with modifications that emphasize visual observations of creek conditions.

Action WS-6-2

Prepare an annual "State of the Watershed" report.

The WMO will prepare an annual "state of the watershed report." This report will include the full results of the evaluation program described in Action WS-6-1. It will also summarize any data on Johnson Creek reported by other agencies. The report will include a record of all volunteer activities. A summary of the report will be included in an issue of the quarterly newsletter (Action WS-2-2).

CHAPTER 5

PAYING FOR THE PLAN

Funds to pay for implementation of the RMP will come from a variety of public and private sources. The discussion of funding sources is prefaced by a description of the benefits produced and the costs incurred by RMP implementation.

Estimated Benefits and Costs

■ BENEFITS

The RMP will produce a variety of benefits, only some of which can be readily expressed in monetary terms. The primary near-term monetary benefits of the RMP stem from the diminution of flood risk for hundreds of existing homes and businesses. Flood insurance and damage costs will be lowered and public safety will be improved. The actions in the RMP designed to reduce damage to existing flood-vulnerable properties would prevent damages estimated at least $28 million over a fifty year period. The actions in the RMP designed to prevent further development from making flooding worse will also save money.

Monetary benefits will also accrue because implementation of the RMP will make the Johnson Creek watershed a better place to live. By protecting water quality and wildlife habitat and reducing flooding, while allowing responsible development to continue, the watershed will attract new residents and visitors. This will, in turn, increase the value of property and the patronage of local businesses. New jobs may be created and, as property values increase, cities and counties will have more funds to spend on local services and capital improvements. Thus, the RMP will act as a catalyst for economic growth, producing widespread, but difficult-to-estimate long-term monetary benefits, as well as the more obvious flood control benefits and the non-monetary benefits of a pleasant environment.

A number of studies have shown that the conversion of former railroad routes to recreational trails increases visitation and produces visitor-serving economic activity. Trailside residents note that the Springwater Trail is already attracting hikers and bicyclists to the Johnson Creek watershed in greater numbers than formerly. As Johnson Creek itself is improved, the amenity value of the Springwater Trail will increase, attracting still more new users. There is also some evidence that proximity to natural areas and recreational resources increases property values. However, because it takes time for community character to change, and for the change to be recognized by homebuyers, it may be many years before significant appreciation in property prices occurs.

The RMP actions designed to improve water quality, fish and wildlife habitat, and recreational opportunities will not only contribute to long-term community improvement but will also produce near-term non-monetary benefits. Measurable improvements in fish and wildlife habitat and passive recreational opportunities will be evident within five years of implementation, although the full benefits of stream improvements will not be realized for 30 to 50 years. Residents and visitors alike will enjoy the benefit of quiet streamside groves and the pleasure of watching fish, birds and animals in a natural setting.

■ COSTS

In order to obtain the benefits described above investments must be made. Most of the direct investment cost will be borne by the public sector. The estimated public sector cost of implementing the RMP is summarized by element in Table 31. The cost estimates should be regarded as planning level estimates. They are based on conceptual, rather than detailed, plans and programs.

TABLE 31
Estimated Public Sector Costs of RMP

	Initial Costs[a]		
PP-1	Capital	Program	Annual Costs
Pollution Prevention[b]	$300,000	$273,000	$15,000
Flood Reduction	14,000,000	165,000	158,000
Fish and Wildlife Habitat Enhancement	650,000	95,000	—
Watershed Stewardship	—	90,000	100,000
TOTAL	**$14,950,000**	**$623,000**	**$273,000**

Notes: a Initial costs are non-recurring costs; that is they are costs which are only incurred once. Initial costs are sub-divided into capital costs and program costs. An example of an initial capital cost is the construction cost of a flood detention basin. An example of an initial program cost is the cost of drafting and adopting a non-point source pollution control ordinance.

b An estimated $800,000 per annum is already being expended by the cities of Gresham and Portland and Clackamas County to control pollution from urban stormwater in the Johnson Creek watershed.

Two kinds of costs are shown in Table 31: initial costs and continuing costs. Initial costs are non-recurring costs; that is they are costs which are only incurred once. Initial costs are sub-divided into capital costs and program costs. An example of an initial capital cost is the construction cost of a flood detention basin. An example of an initial program cost is the cost of drafting and adopting a non-point source pollution control ordinance. Continuing costs are costs that recur periodically, for example, the cost of operating the watershed management organization and the cost of maintaining the capacity of the creek channel.

The initial public sector cost of implementing the RMP will be $15.6 million. All but about $650,000 will be construction cost. The remainder will be the cost to begin a variety of environmental improvement programs including forming the WMO. Continuing costs of about $300,000 will be incurred to implement the RMP. Half of the cost will be to operate the WMO, while the remainder will be used to maintain facilities.

Private sector costs are more difficult to estimate. Private parties may make direct investments in improving the watershed's environment, primarily by revegetating privately-owned creekside lands with native trees and shrubs. Because most of the private investments will be entirely voluntary it is impossible to estimate how extensive they will be. If all stream side private property owners on the mainstem of Johnson Creek participated in the riparian revegetation project, then the total cost for revegetation is estimated to be $1,400,000.

In a few cases, some of the costs of the RMP will be borne indirectly by private parties. An example might be the loss of value of a privately-owned lot in the flood plain that becomes unbuildable or less buildable as a result of environmental regulations in the RMP.

Distribution of Costs and Benefits Among Jurisdictions

■ BENEFITS

As noted above, the primary readily-quantifiable monetary benefits of the RMP stem from flood reduction. Because some jurisdictions are more vulnerable to flooding by Johnson Creek than others, the benefits of flood reduction are not shared equally. Johnson Creek runs through five jurisdictions all of which would benefit from flood reduction to some degree. The sixth jurisdiction, the city of Happy Valley, lies some distance away from Johnson Creek. It would receive no benefit from the measures in the RMP that are designed to reduce flooding of existing structures.

Table 16 shows the estimated damage costs associated with various flood frequencies. An important point to note in reviewing the estimates is that most of damage occurs in the Lents area between Interstate 205 and S.E. 128th Avenue. If the total damage caused in a 25-year storm is valued at $10.8 million, then $10.22 million, or more than 90%, would occur in this reach. The area lies entirely within the City of Portland.

If the flood reduction measures contained in the RMP prevented the 25-year flood from occurring then the damage costs shown in Table 16 would be avoided. The primary beneficiary of flood protection would be the city of Portland. The cities of Milwaukie and Gresham and Multnomah and Clackamas County would all obtain minor benefits from the flood reduction measures.

The benefits accrued by the six jurisdictions as a result of water quality and fish and wildlife habitat improvements and increased recreational opportunities are difficult to estimate monetarily. All jurisdictions, through which the creek flows, would benefit from the improvements collectively. Improvements made to reduce sediment discharge from the upper watershed would benefit all downstream communities because water quality would be enhanced and less silt would be deposited in the channel, reducing its capacity to convey floodwater and its suitability as fish habitat. Fish habitat improvements in the lower reaches may eventually increase the numbers of salmonids that return to the upper watershed, benefiting upstream communities. A reasonable basis for allocation of these benefits would be to assume that they are proportional to the lengths of Johnson Creek mainstem within each jurisdiction. A more complex approach to distribution of non-flood control benefits could be attempted, but it is doubtful that it would be any fairer.

COSTS

Various formulae could be used to share the costs between jurisdictions. Several possibilities are discussed below. However, the formula actually used will likely result from negotiation between the jurisdictions.

A common basis for sharing the cost of a project is in proportion to benefits received. This is complicated in the case of the RMP because the plan has multiple benefits some of which cannot be readily quantified. By far the most expensive portion of the RMP is the flood reduction facilities. Costs of the facilities could be shared by the jurisdictions in proportion to the benefits (avoided damages) shown in Table 16. On this basis almost all the cost would be borne by Portland as the bulk of the avoided damage is within that city's Lents-Powellhurst neighborhood.

As noted above a reasonable basis for dividing the benefits of water quality and fish and wildlife habitat improvements would be proportional to stream miles in each jurisdiction. Costs could be shared accordingly. In fact, this approach to cost sharing is probably not practical. The costs of the RMP, other than flood reduction costs, are quite modest. It would be most practical for each jurisdiction to simply pay for the improvements within its own boundaries. This would avoid the need to negotiate a cost-sharing agreement and, because of the modest costs involved, would not work a hardship on any party.

It could be argued that the division of costs described above is unfair to the downstream communities of Portland and Milwaukie. The rapidly growing city of Gresham relies on Johnson Creek to drain floodwater away. Although Gresham has wisely avoided development in the 100-year flood plain, and thus the potential for damage within its own boundaries, its use of Johnson Creek has contributed to flooding in downstream communities. Development in Milwaukie and Portland occurred many years ago when building in flood plains was largely unregulated. While the properties in the floodplain were always vulnerable to flooding their vulnerability has been increased by development of the upper watershed. As homes, businesses, and parking lots have replaced farm land in the Gresham area, the volume and speed of runoff entering Johnson Creek have almost certainly increased. Based on this premise it could be argued that Gresham should share in the cost of protecting downstream properties. Determining an appropriate share is problematic, because the hydrologic data available is insufficient to allow accurate assessment of Gresham's contribution to downstream flooding. The hydrologic modeling conducted in support of the RMP suggests that downstream peak stream flow is not particularly sensitive to changes in land use in the upper watershed.

An alternative approach would be to share the costs of all facilities based on land area or population. It could be argued that all who live in the watershed, or all lands in the watershed, contribute to the problem and, thus, should pay for the solution.

FUNDING

The RMP calls for actions by cities and counties, other government agencies, the yet-to-be created watershed management organization, and private individuals and corporations. Potential funding sources for each of these parties are described separately below.

■ CITIES AND COUNTIES

Cities and counties are responsible for a number of actions in the RMP. Some of the actions involve capital costs. Construction of new flood detention reservoirs and stormwater treatment facilities are examples of actions involving capital expenditures. Others involve administrative costs that only occur once; an example is the cost of revising an ordinance or regulation. Still others involve recurring annual costs. Channel maintenance is an example of an activity that will have recurring annual costs. Funding each of these actions is discussed below.

Initial Capital Costs

Three actions in the RMP involve significant capital costs for cities and counties. They are:

- construction of flood reduction facilities
- construction of stormwater treatment devices
- revegetation of the riparian corridor on public lands.

Flood Reduction Facilities

By far the largest capital cost will be for flood reduction facilities. They will cost approximately $14 million. Because the flood reduction facilities would benefit all jurisdictions within the watershed the cost should be divided among the jurisdictions in accordance with a formula that takes account of benefits received and responsibility for the present flooding problem (see earlier discussion of distribution of benefits and costs among jurisdictions).

Each jurisdiction will obtain its share of capital costs in the manner it chooses but stormwater fees would be a logical choice. Most jurisdictions in the watershed charge property owners a fee for stormwater management. They would be a logical choice as a funding source because flood reduction is a major component of stormwater management. Furthermore equity suggests that, because everyone living in the basin contributes to the problem, they should also pay for the solution.

Alternatively, the cities and counties in the watershed could try to obtain federal funds to support construction of flood control facilities. There are a number of federal programs for this purpose. They are listed in Technical Memorandum No. 13. One of the largest programs is administered by the U.S. Army Corps of Engineers. Under this program the Corps of Engineers would be required to conduct a feasibility study for Johnson Creek. If the feasibility study demonstrated that the project was cost-effective, in accordance with federal criteria, then it would be designed and built by the Corps. The cities and counties in the watershed would have to contribute 50 percent of the cost of the feasibility studies and a negotiated proportion of the design and construction costs.

Stormwater Treatment Devices

The RMP calls for the construction of fifteen small stormwater treatment projects. Capital costs will most likely be borne by the jurisdictions within which the improvements lie. These projects could also be funded by stormwater management fees. Stormwater management regulations explicitly include provisions for stormwater treatment. Although a number of federal programs provide funds for water pollution control projects it is unlikely that the proposed stormwater treatment devices would be eligible for support.

Revegetation

The RMP also calls for revegetation of the riparian corridor on public lands, much of which lie within parks. Only two park providers, the cities of Gresham and Portland, own lands on the creek. The estimated cost of revegetation is approximately $400,000, although the cost will vary widely from location to location. In some cases where the riparian corridor is intact, albeit degraded, only minor planting and clearing of non-natives may be needed. In others, complete revegetation will be necessary..

The most likely source of funds for restoration of the riparian corridor are the parks and recreation budgets of Portland and Gresham. Another source could be city water quality management budgets because revegetation of the riparian corridor would reduce water temperatures and otherwise benefit water quality. Because planting plans will have to be developed to ensure that revegetation is compatible with other park uses, the costs are likely to be spread over several years. As a result, the annual impacts on each city's budget

will not be large and the expenditures can be planned well in advance.
The riparian revegetation projects may be eligible for funding under a number of federal and state watershed enhancement programs. In Oregon, both the Governor's Watershed Enhancement Board and the Department of Water Resources' Watershed Health Program provide funding for projects of this type. Gresham has already applied for a grant from the Governor's Watershed Enhancement Board to restore the riparian corridor in Gresham Main Park. Some private foundations also support stream revegetation projects.

Initial Program Costs

Initial program costs are start-up administrative costs. A number of actions in the RMP will require a one-time commitment of public agency staff time to draft and adopt new, or modified, regulations. An example is the redrafting and adoption of new regulations for stormwater management at new developments.

In some cases, the additional work required will fall within the normal duties of existing government staff members and will consequently cost very little. In other cases a substantial commitment of staff time will be needed, although the estimated cost of the extra work is modest compared to the capital costs. Sources of funds for initial program costs will include stormwater management fees and, to the extent that the required work complements ongoing city activities, general funds.

Continuing Costs

The primary continuing cost borne by cities and counties will be for maintenance of the creek channel, flood reduction and pollution prevention facilities. The most likely source of funds for these activities will be city and county public works departments' maintenance budgets. Another city and county continuing cost will be financial support of the watershed management organization. Funding of the WMO is discussed in detail below.

■ OTHER GOVERNMENT AGENCIES

The RMP calls for a few actions by government agencies other than cities and counties. The actions involve the development of new plans and enforcement of new regulations. Costs will be borne by the agencies responsible for the actions.

Action PP-2-5 calls for Oregon Department of Environmental Quality to ensure that industrial stormwater generators in the watershed apply for and obtain discharge permits under the NPDES system. Although this action is already required by law it has not yet been fully implemented. It was assumed that one person-year of effort would be needed to take effective action and that this amount should be included in DEQ's budget.
Action PP-3-1 calls for the preparation of stormwater management plans for rural areas at an estimated cost of $100,000. The agencies responsible for preparing the plans would be the soil and water conservation districts. Potential funding sources include the Oregon Department of Agriculture and the U.S. Department of Agriculture, Natural Resources

Conservation Service. Natural Resources Conservation Service programs that might support environmental planning in agricultural areas are listed in Technical Memorandum No. 13.

WATERSHED MANAGEMENT ORGANIZATION

Many actions in the RMP will be undertaken by the newly-created watershed management organization (WMO). Obtaining a stable funding source for the WMO will be critical to the success of the RMP. With a budget of $100,000 the WMO would have a permanent staff, an office and a library focused on watershed management and environmental resources.

Initially the WMO will be funded from a variety of sources which might include jurisdictions in the watershed. In general, participation of the jurisdictions in funding the WMO will not impose new costs on the cities and counties because they will be offset by benefits derived from WMO activities. WMO activities will include citizen education designed to curb practices that cause water pollution, volunteer construction of pollution control facilities and creek enhancement projects, prompt reporting of instances of pollution in the watershed and monitoring to determine the cause of water quality problems. Action taken now by the WMO to reduce pollutant emissions could avoid the need for action by cities and counties later, when water quality regulations for Johnson Creek become more stringent.

Over time it is expected that operating funds for the WMO will be augmented by funds from private foundations and from state and federal sources including Oregon's watershed enhancement programs

There are a number of private foundations that offer grants for environmental improvement projects. A list of foundations supporting activities most closely linked to the proposed WMO charter can be found in Technical Memorandum No. 13. The WMO will establish an adjunct non-profit corporation or enter into an agreement with an existing non-profit corporation to facilitate receipt of funds from foundations and other private parties.

CHAPTER 6

CONTRIBUTORS

Scores of individuals contributed to the RMP in a variety of ways. The Johnson Creek Corridor Committee, named in the frontispiece, directed preparation of the plan. Primary funding and contract management was provided by the City of Portland, Bureau of Environmental Services. The City's project manager was Eric Machorro. Earlier, Jim Soli and Jean Ochsner served as project managers for the City.

The prime contractor for plan preparation was Woodward-Clyde Consultants. John A. Davis served as the Woodward-Clyde's project manager and was the principal author of the report. Craig Harper served as assistant project manager. The following individuals were responsible for preparing portions of the plan and otherwise supporting the planning process.

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In preparing the plan the technical staff were assisted by four task groups. The task groups consisted of members of the Johnson Creek Corridor Committee and others interested in particular aspects of the planning process. The membership of the task groups was as follows:

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Ela Whelan	Clackamas County Department of Utilities
Jeff Uebel	U.S. Forest Service
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Mel Miracle	City of Gresham
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Bill Bradfield	Stream reach representative
Walt Mintkeski	Friends of Johnson Creek
Larry Fishbain	Philip Williams & Associates, Ltd.
Jeff Uebel	U.S. Forest Service
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Jim Carlson	Oregon Association of Nurserymen
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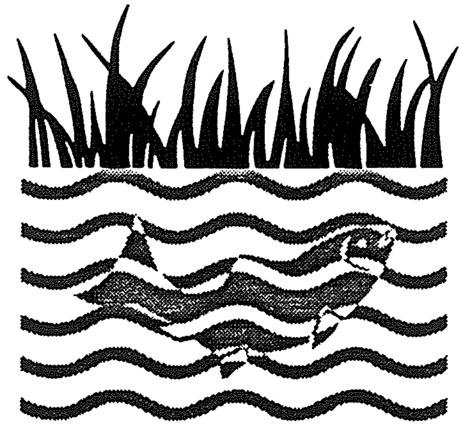
Jim Crumley	City of Milwaukie Planning Department
Rob Kappa	City of Milwaukie Council member
Jonathan Harker	City of Gresham Planning Department
Mary Anne Cassin	City of Portland, Bureau of Parks and Recreation
Mike Bercutt	Opus Homes, Inc.



APPENDIX

Industries In the Johnson Creek Watershed
Which Have Obtained a Permit for Their Stormwater Discharges

Facility	Legal Name	P-Type	Location	City	Zip
88776/A	CGC, Inc.	GEN 12C	E. of Regner Rd., W. of Hogan Rd., S.	Gresham	
107829/A	B.I. Gentry Construction Company, Inc.	GEN 12C	Between 30th & 31st Ave., E. of 190th	Gresham	97030
107834/A	Brown, Lester & Patricia	GEN 12C	Cedar Lake Subdivision	Gresham	97080
107836/A	Cascade Communities, Inc.	GEN 12C	4005 N.E. Division St.	Gresham	
107838/A	Cascade Development Company	GEN 12C	1180 S.E. Hogan Rd.	Gresham	
108049/A	Hemstreet, Greg A.; Rockwell, Mark P.	GEN 12C	2650 S.E. Palmblad Rd. at Hillyard's	Gresham	97030
107868/A	Hunters Highland Inc.	GEN 12C	182nd Ave.	Gresham	
107867/A	Winmar Pacific, Inc.	GEN 12C	E. of 185th Ave., S. of Mari	Gresham	
108003/A	Van Loo, Mike	GEN 12C	S.E. Rex Street and 109th	Portland	
106772/A	Oregon Department of Transportation	GEN 12CA	Milwaukie	97222	
78990/A	Scenic Fruit Company	GEN 12F	7510 S.E. Altman Rd.	Gresham	97080
100484/A	Associated Chemists, Inc.	GEN 12H	4401 S.E. Johnson Creek Blvd.	Portland	97222
106844/A	Miles Fiberglass & Plastics, Inc.	GEN 12H	8855 S.E. Otty Road	Portland	97266
100481/A	Precision Castparts Corp.	GEN 12H	4600 S.E. Harney Drive	Portland	97206
107733/A	Roper Industries, Inc. – dba	GEN 12L	2323 S.E. Harvester Drive	Milwaukie	97222
106157/A	Precision Castparts Corp.	GEN 12L	6465 S.E. Crosswhite Drive	Portland	97206
106956/A	Precision Castparts Corp.	GEN 12L	9109 S.E. 64th	Portland	97206
101366/A	Brod & McClung-Pace Co.	GEN 12L	9800 S.E. McBrod Avenue	Portland	97222
100551/C	East Side Plating, Inc.	GEN 12L	8400 S.E. 26th Place	Portland	97202
107563/A	Union Oil Company of California	GEN 12T	2176 S.E. First Street	Gresham	97030

Wildlife Habitat Protection and Improvement Site Specific Recommendations
Johnson Creek Watershed

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
		MAINSTEM – JOHNSON CREEK	
Mainstem 0.0 -.27 (mouth to 17th)	UFO-99-R: disturbed; primarily an alder forest; Himalayan blackberry dominates shrub layer; connectivity level 2	Low – narrow strip of habitat; lacks species and structural diversity and dead wood habitat	Enlarge riparian zone, where possible; revegetate with native trees, shrubs, and forbs; remove Himalayan blackberry
.27-.35 (begins at 17th St. crossing)	UFC-99-R: disturbed; dominated by alder (sapling and larger trees) in clumps; no well developed shrub layer; exotic grasses; connectivity level 2	Low – narrow strip of habitat; lacks species and structural diversity and dead wood habitat	Widen riparian zone, where possible; revegetate with native trees, shrubs, and forbs; remove Himalayan blackberry
.35-.45	UM: highly disturbed; riparian vegetation lacking; connectivity level 2	Low – narrow strip of habitat; lacks species and structural diversity and dead wood habitat	Widen riparian zone, where possible; revegetate with native trees, shrubs, and forbs; remove Himalayan blackberry
.45-.73 (ends at Milport)	UFO-99-R: disturbed; primarily alder saplings; no shrub layer; connectivity level 2	Low – narrow strip of habitat; lacks species and structural diversity and dead wood habitat	Widen riparian zone, where possible; revegetate with native trees, shrubs, and forbs; remove Himalayan blackberry Remove some instream vegetation to accommodate flood channel capacity goal; re-terrace and soil bioengineer new bank, plant natives as above, and allow to succeed (see Profile #1)
.60-.73	UM: disturbed; alder saplings in clumps; mostly grasses; connectivity level 2	Low – narrow strip of habitat; lacks species and structural diversity and dead wood habitat	Widen riparian zone, where possible; revegetate with native trees, shrubs, and forbs; remove Himalayan blackberry
.73-.96	UFC-99-R: disturbed larger alder trees; no shrub layer; grass to creek edge in local spots; connectivity level 2	Low – narrow strip of habitat; lacks species and structural diversity and dead wood habitat	Widen riparian zone, where possible; revegetate with native trees, shrubs, and forbs; remove Himalayan blackberry
.96-1.14 (ends at Ochoco St.)	UFO-99-R: disturbed; young alder, H. blackberry, trash on stream & on bank; connectivity level 2	Low – narrow strip of habitat; lacks species and structural diversity and dead wood habitat	Widen riparian zone, where possible; revegetate with native trees, shrubs, and forbs; remove Himalayan blackberry
1.14-164 (Ochoco north to 99)	UFO-99-R: disturbed; alder forest primarily; H. blackberry in understory; lawns; connectivity level 2	Low – narrow strip of habitat; lacks species and structural diversity and dead wood habitat	Plus bank restoration needed at Sherrett
1.64-1.75 (in between McLoughlin and RR)	No riparian zone; little or no vegetation, except grasses and H. blackberry; no connection to other habitats	Very low – no habitat Only weed grasses; no riparian cover	Restore riparian zone with native plants (see planting plan)
1.75-2.2	UFC-99-R: disturbed; east bank mostly alder; west bank-grass and H. blackberry; connectivity level 2	Low – as 0.-.27	Restore riparian zone with native plants (see planting plan)

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
2.2-2.45 (south end of golf club at Berkeley St.)	UFO-99-R: mostly sapling alder with scattered larger alder and big-leaf maple; reed canary grass and H. blackberry dominate openings; connectivity level 2	Low – good tree canopy but lacks species diversity, shrub layer and dead wood habitat	Add shrub layer and dead wood component; add shrub and forb layers of native plants; remove exotic invasive plants
2.45-2.6	UFC-99-R: natural; fairly dense stand of larger alder and maple; connectivity level 2	Low to medium – some natives but needs more structural diversity	develop off channel ponds on north bank to provide additional aquatic habitat for wildlife and fish
2.6-6.8	UFO-99-R: disturbed and natural; alder is dominant tree; patches of scattered Douglas fir; H. blackberry is dominant shrub: in local areas (e.g., at south Luther Road bridge) canopy is clumped and scattered sapling alder with more extensive stands of H. blackberry; connectivity level 2	Low – narrow riparian corridor; lacks structural diversity; subject to high disturbance from adjacent development; dead wood lacking	• Widen riparian corridor and revegetate with native trees, shrubs, and herbs. • Remove Himalayan blackberry and replace. • Identify possible connecting areas to upland habitats and revegetate.
Tideman Johnson Park			• Place log barrier at west end of RR abutment to expand aquatic habitat into floodplain; place instream structures (logs) to meander stream channel • Revegetate where necessary
RM 2.7 to 2.9			• Add off channel aquatic habitat on west side of creek across from waterfall area • Replant as necessary with native shrubs and forbs
Bell Station Area			• Remove some instream vegetation to accommodate flood channel capacity goal; bioengineer new bank, plant natives as above (Profile #5), and allow to succeed
5.0 to 5.4	USS-99-R: disturbed; open field area north of creek vegetated mostly by Himalayan blackberry and reed canary grass	low: poor cover, mostly unvegetated or has non-native plants	• Develop off channel to provide additional aquatic habitat for wildlife and fish • Replant with native species
6.8-7.4 (Freeway Land Co.)	UFO-99-R: natural; Pacific willow is dominant tree; canopy area over creek; Himalayan blackberry on steep banks; connectivity level 3	Low to medium – well connected, but seasonal cover and narrow, Himalayan blackberry a problem; lacks dead wood habitat	• Widen riparian corridor and revegetate with native trees, shrubs, and herbs. • Remove Himalayan blackberry and replace. • Identify possible connecting areas to upland habitats and revegetate.

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
6.61 Corner of Knapp Road & I-205 (Freeway Land Co.)	WM-99-R: disturbed; area mowed and being filled from north end; willow, rushes, sedges dominate; snags abundant along old stream channel; seasonal cover; connectivity level 2	Low to Moderate – land disturbed but still native plants; hydrology and soils give site good potential for restoration of enhancement	• Possible contaminants from chemical and fuel tanks, parking lot runoff. • Expand and diversify wet meadow area in SW corner of property to include emergent marsh; stop filling. • At Bell Station, remove vegetation in channel to accommodate flood control goals; bioengineer new bank, and revegetate per Profile #5. • Maintain link to other habitats.
7.24 (Freeway Land Co.) S.E. at Smurfitt, on south side of Johnson Creek	UFC-90-R: developed/disturbed, dominated by 40-50 year old cottonwood, hawthorne, and flowering cherry. Himalayan blackberry a dominant in shrub layer; ground cover mostly weed species; snags and dead and downed wood common; barriers to wildlife from cyclone fence and industrial area to west; beaver sign and good birds; seasonal cover; connectivity level 2	Moderate – lacks some species and structural diversity, but native plants and water present or available; good dead wood habitat for cavity nesters; provides corridor from adjacent forest (to the southeast) and Johnson Creek	• Possible pollution from industrial sites to west. • Control weeds and re-establish native understory. • Potential to reconnect old channel and re-establish hydrology to marsh area to S.W. side of property, thereby improving connection to other habitats.
7.4-8.06	UFO-99-R: natural; dominated by a mix of sapling and larger alder; H. blackberry is dominant shrub; no snags; connectivity level 2	Low to medium – well connected, but seasonal cover and narrow; Himalayan blackberry a problem; lacks dead wood habitat	• Widen riparian corridor and revegetate with native trees, shrubs, and herbs. • Remove Himalayan blackberry and replace. • Identify possible connecting areas to upland habitats and revegetate.
8.06-8.63 (south of Franz Bread Co.) (Brookside)	USS-99-R: Narrow riparian strip dominated by a thicket of sapling alder and willow with a few scattered big leaf maple: associated with upland wet meadow of H. blackberry and various grasses; no snags; connectivity level 3	Low to medium – some species diversity but narrow zone of vegetation; has potential for enhancement	• Enhance riparian vegetation with native trees and shrubs. • Restore old meanders and remove fill to provide ponded area and create wetland or wet meadow edge.
8.63-9.6	UFC-20-R: disturbed and natural; mixed conifer canopy dominated by western red cedar; H. blackberry dominates shrub layer in disturbed areas; some openings that are grassed (lawns); connectivity level 2	Medium – some diversity in the tree canopy, shrub, and herbaceous layers, but problems with H. blackberry and openings at creek side	• Control Himalayan blackberry and other exotics. • Enhance riparian vegetation with addition of native shrub and herbs. (See Profile #2.)

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
9.6-10.25 (Bundee Pk included)	UFC-90-R: natural; forested riparian area dominated by alder with scattered cedar and big leaf maple; a few snags (alder) sword fern in ground layer; connectivity level 3 (at Bundee Pk)	Medium to high – native plants and some dead wood habitat; well connected; high potential for enhancement	• Control exotic plants. • Revegetate north bank at Bundee Pk with natives plants. • Add downed logs. • Protect side drainages.
10.27-12.52	UFC-99-R: natural; narrow riparian vegetation dominated by sapling alder; scattered shrubs - rose and H. blackberry; open grassy areas to creek; no snags; connectivity level 2	Low to medium – some areas connected to upland habitats; paths of native shrub	• Control exotics. • Create snags, where possible. • Maintain connection to upland habitats.
11.8 to 12.0	WSS-99-R: natural; willow is dominant shrub in this community which has developed within the channel	High: native vegetation that is rare within watershed; well connected	• Expand SS habitat into wider riparian area, if possible • Coordinate proposed expansion with flood control element (see Profile #7)
12.52 - 12.67 both sides	USS-80-R: disturbed; riparian area with open shrub density; has been disturbed but connectivity level 3	Low – disturbed; dominated by non-natives; stream cover lacking; beaver activity within survey area	• Restore riparian vegetation. • Maintain connection to upland habitat.
At 12.59 south side	WMO-99-R: natural: open shrub layer; connectivity level 2	Low – invading Himalayan blackberry and very dense reed canary stand grass; natural but non-native	• Restore native vegetation and allow to succeed
12.78 south side forest east of Jenne Road (upland site)	UFC-90-R: natural; 80-100 year old fir and cedar; connectivity level 2	High – many native species (rare plants-tall bugbane), seep present; large block of habitat	• Protect butte. • Control exotic plant invasion on fringes.
12.67 - 13.03 both sides	WSS-99-R: natural and disturbed; closed shrub canopy; connectivity level 2	Medium – has Springwater Trail through area, but vegetation is mostly native; beaver present	• Enhance habitat through control of exotic plants and revegetate with native plants
13.03 - 13.07 north side	UFO-40-R: natural and disturbed; includes Cedarville Park; cedar and big-leaf maple with some 36" dbh trees; 50-100 years age range; few shrubs - manicured; older alder making snags; connectivity level 2	Low – shrub layer not developed; creek side lacks vegetation	• Add native shrub and herb layer within riparian zone
13.07 - 13.38 North side (north of Springwater Trail)	UFC-70: natural; includes weedy meadow along trail, occasional large cedar (36" dbh); some 100' tall fir and cedar; snags rare; connectivity level 1	Medium to High – mostly native; moderate problem with holly, ivy, and Himalayan blackberry; not well connected (if exotics removed, would become native forest)	• Remove exotic plants. • Create snags where possible.

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
13.38 - 13.58 overlays 190th	USC-99-R: disturbed; mostly H. blackberry; no dominant tree but has scattered ash trees; shrub layer dominated by H. blackberry; beaver activity; connectivity level 2	Low – mostly disturbed and dominated by Himalayan blackberry	• Investigate hydrology for possible restoration of wetland forest.
13.58 - 13.88 north side	WFC-99-R: natural; extensive H. blackberry; mostly 15-20 year old trees with some older alder; snags lacking connectivity level 2	Medium – good natives but many trails, H. blackberry and possible pollution from the subdivision to north of site	• Allow tree canopy to succeed naturally. • Enhance with native shrubs and herbs. • Remove and control Himalayan blackberry.
13.88 - 13.90 (mouth of Butler Creek) both sides	UFC-50-R: natural; alder and cedar (60 years old); salmonberry and Douglas-fir dominate; grazed by 14th street; Potential tall bugbane habitat south of creek; coyote sign; connectivity level 3	Medium to high – young forest but relatively undisturbed	• Protect habitat. • Control grazing in riparian zone. • Maintain connection to uplands.
13.90-14.30	UFC-99-R that connects to WFC-99-R as above under RM 13.58	as above	• expand small open area to provide additional aquatic habitat for wildlife and fish • Revegetate with native plants and control H. blackberry
14.30 - 15.34 (east of 209th) both sides	UFC-99-R: very disturbed and weedy; few trees, H. blackberry dominated; connectivity level 1; beaver dam	Low – Himalayan blackberry and no riparian shade	• Revegetate riparian zone. • Control exotic.
15.34 - 15.42 south side (upland)	UM-99-R: natural; H. blackberry, fescue, and canary grass dominate; old grazing area; connectivity level 2	Low – little variety and extensive exotic invasion; poor connectivity	• Control exotic plants and replace with natives. • Revegetate. • Burn and reseed with native grasses/forbs.
15.42 - 15.58 both sides	WFO-60-R: natural; 40' ht. shrubs include H. blackberry and red osier dogwood; willow; beaver; connectivity level 2	Mod to Low – no recent disturbance; street drainage may be a problem	• Remove and replace exotic plants. • Control possible street drainage.
15.58 - 15.83 both sides	UFC-90-R: natural; 60' alder and ash; uniform blackberry; snags are rare; connectivity level 2	Low – underdeveloped and poor diversity in shrub and herb layer	• Remove Himalayan blackberry. • Revegetate with native shrubs and herbs. • Enhance snag habitat, where possible.
16.13 - 16.58 (Along Springwater Trail) both sides	WFC-50-R: natural; willow and alder forest; native shrubs; connectivity level 3	High – excellent songbird (especially alder) habitat for neo-tropical migrants; habitat in urban area	• Protect habitat. • Plant native grasses and forbs along Spring Water Trail. • in old channel meander (RM16.1-.2), expand and reconnect, where possible, remnant wetlands

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
16.21 - 17.06 (Walter's Hill) both sides	UFC-50-R: natural; forested and residential; big-leaf maple, fir and alder with hazelnut and salmonberry; diverse, healthy but some problems; connectivity level 2	High – good diversity of native plants; possibility of springs; large block of habitat	• Protect habitat.
17.06 - 17.98 westside	UFC-90-R: natural; alder 70'& 50-60 yrs. old; salmonberry and sword fern; snags uncommon; connectivity level 2	Low to Medium – low diversity but many native species; beaver present	• Enhance with plantings of native conifers, shrubs, and herbs. • Check possible illegal fill at road expansion.
17.98 - 20.00 (Brick factory area) both sides	UFC-99-R: natural; alder with cedar just ea. of 252nd; native shrubs; good shading; snags common in places; scattered large trees; connectivity level 2	Medium to High – young forest but good natives; difficulty of public access provides protection to resources	• Protect habitat. • Create downed wood habitat. • Control livestock access to creek.
18.53 - 18.65 (east side at 252nd)	WFC-80-R: natural; ash of uniform size with some large cottonwood (80'); wild rose; slough sedge; no snags; connectivity level 2	High – uncommon habitat type with dominant native plants	• Protect habitat. • Enlarge wetland forest into pasture area.
20.00 east side (same forest so. of Hwy 26)	UFC-60-R: natural; alder and big leaf maple at 60+ yrs; some ash with cedar; few snags; connectivity level 2	Moderate to High – undisturbed; good native plant diversity; but broken by freeway	• Protect habitat. • Connect fragments under freeway
20.33 - 20.81 (E. Hwy 26, N. Stone Rd.) both sides of creek	WFO-60-R: disturbed; 30 year old alder; native shrubs; reed canary grass; connectivity level 2	Low – poor diversity and possible pollution	• Control pollution sources. • Enhance habitat with native plants.
at 282nd	Mowed ditch draining to J. Creek; has some parking lot drainage adjacent to "Precision Products"	Low – mowed	• Restore riparian vegetation along mowed ditch.
20.81 - 21.08 both sides	WFC-90-R: disturbed; 40 yr. old ash; occasional taller cottonwood; lawn grasses; mink; connectivity level 2	Low – many yards; no native plants in understory; some potential pollution from nurseries	• Add native shrub and herb layer. • Identify and control potential pollutants. • Remove electric fence in creek.
21.08 - 21.87 (at junction of Stone and Short roads) both sides	WFO-60-R: disturbed and agricultural; alder, ash, and some cotton- wood forest; H. blackberry; no snags; reed canary grass; connectivity level 2	Low – often very narrow riparian; hayed and grazed; chemicals/cows present	• Enhance shrub layers in riparian area. • Control cattle access. • Create snags, where possible. • Ensure cottonwood recruitment. (See Profile #3.)
Break in riparian zone at 21.87- 21.96	Grazed area: reed canary grass; no riparian vegetation	Low – no vegetation cover	• Restore riparian vegetation. • Control livestock access to creek. • Remove reed canary grass. (Profile #3)

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
22.41 - 22.99 both sides (east and west of Pleasant Home Rd.)	WFC-80-R: disturbed; alder and ash dominate; 30-yr old forest; H. blackberry; possible springs snags are common; connectivity level 4	Moderate to High – many native plants; good songbird and woodpecker habitat; well connected, high potential for enhancement	• Protect habitat. • Control Himalayan blackberry. (See Profile #3)
22.99 - 23.24 both sides (east of Pleasant Home Rd.)	UFC-60-R: parts natural, others disturbed; big leaf maple and Douglas-fir dominate; vine maple; small area of palustrine wetlands; no snags; connectivity level 2	Moderate to High – native plants plus some wetland areas; lacks shrubs and dead/down wood	• Add native shrubs and herbs. • Create or add dead wood habitat. • Enhance wetland and protect.
23.24 - 23.40 both side (west of Bluff Rd.)	UFC-20-R: natural and developed; 70-yrs. old cedar, Douglas-fir, salmonberry dominate; possible springs snags and little dead/down wood; connectivity level 2	Moderate – native plants but little diversity; ivy is encroaching	• Enhance native plant diversity in all layers. • Control ivy. • Protect springs.
23.40 - 23.60 both sides (begins at east side of Bluff Rd. between Bluff Rd. and 327th)	WFO-70-R: disturbed; 25 yrs. old; alder and willow dominate; snags lacking; H. blackberry encroaching; connectivity level 2	Moderate – young forest with mix of native and exotic plants; H. blackberry and reed canary grass could be a problem	• Replace exotic plants with natives.
23.60 - 24.90 both side (east of 327th at S.E. end of large pond	UFC-90-R: disturbed and agricultural; 40-yr. old forest of alder with pasture grasses underneath; snags rare; connectivity level 3	Low – poor structural and species diversity; culvert at 347th emptying possible contaminants into creek	• Correct potential water quality problem. • Add native trees, shrubs, and herbs. • Control livestock access to creek.
24.90 - 25.05 both sides (E. 347th and water tower)	UFC-20-R: natural; Douglas-fir, cedar and alder; 70 year old forest; H. blackberry; some snags; tall stumps; connectivity level 2	Moderate to High – good natives in over-and understories; snag habitat	• Protect habitat. • Control exotic plants. • Remove dam in creek.
UPPER JOHNSON CREEK TRIBUTARIES			
25.05 - headwaters	UFC-99-R: disturbed; red alder; no access for survey		Protect headwater by maintaining native vegetation (see Profile #8)
Kelley Creek both sides (mouth at Johnson Creek below Foster Rd.)	UFC-80-R: disturbed; residential; 75 years old; Douglas-fir and cedar dominate; shrub layer scattered; sword fern and trailing H. blackberry in ground cover; no snags; connectivity level 1 (to Johnson Creek); cover broken by roads	Moderate – some native plants but under-manicured by residents leaving poorly developed shrub and herb layer; rock walls at pond block passage for fish	• Add native shrub and herb layer. • Remove fish barriers. (See Profile #4)

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
Kelley Creek above (south of) Foster Rd. east side of 162nd	UFC-40-R: natural and disturbed; trash in creek area by road; cedar and big-leaf maple, salmonberry and swordfern dominate; springs possibly present; snags & dead/down wood rare; connectivity level 2	Moderate – mix of natives and exotics but lacks some structural diversity	• Enhance native tree, shrub, and herb layers. • Protect springs. • Add downed logs in aquatic and upland habitats. (Profile #4)
Kelley Creek at crossing with Richey Rd. (east of Foster Rd.)	WFO-60-R; disturbed; scattered larger (100') cottonwoods and Douglas-fir in alder-dominated forest; H. blackberry is dominant shrub; mowed and grazed in areas; possible springs; snags rare; connectivity level 2	Low to Moderate – mostly native species but lacks structural diversity; needs more riparian vegetation; opportunity in flat areas to restore wetland areas	• Enhance riparian vegetation. • Restore wetlands in flat areas. • Create snags where possible. (Profile #4)
Kelley Creek west of Rodlun Rd.	UFC-80-R: disturbed and agricultural; 60-80 yr old forest; Douglas-fir and cottonwood up to 120' fall; no dominant shrub and pasture grasses in herb layer; no snags; mainly agricultural land; connectivity level 2	Low to Medium – lacks structural diversity in understory and ground layers but good potential for improvement	• Enhance shrub and herb layers. • Control livestock access. (Profile #4)

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
UPPER JOHNSON CREEK TRIBUTARIES			
Unnamed Trib. #1 Kelley Creek N. of Mitchell Creek	UFC-70-R: natural; Douglas-fir and cedar dominate; cedar in midstory also; 50-60 yrs. old; H. blackberry in shrub layer; possible springs; snags rare; dead/down wood common; connectivity level 1 (to Kelley Creek)	Medium – fair species and structural diversity; cedar regeneration not common in urban areas; some problems with H. blackberry, ivy and holly	• Control exotics. • Enhance shrub and herb layer with native plants. • Protect springs.
Unnamed Trib. #2 - Kelley Creek at Pleasant Valley School	WFO-70-R: natural and disturbed; alder/ash forest; native shrubs, including snowberry; plus exotics (H. blackberry); possible springs; connectivity lacking for surface resources but connected somehow hydrologically	Medium – mix of native/non-native but good structural diversity; excellent songbird habitat; potential environmental educational opportunity for school	• Enhance wetland forest. • Control exotics and replace with native plants. • Explore opportunity for ecological education at nearby school. (See Profile #6, 4)
Mitchell Creek W. of 162nd	UFC-60-R: natural; alder/cedar forest 60-80 yrs. old; salmonberry and H. blackberry dominate shrub layer; trailing blackberry dominates herb layer; potential tall bugbane habitat; snags uncommon	Medium to High – good species and structural diversity with a few problems; dumping and potential pollution from package plant	• Protect riparian vegetation. • Create snags, where possible. • Control potential pollution from package plant. • Remove illegal road crossing. (See Profile #4)
Mitchell Creek cont'd. E. of 162nd	UFC-10-R: natural; 60-yr. old Douglas-fir and cedar forest with hazelnut and trailing blackberry and swordfern as shrub and herb dominant; appears to have been thinned about 20 yrs. ago; snags uncommon and dead/down wood rare; a few scattered 36" dbh Douglas-fir; connectivity level 1 (to Kelley Creek)	Medium – nice mix of native plants in all layers; poor connectivity; disturbance potential from adjacent housing	• Protect native riparian vegetation.
South Fork Butler Creek "Black Locust Square"	UFC-99-R: disturbed; red alder and big-leaf maple are dominant, except S.W. section of forest is nearly a pure stand of black locust; shrub layer dominated by salmonberry, hazel, vine maple, and Himalayan blackberry; ground cover dominant include trailing blackberry and sword fern; snags and downed wood rare; connectivity level 1.	Low to Moderate – native vegetation present but site lacks connection to other habitats; dead wood habitat lacking	• Control Himalayan Blackberry and black locust trees.
"Sunshine" Creek Trib. to Johnson Creek, whose mouth is at Telleford Rd., at dead end of Hideaway Rd.	WFO-70-R: natural; alder/willow forest; some H. blackberry and reed canarygrass; springs possible; beaver dams; snags rare; connectivity level 2. Note: No access into site - private land	Medium to High – some H. blackberry encroachment and grazing problems but series of beaver dams have created ponds and wetlands	• Protect habitat at streamside and connect uplands. • Control livestock access. • Control Himalayan blackberry. (See Profile #3, 4)

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
N. of dead end; west of Hideaway Rd.	UFC-99-R: natural, disturbed and agricultural; 40 yr. old uniform alder forest; salmonberry, elderberry and Himalayan blackberry are dominant shrubs; buttercup and pasture grasses dominate herb layer; connectivity level 2 (upstream and downstream)	Low – poor species and structural diversity generally; grazing into creek; Himalayan blackberry problem; fill problems	• Enhance riparian vegetation. • Control Himalayan blackberry. • Control livestock access. • Remove potential illegal fill on eastside of creek.
Unnamed tributary to Johnson Creek South side at 282nd & Stone Rd. both sides	UFC-60-R: natural; big-leaf maple and cedar forest; no dominant shrub; swordfern dominates herb layer; springs present; no snags or dead/down wood; connectivity level 1 (to Johnson Creek)	Low – poor diversity; surrounded by ag. and rural residential areas with potential pollution problems.	• Add native shrub layer. • Protect springs. • Create snags, where possible. • Control potential pollution sources.
Hogan Creek (enters Johnson Creek just east of brick factory)	UFC-80-R: natural and disturbed; forest dominated by red alder, big-leaf maple, Douglas-fir and other conifers; sand and gravel operation near headwaters; snags rare; connectivity level 3	Medium to High – contains native plants and is connected to larger blocks of interior forest habitat and interspersed with open pasture/meadow habitats.	• Replant riparian area where sparse at sand and gravel operation. • Protect interior forest habitat. • Dense riparian area where vegetation is impacted by livestock.
	UPLAND HABITATS		
86th Avenue Forest	UFC-80-R: natural; dominant trees include Douglas-fir, big-leaf maple and red alder; shrubs include Oregon hazel, vine maple, and Himalayan blackberry; no snags or downed wood; Johnson Creek goes through site; connectivity level 1	Medium – although shrub layer and ground cover is sparse, site provides only real upland habitat between Johnson Tideman Park and Mt. Scott; area is protected from human disturbance by perimeter of blackberry	• Remove Himalayan blackberry in understory and garbage. • Revegetate tree, shrub, and herb layer with native plants.
Upland Habitat S.E. of Freeway Land Co. at 112th Street	UFC-60: natural; upland forest dominated by big-leaf maple with Douglas-fir and western red cedar; Himalayan blackberry dominates shrub layer with swordfern and trailing blackberry as dominant ground covers; tall bugbane present; possible springs; snags and downed wood rare; yew present; mix of bird species; year round cover; connectivity level 1	Moderate – good mixture of native plants in all layers; dead wood habitat and linkage to other habitats missing; however, provides important block of upland habitat for plants and animals	• Control weeds/invaders; block access to ORV field to south. • Enlarge forest link to north to Johnson Creek.

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
Walter's Hill Complex (40, 41, 42) (Boring Lava Hills)	UFC-80: natural and disturbed; alder, big-leaf maple and Douglas-fir dominate; shrubs include vine maple; salmonberry and Himalayan blackberry; few snags but large scattered stumps and log; trails and driveways in site; connectivity level 2 (by several small creeks to Johnson Creek)	Medium to High – large block of forested land on a series of linked hills; several drainages occur within complex	• Replace Himalayan blackberry with native shrubs. • Control motorcycle use on trails. • Maintain low density housing.
Jenne Butte (also see RM 11.78 above for north slope description)	UFC-70-R: natural; overstory dominated by Douglas-fir; big-leaf maple, red alder, and some cedar; shrubs include blue elderberry, vine maple, hazel, and domestic cherry; herb layer includes sword fern, starry Soloman's seal, and baldhip rose; snags few and scattered; some hiking and horse trails and domestic animals (sheep, goats) use, connectivity level 3	High – species and structural diversity of native plants; well connected; large block of habitat; several small drainages; lacks snags and has potential for increased disturbance	• Protect butte. • Control exotic plant invasion on fringes. • Control domestic livestock. • Maintain open space corridor to the northeast and drainage to Kelley Creek.
Bundee Park (at Deardorff Bridge)	UFC-70-R: natural; overstory dominated by Douglas-fir; big-leaf maple, red alder, and some cedar; shrubs include blue elderberry, vine maple, hazel, and domestic cherry; herb layer includes sword fern, starry Soloman's seal, and baldhip rose; snags few and scattered; some hiking and horse trails and domestic animals (sheep, goats) use, connectivity level 3	High – high species and structural diversity of native plants, snags, and river meander; site used as model for native riparian forest	• Protect park and expand, if possible. • Stabilize north bank east of bridge.
Barbara Welch at Foster Road	WFC-99-R: natural; steep banks dominated by young alder, big-leaf maple, willow, and Himalayan blackberry; connectivity level 2	Medium – good species and structural diversity; well connected to Johnson Creek and upland sites; steep banks are unstable and dead tree habitat is lacking	• Replace Himalayan blackberry with native plants. • Continue revegetation of Riparian strip to stabilize bank and control erosion.
Barbara Welch Rd Uplands (pt of Boring Lava Hills)	UFC-80: natural: upland forest dominated by Douglas-fir, big-leaf maple, red alder, and some cedar; shrub and forb layer also dominated by natives; connectivity level 3	High: native species dominate with vegetation developed in all layers, well connected, and water exists as seeps and small drainages.	• Protect upland habitat. • Remove exotic vegetation.

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
Powell Butte	UFC-70 and UM: natural and developed: this site is unique in that it contains two major habitat types: the meadow has been grazed and contains some invading hawthorn shrubs; the forest is mature maple and alder with 30-50 year old Douglas-fir; standing dead wood is common with some dead and down wood from windthrow	High: upland meadow habitat is rare within the metropolitan area.; native species dominate and the area is well connected	• Protect encroachment of forest especially on south side where habitat joins the creek riparian area • Remove and replace Himalayan blackberry and exotic grasses with native plants
Kelly Butte (south slope only)	UFC, WFC, WSS and UM: natural: This butte possess a mixture of forest (western hemlock), wetlands, and meadow. The south slope contains the only known population of wild trout lilies within Portland; dominant trees include Douglas-fir, western hemlock and Pacific dogwood; shrubs include western hazel, Oregon grape, wild rose and vine maple; forb layer is a diverse mix of native species	Medium to high: the area is surrounded by development and roads but has several habitat types and has two rare plant communities - western hemlock forest and wild trout lilies	• Protect butte from further development especially along south slope within the Johnson Creek watershed
Unnamed Butte (N, E, and W Slopes only); headwater to Sunshine Creek	UFC-90-R: natural: large block of forested habitat similar to other upper watershed buttes; dominant trees include Douglas-fir, big-leaf maple, western red cedar, and alder; water present as small drainages and seeps;connectivity level 2	High: native plants are dominants, water is present, and the area is well connected to other habtiat types on all sides	• Protect area from fragmentation and invasion of exotic plants
Mt. Scott	UFS and UFC-80-R: natural and disturbed: forest canopy is dominated by Douglas-fir, maple, and alder but part of site has been developed for housing and open agricultural field: contains Veterans Creek; connectivity level 2	Medium to high: although part of the area has been disturbed, the site has potential for improvement along Veterans Creek and is connected to wetland habitat and Johnson Creek	• Protect area • Enhance habitat along Veterans Creek by revegetating riparian area and adjacent buffer zone with native plants • Control exotic invasive plants
Willamette Cemetery Hill Lincoln Memorial PK	Open developed area and UFC on north and east slopes: natural and disturbed: open canopied forest of native trees including Douglas-fir, big-leaf maple and alder: developed for cemetery and planted with non-native trees and shrubs : has small tributary creek to Veterans Creek; connectivity level 2	Low: large disturbed area with many non-native plants	• Protect remaining forest • Plant buffer area between cemetery and forest with native shrubs and forbs

Wildlife Habitat Protection and Improvement Site Specific Recommendations (Continued)

Site by River Mile	General Habitat Description	Limiting Factors and Habitat Value	Recommendations
Wetland Sites, including wet meadows (Freeway – Land Co.); wetland shrub/scrub habitats (middle reaches), and open and closed canopied wetland forest habitats (upper basin)	details given above by mainstem river mile or in upland habitat section	Values are mostly high for all wetland habitats because of their rarity within the watershed	• Protect all sites • Enhance or expand habitat where possible • Determine boundaries of existing wetland and potential boundary for enlarged wetland • Develop site-specific plans • Remove exotic vegetation • Fence where necessary

Notes:

Low Habitat Value: Generally applied to areas lacking in vegetative and wildlife species diversity; lacks structural diversity, e.g., only one to two vegetative layers present and age class diversity is noticeably absent; canopy closure is less than 30% which will not provide sufficient shade to control stream temperatures (if present) or provide thermal cover for wildlife; completely or mostly non-native species.

Medium Habitat Value: Generally applied to areas with some vegetative and wildlife species diversity; provides at least two vegetative layers (tree, shrub, and herbaceous); structural diversity also includes a variety of age classes with possibly some recruitment of young trees; canopy closure can range from 30% to 60% providing shade and thermal cover; plants may be a combination of native and non-native; water is present or nearby.

High Habitat Value: Generally applied to areas with a high level of vegetative and wildlife species and structural diversity; canopy closures range from 60-100% providing excellent shade and thermal cover; all vegetative layers are well developed and are dominated by native species or non-natives that are not invasive and provide food or shelter for wildlife; water is available.