CHAPTER 9: RECOMMENDED PLAN IMPLEMENTATION

Service Level 1 is the recommended plan for the Woodland/Woodard basin, based on cost and effectiveness at meeting local stormwater management goals. This chapter describes the specific tasks for implementing the recommended plan, and discusses some of the issues involved in implementing specific projects.

9.1 OVERVIEW OF THE IMPLEMENTATION PROCESS

Implementation of the basin plan will involve three basic steps: adoption, implementation, and revision. Each step is discussed briefly below.

9.1.1 ADOPTION

The basin plan must be adopted by Thurston County, Lacey and Olympia in order to work effectively, because the plan recommendations span all three jurisdictions. The county commissioners and city councils will take public testimony on the plan at public hearings publicized through the media. Each jurisdiction may adopt the plan as written or direct the staff to prepare changes. Any revisions proposed by one jurisdiction must gain the support of the other jurisdictions so that all three jurisdictions adopt the same version of the plan. The basin plan may also be adopted by reference in the jurisdictions' Comprehensive Plans, which would give the basin plan additional authority. Comprehensive Plan revisions are reviewed by the appropriate Planning Commission, then forwarded to the commissioners or city councils with a recommendation.

The plan will also be submitted to the Department of Ecology for approval. The Department may also approve or request revisions. Approval by the Department of Ecology will make the recommendations eligible for a variety of state grant and loan programs.

9.1.2 IMPLEMENTATION

Adoption by the county and cities does not commit actual dollars to specific recommendations. Each recommendation must then go through a separate implementation process, depending on the nature of the recommendation. The cost estimates will be refined and the details of each recommendation will be fleshed out at that time. Each recommendation will be subject to further public review through the implementation processes.

Some of the plan's recommendations will require revising local ordinances or regulations. For instance, the nonstructural management plan recommends restricting development in the floodplain. This recommendation has already been incorporated into the county's revised critical areas ordinance, following review by the county Planning Commission and adoption by the county commissioners. However, county building regulations must still be revised to become consistent with the critical areas ordinance and fully implement the basin plan recommendation. This will require additional actions by the county commissioners and more

opportunities for public comment. The cities must also revise their building regulations to implement this recommendation.

All city and county capital facilities must be included in the jurisdictions' capital facilities plans, which are adopted as part of the Comprehensive Plans. The capital facilities plans must support the projected population growth for 20 years, and identify sources of funding for 6 years. The capital facilities plans cover all capital projects including sewer, roads, parks, etc, and they must balance the stormwater projects against all the other public needs. This process may lead to some stormwater projects receiving lower priority. The capital facilities plans may be updated once a year. The capital recommendations must also be coordinated between jurisdiction so that the correct project share is budgeted in the appropriate year for joint projects.

The county and cities currently have a general interlocal agreement on stormwater projects, which provides the basis for shared participation on projects. Specific agreements attached to the general agreement detail the actual cost shares for various projects. For instance, the ambient monitoring agreement details the annual water quality monitoring budget and specifies the financial contribution of each jurisdiction. Some of the basin plan recommendations will require development of new interlocal agreements and/or revision of existing ones. These agreements must be approved by the county commissioners and city councils.

Each recommendation must be incorporated into the appropriate agencies' annual work plans and budgets. The annual planning process usually begins in early summer for the local jurisdictions, leading eventually to budget approval by the end of the year. Coordination between jurisdictions begins early in the planning process, which insures that each jurisdiction's budget allocation reflects their correct share for joint projects.

The commissioners and city councils review and approve the annual plans and budgets, with opportunities for public comment. No actual funds are committed to any project or program until this time. Each jurisdiction has its own specific process for adopting the annual budget. The cities accomplish most of the initial review and revision in subcommittees. The county commission requests input from the Storm and Surface Water Advisory Board, prior to approving the stormwater budget.

Many recommendations identify a "lead agency". The lead agency for capital projects is usually the jurisdiction where the project will be constructed. The lead agency is responsible for making sure that all the needed interjurisdictional coordination occurs. The lead agency for capital projects and some nonstructural projects usually does the work, pays for the project, and bills the other participating jurisdictions. Some recommendations will be implemented separately by each jurisdiction, but planned cooperatively. The Stream Team program is an example of how the local jurisdictions plan and coordinate a program together,

even though it is funded separately. Many drainage basin recommendations require this kind of close coordination because the basins cross city and county boundaries.

9.1.3 REVISION

The basin plan must be revised and updated in the future, as the basin changes and additional information becomes available. Monitoring will be critical to revising the basin plan.

Ambient monitoring will indicate the overall trends in the condition of the watershed. If monitoring detects continued declines in water quality or habitat, additional measures may be needed to protect the basin's resources. Project-specific monitoring will provide essential information for determining the most effective actions.

Project-specific monitoring will be incorporated in the funding and operation of each capital project and will include pre-construction (baseline) and post-construction data collection. Project-specific monitoring plans must be designed to portray as accurately as possible the effectiveness of each management measure under a range of environmental conditions, which will take several years.

The results of monitoring will be interpreted for management implications and fed back into the basin planning process. As the basin develops, the conditions will change and the basin model will need to be updated to reflect the changes. The model will be revised and the original predictions will be checked periodically, perhaps once every 10 years. Sufficient time must elapse between model runs to implement and monitor plan measures and land use changes.

Between model runs, the jurisdictions will continue to monitor and report on the basin's water resources through ambient water quality monitoring, stream flow and precipitation monitoring, habitat surveys and citizen reports. The plan will be revised to reflect the additional knowledge, and the revisions will go through an adoption process similar to the original adoption. In this way, the basin plan will be a dynamic document that evolves in response to changing conditions.

9.2 PROJECT PRIORITIZATION

The Storm and Surface Water Advisory Board worked with staff to evaluate each capital facility recommendation against several criteria, in order to prioritize the projects. The nonstructural recommendations were not ranked because of the difficulty in comparing a program such as enforcement or education with a capital facility such as a stormwater treatment pond. The project prioritization presented here represents the county staff and citizens' best effort to identify the most important problems and projects in the basins. The basin plan priorities presented here are intended to provide an objective, cost-benefit basis for future actions. However, each jurisdiction will probably need to rearrange the list to reflect its own priorities, construction schedules, and financial limitations.

The capital projects were ranked using a point system, with points assigned to each of the several criteria. Table 9-1 shows the ranking criteria and table 9-2 shows the prioritized list of projects along with the final score of each project.

The Storm and Surface Water Advisory Board reviewed the prioritized project list and identified projects that require land acquisition. The project sites were field-checked to discover which sites had imminent development pressures. The following projects were identified as high-priority for land acquisition:

- WL7 15th and Enterprise
- WL15C Martin Way East Additional Treatment
- WL15A Martin Way Carpenter Road Gravel Pit
- WL26D Eagle Creek Detention Facility
- WD12B South Bay Road Detention Facility
- WL26F Fox Creek Detention Facility
- WL26E Covington Court Detention Facility

Ultimately, the responsible jurisdicitions must revise these priorities to reflect the realities and opportunities that exist in each basin. Phasing of projects will be critical. For instance, drainage pipe enlargements must be timed so they don't flood under-sized ponds, and fish passage improvements should progress from downstream to upstream. Capital projects that require road work, such as the proposed culvert improvements, can be incorporated into scheduled road improvements. The annual revisions to each jurisdiction's Capital Facilities Plan will provide the opportunity to update the implementation priorities and schedules.

Table 9-1 Project ranking worksheet

Criteria		Points
A.	**Ability to Implement - 60 points**	
A1	Public Cost: Availability of Outside Funds	0 - not available 3 - medium 5 - high grant availability
A2	Public Cost: Effect on the Tax Base	0 - no change in tax base 3 - will increase tax base
A3	Public Cost: Private Costs vs. Public Costs	0 - no private cost 2 - at least 25% privately funded
A4	Public Cost: Operations and Maintenance Costs	0 - high cost 3 - medium cost 5 - low cost
A5	Technical Feasibility	0 - unproven technology 10 - proven technology/unknown site conditions 20 - proven technology on site
A6	Equity	0 - local benefit/regional cost 5 - costs borne equally by beneficiaries
A7	Legal Mandate	0 - not mandated 20 - mandated
B.	**Environmental Sustainability - 60 points**	
B1	Aquatic/Riparian Resources	0 - no impact 7 - protects/preserves 15 - improves/restores
B2	Water Quality	same as B1, above
B3	Channel Stability	same as B1 above
B4	Minimum Flows	0 - no impact 3 - protects/preserves 5 - improves/restores
B5	Maximum Flows	same as B4 above
B6	Aquifer Recharge	same as B4 above
C.	**Effectiveness - 40 points**	
C1	Completeness of Solution	0 - totally dependent on other projects to work 7 - partial solution without other projects 15 - solves problem by itself
C2	Accommodation of Future Growth	0 - no accomodation 5 - at least some accomodation
C3	Solves Regional Problem over Local Problem	0 - primarily local benefits 5 - some local, some regional benefits 10 - mostly regional benefits
C4	Multiple Use Capability	0 - single use only 5 - potential for limited multiple uses 10 - multiple use

Table 9-1 continued

D.	**Property Damage - 40 points**	
D1	Jurisdictional Liability	0 - low risk if project not done 7 - medium risk if project not done 15 - high risk if project not done
D2	Property Loss or Inconvenience	0 - no or minor prevention 15 - moderately prevents property loss 25 - prevents property loss
E.	**Public Safety - 60 points**	
E1	Public Health Hazard	0 - does not solve a public health hazard 15 - solves a suspected problem 30 - solves a documented problem 40 - solves declared public health hazard
E2	Transportation Interruption-Safety Considerations	0 - minor problem/partial solution 5 - medium problem/partial solution or minor problem/complete solution 10 - major problem/partial solution or medium problem/complete solution 20 - major problem/complete solution
F.	**Vision Statement* - 30 points**	
F1	Comprehensive Approach	0 - addresses one water resource locally 5 - addresses one water resource regionally 10 - addresses multiple water resources locally 15 - addresses multiple water resources regionally
F2	Promotes Interjurisdictional Solutions/Cooperation	0 - only one jurisdiction 10 - involves multiple jurisdictions
F3	Concurrency	0 - not needed to meet 6-year growth projection 5 - needed to meet 6-year growth projection

* "Vision Statement" is a philosophy developed by the Thurston County Storm and Surface Water Advisory Board for a county-wide coordinated water resources management program.

Table 9–2 Woodland/Woodard Prioritized Project List

PROJECT #	Project Description	RANKING CRITERIA																						RANKING SCORE	PARTICI-PANTS
		A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	D1	D2	E1	E2	F1	F2	F3		
WL16	College Cr @ 6th Ave SE Treatment	5			4	20	5	5	15	15					15	5	10	8			25		15			147	L
WL15A	Martin Way @ Carpenter Rd Treatment	5			4	20	3	5	15	15	7	4	4	4	10	5	8					5	15	10		139	TC
WL14	Ruddell Rd @ Hicks Lake Treatment	5			5	20	5	7	10	15					15		10	5			15		15			127	L
WD4	Woodard Cr @ Ensign Rd Treatment	5			3	10	5	5	15	15					15		10	5			10		15	10		123	O
WL15B	Martin Way East Treatment	3			5	20	5	5	15	15					10	5	10						15	10		118	TC,L
WL7	15th Avenue & Enterprise Drainage	3	2		3	10	3		5	10	5		2	2	12	5	5		2	8		10	15	10		112	L,TC,O
WL17A	College Cr @ Martin Way West Treatment	4			3	10	5	3	15	15					10		10				25		10			110	L,O,DOT
WD12A	Woodard Cr Headwaters Detention			5	3	20	5		7		7		3		7	5	10	10					15	5	3	105	O,L,TC
WL15C	Martin Way East Additional Treatment	3			3	10	5	5	15	15					7	5	10						15	10		103	L
WL17D	Woodland Cr @ I–5 Treatment	3			3	20	5		15	15					7		10						10	5		93	DOT
WL3	Steilacoom Rd & School St Pond		1		2	15	2			15				3	12		5	5	3	15		15				93	TC
WD5A	Woodard Cr @ Pacific Ave Treatment	5			3	10	5	5	15	15					7		10				5		5	5		90	O,DOT
WL4	So. Tanglewilde Infiltration System		3		3	20				5				3	15	5				20		5	10			89	TC
WL17B	College Cr @ I–5 Treatment	3			3	20	5		15	15					7		10						5	5		88	DOT
WL18	Pleasant Glade NE Culvert	3			5	20	5	5	15						15	5	10						5			88	TC
WD8	36th Ave NE Culvert	3			5	20	5	5	15						15	5	10						5			88	TC
WL26A	College Cr @ St. Martins Detention			5	3	10	5		7		7		3		7	5	10	7					15		3	87	L
WL1	Forest Glen Subd. 4 Infiltration		3		2	10				5				3	7	5				20		10				85	TC
WL26B	College Cr @ Pacific College Detention			5	3	10	5		7		7		3		7	5	10	3					15		3	83	L
WL26D	Eagle Creek Detention			5	3	10	5		7		7		3		7	5	10						15		3	80	TC
WL26E	Covington Ct & Palm Rd Detention			5	3	10	5		7		7		3		7	5	10						15		3	80	TC
WL26F	Fox Cr @ Pleasant Glade Detention			5	3	10	5		7		7		3		7	5	10						15		3	80	TC
WL26G	Jorgensen Creek Detention			5	3	10	5		7		7		3		7	5	10						15		3	80	TC
WL26C	College Cr @ 2nd I–5 Crossing Detention			5	3	10	5		7		7		3		7	5	10						15		3	80	L,TC
WD12B	Woodard Cr @ So Bay Rd Detention			5	3	10	5		7		7		3		7	5	10						15		3	80	TC
WL17C	Woodland Cr @ Martin Way West Swales	3			3	10	5	1	15	15					7		10						10			79	L
WD9	So Bay Rd Culvert	3				10	5	5	15						15	5	10						5			73	TC
WL12	Lakemont Drive & 49th Drainage	3	1		3	15		2	7	10				3	7		5			7		5	5			73	TC
WL25	Interstate 5 Culvert	3				10	5	5	15						15		10						5			68	L,DOT
WL23	Martin Way Culvert	3				10	5	5	15						15		10						5			68	L
WD11	I–5 & Pacific Ave Culverts	3				8	5	5	15						15		10						5			66	DOT,O
WL6	Tanglewilde East Infiltration		1			10				5				3	7	3				15		10		10		64	TC
WL5A	Tanglewilde Husky Way Conveyance	2	3		5	20									7	5				10		10				62	TC,L
WD5B	Woodard Cr Untreated Discharges (Level 1)				5	10			15	15							5						7	5		62	O,TC
WL5B	Tanglewilde Martin Way Conveyance	2	3		5	20									7	5				10		10				62	TC,L
WL17E	Woodland Untreated Discharges				5	10			15	15							5						7	5		62	L,TC
WD2A	Woodard Basin Failing Drainage (Level 1)		1		3	10				5				5	7	5	5			5		5	5			56	O,TC
WL13A	Woodland Basin Failing Dry Wells		1		3	10				5				3	7	5	5			5		5	5			54	L,TC
WL11	Alder Drive Remedial Maintenance		1		3	15				5				3	7				1	8		8				51	L
WL10	Homann Drive Remedial Maintenance		1		3	15				5				3	7				1	10		5				50	L
WL9	35th & 36th SE Remedial Maintenance		1		3	15				5				3	7				1	10		5				50	L
WD1	12th & Boone Remedial Maintenance		1		3	10				5				3	7	5				10		5				49	L

9.3 PROJECT-SPECIFIC IMPLEMENTATION ISSUES

9.3.1 USE OF WETLANDS FOR STORMWATER DETENTION

The basins' wetlands are components of larger hydrologic systems, and they perform a range of functions within their systems. Wetland functions may include, for example, sediment retention, stream peak flow reduction, water quality treatment, erosion control and fish and wildlife habitat. Each wetland performs a unique combination of functions in its basin.

The basin plan proposes several projects to increase the stormwater detention functions of tributary wetlands in order to repair the damage caused by significant alterations to the Woodland and Woodard Creek hydrologic systems. Unnaturally high, frequent runoff flows from developed areas have eroded the stream channels downward, undercut the stream banks and caused extensive bank sliding. The eroded banks cannot recover before the next large runoff event renews erosion. The streams' fish habitat has suffered as a result. The proposed stormwater detention projects would reduce this cycle of degradation by improving the wetlands' capacity to detain stormwater and reduce downstream peak flows.

The affected wetlands are primarily long, sinuous riparian systems that form narrow bands alongside seasonal drainageways. These wetlands have relatively low functional value for water quality treatment, sediment control or peak flow reduction because water flows through them without constriction. The wetlands are not utilized by anadromous fish, but they function as wildlife habitat.

The proposed projects would increase the water quality, sediment control and peak flow reduction functions of the wetlands by constricting their outlets. The constrictions would increase the detention time of water passing through the wetlands, allowing more sediment to settle out, removing more pollutants and reducing downstream peak flows.

The altered hydrology could cause changes to the wetlands' vegetation and wildlife communities. The effects of altered hydrology on wetlands are not well-understood, and are currently being studied by the University of Washington Center for Urban Water Resources. The projects' biggest impact on the wetlands would occur during major storm events in the 25-year to 100-year range. Runoff from smaller events would drain down into the streams without raising the base water level of the wetlands. However, the maximum flooded area and depth from major storms would increase.

The projects would require careful design and analysis to reduce their potential impacts. The University of Washington has drafted guidelines for minimizing the impact of hydrologic changes. The projects could be evaluated using recently developed methods to compare the functional values of planned wetland projects. Two of the most promising methods are the *Evaluation for Planned Wetlands* method (Bartoldus et al, 1994) and the new US Army Corps of Engineers wetland assesment procedure (in press).

The basin plan presents a strong case for the cumulative benefits of the projects for fish and stream habitat, when viewed in total. Ultimately, the benefit of the projects must be weighed against their potential impacts. Thorough understanding of the existing functions and conditions of the wetlands will be critical for making these decisions.

The final decisions will be made through the environmental review and permitting processes, which are designed to identify and prevent negative impacts to the environment from development proposals. The processes and regulations are not designed to address proposals to restore environmental functions, so they do not accommodate the proposed projects well. The basin plan analysis should be used as the context for the environmental review of the projects.

9.3.2 College Creek Projects

College Creek is the largest tributary to Woodland Creek and drains a major stormwater system that serves a large area between St. Martins campus and Sleater-Kinney Road. The creek flows through several culverts, crossing under Martin Way and I-5 exit ramps and passing under the freeway twice. Along the way, more runoff drains to the creek from all the major roads. Some of the stormwater discharges have been documented as significantly contaminated.

The basin plan proposes several projects on College Creek (see figure 7-6). Three projects (WL26A-C) would reduce peak stream flows in Woodland Creek. Three projects (WL16, WL17A-B) would provide water quality treatment. One project (WL7) would reduce local flooding and provide treatment and some storage upstream of College Creek.

The basin plan tried to find opportunities to combine treatment and detention functions, and reduce flooding problems. Unfortunately, most of the water quality problems occur in developed areas with little land available. The areas needed for large detention volumes occur further downstream in less developed neighborhoods. The detention facilities would provide some water quality benefits to downstream waters, primarily by settling out suspended solids and preventing downstream erosion, but they would not be designed to provide efficient treatment.

Treatment ponds or swales must be carefully engineered to maximize water contact with plant materials and settle out solids. Building treatment facilities in wetlands would require extensive grading and planting, which would cause great disturbance to the wetlands compared to detention facilities. Separate, upstream treatment facilities would remove pollutants before runoff discharges into streams and wetlands, which would help protect the wetlands.

Given these constraints, a few opportunities do exist for multi-function facilities. One possible site for combining projects is where the Lacey stormwater system feeds into College

Creek on St. Martin's campus, between 6th Avenue SE and Martin Way. The basin plan proposes a detention facility (WL26A) for this site. Lacey had a consultant develop a conceptual design for a water quality treatment facility (WL16) at this site in 1993. That project was postponed because the property cost was very high, and St. Martin's College was in the process of drafting a comprehensive land use plan for the campus. The site contains one fairly small, highly disturbed wetland that could probably be used for stormwater storage and/or treatment with little impact to the wetland. These two projects are listed separately to reflect the worst-case scenario that the projects would have to be built on separate sites.

Another area with the potential to serve multiple functions is along 15th Avenue NE, north of College Creek. Untreated runoff from 15th Avenue NE drains through a ditch into College Creek a little upstream from the I-5 culvert. The runoff originates in developments along Sleater-Kinney Road, 15th Avenue NE and around Enterprise Road which have extensive flooding problems.

Improving the drainage conveyance along 15th Avenue NE and constructing a treatment facility somewhere on the drainage ditch between 15th and College Creek would reduce flooding and improve water quality. Upgrading the conveyance on 15th Avenue by constructing a grassy swale would improve water quality, but it would also increase peak flows to the creek. Reducing runoff at the sources would help the known flooding and peak flow problems, and consequently reduce any water quality contamination in the runoff.

No single solution will completely address all the problems; some combination will undoubtedly be needed. The basin plan proposes several measures, including reducing runoff at the source, improving the conveyance, providing treatment in a swale (all parts of WL7), and providing detention on College Creek (WL26C). Monitoring the runoff will help determine if additional measures are needed. The area along the ditch between 15th Avenue and College Creek is community open space that could be used for additional treatment if needed.

9.3.3 Stormwater Facilities in Tanglewilde near Martin Way

Drainage facilities in the Tanglewilde neighborhood that spans Martin Way between Carpenter Road and Marvin Road contribute to several related problems, including local flooding (WL5), water quality contamination (WL15) and peak flows (WL26). Solutions to any of these problems must consider the entire range of impacts.

As in the 15th Avenue and Enterprise neighborhood discussed above, reducing runoff at the sources would be the most effective way to deal with all the problems in the Tanglewilde area. Unfortunately, preliminary engineering studies indicated that retrofitting the existing neighborhoods would be prohibitively expensive (Entranco, 1994).

Improving the drainage conveyance systems in the Tanglewilde neighborhood to meet Service Level 1 standards would reduce or eliminate most of the local flooding problems, but it would exacerbate the water quality and peak flow problems on Woodland Creek. Stormwater treatment facilities could be constructed on the outfalls, which would improve water quality and slightly reduce peak flows. Treatment facilities could be constructed regardless of drainage conveyance improvements, but the treatment facilities would have to be larger if the conveyance systems were enlarged. The treatment facilities would have to be constructed first to prevent drainage conveyance improvements from causing more water quality and peak flow problems.

It would be much cheaper to build enough treatment capacity initially to handle potential future conveyance improvements than to enlarge the treatment facilities after they are constructed. The basin plan proposes all the facilities and improvements that may be needed to address flooding, water quality and peak flow problems in the worst-case scenario (see figure 7-4). However, all these facilities might not be needed. The water quality treatment facilities and conveyance improvements that address the worst problems could be constructed first, with extra future capacity. Additional improvements could be made later if monitoring indicates the need for more treatment.

The treatment facility at Carpenter Road (WL15A) would substantially reduce, but not eliminate, discharge to Woodland Creek. The extent of remaining discharges to Martin Way will be difficult to predict until the Carpenter Road facility begins operating. A swale could be installed between the existing outfall on Martin Way and Woodland Creek (WL15B) to treat the remaining discharge. Some basic conveyance improvements could be installed at the same time that the Carpenter Road facility is constructed, which would help reduce local flooding. The additional water quality facility on Martin Way (WL15C) could be constructed if monitoring indicates the need.

After the Carpenter Road facility and associated conveyance improvements have been made, additional conveyance upgrades (WL5A) could be installed as needed. Conveyance upgrades to the systems draining to Martin Way (WL5B) could be installed after the Martin Way outfall improvements have been installed. This phased approach would provide cost-efficient solutions to water quality and flooding problems without causing additional impacts.

9.3.4 Failing Drainage Systems

The basin plan identifies several failing drainage systems in both basins. The plan placed the highest priority on investigating and developing solutions for the sites with documented, repeated flooding problems (WL1-WL12 and WD1). Field inspection revealed signs of failure for the remaining systems (WL13 & WD2), but they have not caused reported instances of flooding yet.

Whenever possible, the plan opts for increased maintenance and remediation over building new facilities to solve flooding problems. Most of the stormwater facilities in the basin have never received adequate maintenance, which has caused a high rate of failure. These systems might function properly if they receive adequate maintenance. Maintenance is much less expensive and disruptive than installing new facilities in existing developed areas where construction would disturb roads, yards and buildings.

The basin plan recommends conducting engineering analyses to develop solutions for the remaining failing drainage systems. Increased maintenance may be a feasible solution for many of these systems. The county is currently developing a new stormwater maintenance program and stepping up efforts to make subdivisions maintain their stormwater facilities, in order to comply with requirements of the *Puget Sound Water Quality Management Plan* (1991), and Lacey is investigating options for increased maintenance. Maintenance recommendations from the engineering studies could be added to the new maintenance program, and the facilities could be monitored to insure that maintenance prevents future failures.

9.3.5 Direct, Untreated Stormwater Discharges

The basin plan places the highest priority on remediating the direct, untreated stormwater discharges sites with documented water quality problems (WL14-16 and WD3-4) or highly suspected of water quality problems (WL17A-D and WD5A). These sites represent the worst stormwater discharges that drain densely developed commercial areas and high-traffic roads.

The proposed facilities for these discharges can provide immediate relief for degraded areas of Woodland and Woodard Creeks. These are high profile areas with significant problems that must be resolved before monitoring the remaining outfalls in the basin (WL17E & WD5).

Stormwater monitoring has focussed primarily on conventional chemical parameters and sediment analysis, which may not provide the best indication of habitat problems in the stream. The proposed monitoring of additional outfalls should be based on a strategy for the basin that defines the monitoring goals and maps out the best plan for collecting the relevant information efficiently. The monitoring should progress in a manner that identifies the sources of water quality problems and leads to quick remedial action.

9.3.6 Culvert Repairs

The basin plan proposes several culvert improvements to eliminate blockages to fish passage (WL18, 20, 23, 25 & WD7-9, 11). The cost estimates were based on designing and installing each project separately. The cost of designing and installing these projects could be reduced by packaging the projects together or with other projects.

All the culvert improvements could be combined into one culvert upgrade contract, which could substantially reduce the cost. If the culvert projects were combined, the installation could be phased to move in a logical order from downstream to headwaters. The culverts would be designed to accommodate the projected future flows. Alternatively, the culverts could also be included in road improvement projects, which could significantly reduce the cost. The final implementation strategy should probably integrate these two approaches, adding culvert improvements to road projects wherever possible and packaging the remaining projects into one contract.

Culvert replacements typically require landscaping to revegetate the fill around the culverts. Volunteer crews could accomplish most of the planting, which would further reduce the project costs (Olympia successfully used volunteers on a culvert project on Bowman Street).

Most of the culvert cost estimates are based on replacing the culverts with natural bottom, arched culverts, which would require tearing out the old culverts and resurfacing the road. The Department of Fish and Wildlife prefers, in descending order, bridges, natural-bottom culverts, and culvert baffles retrofitted into existing culverts. However, the cost and benefit of replacing culverts compared to installing baffle structures might not warrant replacing the culverts, unless they can be replaced as part of scheduled road repairs. Clearly, replacing the culverts under the freeway would be prohibitively expensive. Careful analysis at the pre-design stage would identify the most cost-effective approach.

9.3.7 Martin Way Water Quality Treatment Projects

The basin plan proposes constructing water quality treatment facilities to treat runoff from Martin Way in both basins (WL17A, WL17C & WD4). Olympia and Lacey have planned several road improvements for Martin Way. The water quality treatment facilities could be combined with scheduled road improvements to reduce the total cost of the projects.

9.3.8 Woodard Creek Pacific Avenue Water Quality vs. Fish Passage

The basin plan recommends installing water quality treatment facilities on the Pacific Avenue/I-5 outfalls to Woodard Creek (WD5A) and installing fish passage improvements on the Woodard Creek culverts under I-5 and Pacific Avenue (WD11) (see figure 7-9). The area is completely developed with little room left for treatment facilities. Vaults under the road are the only feasible option for treating most of the road runoff. There might be enough room along the east edge of the creek just below Pacific Avenue to install a small bioswale at the main stormwater outfall. The swale would not be large enough to accommodate the design storm specified in the regional drainage standards for water quality treatment, but it would still provide some additional treatment to the runoff before it enters the creek.

The culverts under Pacific Avenue, I-5, and the railroad are too long and deeply buried to replace without exorbitant costs. The culverts prevent salmon from reaching the headwater

wetlands, which could offer prime coho winter rearing habitat. Given the impracticality of replacing the culverts, the basin plan proposes to back water up at the culvert outlets to reduce the velocities through the culverts, and build up fish ladders below the outlets. However, this might submerge the area along the edge of the creek that offers the only opportunity for a bioswale to treat the road runoff. An engineering feasibility study would determine if this were the case.

Ultimately, the decision will probably have to be made between improving fish passage and treating the road runoff. The area immediately below Pacific Avenue contains another large wetland that extends all the way to Martin Way and is already accessible to fish. The lower wetland is less pristine than the headwater wetland, but still offers good coho rearing habitat. Treating the road runoff from upstream would improve the habitat value of the lower wetland. These factors favor runoff treatment over fish passage.

9.4 FUNDING

9.4.1 EXISTING REVENUE SOURCES

Revenue for financing the basin plan recommendations can basically be grouped into two categories: local sources and grants. Existing local sources include stormwater utility fees, road funds, city and county general funds, various building fees, and development charges. Each local source generates money from a different mix of residents. Grants include a variety of federal and state programs.

Stormwater Utility Fees The Thurston County, Olympia, Lacey and Tumwater all have stormwater utilities that collect fees from property owners within their boundaries (Thurston County only collects fees in the northern county). The charges are based primarily on the amount of impervious area (as measured, estimated or averaged) and the type of property use. Each jurisdiction's utility has a unique rate structure. Table 9-2 compares the local jurisdictions' utility rates.

The local stormwater utilities' current rate revenues would not be sufficient to finance the basin plan recommendations. One possible source of revenues for basin plan recommendations would be increasing the stormwater utility rates.

Road Funds Funding for drainage improvement and maintenance in Thurston County is largely the responsibility of the Roads and Transportation Services Department. Road drainage improvements such as culverts and ditches are constructed as a part of road projects because they are necessary to accommodate transportation needs. Road funds currently support only minor capital improvements. Thurston County's stormwater system is largely comprised of ditches and culverts. Minimal additional funds can be expected from this source. Olympia and Lacey use a variety of sources for street repairs and construction, including grants and general funds. Olympia and Lacey road funds could probably be used to partially fund facilties designed to treat road runoff.

Table 9-2 Local Stormwater Utility Annualized Rates[1]

Land Use	Olympia	Tumwater	Lacey	Thurston County
Single-Family Residential	$72.00/60.00[2]	$54.00	$60.00	$20.00 + 1.00 per acre[4]
Duplex	$144.00/60.00[2]	$108.00	$120.00	$13.00 per unit + 1.00 per acre[4]
Multi-Family Residential	$102 + 28.80/53.28/79.20[2]	9.00 + (45.00 per gross impervious area ÷ 3250 sq.ft.)	$25.32 to $588.84 per gross acre[3]	$6.00 per unit
Commercial, Industrial, and Schools	Same as multi-family	Same as multi-family	Same as multi-family	$5.56 per 1,000 sq ft impervious area
Streets, Roads, and State Government	30% of commercial charge	30% of commercial charge	No charge	30% of commercial charge

Notes: [1]Olympia, Lacey and Tumwater charge monthly rates and offer various incentives for improved facilities. Contact the local Public Works Department for complete details. Lacey rates effective 4/1/94.
[2]Olympia's surcharges vary according to the date of development, in order to reduce rates for developments which meet higher standards. The higher rate is the base rate which most parcels pay.
[3]Lacey sets 7 nonresidential rates on a scale according to the % of impervious area. Parcels which mitigate their stormwater impacts receive a one-step rate reduction.
[4]Thurston County surcharges residential parcels $1.00/acre for each additional acre over one-half acre. The duplex rate also applies to triplex and fourplex.

General Funds The local jurisdictions' general funds can be used for a variety of projects and programs including stormwater management. The general funds derive from property tax assessments and other local taxes and fees. Historically, these funds have paid for a variety of capital improvements. However, the stormwater utilities were created at least partially to eliminate or reduce reliance on general funds to pay for stormwater projects. Increasing demands on general funds have compounded revenue shortfalls, so general funds are not likely to be available for stormwater management.

Plan Review and Inspection Fees The local jurisdictions charge customers for some of the costs of plan review and building inspection to enforce codes, regulations, and policies. All aspects of stormwater and environmental design are subject to review and inspection. Some of the costs for the nonstructural recommendations would fall in this category. These fees vary from fixed rates for small developments to variable rates for larger developments, but

they do not usually cover the entire cost of review and inspection. Potential increases in the fee structure would generate minimal additional revenues.

Connection Fees Connection fees are charged to developers at the time of development to buy into the existing public facilities used by the developments, such as roads, parks and stormwater facilities. Connection fees may also be used to pay for new facilities required by the new developments, in which case they are similar to impact fees, described below. Olympia and Lacey charge a connection fee called a general facilities charge (GFC) to pay for the public stormwater drainage system. The charges allocate the cost of facilities constructed for future growth to the developments they were built to serve.

Olympia charges $40 per 1,000 square feet of site area, and provides various exceptions including lots containaing more than 1/4 acre of wetlands or other critical areas (City of Olympia, 1994). Lacey charges a base "cumulative" fee of $60.90 stormwater connection fee for residential hook-ups, and a $609 fee for commercial hook-ups, plus additional charges according to how many months have elapsed since July 1, 1990. Lacey's total fees as of February 1995 were $299.90 for residential, and $609.00 plus $102.45 per acre for commercial. Thurston County does not charge connection fees.

Latecomer Fees "Latecomer fee" agreements are alternatives to GFCs for generating revenue to pay for facilities related to future growth. Under a latecomer fee agreement, the first developer of an area requiring regional stormwater facilities would pay for and construct the needed facilities. Later developments would be charged latecomer fees to repay the investment of the original developer. Olympia occasionally uses latecomer agreements for new sewer service.

9.4.2 Potential Revenue Sources

Shellfish Protection Districts The 1992 Washington State legislature substantially expanded counties' authority to establish and fund "shellfish protection districts". Shellfish protection districts can be established county-wide or watershed by watershed, and they can be funded through a variety of mechanisms, but they cannot charge property owners who already pay a stormwater fee, unless they provide different services. Shellfish protection districts have the spending authority to finance a wide variety of projects and activities so long as they ultimately benefit water quality. However, projects in closed basins which do not drain to marine waters may not be eligible for funding. There are no existing shellfish protection districts in Thurston County.

Aquifer Protection Areas State legislation amended in 1990 gives counties the authority to form "aquifer protection areas" (APA) and assess rates, upon the approval of the voters. Aquifer protection areas must be delineated according to aquifer boundaries, and fees must reflect ground water usage and impacts. The authorizing legislation allows APAs to pay for a broad range of activities, including stormwater facilities. Vacant land cannot be charged in

an aquifer protection area. The local jurisdictions are considering an APA ballot measure for 1995.

Impact Fees The State Growth Management Act gives local jurisdictions the authority to charge impact fees to new developments in order to fund infrastructure improvements required by the developments. Impact fees are charged to offset the public costs associated with growth. Olympia charges impact fees for parks, fire and schools, but not for roads. Thurston County and Lacey do not charge impact fees. The law does not allow collection of impact fees for stormwater capital facilities. However, impact fees may fund road improvements including culvert upgrades and stormwater facilities for road runoff, and parks and open space preservation including purchasing multiple-use lands and preserving streamside habitat.

Street Utility Fees Local jurisdictions have the authority to impose street utility fees to pay for streets and related improvements. Street utilities can assess $2/month to single family residences and $2/month/employee to employers. State offices are exempt from paying the utility assessment on their employees. In the north Thurston County area the state employs approximately 35% of the work force. The only stormwater projects eligible for street utility funding would be those associated with street improvements, but many such projects exist within the basins.

Fee-in-Lieu of Construction The local jurisdictions have the authority to allow developers to pay into the stormwater funds for regional stormwater facilities instead of constructing required on-site facilities. The preferred management method is on-site infiltration, but regional facilities might be cost effective, environmentally beneficial alternatives in certain situations. Costs to both private and public entities might be reduced for some projects. Regional facilities intended to also serve new developments must be constructed before the new developments to prevent downstream impacts.

Local Improvement Districts (LIDs) Local improvement districts (LIDs) are used to fund infrastructure construction or improvement where the beneficiaries of the project can be readily identified. Local jurisdictions may sell bonds to finance projects, and supervise project construction, for established LIDs. The LID residents pay monthly or annual rates to the local jurisdiction to pay off the project costs. LIDs have not been used to fund stormwater improvements in Thurston County, because the project beneficiaries are often difficult to specify, and the administrative costs are often high.

Flood Control Zone Districts Counties may establish areas for the purpose of managing stormwater projects which reduce flood hazards in a specific area or watershed. Funds to support the districts can be obtained by tax levies, special assessments, and LIDs.

9.4.3 State and Federal Grants

Adopting the basin plan will greatly improve the local jurisdictions' ability to compete for increasingly limited grants. Local governments have been highly successful in obtaining state and federal grants in the past. State-administered grants target existing water quality and flooding problems, and problems which cause property damage or present public health or safety hazards usually rate highly for grant eligibility. Public involvement and education programs are also eligible for limited grant funding. Funds targeted at historical problems may also address potential future problems, or they may free up other funds for the prevention of potential problems.

Most grants require some amount of local matching funds, which may sometimes take the form of services-in-kind. Grant sources have dried up in recent years as government has reduced spending at all levels. Grants help bolster finite local funds, but they are highly uncertain and cannot be relied on for long-term planning.

Centennial Clean Water Fund The Centennial Clean Water Fund is administered through the Washington Department of Ecology's water quality financial assistance program. The fund was established in 1986 to provide financial assistance for planning, design, acquisition, construction, and improvement of water pollution control facilities including nonpoint source control projects. The fund supports these projects in order to meet state and federal pollution control requirements. Grant recipients are required to provide a local match of 25-50%. The fund had $45 million available per year through 1995, though a large share was reserved for Spokane aquifer and Seattle Metro projects. The remainder is allocated on a competitive basis, so all projects in Thurston County compete for a limited share of the fund. Implementation projects such as capital facilities are generally eligible for 50% funding. The fund will probably be cut back this year, and the Department of Ecology anticipates a total appropriation of $20 million for fiscal year 1996.

Flood Control Assistance Account Program The Department of Ecology administers the flood control assistance account program (FCAAP). FCAAP is a grant program that assists cities, counties and local districts with flood control maintenance and capital improvement projects. The maximum funding available per county each biennium is $500,000 for non-emergency grants and $150,000 for emergency grants, and counties must provide matching funds of 50% and 20%, respectively.

Puget Sound Water Quality Authority Public Involvement and Education Fund Grants are periodically available to local governments and other organizations to initiate and continue public involvement and education activities in the Puget Sound region. The grants can potentially fund a wide variety of public education projects. The funding for these grants originates from the Washington State Centennial Clean Water Fund. Approximately $500,000 was available in 1993-94. Grants are limited to $40,000 per project, but projects rarely receive more than $20,000.

Washington State Ecosystems Conservation Project The Washington Department of Fish and Wildlife cooperates with the U.S. Fish and Wildlife Service on two programs aimed at the protection of valuable upland, riparian, and wetland habitats within the state. Approximately $300,000 annually has been allocated to support the programs.

One of these programs, the Washington State Upland Wildlife Program addresses the loss of upland habitat and associated decreasing wildlife diversity. The current focus of the program is on the acquisition of upland habitat in eastern Washington. The second program is the Washington Wetlands and Riparian Initiative. The goal of this program is to protect wetlands and riparian resources. Public ownership, incentives, easements, cooperative agreements, land trusts, and other innovative approaches are encouraged.

Federal Clean Water Act Section 319 Grants The federal government makes grants available to local governments through the EPA for reducing nonpoint pollution. The Washington State Department of Ecology administers Section 319 grants. The grant programs are split into several categories, including research, monitoring, watershed action plan implementation, and environmental restoration. The amount available changes from year to year.

9.4.4 Debt Financing Mechanisms

Local government's ability to pay for the basin plan recommendations is limited by the existing revenues described above. These revenue sources might be able to pay for gradual implementation of basin plan recommendations with available funds over several decades. This "pay-as-you-go" approach could not implement the basin plan recommendations in time to prevent or repair the damage they are intended to address. Local governments have two basic debt financing mechanisms for obtaining additional, up-front funds in excess of current revenues: loans and bond sales.

Major capital improvement projects often require large sums of capital for construction, but they have low operating costs and long life spans. Debt financing offers a method for spreading out the impact of high-cost construction over a long period of time. Mechanisms such as bonds and low-interest loans have long been used to ease the immediate burden of financing capital construction, but they add financing charges to the total cost of the projects.

The basin plan recommends a combination of ongoing and one-time activities. The ongoing activities such as monitoring, maintenance and education constitute the base work programs of the stormwater utilities or other local agencies. The capital facilities would be one-time expenditures for facilities with finite life spans. Existing or projected revenues must be sufficient to fund ongoing activities because debt-financing of basic work programs would be financially risky.

Capital facilities are good candidates for debt-financing, because they require a one-time expenditure. The cost of capital facilities can be spread across the lifespan of the facilities, or some shorter period. Spreading the cost over several years reduces the financial burden of any particular year, but the longer that financing is extended, the greater the additional financing charges. Debt-financing would probably delay implementation of lower-priority projects, because they could not be funded until the debt from the high-priority projects was retired.

Washington Public Works Trust Fund Loans The Department of Community Development offers $2.5 million per jurisdiction per year in Public Works Trust Fund low-interest loans to repair, replace, rehabilitate, reconstruct, or improve existing public works facilities. Many drainage facilities are eligible, as well as projects to enhance or protect wetlands from stormwater impacts. The fund covers up to 90% of the project cost and charges interest of 1-3%, depending on the amount of local match. The program is not intended to finance growth-related projects, but it does include emergency loans.

Department of Ecology Centennial Clean Water Fund Loans In addition to the grants described previously in this chapter, the Centennial Clean Water Fund offers loans to local governments for activities and facilities that protect and enhance water quality. Loans are available for up to 100% of the total eligible project costs. Loans for 0-5 years are interest-free, 6-14 year loans cost 4% per year, and 15-20 year loans cost 5% per year. Funds are available for planning, design, construction, or implementation of water related projects.

Washington State Revolving Fund for Water Pollution Control Loans The state revolving fund was established in 1988 to provide low-interest loans to public bodies for high priority water quality needs, including nonpoint source pollution control projects, and conservation and management projects in estuaries. Eighty percent of the fund is directed towards the planning, design, and construction of water pollution control facilities. The remainder is targeted towards nonpoint source pollution projects and estuary conservation and management. The fund is self-sustaining through capitalization by federal grants. Project costs may be 100% eligible and repayable over 20 years. Interest rates are set at 60% of market rate for 6-14 year loans and 75% of market rate for 15-20 year loans.

Bonds Municipal bonds are financial notes which obligate the seller to pay specified sums of money (usually as interest) to the buyer in the future, in return for use of the capital now. Utility bond sales can raise capital to fund the construction of needed projects, with the costs repaid over time. Two basic types of bonds are general obligation bonds and revenue bonds. Stormwater utility revenues can only be used to pay off revenue bonds. State law does not limit the amount of revenue bonds sold by local jurisdictions, but requires assurances that the revenues are sufficient to repay the bonds.

Local jurisdictions have historically sold bonds to finance major improvements such as new schools or bridges. Thurston County, Olympia and Lacey have never sold bonds to finance stormwater projects because past projects have been small enough to fund from existing revenues. However, as local governments proceed with comprehensive facilities planning for stormwater and other infrastructure projects, bonds have become a more realistic approach.

9.4.5 Plan Cost Distribution

The revenue sources and financing mechanisms described above provide several alternatives for distributing the costs of the basin plan's recommendations over time and between individuals. Each basin plan recommendation benefits the general public, groups and individuals to greater or lesser degrees. The ideal cost distribution method would charge each person in direct proportion to the benefit received, but the perfect cost distribution does not exist, and several of the basin plan's benefits cannot be quantified on a per-person basis. Also the more complicated the system for distributing costs, the higher the administrative costs.

Watershed-based Cost Distribution Comprehensive basin planning creates a unique set of recommendations for each watershed or drainage basin, and some basins require much more investment than others. Woodland Creek basin will probably require the highest level of spending of any basin in the north County. Revenue sources could be adjusted to allocate a proportionally larger share of the costs to the Woodland Creek watershed. The city of Kent, Washington's stormwater utility uses a base fee to cover ongoing activities and assesses a watershed-specific surcharge to cover additional measures (Kent City Code chapter 7.20).

A watershed-based system would result in higher charges for residents of more developed areas, and lower rates for more pristine areas. The highly developed areas that cause most of the problems in Woodland Creek basin are regional commercial centers that serve the entire urban area as well as much of rural northern Thurston County. The watershed-based system would not allocate costs to people who live outside the basin but use the commercial centers.

Higher fees for the developed areas would also have the affect of driving up the cost of living in the developed areas, which would tend to force development into the more pristine areas that have lower costs because they have fewer problems. In that respect, residents of the rural and forested watersheds have a financial interest in keeping costs down in the developed urban areas.

Urban-Rural Cost Distribution The trade-offs of distributing costs between urban and rural areas largely mirror the watershed issues discussed above. Most of the proposed projects would be sited in the cities or urban growth areas, because they address problems related to development. The urban areas support the rural areas to the extent that they provide commercial centers, hospitals, emergency services, colleges and other benefits to rural as

well as urban residents. Allocating higher costs to urban areas would tend to drive development into rural areas.

For the most part, basin plan recommendations for the rural areas are small enough that they could be funded by existing stormwater revenues from rural residents. Allocating a large share of urban projects to rural residents might result in the need to debt-finance the rural projects as well, which would increase their total cost.

The Urban Growth Management Area is expected to be annexed by the cities within the next 20 years. When an area is annexed, the tax and utility revenues associated with the land would shift to the annexing city from the county. The county might not be able to repay debt-financed projects in the urban growth area if annexation reduces the county's revenues. However, state law provides that the county could continue collecting revenues from the annexed area to pay off the remaining debt.

When a city annexes an area with a county-built stormwater facility, the details of the annexation agreement would determine who owned the facility. If the ownership were transferred over to the city, they would gain the value of the facility at essentially no cost. Long-term debt-financing would be one way to insure that the city shares some of the cost of building the facility. Alternatively, the annexing juridiction could build and operate the facilities and collect reimbursements from county ratepayers until annexation occurs. Interjurisdictional agreements could resolve many of these issues.

Existing Development vs. Future Growth Most of the projects proposed in the basin plan address problems caused by existing development and past practices. However, some of the stormwater detention projects (WL26A-G, WD12A-B) are designed to prevent increased stream peak flows from future development. Modelling indicates that poor soils will prevent development from absorbing all the runoff on-site in these sub-basins, so regional detention facilities will be needed.

The local governments have adopted a general approach that growth should pay for growth. This approach would require that the costs of projects designed to accommodate future development be allocated differently from projects to address existing problems. There are several possible mechanisms for allocating future growth costs.

The responsible jurisdictions could build the facilities and collect reimbursements from new developments when they are approved. The facilities would have to be approved in the jurisdictions' capital facilities plans in order for the local government to build them. Connection fees or impact fees could be used to collect the revenue from developers. Lacey has connection fees that could be used for this purpose. The county would have to implement connection fees or impact fees to collect the revenues from developers.

The facilities could also be constructed by the first new development and the reimbursements collected through latecomer fees. Facilities constructed this way would not have to be approved in the local governments' capital facilities plans. The required facilities would be identified during the development review process for the proposed development. Agreements would be drafted between the developer, the local jurisdiction and future developments regarding facility operation and maintenance. Facilities constructed under this arrangement could be initially financed by loans to the developer, and the people who buy into the new development and future developments served by the facility could repay the latecomer fees used to retire the loans. Debt-financing of future growth projects makes sense because the debt would be repaid in the future when the facilities are being used.

9.5 RECOMMENDED IMPLEMENTATION STRATEGY

The basin plan must be implemented in stages, some of which will require additional study. Chapter 7 listed the recommendations as though they will all be needed, but implementing the top priorities will probably reduce or eliminate the need for some of the later projects. This section suggests a three-stage implementation process. The final project list for each phase will be revised by the local jurisdictions. The tables at the end of the chapter summarize the financial impacts of the recommended plan, based on the implementation strategy described above.

Table 9-3 Recommended Plan Cost Summary This table lists all the plan recommendations, states the total estimated cost of each recommendation, and details the cost breakdown between land and construction for capital projects. The adjacent columns show the share of total project costs allocated to each jurisdiction according to the percentage of contributing area, including the land/construction cost breakdown.

Tables 9-4 through 9-6 These tables group the cost information from table 9-3 into separate project lists for each jurisdiction.

Table 9-7 Potential Reveneues This table suggests revenue sources for each project, based on the implementation strategies explained above.

Table 9-8 Phase 1 Projects and Revenues This table lists the projects and revenue sources for the potential first phase of implementation. Phase 1 projects, based on the prioritized project list and the recommended implementation strategies, include the worst water quality problems, flooding sites that block arterial roads, and regional detention for future growth.

Table 9-9 Phase 2 Projects and Revenues This table lists the projects and revenue sources for the potential second phase of implementation. Phase 2 projects, based on the prioritized project list and the recommended implementation strategies, include flooding sites that block feeder roads, and fish passage projects.

Table 9-10 Phase 3 Projects and Revenues This table lists the projects and revenue sources for the potential third phase of implementation. Phase 3 projects, based on the prioritized project list and the recommended implementation strategies, include the remaining flooding sites, projects which are contingent on other projects, and projects that may not be needed depending on the outcome of additional study.

The following recommendations are intended to provide additional direction and guidance for implementing the basin plan recommendations:

1. Design regional stormwater detention facilities to minimize the impact on wetlands as much as possible.
2. Combine the water quality and detention facilities on St. Martins campus if possible (WL26A & 16).
3. Improve upstream stormwater storage and infiltration in the 15th Avenue and Enterprise Road area before enlarging the conveyance to reduce local flooding (WL7).
4. Monitor flows to College Creek from 15th Avenue for its impact to the detention project at the 2nd I-5 crossing on College Creek (WL26C).
5. Implement the Tanglewilde/Martin Way measures in the following order:
   a) Construct the Carpenter Road facility to accomodate 25-year storms (WL15A).
   b) Install a swale on the Martin Way outfall to accomodate the remaining discharge (WL15B).
   c) Monitor the new facilities and provide additional treatment if needed (WL15C).
   d) Install additional conveyance upgrades if needed (WL5A-B).
6. Increase maintenance frequency of failing drainage facilities before planning capital improvements for them.
7. Install water quality treatment on known problem outfalls before investigating other outfalls.
8. Include culvert improvements with in road projects where possible, and combine the remaining culverts improvements in one contract.
9. Use volunteers to replant around culverts and other capital facilities.
10. Consider installing culvert baffles instead of replacing culverts.
11. Combine Martin Way treatment facilities with road projects if possible (WL17A,C,WD4).
12. Give higher priority to runoff treatment than to fish passage at Woodard Creek and Pacific Avenue/I-5 interchange (WD5A & WD11).
13. Finance projects in the UGMA by selling stormwater revenue bonds.
14. Allocate a small percentage (~25%) of the cost for UGMA projects to residents outside the UGMA.
15. Build the projects outside the UGMA from current revenues, if possible.
16. Allocate the cost of projects for future growth to new developments.

PROJECT #	Project Description	TOTAL COST 1994 $	CONST COST 1994 $	LAND COST 1994 $	LACEY Cost 1994 $			OLYMPIA Cost 1994 $			COUNTY Cost 1994 $			WDOT Cost 1994 $
					TOTAL	CONSTR.	LAND	TOTAL	CONSTR.	LAND	TOTAL	CONSTR.	LAND	TOTAL
WL1	Forest Glen Subd. 4 Infiltration	24,000									24,000			
WL3	Steilacoom Rd & School St Pond	119,058	119,058								119,058	119,058		
WL4	So. Tanglewilde Infiltration System	3,537,120	3,537,120								3,537,120	3,537,120		
WL5A	Tanglewilde Husky Way Conveyance	4,593,787	4,593,787								4,593,787	4,593,787		
WL5B	Tanglewilde Martin Way Conveyance	1,277,003	1,277,003								1,277,003	1,277,003		
WL6	Tanglewilde East Infiltration	12,000									12,000			
WL7	15th Avenue & Enterprise Drainage	141,722	122,409	19,313	112,567	97,227	15,340	13,774	11,897	1,877	15,382	13,286	2,096	
WL9	35th & 36th SE Remedial Maintenance	•			•									
WL10	Homann Drive Remedial Maintenance	•			•									
WL11	Alder Drive Remedial Maintenance	•			•									
WL12	Lakemont Drive & 49th Drainage	90,000	90,000								90,000	90,000		
WL13A	Woodland Basin Failing Dry Wells	192,000									192,000			
WL14	Ruddell Rd @ Hicks Lake Treatment	898,300	898,300		898,300	898,300								
WL15B	Martin Way East Treatment	•												
WL15A	Martin Way @ Carpenter Rd Treatment	2,488,352	2,417,352	71,000							2,488,352	2,417,352	71,000	
WL15C	Martin Way East Additional Treatment	4,857,990	4,324,490	533,500	384,379	342,167	42,212				4,605,329	4,099,576	505,753	
WL16	College Cr @ 6th Ave SE Treatment	2,150,000	2,150,000		2,150,000	2,150,000								
WL17A	College Cr @ Martin Way West Treatment	540,000	540,000		275,400	275,400		156,600	156,600					108,000
WL17B	College Cr @ I-5 Treatment	33,770	33,770											33,770
WL17C	Woodland Cr @ Martin Way West Swales	237,367	237,367		237,367									
WL17D	Woodland Cr @ I-5 Treatment	94,843	94,843											94,843
WL17E	Woodland Untreated Discharges	136,100			38,108			1,361			96,631			
WL18	Pleasant Glade NE Culvert	163,374	163,374								163,374	163,374		
WL19A	Woodland Cr Stream Watch	2,000			1,000						1,000			
WL19B	Woodland Cr Habitat Restoration	25,000			7,000			250			17,750			
WL23	Martin Way Culvert	79,181	79,181		79,181	79,181								
WL25	Interstate 5 Culvert	94,843	94,843											94,843
WL26A	College Cr @ St. Martins Detention	1,118,324	442,034	676,290	1,118,324	442,034	676,290							
WL26B	College Cr @ Pacific College Detention	918,390	836,106	82,284	918,390	836,106	82,284							
WL26C	College Cr @ 2nd I-5 Crossing Detention	281,933	87,180	194,753	281,933	87,180	194,753							
WL26D	Eagle Creek Detention	151,728	45,498	106,230							151,728	45,498	106,230	
WL26E	Covington Ct & Palm Rd Detention	314,469	37,089	277,380							314,469	37,089	277,380	
WL26F	Fox Cr @ Pleasant Glade Detention	164,493	120,993	43,500							164,493	120,993	43,500	
WL26G	Jorgensen Creek Detention	219,714	59,259	160,455							219,714	59,259	160,455	
WL26H	Woodland Cr Fish Habitat Monitoring	5,000			1,400			50			3,550			
WD1	12th & Boone Remedial Maintenance	•			•									
WD2A	Woodard Basin Failing Drainage (Level 1)	28,000						14,000			14,000			
WD4	Woodard Cr @ Ensign Rd Treatment	1,089,103	857,303	231,800				1,089,103	857,303	231,800				
WD5A	Woodard Cr @ Pacific Ave Treatment	1,350,000	1,350,000					995,075	995,075					354,925
WD5B	Woodard Cr Untreated Discharges (Level 1)	38,900			1,167			9,725			38,900			
WD6A	Woodard Cr Stream Watch	2,000			60			500			1,440			
WD6B	Woodard Cr Habitat Restoration	25,000			750			6,250			18,000			
WD8	36th Ave NE Culvert	66,512	66,512								66,512	66,512		
WD9	So Bay Rd Culvert	66,512	66,512								66,512	66,512		
WD10	Woodard Cr Fish Stranding Mitigation	•						•						
WD11	I-5 & Pacific Ave Culverts	5,000						1,277						3,723
WD12A	Woodard Cr Headwaters Detention	252,113	40,863	211,250	100,784	16,335	84,449	151,328	24,527	126,801				
WD12B	Woodard Cr @ So Bay Rd Detention	137,958	100,334	37,624							137,958	100,334	37,624	
WD12C	Woodard Cr Fish Habitat Monitoring	5,000			150			1,250			3,600			
	GRAND TOTAL	28,027,957			6,606,260			2,440,542			18,433,659	16,806,750		690,105

TABLE 9–4: LACEY SHARE OF ESTIMATED PLAN COST

PROJECT #		TOTAL COST 1994 $	CONST COST 1994 $	LAND COST 1994 $	LACEY Cost 1994 $			OLYMPIA Cost 1994 $			COUNTY Cost 1994 $			WDOT Cost 1994 $
	Project Description				TOTAL	CONSTR.	LAND	TOTAL	CONSTR.	LAND	TOTAL	CONSTR.	LAND	TOTAL
WL7	15th Avenue & Enterprise Drainage	141,722	122,409	19,313	112,567	97,227	15,340	13,774	11,897	1,877	15,382	13,286	2,096	
WL9	35th & 36th SE Remedial Maintenance	*			*									
WL10	Homann Drive Remedial Maintenance	*			*									
WL11	Alder Drive Remedial Maintenance	*			*									
WL14	Ruddell Rd @ Hicks Lake Treatment	898,300	898,300		898,300	898,300								
WL15C	Martin Way East Additional Treatment	4,857,990	4,324,490	533,500	384,379	342,167	42,212				4,605,329	4,099,576	505,753	
WL16	College Cr @ 6th Ave SE Treatment	2,150,000	2,150,000		2,150,000	2,150,000								
WL17A	College Cr @ Martin Way West Treatment	540,000	540,000		275,400	275,400		156,600	156,600					108,000
WL17C	Woodland Cr @ Martin Way West Swales	237,367	237,367		237,367									
WL17E	Woodland Untreated DischargeS	136,100			38,108			1,361						
WL19A	Woodland Cr Stream Watch	2,000			1,000									
WL19B	Woodland Cr Habitat Restoration	25,000			7,000			250						
WL23	Martin Way Culvert	79,181	79,181		79,181	79,181								
WL26A	College Cr @ St. Martins Detention	1,118,324	442,034	676,290	1,118,324	442,034	676,290							
WL26B	College Cr @ Pacific College Detention	918,390	836,106	82,284	918,390	836,106	82,284							
WL26C	College Cr @ 2nd I–5 Crossing Detention	281,933	87,180	194,753	281,933	87,180	194,753							
WL26H	Woodard Cr Fish Habitat Monitoring	5,000			1,400			50						
WD1	12th & Boone Remedial Maintenance	*			*									
WD5B	Woodard Cr Untreated Discharges	38,900			1,167			9,725			38,900			
WD6A	Woodard Cr Stream Watch	2,000			60			500						
WD6B	Woodard Cr Habitat Restoration	25,000			750			6,250						
WD12A	Woodard Cr Headwaters Detention	252,113	40,863	211,250	100,784	16,335	84,449	151,328	24,527	126,801				
WD12C	Woodard Cr Fish Habitat Monitoring	5,000			150			1,250						
	GRAND TOTAL	11,714,320			6,606,260			341,088			4,659,610	4,112,861		108,000

* These projects can be funded under existing budgets

TABLE 9–5: OLYMPIA SHARE OF ESTIMATED PLAN COST

PROJECT #	Project Description	TOTAL COST 1994 $	CONST COST 1994 $	LAND COST 1994 $	LACEY Cost 1994 $			OLYMPIA Cost 1994 $			COUNTY Cost 1994 $			WDOT Cost 1994 $
					TOTAL	CONSTR.	LAND	TOTAL	CONSTR.	LAND	TOTAL	CONSTR.	LAND	TOTAL
WL7	15th Avenue & Enterprise Drainage	141,722	122,409	19,313	112,567	97,227	15,340	13,774	11,897	1,877	15,382	13,286	2,096	
WL17A	College Cr @ Martin Way West Treatment	540,000	540,000		275,400	275,400		156,600	156,600					108,000
WL17E	Woodland Untreated Discharges	136,100			38,108			1,361						
WL19B	Woodland Cr Habitat Restoration	25,000			7,000			250						
WL26H	Woodard Cr Fish Habitat Monitoring	5,000			1,400			50						
WD2A	Woodard Basin Failing Drainage (Level 1)	28,000						14,000						
WD4	Woodard Cr @ Ensign Rd Treatment	1,089,103	857,303	231,800				1,089,103	857,303	231,800				
WD5A	Woodard Cr @ Pacific Ave Treatment	1,350,000	1,350,000					995,075	995,075					354,925
WD5B	Woodard Cr Untreated Discharges (Level 1	38,900			1,167			9,725			38,900			
WD6A	Woodard Cr Stream Watch	2,000			60			500						
WD6B	Woodard Cr Habitat Restoration	25,000			750			6,250						
WD10	Woodard Cr Fish Stranding Mitigation	*						*						
WD11	I–5 & Pacific Ave Culverts	5,000						1,277						3,723
WD12A	Woodard Cr Headwaters Detention	252,113	40,863	211,250	100,784	16,335	84,449	151,328	24,527	126,801				
WD12C	Woodard Cr Fish Habitat Monitoring	5,000			150			1,250						
	GRAND TOTAL	3,642,938			537,386			2,440,542			54,282	13,286		466,649

* These projects can be funded under existing maintenance budgets

TABLE 9–6: THURSTON COUNTY SHARE OF ESTIMATED PLAN COST

PROJECT #	Project Description	TOTAL COST 1994 $	CONST COST 1994 $	LAND COST 1994 $	LACEY Cost 1994 $			OLYMPIA Cost 1994 $			COUNTY Cost 1994 $			WDOT Cost 1994 $
					TOTAL	CONSTR.	LAND	TOTAL	CONSTR.	LAND	TOTAL	CONSTR.	LAND	TOTAL
WL1	Forest Glen Subd. 4 Infiltration	50,000									50,000			
WL3	Steilacoom Rd & School St Pond	119,058	119,058								119,058	119,058		
WL4	So. Tanglewilde Infiltration System	1,623,895	1,623,895								1,623,895	1,623,895		
WL5A	Tanglewilde Husky Way Conveyance	4,593,787	4,593,787								4,593,787	4,593,787		
WL5B	Tanglewilde Martin Way Conveyance	1,277,003	1,277,003								1,277,003	1,277,003		
WL7	15th Avenue & Enterprise Drainage	141,722	122,409	19,313	112,567	97,227	15,340	13,774	11,897	1,877	15,382	13,286	2,096	
WL12	Lakemont Drive & 49th Drainage	90,000	90,000								90,000	90,000		
WL13A	Woodland Basin Failing Dry Wells	225,000									225,000			
WL15A	Martin Way @ Carpenter Rd Treatment	2,486,500	2,417,500	69,000							2,486,500	2,417,500	69,000	
WL15C	Martin Way East Additional Treatment	4,858,700	4,325,200	533,500	252,698	224,951	27,747				4,606,002	4,100,249	505,753	
WL18	Pleasant Glade NE Culvert	163,374	163,374								163,374	163,374		
WL19A	Woodland Cr Stream Watch	2,000			1,000						1,000			
WL19B	Woodland Cr Habitat Restoration	25,000			7,000			250			17,750			
WL26D	Eagle Creek Detention	151,728	45,498	106,230							151,728	45,498	106,230	
WL26E	Covington Ct & Palm Rd Detention	314,469	37,089	277,380							314,469	37,089	277,380	
WL26F	Fox Cr @ Pleasant Glade Detention	164,493	120,993	43,500							164,493	120,993	43,500	
WL26G	Jorgensen Creek Detention	219,714	59,259	160,455							219,714	59,259	160,455	
WL26H	Woodland Cr Fish Habitat Monitoring	5,000			1,400			50			3,550			
WD2A	Woodard Basin Failing Drainage Level 1	28,000						14,000			14,000			
WD5B	Woodard Cr Untreated Discharges (Level 1	38,900			1,167			9,725			38,900			
WD6A	Woodard Cr Stream Watch	2,000			60			500			1,440			
WD6B	Woodard Cr Habitat Restoration	25,000			750			6,250			18,000			
WD8	36th Ave NE Culvert	66,512	66,512								66,512	66,512		
WD9	So Bay Rd Culvert	66,512	66,512								66,512	66,512		
WD12B	Woodard Cr @ So Bay Rd Detention	137,958	100,334	37,624							137,958	100,334	37,624	
WD12C	Woodard Cr Fish Habitat Monitoring	5,000			150			1,250			3,600			
	GRAND TOTAL	16,876,323			376,642			44,549			16,466,025	14,894,347		

Table 9-7 Potential Revenues for the Recommended Plan

PROJECT #	Project Description	PROJECT COST 1994 $	LACEY STORM WATER	OLYMPIA STORM WATER	COUNTY STORM WATER	WDOT	GRANTS/ ROAD FUNDS	FUTURE GROWTH
WL16	College Cr @ 6th Ave SE Treatment	2,150,000	2,150,000					
WL15A	Martin Way @ Carpenter Rd Treatment	2,488,352			2,488,352			
WL14	Ruddell Rd @ Hicks Lake Treatment	898,300	898,300					
WD4	Woodard Cr @ Ensign Rd Treatment	1,089,103		1,089,103				
WL15B	Martin Way East Treatment	*						
WL7	15th Avenue & Enterprise Drainage	141,722	112,567	13,774	15,382			
WL17A	College Cr @ Martin Way West Treatment	540,000	275,400	156,600		108,000		
WD12A	Woodard Cr Headwaters Detention	252,113						252,113
WL15C	Martin Way East Additional Treatment	4,857,990	384,379		4,605,329			
WL17D	Woodland Cr @ I-5 Treatment	94,843				94,843		
WL3	Steilacoom Rd & School St Pond	119,058			119,058			
WD5A	Woodard Cr @ Pacific Ave Treatment	1,350,000		995,075		354,925		
WL4	So. Tanglewilde Infiltration System	3,537,120			3,537,120			
WL17B	College Cr @ I-5 Treatment	33,770				33,770		
WL18	Pleasant Glade NE Culvert	163,374			81,687		81,687	
WD8	36th Ave NE Culvert	66,512			33,256		33,256	
WL26A	College Cr @ St. Martins Detention	1,118,324						1,118,324
WL1	Forest Glen Subd. 4 Infiltration	24,000			24,000			
WL26B	College Cr @ Pacific College Detention	918,390						918,390
WL26D	Eagle Creek Detention	151,728						151,728
WL26E	Covington Ct & Palm Rd Detention	314,469						314,469
WL26F	Fox Cr @ Pleasant Glade Detention	164,493						164,493
WL26G	Jorgensen Creek Detention	219,714						219,714
WL26C	College Cr @ 2nd I-5 Crossing Detention	281,933						281,933
WD12B	Woodard Cr @ So Bay Rd Detention	137,958						137,958
WL17C	Woodland Cr @ Martin Way West Swales	237,367	118,684				118,684	
WD9	So Bay Rd Culvert	66,512			33,256		33,256	
WL12	Lakemont Drive & 49th Drainage	90,000			90,000			
WL25	Interstate 5 Culvert	94,843						94,843
WL23	Martin Way Culvert	79,181	39,590				39,590	
WD11	I-5 & Pacific Ave Culverts	5,000		1,277		3,723		
WL6	Tanglewilde East Infiltration	12,000	12,000		12,000			
WL5A	Tanglewilde Husky Way Conveyance	4,593,787			4,593,787			
WD5B	Woodard Cr Untreated Discharges (Level 1)	38,900	1,167	9,725	38,900			
WL5B	Tanglewilde Martin Way Conveyance	1,277,003			1,277,003			
WL17E	Woodland Untreated Discharges	136,100	38,108	1,361	96,631			
WD2A	Woodard Basin Failing Drainage (Level 1)	28,000		14,000	14,000			
WL13A	Woodland Basin Failing Dry Wells	192,000			192,000			
WL11	Alder Drive Remedial Maintenance	*	*					
WL10	Homann Drive Remedial Maintenance	*	*					
WL9	35th & 36th SE Remedial Maintenance	*	*					
WD1	12th & Boone Remedial Maintenance	*	*					
	TOTAL		4,030,194	2,280,914	17,251,759	595,262	306,472	3,653,964

Table 9-8 Phase 1 Projects and Revenues

PROJECT #	Project Description	PROJECT COST 1994 $	LACEY	OLYMPIA	COUNTY	WDOT	GRANTS/ ROAD FUNDS	FUTURE GROWTH
WL16	College Cr @ 6th Ave SE Treatment	2,150,000	2,150,000					
WL15A	Martin Way @ Carpenter Rd Treatment	2,488,352			2,488,352			
WL14	Ruddell Rd @ Hicks Lake Treatment	898,300	898,300					
WD4	Woodard Cr @ Ensign Rd Treatment	1,089,103		1,089,103				
WL15B	Martin Way East Treatment	*						
WL7	15th Avenue & Enterprise Drainage	141,722	112,567	13,774	15,382			
WL17A	College Cr @ Martin Way West Treatment	540,000	275,400	156,600		108,000		
WD12A	Woodard Cr Headwaters Detention	252,113						252,113
WL17D	Woodland Cr @ I-5 Treatment	94,843				94,843		
WL3	Steilacoom Rd & School St Pond	119,058			119,058			
WD5A	Woodard Cr @ Pacific Ave Treatment	1,350,000		995,075		354,925		
WL17B	College Cr @ I-5 Treatment	33,770				33,770		
WL26A	College Cr @ St. Martins Detention	1,118,324						1,118,324
WL26B	College Cr @ Pacific College Detention	918,390						918,390
WL26D	Eagle Creek Detention	151,728						151,728
WL26E	Covington Ct & Palm Rd Detention	314,469						314,469
WL26F	Fox Cr @ Pleasant Glade Detention	164,493						164,493
WL26G	Jorgensen Creek Detention	219,714						219,714
WL26C	College Cr @ 2nd I-5 Crossing Detention	281,933						281,933
WD12B	Woodard Cr @ So Bay Rd Detention	137,958						137,958
	TOTAL	12,464,269	3,436,267	2,254,552	2,622,792	591,538		3,559,121

Table 9-9 Phase 2 Projects and Revenues

PROJECT #	Project Description	PROJECT COST 1994 $	LACEY	OLYMPIA	COUNTY	WDOT	GRANTS/ ROAD FUNDS	FUTURE GROWTH
WL4	So. Tanglewilde Infiltration System	3,537,120			3,537,120			
WL18	Pleasant Glade NE Culvert	163,374			81,687		81,687	
WD8	36th Ave NE Culvert	66,512			33,256		33,256	
WL1	Forest Glen Subd. 4 Infiltration	24,000			24,000			
WL17C	Woodland Cr @ Martin Way West Swales	237,367	118,684				118,684	
WD9	So Bay Rd Culvert	66,512			33,256		33,256	
WL12	Lakemont Drive & 49th Drainage	90,000			90,000			
WL25	Interstate 5 Culvert	94,843						94,843
WL23	Martin Way Culvert	79,181	39,590				39,590	
WD11	I-5 & Pacific Ave Culverts	5,000		1,277		3,723		
	TOTAL	4,363,907	158,274	1,277	3,799,318	3,723	306,472	94,843

Table 9-10 Phase 3 Projects and Revenues

PROJECT #	Project Description	PROJECT COST 1994 $	LACEY	OLYMPIA	COUNTY	WDOT	GRANTS/ ROAD FUNDS	FUTURE GROWTH
WL15C	Martin Way East Additional Treatment	4,857,990	384,379		4,605,329			
WL6	Tanglewilde East Infiltration	12,000	12,000		12,000			
WL5A	Tanglewilde Husky Way Conveyance	4,593,787			4,593,787			
WD5B	Woodard Cr Untreated Discharges (Level 1)	38,900	1,167	9,725	38,900			
WL5B	Tanglewilde Martin Way Conveyance	1,277,003			1,277,003			
WL17E	Woodland Untreated Discharges	136,100	38,108	1,361	96,631			
WD2A	Woodard Basin Failing Drainage (Level 1)	28,000		14,000	14,000			
WL13A	Woodland Basin Failing Dry Wells	192,000			192,000			
WL11	Alder Drive Remedial Maintenance	*	*					
WL10	Homann Drive Remedial Maintenance	*	*					
WL9	35th & 36th SE Remedial Maintenance	*	*					
WD1	12th & Boone Remedial Maintenance	*	*					
	TOTAL	11,135,780	435,654	25,086	10,829,650			

REFERENCES

Advanced Engineering Consultants, Inc. 1979. *Woodard Creek drainage study.* Prepared for cities of Olympia and Lacey, Washington.

———. 1979. *Woodard Creek pollution control reduction study.* Prepared for city of Lacey, Washington.

Arno, Stephen F. and Ramona Hammerly. 1977. *Northwest trees.* Seattle: The Mountaineers.

Baranski, C. February 1991. Letter to Phillip Jensen dated February 21. Washington Department of Fisheries, Olympia, WA.

Bartoldus, Candy C., E.W. Garbisch and M.L. Kraus. 1994. *Evaluation for Planned Wetlands.* Environmental Concern Inc. St. Michaels, MD.

Berris, S. 1990. Telephone conversation with Tom Holz. United States Geological Survey. Tacoma, WA.

Beyerlein, D.C. and J.T. Brascher. 1994a. *Woodland and Woodard Creek HSPF Calibration for Thurston County, Washington.* Prepared for Thurston County by Aqua-Terra Consultants, Everett, WA.

Beyerlein, D.C. and J.T. Brascher. 1994b. *Woodland and Woodard Future Conditions, Thurston County, Washington, Final Results.* Prepared for Thurston County and the U.S. Geological Survey by Aqua-Terra Consultants, Everett, WA.

Bisson, Peter. 1992. Habitat needs of salmon in the city. Paper presented at symposium, Salmon in the City: effects of urbanization on fish habitat, March 11-13. Sponsored by the American Public Works Association, Pack Forest, Eatonville, WA.

Boule, Marc et al. *See* U.S. Department of Defense. Army Corps of Engineers.

Bretz, J. H. 1910. Glacial lakes of Puget Sound. *Journal of Geology* 18: 448-458.

———. 1913. Glaciation of the Puget Sound region. *Washington Geology Survey Bulletin* 8.

Brown, R.E. *See* U.S. Department of Agriculture. Forest Service.

Brown and Caldwell Consultants. 1990. *McAllister/Eaton Creek ground water risk assessment.* Prepared for Thurston County, WA.

Castelle, A. *See* Washington State. Department of Ecology.

City of Kent. *See* Kent, City of.

City of Lacey. *See* Lacey, City of

City of Olympia. *See* Olympia, City of.

Cowardin, L. et al. *See* U.S. Department of the Interior. Fish and Wildlife Service.

Crandell, D.R., D.R. Mullineaux, and H.H. Waldron. *See* U.S. Department of Interior. Geological Survey.

Creso, Irene. 1984. *Vascular plants of western Washington.* Tacoma, WA.

Curray, J. R. 1962. Late quaternary sea level; a discussion. *Geological Society of America Bulletin* 72: 1707-1712.

Davis, S. and R. Coots. *See* Thurston County. Department of Public Health and Social Services.

Dinicola, R.S. *See* U.S. Department of Interior. Geological Survey.

Dobbs, A. et al. 1977. *Woodland Creek, a baseline study.* Report to the Washington State Department of Game. Olympia, WA: The Evergreen State College.

Entranco. 1982. *Water quality analysis and restoration plan for Pattison and Long Lakes,*

Volumes I and II. Prepared for Thurston County, WA. Seattle.

Federal Emergency Management Agency. 1982. *Flood insurance study, Thurston County and regions.* Washington, D.C.

Franklin, J.F. and C.T. Dyrness. *See* U.S. Department of Agriculture. Forest Service.

Golder Associates Inc. 1990. *Report to the Thurston County Health Department on hydrogeologic evaluation of McAllister Springs geologically sensitive area.* Prepared for Thurston County, WA.

Gregory, S. V., F. J. Swanson, W.A. McKee, and K.W. Cummins. September 1991. An ecosystem perspective of riparian zones. *BioScience* 41 (8): 540-550.

Harrison, B. and L. Hofstad. *See* Thurston County. Department of Public Health and Social Services.

Hitchcock, C. L. and A. R. Cronquist. 1976. *Flora of the Pacific Northwest.* Seattle: University of Washington Press.

Hofstad, L. *See* Thurston County. Department of Public Health and Social Services.

Horner, R. R. and S. R. Wonacott. 1985. *Performance evaluation of a detention basin and coalescing plate oil separator for treating urban stormwater runoff.* Water Resources Series Technical Report No. 98. Seattle: University of Washington Department of Civil Engineering.

Horner, R. R. 1988a. *Long term effects of urban stormwater on wetlands.* Proceedings of the Engineering Foundation Conference on Urban Runoff; Potosi, MO.

———. 1988b. *Biofiltration systems for storm runoff water quality control.* Prepared for Washington State Department of Ecology, Municipality of Metropolitan Seattle, King County, City of Bellevue, City of Mountlake Terrace, City of Redmond, Wa.

Johnson, A. and J. Caldwell. March 1992. Analysis of fish habitat and stormwater management options for Woodland Creek, Thurston County, Washington. Paper presented at symposium, Salmon in the City: effects of urbanization on fish habitat, March 11-13. Sponsored by the American Public Works Association, Pack Forest, Eatonville, WA.

Kent, City of. City Code Chapter 7.20. Kent, WA.

Kessler, Richard. 1990. *The oak woodlands of Thurston County, WA: mapping and description of stands.* Prepared for Washington Department of Wildlife and the Capitol Land Trust. Olympia, WA.

Kramer Chin and Mayo, Inc. 1990. *Dungeness River Comprehensive Flood Control Management Plan.* Prepared for Clallam County Public Works Department, WA.

Kruckeberg, Arthur. 1991. *The natural history of Puget Sound country.* Seattle: University of Washington Press.

Lacey, City of. Water Resources Division. 1992. *Lacey stormwater monitoring program final report.* Lacey, WA.

Lacey, City of. 1994a. *Wetlands protection, Lacey municipal code chapter 14.28.* Lacey, WA.

Lacey, City of. 1994b. *Environmental protection and resource conservation plan.* Lacey, WA.

Lacey, City of and Thurston County. 1994. *City of Lacey and Thurston County land use plan for the Lacey urban growth area: a joint planning document prepared as the Lacey comprehensive land use plan and an element of the Thurston County comprehensive land*

use plan. Lacey, WA.

Lang, F. A. 1961. A study of vegetation change on the gravelly prairies of Pierce and Thurston Counties, western Washington. Master's thesis, University of Washington.

Linsley et al. 1982. *Hydrology for engineers*, 3rd edition. McGraw-Hill.

Lowrance, R. R., R. Todd, and L. Asmussen. 1984. Nutrient cycling in an agricultural watershed. *Journal of Environmental Quality* 13:22-27.

Lowrance, R.R., R. Todd, J. Fail, Jr., O. Hendrickson, Jr., R. Leonard, and L. Asmussen. 1984. Riparian forests as nutrient filters in agricultural watersheds. *BioScience* 34:374-377.

Macklin, J. D. and D. C. Thompson. 1992. *Oregon white oak woodlands of Fort Lewis, Pierce County, Washington.* Report to the Seattle District Corps of Engineers, Environmental Resources Section. Contract # DACA 67-90-D 0009. Bellevue, WA.

Marr, R.R. et al. *See* Washington State. Department of Transportation.

McGavock, E.H. et al. *See* U.S. Department of Interior. Geological Survey.

McMillan, A. *See* Washington State. Department of Ecology.

Mead, Bob. 1994. Personal communication with author. Thurston County Department of Public Health and Social Services, Olympia, WA.

Miller, R.J. and E.L. Brannon. 1981. The origin and development of life history patterns in Pacific salmonids. In proceedings, Salmon and trout migratory behavior symposium, edited by E.L. Brannon and E.O Salo.

Noble, J.B. and E.F. Wallace. *See* Washington State. Division of Water Resources.

Olympia, City of. 1984. *Draft environmental impact statement for Martin Way annexation/rezone application.* Olympia, WA.

———. 1988. *Comprehensive plan.* Olympia, WA.

———. 1994a. *Comprehensive plan for Olympia and the Olympia Growth Area.* Olympia, WA.

———. 1994b. *Olympia Municipal Code, Section 13.16, Procedures for the collection of storm GFC and stormwater utility billing.* Olympia, WA.

Olympia Salmon Club. 1992. Personal communication, Olympia, WA.

Pedersen, E.R. 1981. The use of invertebrate data for evaluating impacts of urban stormwater runoff. Master's thesis, Department of Civil Engineering, University of Washington.

Petterjohn, W. T., and D. L. Correll. 1984. Nutrient dynamics in an agricultural watershed: observations on the role of the riparian forest. *Ecology* 65:1466-1475.

Poultridge, A. *See* Washington State. Department of Natural Resources.

Powers, P. 1991. Letter to Phillip Jensen dated January 24. Washington Department of Fisheries, Olympia, WA.

Puget Sound Water Quality Authority. 1990. *1991 Puget Sound water quality management plan.* Olympia, WA.

R.W. Beck and Associates. 1989. *Scriber Creek watershed management plan.* Prepared for Snohomish County Public Works Department. Everett, WA.

Randall, Warren R., R. F. Keniston, D. N. Bever, and E. C. Jensen. 1990. *Manual of Oregon trees and shrubs.* Corvallis, OR: Oregon State University Book Stores

Reinelt, L. et al. 1990. *Puget sound wetlands and stormwater management research*

program. Seattle: University of Washington.

Reed, P.B. *See* U.S. Department of the Interior. Fish and Wildlife Service.

Resource Planning Associates. July 1990. *Background report on establishing design criteria for the drainage manual for LOTT*. Olympia, WA.

Robison, E. G. 1993. A quantitative habitat assessment protocol for field evaluation of physical habitat for small wadable streams: Oregon Version. Unpublished draft. Corvallis, OR: Oregon State University, Fisheries and Wildlife Dept.

Rodrick, E. and R. Milners, eds. *See* Washington State. Department of Wildlife.

Schueler, Thomas R. 1987. *Controlling urban runoff, a practical manual for planning and designing urban BMPs*. Washington D.C.: Washington Metropolitan Water Resources Planning Board.

Schuett-Hames, D., L. Bullchild, S. Hall and A. Pleus. 1992. *T-F-W Ambient Monitoring Manual*. Olympia, WA: Northwest Indian Fisheries Commission.

Seattle Audubon Society. 1993. *Washington State breeding bird atlas*. Seattle, WA.

Sedell, J.R., F.H. Everest and F.J. Swanson. 1982. Fish habitat and streamside management: past and present. Pages 244-255 in Proceedings of the Society of American Foresters Annual Meeting. Society of American Foresters, Bethesda, MD.

Sedell, J. R. and R. L. Beschta. 1991. Bringing back the "bio" in bioengineering. In Proceedings of the American Fisheries Society Symposium 10:160-175.

Starry, A. *See* Thurston County. Department of Public Health and Social Services.

Taylor, M. *See* Thurston County Department of Public Health and Social Services.

Thurston County. *Thurston County Code*. Olympia, WA.

Thurston County. Department of Public Health and Social Services. 1984. *The Henderson and Eld Inlet water quality study*. By M. Taylor. Olympia, WA.

———. 1988. *Henderson, Eld and Totten Inlets: 1986-1987 water quality investigation*. By B. Harrison and L. Hofstad. Olympia, WA.

———. 1989. *Woodland and Woodard Creek basins stormwater quality survey*. By S. Davis and R. Coots. Olympia, WA.

———. 1990. *Henderson Inlet and watershed: 1987-1989 water quality and remedial action report*. By A. Starry. Olympia, WA.

———. 1992. *Northern Thurston County ground water management plan*. Olympia, WA.

———. 1993. *Watershed implementation, Eld, Henderson and Totten/Little Skookum, 1990-1992, final report*. By L. Hofstad. Olympia, WA.

———. 1993. Thurston County Ordinances, Title 17. Olympia, WA.

Thurston County. Department of Public Works. July 1978. *Final environmental impact statement on proposed Thurston County Lakes Restoration Project*. Lakes Program, Olympia, WA.

———. 1991. *Drainage design and erosion control manual for Thurston County and the cities of Lacey, Olympia, and Tumwater, Washington*. Storm and Surface Water Program, Olympia, WA.

Thurston County Department of Water and Waste Management. 1994. *Drainage design and erosion control manual for Thurston County*. Thurston County, Olympia, WA.

Thurston County Planning Department. 1989. *Henderson Inlet watershed action plan*. Olympia, WA.

———. 1988. *Thurston County comprehensive plan.* Olympia, WA.

Thurston Regional Planning Council and Thurston County Department of Public Works. 1983. *Stormwater management in north Thurston County, Volumes I and II.* Olympia, WA.

Thurston Regional Planning Council. 1987. *Wetlands and stream corridors phase II, Volume 1 and 2, final report and appendices.* Olympia, WA.

———. 1988a. *Woodard Bay natural resources conservation area.* Olympia, WA.

———. 1988b. *Memorandum of understanding: an urban growth management agreement.* Olympia, WA.

———. 1990a. *Industrial lands inventory summary.* Olympia, WA.

———. 1990b. *Shoreline master program for the Thurston region.* Thurston County, Olympia, WA.

———. 1991. *The profile.* Olympia, WA.

URS Consultants. 1989. *Edmonds drainage basin studies.* Edmonds, WA.

U.S. Department of Agriculture. Forest Service. 1973. *Natural vegetation of Oregon and Washington.* By J. F. Franklin and C. T. Dyrness. General Technical Report PNW-8. Portland OR.

———. Pacific Northwest Region. 1985. *Management of wildlife and fish habitats in forests of western Oregon and Washington, Part 1 and 2.* Ed. by R. E. Brown.

U.S. Department of Agriculture. Soil Conservation Service. 1990. *Soil survey of Thurston County, Washington.* Olympia, WA.

U.S. Department of Defense. Army Corps of Engineers. 1985. *Wetland plants of the Pacific Northwest.* By Marc Boule, K. Brunner, J. Malek, F. Weinmann, and V. Yoshino. Seattle.

U.S. Department of Defense. Army Corps of Engineers. 1989. *Federal manual for identifying and delineating jurisdictional wetlands.* Washington, DC.

U.S. Environmental Protection Agency Office of Water. 1993. *Guidance specifying management measures for source of nonpoint pollution in coastal waters.* Publication # EPA-840-B-92-002. Washington DC.

U.S. Department of the Interior. Fish and Wildlife Service. 1979. *Classification of wetlands and deepwater habitats of the United States.* By L. Cowardin et al. FWS/OBS-79/31. Washington, DC.

———. 1987. National wetland inventory. Washington, DC.

———. 1988. National list of plant species that occur in wetlands. By P. B. Reed. NEC-88/18.47. Saint Petersburg, FL.

U.S. Department of the Interior. Geological Survey. 1965. *Age and origin of the Puget Sound trough in western Washington.* By D. R. Crandell, D. R. Mullineaux, and H. H. Waldron. Professional Paper 525-B:B132-36.

———. 1981. *Water resources data, Washington water year 1981 v.1.* Water-data report WA-81-1. Tacoma, WA.

———. 1988. *Water resources data, Washington water year 1986.* By E. H. McGavock, W. D. Wiggins, P. R. Boucher, R. L. Blazs, L. L. Reed, and M. L. Smith. Water-data report WA-86-1. Tacoma, WA.

———. 1989. *A regional rainfall-runoff simulation model for the Puget Sound area of*

Washington State. By R. S. Dinicola. Water Resources Investigation Report. Tacoma, Washington.

———. 1990. *Characterization and simulation of rainfall-runoff relations for headwater basins in western King and Snohomish counties, Washington*. By R. S. Dinicola. Water Resources Investigations Report 89-4052. Tacoma, WA.

Washington State. *Washington Administrative Code*.

Washington State. *Revised Code of Washington*.

Washington State. Department of Conservation. 1964. *Miscellaneous stream-flow measurements in the State of Washington, 1890 to January, 1961*. Water-Supply Bulletin No. 23. Olympia, WA.

Washington State. Department of Ecology. 1972. *Final Guidelines for the Shoreline Management Act of 1971*. Olympia, WA.

———. 1984. *Shellfish protection strategy*. Olympia, WA.

———. 1988a. *Wetland regulations guidebook*. Publication #88-5. Olympia, WA.

———. 1988b. *Washington's wetlands*. By A. McMillan. Publication #88-24. Olympia, WA.

———. 1989. *A guide to conducting wetland inventories*. Publication #89-60. Olympia, WA.

———. 1991. *Washington State wetlands rating system*. Publication #91-57. Olympia, WA.

———. 1992a. *Wetland buffers: use and effectiveness*. By A. Castelle. Publication #92-10. Olympia, WA.

———. 1992b. *Stormwater program guidance manual for the Puget Sound basin: volumes 1 & 2*. Publications #92-32 and 92-33. Olympia, WA.

———. 1994. *Focus: Water quality in Washington State (section 303(d) of the Federal Clean Water Act)*. Publication F-WQ-94-37. Olympia, WA.

Washington State. Department of Fisheries. 1975. *A catalogue of Washington streams: vols. 1 & 2*. By R. W. Williams, R. M. Laramie and J. H. Ames. Olympia, WA.

Washington State. Department of Natural Resources. 1991. *Boomtime: a history of the Woodard Bay natural resources conservation area*. By A. Poultridge. Division of Land and Water Conservation, Olympia, WA.

———. 1994. *Endangered, threatened and sensitive vascular plants of Washington*. Natural Heritage Program, Olympia, WA.

Washington State. Department of Transportation. 1982. *Summary-Washington State highway runoff water quality study, 1977-1982*. By B. W. Mar, R. R. Horner, J. F. Ferguson, D. E. Spyridakis, and E. B. Welch. WA-RD-39.16. Olympia, WA.

Washington State. Department of Wildlife. 1991. *Management recommendations for Washington's priority habitats and species*. Ed. by E. Rodrick and R. Milner. Olympia, WA.

———. June 1993. Priority habitat and species tabular data report. Olympia, WA.

Washington State. Division of Water Resources. 1966. *Geology and ground-water resources of Thurston County, Washington*. By J. B. Noble and E. F. Wallace. Water Supply Bulletin No. 10. Olympia, WA.

Williams, R.W., R.M. Laramie and J.H. Ames. *See* Washington State. Department of Fisheries.

Woodward-Clyde. 1989. *Analysis of storm event characteristics for selected rainfall gages throughout the United States.*

Wright, Harold. 1991. Personal conversation with author, Olympia, WA.