Appendix 2: Tables

Table A-1: Drainage Area Characteristics
Indian/Moxlie Creek Basin

Basin	Subbasin	Area, acres	Land Use Type, approx. percent	Topography, approx. percent	Soils Dominant/Subdominant
Indian	I-1	451	Residential 95 Natural Resources 5	0-2	Mukilteo peat/fine sandy loam
	I-2	201	Residential 60 Retail/Professional 30 Industrial 10	3-15	Fine sandy loam/sandy loam
	I-3	107	Residential 90 Public 10	3-15	Fine sandy loam/loamy sand
	I-4	207	Residential 95 Public 5	3-15	Fine sandy loam
	I-5	142	Residential 90 Public 10	3-15	Fine sandy loam/loamy fine sand
	I-6	202	Residential 95 Public 5	15-30	Loamy fine sand/fine sandy loam
	I-7	149	Residential 95 Retail/Office 5	3-15	Fine sandy loam/loamy fine sand
Moxlie	M-1	493	Residential 90 Public 10	3-15	Fine sandy loam
	M-2	312	Natural Resources 90 Residential 10	15-30	Loamy fine sand/Mukilteo peat over clay
	M-3	254	Public 55 Residential 45	3-15	Silt loam/loamy fine sand
	M-4	332	Residential 45 Retail/Professional 55	3-15	Fine sandy loam/fill

Table A-2: Wetland Characteristics
Indian/Moxlie Creek Basin

(Ref: National Wetland Inventory, 1988)

Basin	Subbasin	NWI Classification	Zoning	Land Use	Location
Indian	I-1	– Open Water, Permanently Flooded – Forested, Seasonally Flooded – Scrub/Shrub, Seasonally Flooded – Emergent, Seasonally Flooded	Residential	Woodlot/Pasture	Bigelow Lake
	I-2	Scrub/Shrub, Seasonally Flooded	Residential	Undeveloped	Indian Creek Between South Bay Road and Devoe Street
	I-2	Scrub/Shrub, Seasonally Flooded	Commercial	Undeveloped	Indian Creek North of Martin Way
	I-2	Scrub/Shrub, Seasonally Flooded	Commercial	Undeveloped	Indian Creek Between Martin Way and Pacific Avenue
	I-2	Scrub/Shrub, Seasonally Flooded	Commercial	Woodlot	Indian Creek Between Pacific Avenue and Interstate 5
	I-3	– Open Water, Permanently Flooded – Scrub/Shrub, Seasonally Flooded – Forested, Temporarily Flooded – Aquatic Bed, Permanently Flooded	Residential	Undeveloped/Woodlot	D'Miller Lake West to Boulevard Road
	I-4	Emergent, Semi-Permanently Flooded	Residential	Woodlot	Boulevard Road and Fones Road
	I-4	Scrub/Shrub, Seasonally Flooded	Residential	Woodlot	Indian Creek and Frederick Street
	I-6	Open Water, Permanently Flooded	Residential	Woodlot	Indian Creek and Central Street
Moxlie	M-1	Open Water, Permanently Flooded	Residential	Woodlot	Governor Stevens Avenue and Hoadly Street
	M-1	Open Water, Scrub/Shrub, Permanently/Seasonally Flooded	Residential	Woodlot	Hazard Lake
	M-1	Forested, Temporarily Flooded	Institutional	Woodlot	North Street and Henderson Boulevard, Olympia High School
	M-1	Emergent, Seasonally Flooded	Residential	Woodlot	North Street and Central Street
	M-2	Open Water, Permanently Flooded	Public	Commercial/Highway Right-of-Way	Plum Street and Henderson Boulevard, Artesian Pond
	M-2	Aquatic Bed/Emergent	Public	Woodlot/Interstate Right-of-Way	Moss Lake
	M-2	– Riverine – Upper Perennial – Open Water, Permanently Flooded	Public	Woodland	Moxlie Creek, Watershed Park

Table A-3: Upland Depressions (Potholes) Indian/Moxlie Creek Basin

Subbasin	Street Location and Map Reference	Approximate Volume (Acre-Feet)	Storm System Outfalls	Ownership	Current Land Use
M-1	Gov. Stevens Avenue and Moore Street 5-26-18-2W	146	8", 8", 8", 8"	City of Olympia/ Private	Forested/Residential
M-1	I-5 (Moss Lake) 8-23-18-2W	5	24"	City of Olympia/ Private	Forested/Residential
M-1	Carlyon Avenue and Hawthorne Avenue (Hazard Lake) 6-26-18-2W	49	6"	Private	Forested/Residential
M-1	Henderson Boulevard and Arietta Avenue 2-25-18-2W	4	6"	City of Olympia/ Private	Forested/Residential
M-1	North Street and Henderson Boulevard (Olympia High School) 3-25-18-2W	12	15"	Olympia High School	Partially Forested/School
M-1	North Street and Central Street 3-25-18-2W	11	8"	Private	Residential
M-1	Sherwood Drive and 28th Court 5-25-18-2W	42	8"	Private	Forested/Residential
M-1	Sherwood Drive and Woodcrest Drive 5-25-18-2W	80	8", 6", 12"	Private	Forested/Residential
M-1	Cain Road and Vista Avenue 6-25-18-2W	1	12'	City of Olympia	Partially Forested/ Residential
M-1	Cain Road and North Street (Holiday Hills) 7-25-18-2W	20	6"	Private	Recreational Area/ Residential
M-1	Northwest of Raintree Court 5-25-18-2W	13	None	Private	Partially Forested/ Residential
M-2	Eskridge Road and Cain Road 5-25-18-2W	104	24"	Private	Forested/Residential
M-2	Cain Road and Eastwood Drive 4-24-18-2W	6	None	Private	Forested/Residential
I-4	Fones Road and Frazier Road 2-19-18-1W	90		Private	Pasture/Agricultural
Ward Lake	Log Cabin Road/Ward Lake 8-25-18-2W	5	None	Private	Pasture/Agricultural

Table A-4: Instream Culverts and Pipes
Indian/Moxlie Creek Basin

Basin	Subbasin	Size, inches	Type/Material*	Length, feet	Gradient, percent	Needed Maintenance	Location Landmark
Indian	I-1	24	Culvert/RCP	40	<0.1	Cleaning	12th Avenue
		36	Culvert/CMP	50	<0.1		South Bay Road
	I-2	36	Pipe/CMP	150	<0.1		South Bay Road
		36	Culvert/RCP	122	<0.1	Cleaning	Martin Way
		36	Pipe/CMP	710	<0.1		Pacific Avenue
		36	Culvert/CMP	256	<0.1		Interstate 5
	I-3	2-24	Culvert/RCP	30	1/3.5	Cleaning	BN Railroad
		32	Culvert/RCP	63	1.5	Cleaning	BN Railroad
		32	Culvert/RCP	8	--		Boulevard Road
	I-4	--	--	--	--		
	I-5	36	Pipe/CMP	75	0.5		Boulevard Road
		48	Culvert/CMP	137	4.7		BN Railroad
		24	Culvert/RCP	50	3.3		Frederick Street
		36	Pipe/CMP	150	2.4		BN Railroad
		36/24	Pipe/CMP; Culvert/RCP	255/120	0.4/4.8		BN Railroad
	I-6	36	Culvert/RCP	113	0		Wheeler Road
		36	Culvert/RCP	81	0.9		Wheeler Road
		36	Culvert/RCP	55	3.3		Central Street
		36	Culvert/RCP	130	1.0		Wheeler Road
		36	Culvert/CMP	472	1.8		Interstate 5
	I-7	36	Pipe/CMP	925	1.1		Eastside Street
		54	Pipe/CMP	270	0.5		Pear Street
		2-24/48	Pipe/CMP	260	0.6		Plum Street
Moxlie	M-1	--	--	--	--		
	M-2	48	Culvert/CMP	288	0.2		Interstate 5
	M-3	36	Pipe/CMP	88/318	0.1/0.4		Henderson Boulevard
		36	Pipe/RCP	108	0.4	Repair outlet	Henderson Boulevard
		2-36	Culvert/RCP	148	0.1/0.4		Henderson Boulevard
	M-4	72/84	Pipe/CMP	3,170	0.3		Downtown Olympia

RCP = Reinforced Concrete Pipe   CMP = Corrugated Metal Pipe

Table A-5: Potential Effects of Urban Runoff on Stream Systems

(Ref: Kirkpatrick, 1990)

EFFECTS UPON:

Hydrology	Stream Morphology	Large Organic Debris (LOD)	Riparian Zone	Water Quality
Increase Flow, 150%	Increase Channel Width, 200-400%	Decrease Number and Size of LOD	Decrease Riparian Vegetation	Increase Sediments, 100-400,000%
Increase Peak Flow, 200-500%	Increase Floodplain Elevation	Decrease Cedar and Fir Species	Decrease Naturally-Occurring Tree Speciation	Increase Bacteria, 600-1000%
Increase Concentration Time, 150%	Increase Sediment Transport		Increase Soil Saturation	Increase Oil and Grease
Increase Flood Frequency, 200-500%	Decrease Streambed Stability			Increase Trace Metals
Decrease Base Flow, 0-20%	Increase Erosive Energy			Increase Trace Organics (Pesticides, Plasticizers, Wood Preservatives)
Increase Hydraulic Energy				Increase Orthophosphate, 300%
				Increase Inorganic Nitrogen, 800%
				Increase Oxygen Demand
				Increase/Decrease Temperature

HABITAT RESPONSES:

Hydrology	Stream Morphology	Large Organic Debris (LOD)	Riparian Zone	Water Quality
Flooding	Increase Quantity of Riffles,		Increase Readily- Decomposable LODs	
Decreased Summer Flows	Decrease Quantity of Pools, 50%	Decrease Fish Rearing Pools	Decrease Barrier to High Flow Erosion	Decrease Spawning Success and Juvenile Fish Survival
Decreased Groundwater Recharge	Increase Quantity of Channel Scoured to Great Depth	Decrease Sediment and Organic Matter Storage Sites	Decrease Energy Dissipation	Increase Fish Disease
Displace Fry, Eggs, and Benthic Organisms	Increase Channel Erosion	Decrease Meanders, Secondary Channels, and Backwaters	Decrease Channel Stability	Decrease Benthic Organism Diversity
Decrease Ability of Wetlands to Store Flows	Contaminate Gravels with >10% Fine Sediments	Decrease Fish Refuge from High Flows	Decrease Shade, Food Sources, and Cover	Increase Primary Production
	Smother Eggs	Decrease Cover from Predators	Decrease Filtration of Run-off	Decrease Prey Capture
		Decrease Spanning Areas	Decrease Benthic Organism Diversity, 200-300%	
		Decrease Habitat Diversity	Decrease Lower and Upper Bank Stability	

Table A-6: Predevelopment Peak Flood Flows
Indian/Moxlie Creek Basin

(Ref: EPA SWMM, 1991)

Basin	Location	Flows (cfs) For 1- to 100-Year Storm Events					
		2	5	10	25	50	100
Indian	South Bay Road	8	9	10	10	12	14
	Pacific Avenue	8	9	10	10	12	14
	Fredrick Street	17	18	21	24	28	33
	Interstate 5	22	25	29	33	39	46
	Henderson Boulevard	24	27	32	36	43	51
Moxlie	Interstate 5	12	12	14	17	19	20
	Henderson Boulevard	12	12	14	17	19	20
Indian/Moxlie	Budd Inlet	63	72	82	90	104	116

* 7-day storm events

Table A-7: Existing Peak Flood Flows
Indian/Moxlie Creek Basin

(Ref: EPA SWMM, 1991)

Basin	Location	Flows (cfs) For 1- to 100-Year Storm Events					
		2	5	10	25	50	100
Indian	South Bay Road	16	17	20	23	26	30
	Pacific Avenue	16	17	20	23	26	30
	Fredrick Street	23	25	29	33	39	44
	Interstate 5	60	62	66	68	69	71
	Henderson Boulevard	69	72	77	82	88	97
Moxlie	Interstate 5	24	24	29	32	33	35
	Henderson Boulevard	24	25	31	35	37	40
Indian/Moxlie	Budd Inlet	215	224	255	300	326	348

* 7-day storm events

Table A-8: Full Development Peak Flood Flows Indian/Moxlie Creek Basin

(Ref: EPA SWMM, 1991)

Basin	Location	Flows (cfs) For 1- to 100-Year Storm Events					
		2	5	10	25	50	100
Indian	South Bay Road	24	27	31	35	39	39
	Pacific Avenue	24	27	31	35	39	39
	Fredrick Street	59	64	76	87	97	101
	Interstate 5	69	69	70	72	74	76
	Henderson Boulevard	80	79	83	86	98	98
Moxlie	Interstate 5	29	29	32	32	32	32
	Henderson Boulevard	29	29	34	34	38	40
Indian/Moxlie	Budd Inlet	230	234	262	309	329	353

* 7-day storm events

Table A-9: Salmon Biological and Habitat Requirements Indian/Moxlie Creek Basin

(Ref: Washington Department of Fisheries)

Salmon Species	Spawning Location	Time in Gravel (Eggs)	Gravel Emergence	Rearing Location	Time In Freshwater	Time In Saltwater	Return to Freshwater
Coho	Mid to upper main stem	80-150 days	April - May	Mid or upper main stem; spring-fed tributaries and wetlands	1 year (12 - 14 months) May - June	1.5 years	Late fall
Fall Chinook	Mid to upper main stem	90-150 days	March - April	Main stem and estuaries	60-120 days	1 - 4 years	November (intermittant)
Cutthroat	Mid to upper main stem	90-150 days	June - July	Mid or upper main stem and spring-fed tributaries	2 - 3 years	2 years	Fall and winter
Steelhead (winter)	Mid to upper main stem	50-150 days	June - July	Mid or upper main stem and spring-fed tributaries	2 years	0.5 - 3 years	Early winter
Chum	Mid to upper main stem	90-150 days	Late February, April - May	Saltwater, estuaries	0	3 - 4 years	Early to late fall

Table A-10: Salmon Environmental Parameters
Indian/Moxlie Creek Basin

(Ref: Washington Department of Fisheries)

Category	Parameter Type						
Quality		Levels of Impact					
		Desirable	Acceptable	Chronic	Lethal	Stops Migration	Comments
	DO (dissolved oxygen)	≥9.0 ppm or near saturation levels	7.0-8.0 ppm or ≥80% of saturation	≤6.0 ppm	Not available	Not available	DO levels must not be below 7 ppm at any time during spawning.
	T° (temperature)	<58°F	45°F to 65°F	>68°F and cold water fish cease growing	Not available	Not available	50% reduction in swimming capability of salmonids is known to occur at upper and lower temperature limits.
	SS (suspended solids)	<25 mg/l	25-80 mg/l	80-400 mg/l		>4,000 mg/l ppm	Excessive turbidities can stop or delay upstream migration.
	Sediment	10% of fines in streambed core sample; maximum 72% survival rate	10%-12% fines	12%-15% fines	>25% fines	Not applicable	The McNeil sampling method for sediment is based on streambed core samples in representative spawning areas. Fines are 0.85 mm or less in size. Based on survival-to-emergence ratios.
Quantity		Measurements					
	cfs (cubic feet per second)	Velocities = 10-13 ft/sec approach the upper swimming ability of salmon.					
	Minimum depth	0.59-0.79% of the width of the fish.					
Barriers		Anadromous Barriers					
	Waterfalls	Any falls 10 inches in height.					There is a jumping ability difference between species; chum are poor negotiators of barriers greater than 2 feet in height.
	Culverts	When slope exceeds 2%					

Table A-11: Common Water Quality Contaminants Indian/Moxlie Creek Basin

Pollutant Category	Sources	Potential Impacts	Forms/Measurements
Bacteria	Sediments Animal and manure transport Domestic animals Septic systems	Shellfish bed contamination Drinking water contamination recreation limitations	Coliform indicators: Total Fecal Specific pathogens
Sediment	Construction sites Stream channel erosion Poorly vegetated lands Steep slopes Vehicular deposition	Tissue abrasion Gill clogging Light reduction Benthic siltation Transport of other pollutants	Total suspended solids (a mass measure) Turbidity (a light scattering measure)
Nutrients	Sediments Fertilizers Petroleum products Domestic animals Septic systems Vegetative matter	Eutrophication (enrichment) Nuisance algal blooms Reduced clarity Odors Oxygen depletion Reduced drinking water quality	Phosphorus: Soluble Particulate Nitrogen: Ammonia Nitrate and nitrite Organic
Metals	Sediments Vegetative matter Domestic animals Petroleum products	Toxicity	Lead Copper Zinc Cadmium Others
Organic toxins	Sediments Pesticides Combustion products Petroleum products Paints and preservatives Plasticizers Solvents	Toxicity	Many specific chemicals
Oil and grease	Petroleum products	Benthic accumulation Toxicity	Oil and grease
Oxygen-demanding organics	Sediments Vegetative matter Domestic animals Petroleum products	Oxygen depletion	Biochemical oxygen demand Chemical oxygen demand

Table A-12: Flood Flow Impoundment by Culverts For 2- and 100-Year Storm Events Indian/Moxlie Creek Basin

(Ref: EPA SWMM, 1991)

Location[2]	Existing Conditions		Full Development		Full Development With Reduced Release Rates[1]	
	2-Year[3]	100-Year	2-Year	100-Year	2-Year	100-Year
Indian Creek:						
South Bay Road	--	--	--	19,000 cf[4]	--	15,000 cf
Fredrick Street	--	32,000 cf		36,000	--	34,000
Railroad Grade West of Fredrick Street	--	819,000	5,900 cf	936,000	--	883,000
Moxlie Creek:						
Interstate 5	--	201,000	--	377,000	--	342,000
Henderson Boulevard	--	11,000	--	40,000	--	32,000

[1] Refer to Recommendation R-7, Chapter 11
[2] Other culvert and pipes function without impounding appreciable water volumes
[3] 7-day storm events
[4] cubic feet

A-13: Alternative II: Basin-Specific Projects and Potential Funding Sources Indian/Moxlie Creek Basin

Recommendation		Engrs Cost Est	Existing vs Future	Utility	GFC	Street	Gen Fund	SRF	PWTF	Bonds	LIDs	Centennial	FCAAP
9.1.1	Correct Log Cabin/Cain Road flooding problem	400,000	Existing	X	X		X	X	X	X	X		X
9.1.2	Replace and remove culverts and pipes west of Fredrick Street	315,000	Existing	X	X			X	X	X	X		X
9.1.3	Interstate 5 detention pond construction	200,000	Existing	X				X	X	X		X	
9.1.6	Separate sanitary sewer and stormwater systems	750,000*	Existing/Future	X	X	X	X	X	X	X	X	X	
9.1.7	Upgrade downtown stormwater system	350,000*	Existing	X	X	X							
9.1.8	Retrofit private systems	35,000	Existing	X									
9.2.1	Replace and remove culverts and pipes east of Fredrick Street	91,000	Existing	X					X	X			
9.2.4	Remove Indian/Moxlie pipe near outfall to Budd Inlet	75,000	Existing	X			X			X	X		
9.5.1	Correct bacteria contamination problem in downtown Olympia	15,000	Existing	X					X	X		X	
9.5.2	Correct toxicant contamination problem in downtown Olympia	10,000	Existing	X								X	
9.5.3	Conduct septic system investigations	30,000	Existing	X			X					X	
9.5.4	Upgrade Olympia Maintenance Center system	150,000	Existing	X			X						

* Costs over a 10-Year Period

A-14: Alternative III: Basin-Specific Projects and Potential Funding Sources[1]
Indian/Moxlie Creek Basin

	Recommendation	Engrs Cost Est	Existing vs Future	Utility	GFC	Street	Gen Fund	Fee in Lieu	SRF	PWTF	Bonds	LIDs	Centennial	CZM	FCAAP
10.1.1	Construct regional facility near Moxlie Creek headwaters	500,000	Existing	X	X		X				X		X		
10.1.2	Construct off-channel storage for Indian Creek at Fredrick Street	300,000	Existing	X			X				X				
10.1.3	Construct underground storage at several locations	400,000	Existing	X	X	X	X	X			X				
10.1.4	Manage Interstate 5 flows according to Regional Drainage Manual	300,000	Existing	N/A			X				X				
10.1.5	Reroute stormwater from potholes	500,000	Existing	X			X				X				
10.2.1	Remove portions of instream pipe under downtown Olympia	2,500,000	Existing	X	X		X		X	X	X	X		X	X
10.2.2	Remove additional instream pipe from Indian and Moxlie Creeks	125,000	Existing	X	X		X				X				

Costs are in addition to Alternative II costs of $2,421,000

Table A-15: Implications of Stormwater Utility Rate Changes Indian/Moxlie Creek Basin

Potential Change in Utility	Potential Revenue Increases Under Existing Conditions/Year	
	Olympia	Thurston County
Single Family Residential Base Rate:		
$1.67 to $4.50/month/residence	N/A	10,200
$4.50 to $6.00/month/residence	55,000	16,000
$4.50 to $7.00/month/residence	92,000	19,000
Non-Single Family Residential Base Rate:		
Based on Single Family Equivalency		
$1.67 to $4.50/month/SF equiv.	N/A	8,500
$4.50 to $6.00/month/SF equiv.	51,000	13,000
$4.50 to $7.00/month/SF equiv.	84,000	16,000
*Single Family Surcharge**:		
$1.00/month/residence	33,000	4,000
$2.00/month/residence	66,000	8,000
$3.00/month/SF residence	99,000	12,000
*Non-Single Family Residential Surcharge**:		
$1.00/month/SF equiv.	38,000	400
$2.00/month/SF equiv.	76,000	800
$3.00/month/SF equiv.	114,000	1,200
Streets:		
(Currently charged 30% of non-SF base rate)		
40%	20,600	700
50%	41,200	1,400
60%	61,800	2,100
General Facilities Charges (GFCs) of $1,700/acre:	N/A	8,500

* Surcharge on development without stormwater storage facilities, estimated

Table A-16: Grant and Loan Programs Indian/Moxlie Basin

Agency	Program Purpose and Description	Available to	Financial Information	Matching Requirement	Conditions of Eligibility	Terms
Department of Ecology: Centennial Clean Water Fund	Grants and loans for planning, design, construction or implementation of water pollution control facilities and activities to meet state or federal requirements and protect water quality.	Any public body.	Approximately $45 million per year Freshwater: $4.5 Nonpoint: $4.5 Discretionary: $4.5	50% for facilities 25% for other activities	Ineligible projects: collector sewers, water supply, state and federal facilities, industrial/commercial	Interest-free: 0-5 years 4%: 6-14 years 5%: 15-20 years
Department of Ecology: State Revolving Fund	Low-interest loans for water pollution control projects, both facilities and activities to meet state and federal requirements and to protect water quality.	Any public body.	Approximately $30 million for FY 1993 80% water pollution control facilities; 10% nonpoint; 10% estuary management	None.	Ineligible projects: collector sewers, water supply, state and federal facilities, industrial/commercial	Interest-free: 0-5 years 4%: 6-14 years 5%: 15-20 years
Department of Ecology: Flood Control Assistance Account	Flood plan management program for (1) development of Comprehensive Flood Control Management Plans, and (2) Flood Control Facility Maintenance projects.	Counties, cities, service agencies, districts, tribes.	$150,000/event	20% match		
Department of Community Development: Public Works Trust Fund	Low-interest revolving loan fund which helps local governments finance critical public works needs.	Local governments with long-term plan for financing public works needs. If applicant is a city or county, it must be imposing the ¼% real estate excise tax for capital purposes.	$43+ million		Eligible projects include: repair/replacement/improvement to bridges, roads, local ferries, domestic water, sanitary sewer, and stormwater systems	
Conservation Commission: Water Quality Research Grant Program	Problem-oriented applied or basic research that will produce results for solving high priority water quality problems. Multi-governmental cooperative projects will be considered. Projects must be considered through conservation district.	Counties, cities, Washington State institutions of higher education, districts, tribes, state and federal agencies.	$200,000/biennium; grants	75% match		

Table A-17: Potential Revenue Sources
Indian/Moxlie Creek Basin

Potential Revenue Source	Revenue Increases Under Existing Conditions	
	Olympia	Thurston County
Street Utility: $2.00/month/SF residential Minor business contribution	115,000*	5,000*
Sales Tax Levy:	Two ½% taxes collected. This is the maximum allowed for a jurisdiction to collect.	Two ½% taxes collected. This is the maximum allowed for a jurisdiction to collect.
Real Estate Levy:	Two ¼% taxes collected, both dedicated to capital improvements.	One ¼% tax collected and dedicated to capital improvements; second ¼% tax could be assessed if ordinance passed by County Commissioners.
Development Impact Fees:	Street improvements and open space eligible for collection of impact fees.	Street improvements and open space eligible for collection of impact fees.
Fuel Tax:	Currently, only cities and towns within 10 miles of an international border have the authority to impose a 1-cent-per-gallon fuel tax. In order to impose a fuel tax in Thurston County, a bill would have to be passed by the state legislature and then approved by Thurston County voters.	Currently, only cities and towns within 10 miles of an international border have the authority to impose a 1-cent-per-gallon fuel tax. In order to impose a fuel tax in Thurston County, a bill would have to be passed by the state legislature and then approved by Thurston County voters.
Site Preparation Fee:	Fee based on the amount of clearing and grading done to prepare a site for development. Could generate additional funds, as well as act as an incentive to retain natural vegetation thereby decreasing erosion and water quality problems.	

* These funds would to be used for street improvements and, potentially, stormwater systems associated with streets.

Appendix 3: Stormwater Retention/Detention Facilities

LISTING OF DETENTION FACILITIES IN INDIAN/MOXLIE BASINS

Name	Subbasin	* Type	Volume	Potential for Volume Upgrade
AAA Automobile Club	I-7	U	2840 cf	0%
AM/PM Mini-Mart	M-4	P		0-5%
Assoc. of WA Schools	M-4	U	1036 cf	0%
Brigadoon Subdivision	M-1	P	3246 cf	30-40%
Canterbury Subdivision	M-1	P		0%
Capitol Crossing Apt. 1		P		0-5%
Capitol Crossing Apt. 2		P		0-5%
Capitol View #1 Offices	M-4	U	7319 cf	0-5%
Capitol View #2 Offices	M-4	U	7319 cf	0-5%
Chevron Service Station	M-4	U	combined	0%
Church of Living Water	I-4	U		5-10%
Creekwood Subdivision		P		5-10%
D.O.T, I-5/Plum St. SE	I-7	P	N/A	0-5%
Eastway Circle Apartments	I-7	U	2436 cf	0%
Fairwood Subdivision	M-1	P	5048 cf	0-5%
Fir Grove Business Park	I-2	U	5515 cf	0%
First Community Bank	I-2	U	1078 cf	0%
Foxwood Subdivision	M-1	P	5521 cf	0%
Goldmark Plaza	I-2	U	1130 cf	0%
Hutchinson Dental Bldg.	I-7	U	514 cf	0%
Iblings Office Building	M-4	U	625 cf	0%
Intercity Transit	I-2	U		0%
Jiffy Lube	I-2	U	combined	0%
Lutheran-Shepherd Church	M-1	P		0%
Mcdonalds		U		0%
Nottingham Subdivision	M-1	P	3481 cf	0%
Olympia Maintenance Center		P		10-20%
Pay-N-Pak	I-2	U	5478 cf	0-5%
Puget Power	I-2	U	7635 cf	5-10%
Rapid Brake	M-2	P	1479 cf	0-5%
Republic Building	I-7	U	2988 cf	0%
Sinclair Building	M-4	U	109 cf	0%
Sonrise Church of God	I-4	P		20-30%
State/Sawyer Bldg.	I-2	U	1080 cf	0%
Storage Land Mini-Storage	I-2	P	2517 cf	0-5%
Westminster Presbyterian	I-4	P	6581 cf	20-30%

* P = Pond; U = Underground Pipes

Appendix 4: SWMM Modeling Technical Information

EPA SWMM COMPUTER MODELING DESCRIPTION

The SWMM (Surface Water Management Model) computer model is a complex program which simulates land surface and in-stream hydrologic processes. Since its development in the 1970's, it has been continually maintained and updated. The model's ability to accurately evaluate pipes and culverts and associated surcharge and impoundment problems was critical to its use for the Indian/Moxlie basin.

The model is comprised of several major computational blocks as follows:

- Key input parameters for the runoff computational block include the following: subbasin area, width of overland flow, percent impervious, ground slope, roughness factor for both impervious and pervious surfaces, depressions storage, and Hortonian infiltration parameters. Each subbasin block receives rainfall and losses moisture due to evaporation, infiltration, and storage.

- Flow routing from subbasins along the connected reaches of the entire basin to the outlet of the basin. Routing allows the runoff from different parts of the basin to be correctly sequenced in time. Flow routing for the subbasins is accomplished by approximating them as non-linear reservoirs and using a spatially lumped continuity equation coupled with Manning's equation. The solution procedure for the flow routing follows a kinematic wave approach in which disturbances are allowed to propagate only in the downstream direction.

- The extended transport block (extran) is used to evaluate surcharge and backwater conditions. The extran component is a dynamic flow routing model that routes inflow hydrographs through a open channel and/or conduit system, computing the time history of the flow and hydraulic head throughout the system. The block uses a link-node description of the drainage system to solve the gradually varied unsteady flow equations. The program solves the full dynamic equation for gradually varied flow (Navier-Stokes equation) using an explicit solution technique to progress in time period. The time step is governed by the wave celerity in the shorter channels or pipes and is typically about 10-seconds. Extran can evaluate weirs, pumps, tidal influences, and storage ponds.

MODEL CALIBRATION

The model was calibrated to continuously recorded flow data collected during the winters of 1990/1991. Occasional continuous data collected were also available for both wet and dry seasons in the late 1980's. Monitoring stations were located upstream of the creeks' confluence and outside of the influence of high tides.

Calibration consisted of adjusting input parameters so as to generate flows similar to recorded flows. The accuracy of the calibrated model was then checked against independently recorded storm events. The tidal fluctuations that occurred during recorded storm events were input directly to the model.

STORM EVENTS

Although not a continuous model, various computer runs were developed for one day, seven days, and several month long events. The winters of 1972, 1990, and 1991 were evaluated as extended duration storm events. Calculated and synthetic storm events of 2, 5, 10, 25, 50, and 100 years were used. Peak and average flows were evaluated. Rainfall data collected from the LOTT wastewater treatment facility was used in the analysis. Tidal influences were evaluated on actual and worst-case basis.

LAND USE

Forty subbasins were delineated in the basin. Each subbasin was characterized by physical (soil, slope, and land cover) and hydrologic traits. Land cover was determined based on 1991 aerial photos. Fortunately, the basins' soil type is relatively consistent and of moderately high permeability. All pipe discharges to the creek system were identified and commonly modeled by the HYDRA program. This additional modeling provided a high level of detail to the SWMM model.

Three basic land-use scenarios were addressed in the model as follows:

- Forested, predevelopment conditions are difficult to evaluate with a high level of certainty. The creek system has been highly altered over the years and numerous wetlands filled. Due to the lack of accurate historical information, the analysis assumed existing channel/wetland configurations. Impervious surfaces were assumed to be ten percent of the total basin area. Though qualitative in nature, the results show predevelopment flood flows that were markedly lower than existing flows. No management decisions are based on these less than ideal results.

- Current land use and hydrologic conditions were modeled based on system analysis and recorded flow data.

- Full development conditions were evaluated based on a extensive inventory of developable land parcels within the basins and, to some extent, the potential of land use conversions to higher density developments. Potential developments were modeled based on existing regulations addressing zoning, development standards, and drainage requirements (Drainage Design and Erosion Control Manual for the Thurston Region, Washington). Potential storage facilities and nonstructural management techniques were added to the model to evaluate their impacts.

Appendix 5: Water Quality Monitoring Results

AMBIENT MONITORING (2/12 - 2/22) 1990

	STATION	Fecal Col.	Flow (cfs)	Temp. (C)	D.O. (mg/L)	S.C. (uMHOS)	pH	Turb. (NTU)
INDIAN/ MOXLIE	MI-1 outfall	5,000	17.50					
	MI-2 confluence	80		4.6	12.9	150	6.68	5.4
MOXLIE	MI-3 pre-confl.	45	8.04	7.2	11.9	172	6.89	4.6
	MI-4 Plum St.	10	1.20	7.6	11.8	176	6.63	11
	MI-5 at I-5	5	5.75	8.0	11.3	155	7.03	2.7
	MI-6 west end of park	590	4.10	7.3	11.8		6.35	7.7
	MI-7 at springs	0	0.33	9.2	11.2		6.68	1.6
INDIAN	MI-8 Pear St.	165	6.58	3.9	13.2	130	6.66	6.1
	MI-9 12th Ave.	230	8.53	4.1	13.2	122	6.63	9.6
	MI-10 Wheeler Ave.	90		6.8	12.1	112		5.6
	MI-11 Boulevard Rd.	15	6.36	3.0	13.6	141	6.55	4.9
	MI-12 Puget Power	25		5.9	12.2	126	6.57	3.5
	MI-13 Pacific Ave.	95	4.98	6.0	12.6	108	6.34	3.6
	MI-14 Martin Wy.	110 55	4.63	5.1	12.7	103		3.6
	MI-15 5th Ave.	15	4.89	5.1	12.5	105		2.3

AMBIENT MONITORING (11/6 - 11/9) 1989

	STATION	Fecal Col.	Flow (cfs)	Temp. (C)	D.O. (mg/L)	S.C. (uMHOS)	pH	Turb. (NTU)
INDIAN/ MOXLIE	MI-1 outfall							
	MI-2 confluence	2200 1800			10.4		6.60	54
MOXLIE	MI-3 pre-confl.		8.42	11.5	10.6	171	6.90	>100
	MI-4 Plum St.		4.99	10.4		182	6.40	72
	MI-5 at I-5	1200		10.4		113	6.52	40
	MI-6 west end of park	540						7.7
	MI-7 at springs	0	0.31	10.2	10.9	169	6.67	2.0
INDIAN	MI-8 Pear St.	1330						42
	MI-9 12th Ave.	1180						43
	MI-10 Wheeler Ave.	160						7.7
	MI-11 Boulevard Rd.	120						3.9
	MI-12 Puget Power	90						4.8
	MI-13 Pacific Ave.	115						4.1
	MI-14 Martin Wy.	1900	0.24	10.0		141	6.43	15

AMBIENT MONITORING (3/26 - 3/30) 1990

	STATION	Fecal Col.	Flow (cfs)	Temp. (C)	D.O. (mg/L)	S.C. (uMHOS)	pH	Turb. (NTU)
INDIAN/ MOXLIE	MI-1 outfall	5,000 4,375	14.74	10.1	11.8	747	7.43	7.1
	MI-2 confluence	25		10.0	11.6	150		4.8
MOXLIE	MI-3 pre-confl.	20	7.61	10.3	11.6	173	7.59	6.2
	MI-4 Plum St.	10	6.44	9.9	11.6	173	7.65	6.4
	MI-5 at I-5	0	5.46	9.9	11.6	160	7.03	4.5
	MI-6 west end of park	0	3.62	9.9	11.8	162	7.82	3.9
	MI-7 at springs	0	0.19	10.2	11.7	175	7.80	1.5
INDIAN	MI-8 Pear St.	100	3.60	9.0	11.6	146		6.5
	MI-9 12th Ave.	215	4.98	9.1	11.9	135	7.46	5.4
	MI-10 Wheeler Ave.	125	3.19	8.9	11.9	131	7.47	4.6
	MI-11 Boulevard Rd.	25	3.46	9.0	11.7	134	7.19	3.9
	MI-12 Puget Power	55	1.61	9.1	11.8	144	7.37	3.2
	MI-13 Pacific Ave.	10	2.05	8.5	12.1	134	7.53	4.2
	MI-14 Martin Wy.	0	1.50	8.4	11.8	130	7.36	2.9
	MI-15 5th Ave.	0	1.72	8.3	11.7	134	6.93	2.0

::

AMBIENT MONITORING INDIAN/MOXLIE CREEK November 25-27, 1990							
Station	Fecal Coliform	Flows (CFS)	Temp (C)	D.O. (mg/l)	S.C. (uHMOS)	pH	Turb. (NTU)
MI-1	210	N/A[1]	7.0	11.0	200	6.66	3.7
MI-2	330 50	N/A	10.0	9.1	80.0	6.81	6.1
MI-3	70	5.73	11.0	9.4	100.0	6.69	1.8
MI-4	80	5.80	11.0	8.8	110.5	6.94	5.2
MI-5	100	9.81	11.0	9.2	110	7.0	3.8
MI-6	0.0	.33	10.0	7.8	110.3	7.05	1.6
MI-7	120	1.64	10.5	9.2	110	7.01	3.0
MI-8	630	N/A	10.0	9.0	60	7.5	8.1
MI-9	130	N/A	N/A	N/A	N/A	N/A	3.3
MI-10	340	15.38	11.0	10.3	6.2	7.66	8.7
MI-11	80	6.06	7.0	8.5	60.0	6.75	2.6
MI-12	120	N/A	7.0	7.4	60.0	6.56	2.2
MI-13	40	N/A	7.5	7.0	60.0	6.79	1.8
MI-14	260	N/A	9.0	5.2	7.36	6.0	7.36
MI-15	230	11.14	9.0	4.0	60	7.46	2.6

[1] Data not available

INDIAN/MOXLIE NUTRIENT CONCENTRATIONS

STATION	Nitrate + Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphate (mg/L)
MI-2A Confluence	0.30	0.9	0.17 *
MI-2B Confluenc	0.30	0.8	0.16 *
MI-3 Union Ave.	0.39	1.0	0.25 *
MI-4 Plum St.	0.62	1.2	0.28 *
MI-5 at I-5	0.60	1.7	0.25 *
MI-6 Trail Park	0.60	0.5	0.099
MI-7 Springs	2.3	0.6	0.066
MI-8 Pear St.	0.38	0.8	0.11 *
MI-9 12th Ave.	0.45	0.8	0.086
MI-10 Wheeler Ave.	.76	0.6	0.043
MI-11 Boulevard Rd.	0.77	0.6	0.036
MI-12 Puget Power	1.1	0.6	0.054
MI-13 Pacific Ave.	1.1	1.4	0.042
MI-14 Martin Wy.	0.65	0.9	0.12 *

* Exceeds the EPA criteria (Quality Criteria for Water, 1986)

SUMMARY OF INDIAN\MOXLIE SEDIMENT ANALYSIS

ORGANIC COMPOUNDS
(µg/L=ppb)

STA.	CONTAMINANT	CONCENTRATION A	CONCENTRATION B	LAET	HEAT
MI-2 Confluence	Bis(2-ethylhexyl)phthalate	49		1900	19[illegible]
MI-4 Plum St.	Fluoranthene	55		1700	17[illegible]
	Pyrene	51		2600	110[illegible]
	Bis(2-ethylhexyl)phthalate	210		1900	1900
MI-9 12th Ave.	Bis(2-ethylhexyl)phthalate	110		1900	19[illegible]
MI-12 Puget Power	Fluorene		370	540	18[illegible]
	Phenanthrene	3400 *	5800 **	1500	5400
	Anthracene	370	660	960	1900
	Di-n-butyl phthalate		400	1400	14[illegible]
	Fluoranthene	3800 *	6800 *	1700	98[illegible]
	Pyrene	4500 *	6700 *	2600	11000
	Benzo(a)anthracene	1800 *	2500 *	1300	45[illegible]
	Chrysene	2600 *	3300 *	1400	67[illegible]
	Bis(2-ethylhexyl)phthalate	3800 *	6100 **	1900	19[illegible]
	Di-n-octyl phthalate		430		
	Benzo(b)fluoranthene	2500 *	3500 *	1700	98[illegible]
	Benzo(k)fluoranthene	1700 *	2000 *	1700	98[illegible]
	Benzo(a)pyrene	1900 *	2300 *	1600	68[illegible]
	Indeno(1,2,3-c,d)pyrene	1000 *	1500 **	600	880
	Benzo(g,h,i)perylene	860 *	1200 *	670	54[illegible]
MI-13 Pacific Ave.	Phenanthrene	540		1500	5400
	Fluoranthene	830		1700	9800
	Pyrene	640		2600	110[illegible]
	Butylbenzylphthalate	190 *		63	4[illegible]
	Benzo(a)anthracene	280		1300	4500
	Chrysene	340		1400	6700
	Bis(2-ethylhexyl)phthalate	1100		1900	19[illegible]
	Benzo(b)fluoranthene	450		1700	98[illegible]
	Benzo(k)fluoranthene	300		1700	9800
	Benzo(a)pyrene	300		1600	68[illegible]
	Indeno(1,2,3-c,d)pyrene	250		600	8[illegible]
	Benzo(g,h,i)perylene	240		670	54[illegible]

* Between or equal to Lowest Apparent Effects Threshold (LAET)
** Exceeds Highest Apparent Effects Threshold (HAET) values

RESULTS OF SEDIMENT ANALYSIS

One liter of sediment was taken from each of the sites (except for the replicate sample) according to the field protocol described in the DCAP and QA\QC Plan.

STA.#	Location	Method of Collection	Grain Size	% of Total Weight
MI-2	Confluence of Indian and Moxlie Creeks.	Pipe Dredge	Gravel	0
			Sand	95
			Silt	5
			Clay	0
MI-4	Moxlie Creek @ 10m upstream from I-5 access ramp	Pipe Dredge	Gravel	0
			Sand	93
			Silt	7
			Clay	0
MI-7	Moxlie Creek @ 20m upstream from springs	Grabbed with sample jar	Gravel	11
			Sand	84
			Silt	5
			Clay	1
MI-9	Indian Creek @ 5m upstream from 12th Ave.	Pipe Dredge	Gravel	2
			Sand	93
			Silt	5
			Clay	0
MI-12	Indian Creek @ 10m downstream from southern edge of Puget Power service yard	Pipe Dredge	Gravel	15(A) 3(B)
			Sand	53(A) 52(B)
			Silt	28(A) 38(B)
MI-13	Indian Creek @ 5m upstream from Pacific Ave.	Pipe Dredge	Gravel	0
			Sand	40
			Silt	52
			Clay	8

SUMMARY OF INDIAN/MOXLIE SEDIMENT ANALYSIS

METALS
(mg/L=ppm)

Station	Contaminant	Concentration	Freshwater Criteria
MI-2 Confluence	Mercury	0.2 +	0.10
MI-7 Springs	Nickel	28	100
MI-12 Puget Power	Lead	120 (A) +	50
		160 (B) +	50
	Zinc	180 (A) +	100
		210 (B) +	100
MI-13 Pacific Ave.	Arsenic	11 +	10
	Lead	110 +	50
	Zinc	150 +	100

\+ Exceeds freshwater sediment criteria established by Wisconsin Department of Natural Resources (1985)

BIGELOW LAKE WATER QUALITY SAMPLING
OCTOBER 29, 1991

Sampling Location - Northeast corner, deepest part of the lake
Sampling Time - 10:20
Weather Conditions- Overcast, with a slight breeze; air temperature near 45 °C.
Field Equipment - Hydrolab Surveyor II, Kemmerer water sampler, secchi disk, and water column sampler.
Field Samplers - Sammy Blocher, Thurston County Environmental Health Division. Lake resident Adrian Brown assisted.

NUTRIENT AND CHLOROPHYLL *A* DATA

Depth (m)	Total P (mg/L)	NO2+NO3 (mg/L)	Ammonia (mg/L)	Chl *a* (µg/L)	Phaeo *a* (µg/L)
0	0.108	0.013	0.096	--	--
3	0.112	0.028	0.061	--	--
4 - 3m column samples	--	--	--	36.3	<0.1
Outlet Sample*	0.104	0.063	0.365	--	--

* Outlet sample was taken from the Indian Creek culvert at 12th Ave NE. No flow was observed, sampled from a stagnant pool.

Secchi Disk Visibility (water clarity) - 0.82 meters

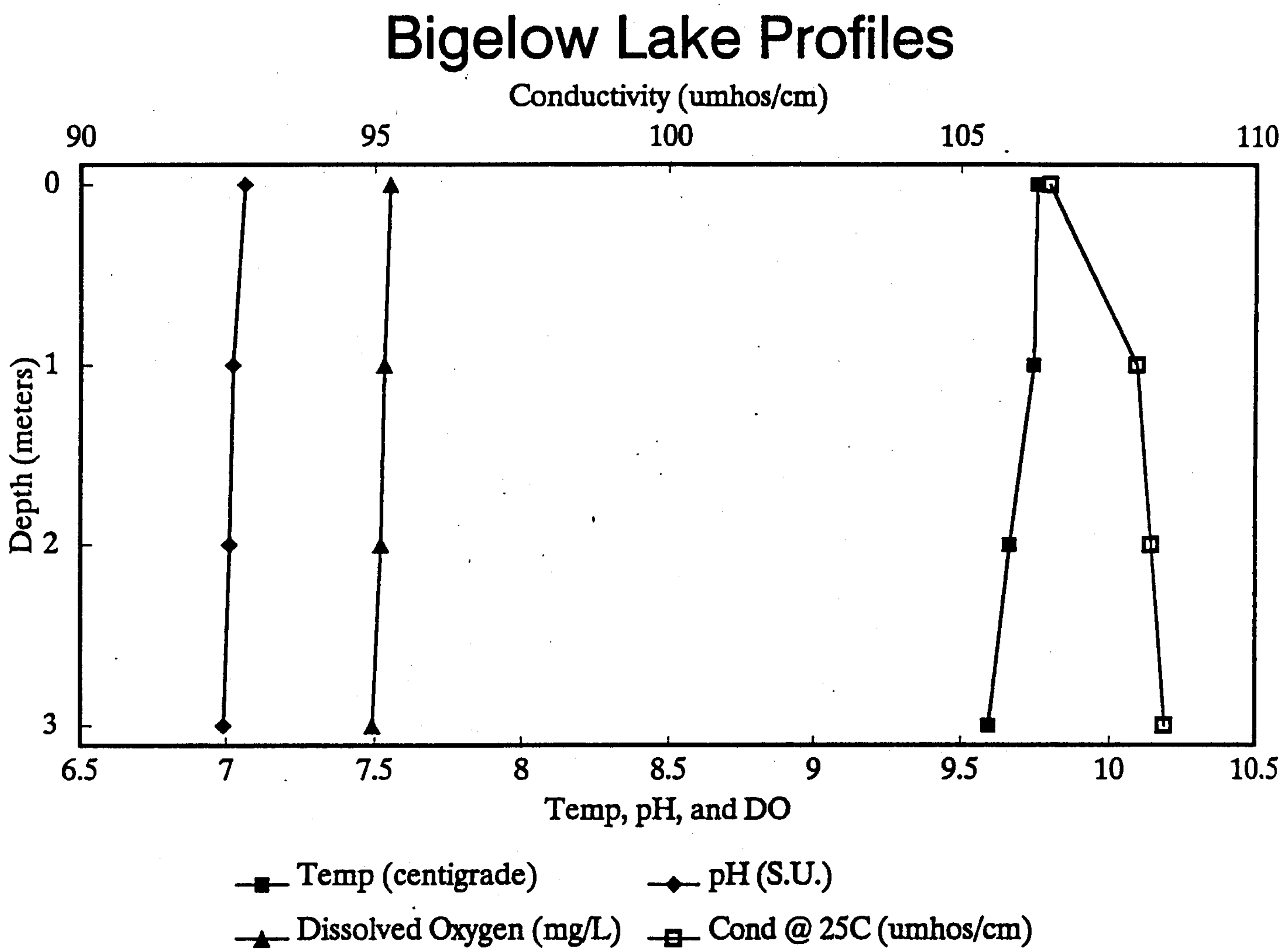
Carlson's Trophic State Index (TSI):

	June 1981	Oct 1991
$TSI_{Secchi\ Disk}$	59	63
$TSI_{Total\ Phosphorous}$	63	72
$TSI_{Chlorophyll}$	61	66

TSI values range from 0, extremely oligotrophic, to 100, extremely eutrophic. Values between 40-50 are considered mesotrophic. The October 1991 TSI values indicate that the lake is more eutrophic, compared to the June 1981 data by Sumioka and Dion, 1985 (Water Supply Bulletin 57).

OBSERVATIONS

- Wetland vegetation was seen along much of the shoreline.
- Dredging and filling was apparent at the NW shore property (large ranch).
- Temperature and dissolved oxygen profiles show the lake to be well mixed.


Bigelow Lake Profiles
Conductivity (umhos/cm)
90
95
100
105
110
0
1
2
3
Depth (meters)
6.5
7
7.5
8
8.5
9
9.5
10
10.5
Temp, pH, and DO
Temp (centigrade)
pH (S.U.)
Dissolved Oxygen (mg/L)
Cond @ 25C (umhos/cm)

BIGELOW LAKE | THURSTON COUNTY | WRIA 13

T18N-R02W-12 | LATITUDE 47° 03' 23" | LONGITUDE 122° 51' 57"

PHYSICAL DATA

Drainage area	0.38 mi^2
Altitude	151 ft
Lake Area	13 acres
Lake Volume	124 acre-ft
Mean Depth	10 ft
Maximum Depth	15 ft
Shoreline Length	0.65 mi
Shoreline Configuration	1.3
Development of Volume	0.64
Bottom Slope	1.8 pct
Surface Inflow	No
Surface Outflow	Yes

CULTURAL DATA

Residential Development	0	pct
Number of Nearshore Homes	0	
Land Use in Drainage Basin		
Residential-Urban	0	pct
Residential-Suburban	38	pct
Agricultural	0	pct
Forest or Unproductive	57	pct
Lake Surface	5	pct
Public Boat Access to Lake	No	

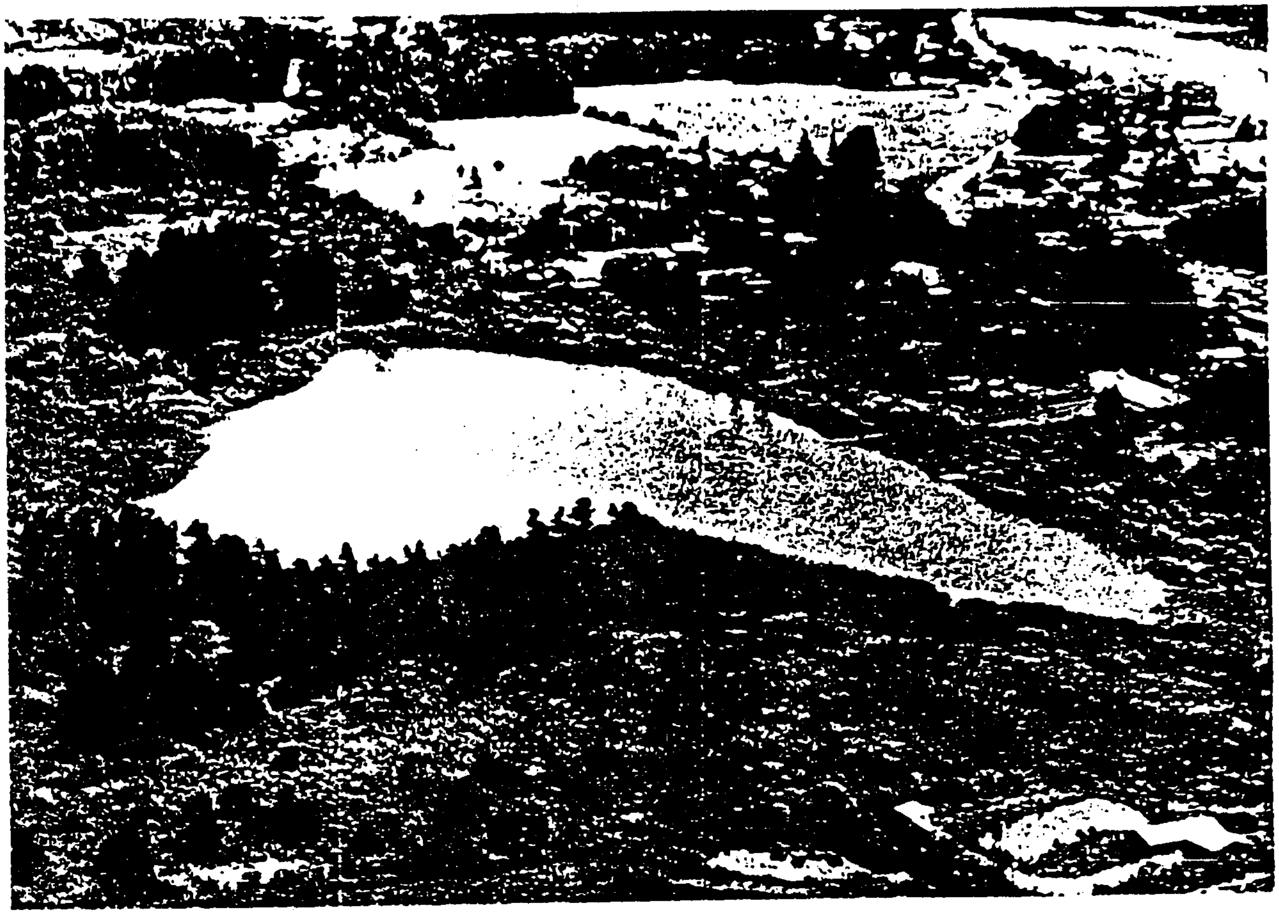
WATER-QUALITY DATA (in milligrams per liter unless otherwise indicated)

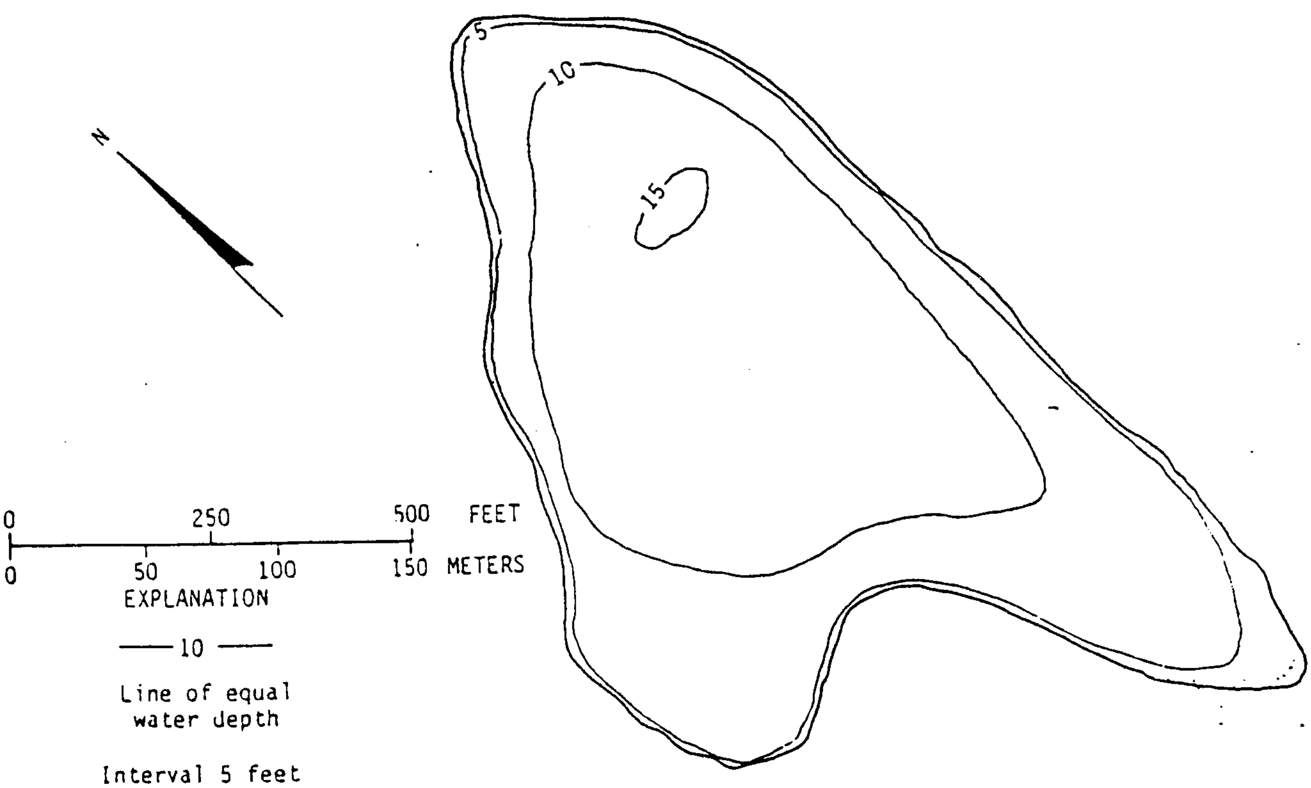
Date	June 10, 1981	
Depth (ft)	3	10
Water Temperature (°C)	16.3	12.0
Dissolved Oxygen	6.3	0.2
Specific Conductance (umho)	57	67
pH (units)	6.3	6.2
Total Nitrate, as N	0.02	.02
Total Nitrite, as N	.00	.00
Total Ammonia, as N	.05	.06
Total Organic Nitrogen, as N	1.1	.94
Total Nitrogen, as N	1.1	1.0
Dissolved Orthophosphate, as P	.03	.03
Total Phosphorus, as P	.06	.07
Secchi-Disc Visibility (ft)	3.5	
Chlorophyll *a* (ug/L)	22.3	--

Aquatic Macrophyte Coverage	
Littoral Zone	90 pct
Water-Surface Zone	10 pct

LAKE TROPHIC CLASSIFICATION

Characteristic Value	304
Trophic State Index (Carlson, 1977)	
TSI_{SD}	59
TSI_{TP}	63
TSI_{Chl}	61





Bigelow Lake, Thurston County. Photo taken June 10, 1981, view northeasterly. Bathymetric map from U.S. Geological Survey, June 2, 1981.

Appendix 6: Water Resource Regulations

WATER RESOURCES REGULATIONS, GUIDELINES, AND MANAGEMENT OPTIONS

Water resources are diverse and require a number of distinct management tools. Two basic methods are used to manage storm and surface water: regulatory and non-regulatory.

Regulatory means of storm and surface water management are used to guide or, in many cases, limit the types of activities that can take place in the vicinity of streams, wetlands, shorelines, and other sensitive areas. Federal, state and local governments administer a variety of regulations directed at protecting sensitive areas. A brief summary of the primary regulations pertaining to storm and surface water follows.

Non-regulatory management tools rely on less traditional methods to protect critical areas. They also utilize such methods as land donations or easements, public involvement and education, technical assistance, and purchase of development rights. A summary of these management methods follows the discussion regulations.

FEDERAL PROGRAMS:

National Pollutant Discharge Elimination System Permit (NPDES)

Under the authority of the U.S. Environmental Protection Agency (EPA), the Washington Department of Ecology regulates point source pollution discharges into receiving waters of the state through NPDES permits. New regulations aimed at reducing non-point source pollution will also be administered through the NPDES program. Since November, 1991, 220 cities and counties in the U.S. are required to apply for the first of a two-part discharge permit. Stormwater discharge regulations apply to urban areas with populations of 100,000 or more. All other urban areas will be required to comply with NPDES regulations in the future. Stormwater discharges from small communities such as Olympia will not be regulated until 1993 or beyond. Projects and planning concerning stormwater should take into account future discharge regulations.

National Flood Insurance Program

The Federal Insurance Administration within the Federal Emergency Management Agency (FEMA) oversees the National Flood Insurance Program. The program subsidizes flood insurance for communities with approved flood management policies. Maps delineating the 100 year floodplain and floodway are provided to member communities. Local governments are responsible for controlling development in these

Section 401 - Clean Water Act

The U.S. Army Corp of Engineers is responsible for the administration of Section 401 of the Clean Water Act. Section 401 addresses the suitability of placing fill materials in waters of the United States. These waters include tributaries adjacent to navigable waters, and wetlands not associated with a stream or tributary.

TRIBAL PROGRAMS:

Squaxin Island Tribe Treaty Rights

Activities proposed for nontribal lands and resources, but that affect treaty-reserved rights guaranteed by the Medicine Creek Treaty are subject to tribal oversight. Percival Creek basin is within the jurisdiction of the Squaxin Island Tribe. Any streamside activity potentially influencing water quality, salmon species and habitat must be approved by the Tribe. Mitigation of adverse effects may be demanded by the tribe.

STATE PROGRAMS:

Growth Management Act (Engrossed Substitute House Bill 2929)

The Growth Management Act (ESHB 2929) was passed in 1990 in an effort to plan for the continued growth of Washington State. It prescribes a series of activities commencing with the adoption of guidelines by the Department of Community Development. Every county in the state with a minimum population of 50,000 and a growth rate of 10% or a population increase of 20% over the last decade is required to designate agricultural, forest, and mineral resource lands. Counties must also adopt development regulations to assure conservation of critical areas including wetlands, aquifer recharge areas, fish and wildlife habitat, frequently flooded areas, and geologically hazardous areas.

In addition, all cities and counties are required to have comprehensive plans and compatible zoning ordinances. The act allows for the collection of interim impact fees from new developments for public facility improvements, and has changed the standard of local government review for subdivisions. The bill also encourages rural communities to improve local capacity for growth through grant funded programs.

Urban Growth Management Agreement (UGM), 1988

The Urban Growth Management agreement was first signed in 1983 by Thurston County, Lacey, Olympia, and Tumwater, and later renewed in 1988. The UGM agreement establishes short- and long-term urban growth boundaries in which the parties agree to cooperate in landuse planning and the provision of public services. The agreement is intended to guide the actions of each jurisdiction as well as phase urban growth and the development of public facilities and expansion of services. Rather than attempting to force a uniform development design for the region, the agreement supports diversity and choice in style and approach.

The UGM agreement is an attempt to generate guidelines for orderly growth in the rapidly expanding South Sound region. The agreement recognizes desirable growth patterns will result from improved communication between the jurisdictions, comprehensive planning, as well as similar standards and regulations between the four jurisdictions.

The primary goals of the UGM agreement are concentration of urban development in planned urban areas, provision of high quality public services at a low cost, and maintenance and protection of significant natural resource lands, agriculture, environmentally sensitive areas, and groundwater.

The majority of the Percival Creek basin is currently included in the short-term urban growth boundary. The western border of the basin lies outside the short-term boundary, but an additional part of the western boundary will be included in the the long-term boundary.

Engrossed Substitute House Bill 5411

House Bill 5411 was passed by the Washington State Legislature on May 21, 1991. The bill, sponsored by the Senate Committee on Agriculture and Water Resources, is primarily concerned with the alleviation of flood damage. The November flooding of 1990 provided the impetus for the drafting of the bill which intends to "develop a coordinated and comprehensive state policy to address the problems of flooding and the minimization of flood damage" (ESHB-5411, Section 1.3).

The bill allows any county legislative authority to adopt a comprehensive flood control management plan for drainage basins located entirely or partially within its jurisdiction. Such a plan must "establish restrictions on land clearing activities and development practices that exacerbate flood problems by increasing the flow or accumulation of flood waters, or the intensity of drainage, on low lying areas" (ESHB-5411, Section 3.5). These restrictions exclude forest practices. The bill also creates a joint select committee on state flood damage reduction which is responsible for consideration of the formation of "comprehensive state flood policies and a comprehensive and coordinated flood damage reduction plan" (ESHB-5411, Section 15.5). This plan would include, among other items, "stormwater runoff pattern alterations and accompanying liabilities, including an analysis of: a) increases in peak flows caused by inadequate stormwater planning and controls; b) the need for minimum standards for land use development activities employing natural watercourses for stormwater conveyance; and c) the need for a statutory cause of action to provide a remedy for downstream property owners who are damaged by accelerated stormwater runoff caused by cumulative upstream activities, including a modification of the court-adopted 'common enemy' doctrine" (ESHB-5411, Section 15.5).

State Environmental Policy Act (SEPA)

The Washington State Environmental Policy Act (SEPA) provides a process whereby environmental concerns are addressed during the local permitting of projects. The disclosure of information pertaining to significant adverse environmental effects of a proposed project is required. Methods to mitigate any significant effects are addressed during review of the SEPA checklist which is required for all nonexempt projects. The SEPA process must be completed prior to issuance of Hydraulic Permit Approvals, Shoreline Substantial Development permits, and applicable local permits. If the SEPA process indicates that a significant adverse effect is likely, an Environmental Impact Statement (EIS) will be required for the project.

Freshwater Sediment Regulations

Recently the Washington State Department of Ecology (WDOE) adopted the Sediment Management Standards rule, Chapter 173-204 WAC. The rule establishes specific chemical and biological criteria as well as narrative standards to designate and protect the quality of all sediments in Washington. The rule also establishes procedures to limit the amount of contaminants entering waterbodies and to clean up existing sediment contamination. The rule currently pertains to chemical and biological contamination in Puget Sound only. Until sediment criteria are developed for the state's other marine waters, estuaries, and freshwaters, the rule's narrative standard of "no acute or chronic adverse effects and no significant human health risk" allows for case-by-case determination of criteria.

Currently, the WDOE is developing and compiling background technical data necessary to establish freshwater sediment criteria. Unanswered questions concerning problem chemicals; effective sampling, testing and interpretation guidelines; and interpretation of the conditions in freshwater benthic communities of different water bodies need to be answered before the criteria are finalized.

Washington's Surface Water Quality Standards

The WDOE has proposed several changes to Washington's Surface Water Quality Standards. Changes concerning antidegradation of wetlands will have the most profound impact on storm and surface water management in Olympia. The proposed changes will be made to Chapter 173-203 WAC.

Specifically, under WAC 173-203-030 "General water use and criteria classes" surface water resources are identified and classified. For Class 6, wetland class, an antidegradation regulation is proposed that would prohibit human-influenced activities which raise fecal coliform levels above natural conditions. Other aspects of the antidegradation rule would also impact stormwater management by requiring that natural hydrologic and substrate conditions within a wetland be maintained so as to preserve the natural water temperature of wetlands and cause no alteration of natural vegetation patterns.

Puget Sound Water Quality Authority Management Plan

The 1991 Puget Sound Water Quality Authority Management Plan requirements form the foundation of the stormwater program being established by the Department of Ecology. The plan was first adopted in 1987 and has been updated several times since. The Puget Sound Plan and WDOE's stormwater program apply to the cities and counties within the Puget Sound basin as well as the Washington State Department of Transportation (WSDOT).

The Puget Sound Plan sets forth a local stormwater program that encompasses the basic requirements for all counties and cities. Rules adopted to implement the program will establish minimum standards for program components including: operation and maintenance of new and existing stormwater facilities; drainage, clearing and grading, erosion and sediment control, and protection of surface and groundwater requirements applicable to all new development and redevelopment; maintenance requirements for all privately owned facilities; and record keeping of all new facilities. All urbanized areas are to begin implementing their program by 2000. All the rules needed to implement the program should be adopted by early 1992.

The program also developed a technical manual, *The Stormwater Management Manual for the Puget Sound Basin*, which provides guidance to local governments for the implementation of their stormwater program. The manual emphasizes source control BMPs as the first and most cost effective method of eliminating or reducing pollution of stormwater. The manual also provides guidance on how to prepare and implement stormwater management plans, including erosion and sediment control plans. The stormwater management plans developed as a result of using the technical manual are in no way a substitute for a comprehensive drainage plan. The manual also is intended to be used when retrofitting BMPs to existing development and as a reference source for the preparation of technical bulletins, leaflets, and brochures for education or specialized BMP implementation.

The plan also establishes a Puget Sound Highway Runoff Program. This program has been developed to control the quality of runoff from state highways in the Puget Sound basin. WSDOT is required to use the above mentioned technical manual for guidance in managing highway runoff, adopt a highway vegetation management program, include BMP's in the construction of new projects, inventory and retrofit state highways with water quality BMPs where practicable, monitor where practicable, and submit biannual reports to DOE. This program became effective on June 21, 1991.

Washington State Hydraulic Code

The Washington State Hydraulic Code mandates review of proposed projects that would affect both salt and fresh waters, and their associated habitat. All projects involving modifications to creeks or their stream banks require a Hydraulic Permit Approval (HPA). The protection of salmonid species and associated habitat is the primary concern of the review process. The Washington Departments of Fisheries and Wildlife administer the code.

Washington State Shoreline Management Act

The Washington State Shoreline Management Act (SMA) seeks to protect water, fish, wildlife, and habitat resources in shoreline areas. Shorelines are defined to include lakes and reservoirs of 20 or more acres, streams with a mean annual flow of at least 20 cubic feet per second, marine waters including an area 200 feet inland from the mean high-water level, and all associated wetlands, floodplains, and floodways. The act excludes wetlands not associated with waters of the State including isolated wetlands and riparian wetlands associated with water bodies smaller than the above requirements. It also exempts most agricultural and forest practices from permit requirements.

The SMA is similar to a combined comprehensive plan and zoning code. It not only contains policies, but also includes specific performance standards and regulations. The SMA uses a permitting process to regulate shoreline activities. A Shoreline Permit is required for any development or construction valued over $2,500 located on or near the water. Compliance with permits is required in addition to compliance with the SMA regulations. Thus, even if a person does not have to obtain a permit for a project, the project must still must comply with the SMA regulations. The Act identifies activities that are inconsistent with shoreline protection and provides guidance to local jurisdictions developing local shoreline plans. The SMA requires that local government's develop their own Shoreline Master Program (SMP).

Washington Coastal Zone Management (CZM) Program

Projects authorized by the U.S. Army Corp of Engineers and other federally permitted projects require certification assuring their compatibility with state and local environmental regulations. The Department of Ecology administers the certification process in the State of Washington.

Washington Department of Fisheries Stormwater Management Guidelines

In November of 1990 the Washington Department of Fisheries (WDF) implemented new stormwater management guidelines which focus on stormwater controls that protect fish habitat and fish resources. Because these are guidelines, in the case of a conflict with established regulations, the regulations would prevail.

Recommendations made in the guidelines include limiting peak discharges from the 2 and 25 year storm, using infiltration of stormwater wherever possible to recharge groundwater and protect base flows, dominant discharge in the stream channel should be preserved through detention and infiltration of stormwater, and use of sedimentation ponds and erosion control practices to reduce pollutants in streams.

WDF offers regulatory protection of habitat through their authority to administer and enforce Hydraulic Project Approval permits.

Governor Executive Orders 89-10 and 90-04

These executive orders were issued by Governor Booth Gardner to order state departments to work within existing policies and programs to achieve "no net loss" of wetlands. The orders also direct state agencies to exercise existing authority to the maximum extent possible to condition, deny, or enforce actions that may affect wetlands.

LOCAL PROGRAMS:

The Drainage Design and Erosion Control Manual for the Thurston Region, Washington
(Drainage Manual)

The cities of Olympia, Lacey, and Tumwater have developed a comprehensive approach to managing stormwater through the use of a region-wide drainage manual. This manual is intended to provide consistent standards and procedures for preparing drainage plans throughout the region while at the same time allowing for site-specific alterations by the jurisdictions. All of the jurisdictions listed above have adopted the manual and require its use when designing stormwater facilities for new development.

City of Olympia Comprehensive Plan

The City of Olympia Comprehensive Plan (1988) cover the issue of stormwater in considerable length. The plan calls for increased stormwater management planning to minimize the impacts of urbanization on water quality in wetlands, streams, lakes and Puget Sound. Several goals relating to storm and surface water management are identified by the plan including implementing a stormwater facility, minimization of runoff generated by new development, maintenance of lakes, ponds, wetlands, and streams in their natural condition, protection of streams from high flows and water quality degradation, and preservation of natural vegetation on development sites.

Thurston County Comprehensive Plan

Thurston County has jurisdiction over the outlying areas in the Percival Creek basin. The plan identifies basin planning as an integral part of Thurston County's stormwater management program. According to the Comprehensive Plan the protection of water resources in the county is to be accomplished by viewing all surface water bodies as part of a connected system instead of as isolated units, protection of fish-bearing streams from development impacts, restoration of degraded systems, maintaining the natural condition of water bodies, and increasing the evaluation of natural resources within the county and implementing the necessary changes to correct existing problems.

In contrast to the predecessors of the comprehensive plans of both Olympia and Thurston County the policies concerning surface water and the natural environment show a clear dedication to preserving streams and wetlands, views and wildlife habitat in their native forms. In addition, both plans dictate stronger limitations on development in unsuitable areas.

City of Tumwater Comprehensive Plan

The City of Tumwater Plan, updated in 1984, establishes a framework for planning decisions, and can be used for the development of appropriate new plans, regulations, and land uses. *The Plan* is designed to guide future development in a desirable and efficient manner, by providing a basis for public decisions regarding the development of community resources, the expenditure of public funds, and the allocation of land for various purposes. *The Plan* is somewhat outdated, however, and does not adequately address issues relating to the protection of natural resources. This deficiency is compensated by the newly adopted Tumwater Environmentally Sensitive Areas Conservation Plan discussed below.

Tumwater Environmentally Sensitive Areas Conservation Plan

The City of Tumwater has developed an Environmentally Sensitive Areas Conservation Plan in order to meet the requirements of the Growth Management Act (SHB-2929). The conservation plan is intended to identify, protect, and conserve critical environmental areas and valuable natural resources. Companion ordinances are included in the document in order to facilitate its rapid adoption. SHB 2929 requires completion and adoption of such conservation plans by September 1, 1991.

The Plan identifies Tumwater's economically viable areas including agricultural lands, forest lands, and mineral resource lands. It also identifies critical areas including wetlands, aquifer recharge areas, frequently flooded areas, geologically hazardous areas, and fish and wildlife habitat areas. Policies for the use and protection of these areas are included in the plan. The Tumwater City Council adopted the plan on August 20, 1991.

Development Permitting Process

The development of new structures and modifications to existing structures requires local review and permitting. Water resource concerns that are addressed during the review process include zoning, proximity to sensitive areas, sewage disposal, drainage management, site design, and open space.

Zoning Ordinances

Zoning ordinances are a means to promote the health, safety, and general welfare of a community through providing development guidance. Zoning also provides regulations and objectives that encourage high development standards, prevent the overcrowding of land, and avoid excessive population concentrations. Stormwater issues are addressed by zoning ordinances through provisions for stream buffers, habitat, accepted uses, and best management practices for stream corridors. The City of Olympia and Thurston County Zoning Ordinances include a mandatory stormwater control plan for all building permits except single family and duplex permits.

Zoning ordinances in Olympia and Thurston County also restrict the types of activities that may take place in flood hazard areas, wetlands, geological hazard areas and other critical areas.

NONREGULATORY MANAGEMENT OPTIONS

There are a number of nonregulatory options available for management of water resources. These options lack a regulatory mandate and are instead characterized by their voluntary nature. Because these options are noncompulsory, in most cases they must be implemented as individual programs based on the willingness of private citizens to participate.

Conservation Easements

Private landowners who wish to preserve the natural state of their property while maintaining ownership may choose to donate their development rights to a qualified conservation organization. Any property with significant conservation or historical value can be protected in this way. The conservation organization then holds the development rights and manages the property under its objectives. If the property owner grants the development rights in perpetuity to a qualified organization, the donation is considered a tax deductible charitable gift and can be deducted from the owner's income tax.

Purchase of Development Rights

Like conservation easements, this option involves the relinquishment of development rights. In this case, however, the rights are purchased from the property owner instead of being donated. This removes the land from the development market while allowing the owner to continue the current use of the property. Once the development rights have been purchased the information is listed on the property title and is binding on all future owners. This is an especially common practice for agricultural lands because it protects them from subdivision and development while allowing their existing use to continue into the future.

Land Trusts

Land trusts are organizations set up to protect property with special value. Trusts rely predominantly on donations of land, but occasionally purchase property they consider especially valuable. Scenic views, wildlife habitat, unique natural features, and sensitive or threatened environments are common features of lands protected by trusts. Most trusts are local and run predominantly by volunteers. Some trusts are set up to manage lands on a permanent basis while others purchase lands and hold them only until a public entity is able to purchase the land.

Trusts manage the lands they acquire according to the wishes of the donating landowner and according to their own objectives. The primary goal of most trusts is to acquire land for public recreation. Secondary goals usually include protection of habitat, flood plains, and water quality.

The Capitol Land Trust, the Olympia-Tumwater Foundation, and the Nisqually River Basin Land Trust are the primary land trusts in the Olympia area. These organizations protect land by accepting donations of conservation easements, actual property, or money. Purchase of especially valuable property with donated funds is used by these entities when possible. On a national scale the Trust for Public Lands is a non-profit organization that purchases and accepts donations of land on a short-term basis. They hold these lands until public entities are able to purchase the areas. They also work with communities to set up local land trusts. Their primary focus is on lands that contain important habitat and can be used for recreation, education, or research.

Open Space

Parks and open space contribute to a high quality of life in urban environments. Buffers of open space can lessen the impact of conflicting land uses, as well as provide a natural area for recreation and wildlife habitat. Open space is made up of more than parks and recreation areas. It can be a secondary result of agricultural practices, wetland and stream bank protection, restricted flood plain development, and preservation of vegetative cover on steep banks and unstable soils.

In 1970 the Washington State Legislature adopted the "Open Space Tax Act." This act allows for lands to be assessed at current use value rather than highest and best use, protecting land owners from high property taxes that could force them to convert their valuable undeveloped urban property to other uses. This tax break provides an incentive to retain undeveloped urban lands as open space.

Open space tax programs are intended to continue private ownership and compensate property owners retaining current use as undeveloped property. The Open Space Tax Act identifies two categories of lands that meet the criteria for open space. The first category includes any land that is designated as open space by a city or county comprehensive plan and is zoned as such. The second classification category covers any land area whose preservation would protect natural, scenic, or cultural resources, stream corridors, wetlands, natural shorelines, aquifers, soil resources, or unique critical wildlife and native plant habitat.

Technical Assistance

Technical assistance can be used to improve or build a stewardship ethic among communities experiencing water related problems. This method is inexpensive and a relatively easy management option to implement. Technical assistance involves staff people in the field who locate and assess problems. Field representatives can also help residents interpret technical plans, and provide personal expertise, as well as assist in locating other available resources to help alleviate problems. While in the field they can provide technical manuals and information, brochures, or guidebooks relevant to the specific needs of each situation.

Public Education

One of the most effective ways to change people's undesirable behaviors is to increase their awareness and understanding of the issues involved. The protection of water resources will require that people understand the impacts on water quality of many daily activities. Public education provides general information to a wide population over a long period of time. While results are not always tangible, it is a very effective process for improving the quality of water resources. Public education often builds a community support group which can help by volunteering to help with improvement projects and by sharing their knowledge with others. Residents who are alert to the issues associated with creeks, shorelines, flood plains, and other water related issues will be better able to anticipate and respond to potentially dangerous situations.