9.0 Appendices

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9.0 Appendices

9.1 Acronyms and Glossary

Acronyms

AR	Administrative Record
BMPs	Best Management Practices
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
°C	Centigrade (degrees)
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
Draft RP/EA	Draft Restoration Plan and Environmental Assessment
DSAYs	Discounted Service Acre-Years
EA	Environmental Assessment
EFH	Essential Fish Habitat (under MSFCMA)
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Ecologically Significant Unit
FONSI	Finding of No Significant Impact
FWCA	Fish and Wildlife Coordination Act
GPS	Global Positioning System
HAZMAT	NOAA's Hazardous Materials Response and Assessment Division
HEA	Habitat Equivalency Analysis
JRC	Joint Restoration Committee
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MTCA	Model Toxics Control Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
OAHP	Office of Archaeology and Historic Preservation
OPA	Oil Pollution Act of 1990
OPLC	Olympic Pipe Line Company (the Company)
PHABSIM	Physical Habitat Simulation Model
RCW	Revised Code of Washington

RDA	Resource Damage Assessment
RP(s)	Responsible Party or Parties
RP/EA	Restoration Plan and Environmental Assessment
SEPA	State Environmental Policy Act
SIMAP	Spill Impact Map
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology

Glossary

anadromous: fish, such as salmon, that live in the ocean but reproduce in freshwater
benthic: relating to, or occurring at the bottom of a body of water
biota: the flora and fauna of a region
estuarine: relating to, or formed in an estuary- an inlet of the sea influenced by freshwater
gabion: a basket or cage filled with earth or rocks and used especially in building a support or abutment
intertidal: The region of the shoreline between the high tide mark and the low tide mark.
invasive species: a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health
invertebrate: lacking a spinal column (backbone or vertebrae); of or relating to invertebrate animals, such as crustaceans, mollusks, worms, gastropods and insects, that lack a backbone or spinal column
macroinvertebrate: An invertebrate visible without the aid of magnification
marine: of or relating to the sea
planform: pattern of a stream channel as seen from the air (e.g. straight or meandering)
riparian: relating to or living or located on the bank of a natural watercourse (as a river) or sometimes of a lake or a tidewater
riprap: a loose assemblage of broken stones erected in water or on soft ground as a foundation
refugia: a place or source of shelter or safety; a sanctuary
salmonid: any of a family (Salmonidae) including salmon or trout
trophic: of or relating to nutrition, generally referring to flow of food or energy from one ecological level to another.
watershed: a region or area bounded peripherally by a divide and draining ultimately to a particular watercourse or body of water

9.2 Index to the Administrative Record

Record Number	Author	Date	Title
001	OPLC	1999	Emergency Restoration Plan for Whatcom Creek and Whatcom Falls Park, Bellingham, Washington
002	NOAA Damage Assessment Center	2000	Whatcom Creek Incident. Preassessment Data Report, Final Draft, 3/20/00.
003	OPLC	1999	Recap Ferndale Station to Bayview Products Terminal 16" pipeline Displacement Activities (Spill Volume)
004	US EPA	1999	Olympic Pipe Line Major Gasoline Spill Whatcom Creek POLREP #16 Bellingham, Washington
005	Stone, V.A.	2000	Whatcom Creek Water Quality in the 1990s and the ecological effects of a gasoline pipeline leak and fire in Bellingham, WA.
006	Co-Trustees	2000	Memorandum of Agreement for the Whatcom Creek Incident
007	Eissinger, A. (Nahkeeta Northwest)	1995	City of Bellingham Wildlife and Habitat Assessment; an Inventory of Existing Conditions and Background Information and Wildlife Habitat Plan
008	Nakano Associates	1995	Whatcom Creek Trail Master Plan
009	City of Bellingham Department of Planning and Community Development	1999	Permit for Whatcom Creek Trail
010	Ashbrook, C. , and D. Doty	2000	Fish and wildlife in-stream mortality assessment following the Olympic Pipeline gasoline spill in Bellingham, Washington on June 10, 1999, Final Report
011	City of Bellingham Parks and Recreation Department	1999	Whatcom Falls Park Closure Maps
012	National Marine Fisheries Service	1999	Chinook Salmon, (*Oncorhynchus tshawytscha*), Puget Sound ESU Listed Threatened, March 1999
013	State of Washington RDA Committee	1999	RDA Committee public meeting notes- Hearing on Assessment, 12 July, 1999
014	US EPA	1999	Incident Summary Report
015	OPLC	2000	Whatcom Creek Draft Long-Term Restoration Plan and Appendices
016	City of Bellingham	1995	Watershed Master Plan, September, 1995
017	City of Bellingham	1999	Whatcom Creek Waterfront Action Program (WCWAP) Summary (http://www.cob.org/oncd/source/htm/special_proj/wcwap/INDEX.HTM)
018	City of Bellingham	1988	Shoreline Management Master Program Update 1988
019	City of Bellingham Department of Planning and Community Development	1995	1995 Bellingham Comprehensive Plan
020	WDOE	1999	Lake Whatcom Watershed Cooperative Drinking Water Project. Results of 1998 Water, Sediment and Fish Tissue Sampling.

021	Thayer, D.V.	1977	Whatcom Creek Salmon Rearing
022	USGS	2002	Physical Habitat Simulation (PHABSIM) Software
023	City of Bellingham	2002	JRC meeting notes
024	Nooksack Salmon Enhancement Association	1997	Nooksack Salmon Enhancement Projects
025	Stanford, J. and F. Hauer	2002	Mitigating the impacts of Stream and Lake regulation in the Flathead River Catchment, Montana, USA: An ecosystem perspective
026	Sullivan, K., Martin, D., Cardwell, R., Toll, J. and S. Duke.	2000	An analysis of the Effects of Temperature on Salmonids of the Pacific Northwest with Implications for Selecting Temperature Criteria
027	Johnson, J., and J. McGowan	1999	Cemetery Creek Sea-Run Cutthroat Trout Rescue Plan
028	WDOE	2000	Bellingham Bay Pilot Project, Fact Sheet: Bellingham Bay Comprehensive Strategy, Final EIS,
029	WDFW	2001	List of State Species of Concern
030	USFWS	2001	Endangered, Threatened, Proposed and Candidate Species, Critical Habitat and Species of Concern in the Western Portion of Washington State, North Pacific Ecoregion as prepared by the US Fish and Wildlife Service, Western Washington Office.
031	City of Bellingham Parks and Recreation Department	1990	Trail Guide
032	City of Bellingham Department of Public Works	2001	Washington Heritage Registry sites in Bellingham
033	American Fisheries Society	1992	Investigation and valuation of fish kills
034	City of Bellingham	2001	Archival list of OPLC Unified Command Documents
035	Albers, P., and M. Gay	1982	Unweathered and Weathered Aviation Kerosene: Chemical Characterization and Effects of Hatching Success of Duck Eggs
036	Berry, W., and J. Brammer	1977	Toxicity of Water-Soluble Gasoline Fractions to Fourth-Instar Larvae of the Mosquito *Aedes aegypti.*
037	Brocksen, R., and H. Bailey	1973	Respiratory Response of Juvenile Chinook Salmon and Striped Bass Exposed to Benzene, a Water-soluble Component of Crude Oil
038	Bue, B.G, Sharr, S., and J.E Seeb	1998	Evidence of Damage to Pink Salmon Populations Inhabiting Prince William Sound, Alaska, Two Generations after the Exxon Valdez Spill.
039	Carls, M., Rice, S., and J.E. Hose	1999	Sensitivity of Fish Embryos to Weathered Crude Oil: Part I. Low-level exposure during incubation causes malformations, genetic damage, and mortality in larval Pacific Herring (*Clupea pallasi*).
040	Carls, M.G, Heintz, R., Moles, A., Rice, S.D., and J.W. Short	2001	Long-Term Biological Damage: What is Known, and How Should That Influence Decisions on Response, Assessment, and Restoration
041	Cline, P., Delfino, J., and P. Rao	1991	Partitioning of Aromatic Constituents into Water from Gasoline and Other Complex Solvent Mixtures
042	CONCAWE	1996	Acute Aquatic Toxicity of Gasolines; Report on CONCAWE Test Program

043	CONCAWE	1992	Gasolines
044	DeGraeve, G., Elder, R., Woods, D., and H. Bergman	1982	Effects of Naphthalene and Benzene on Fathead Minnows and Rainbow Trout
045	Delzer, G., Zogorski, J., Lopes, T., and R. Bosshart	1996	Occurrence of Gasoline Oxygenate MTBE and BTEX Compounds in Urban Stormwater in the United States, 1991-95.
046	Derveer, W., Nadeau, R., and G. Case	1995	A Screening-Level Evaluation of Impacts to a Montana Lotic Macroinvertebrate Community From a Fuel Oil Spill.
047	Devlin, E., Brammer, J., and R. Puyear	1982	Acute Toxicity of Toluene to Three Age Groups of Fathead Minnows (*Pimephales promelas*)
048	French-Mckay, D.	2001	Development and Application of an Oil Toxicity and Exposure Model, OilToxEx.
049	Galassi, S., Mingazzini, M., Vigano, L., Cesareo, D., and M. Tosato	1987	Approaches to Modeling Toxic Response of Aquatic Organisms to Aromatic Hydrocarbons
050	Graves, N.	1985	A Northern Idaho Gasoline Spill and Cleanup Using Stream Bed Agitation
051	Heintz, R., Short, J., and S. Rice	1999	Sensitivity of Fish Embryos to Weathered Crude Oil: Part II. Increased Mortality of Pink Salmon (*Oncorhynchus gorbuscha*) embryos incubating downstream from weathered Exxon Valdez crude oil.
052	Heintz, R.A, Rice, S.D., and B. Bue	1996	Field and Laboratory Evidence for Reduced Fitness in Pink Salmon that Incubate in Oiled Gravel.
053	Hodson, P., Dixon, D., and K. Kaiser	1984	Measurement of Median Lethal Dose as a Rapid Indicator of Contaminant Toxicity to Fish
054	Korn, S., Moles, A., and S. Rice	1979	Effects of Temperature on the Median Tolerance Limit of Pink Salmon and Shrimp Exposed to Toluene, Naphthalene, and Cook Inlet Crude
055	Marty, G.D., Heintz, R.A, and D.E. Hinton	1997	Histology and Teratology of Pink Salmon Larvae near the Time of Emergence from Gravel Substrate in the Laboratory
056	Moles, A.	1980	Sensitivity of Parasitized Coho Salmon Fry to Crude Oil, Toluene, and Naphthalene
057	Moles, A., Rice, S., and S. Korn	1979	Sensitivity of Alaskan Freshwater and Anadromous Fishes to Prudhoe Bay Crude Oil and Benzene
058	Morrow, J.	1974	Effects of Crude Oil and Some of its Components on Young Coho and Sockeye Salmon
059	Morrow, J.	1973	Oil-Induced Mortalities in Juvenile Coho and Sockeye Salmon
060	Pickering, Q., Carle, D., Pilli, A., Willingham, T., and J. Lazorchak	1989	Effects of Pollution on Freshwater Organisms
061	Pontasch, K. and M. Brusven	1988	Diversity and Community Comparison Indices: Assessing Macroinvertebrate Recovery Following a Gasoline Spill
062	Pontasch, K. and M. Brusven	1989	Macroinvertebrate and Periphyton Response to Streambed Agitation for Release of Substrate-Trapped Hydrocarbons
063	Pontasch, K., and M. Brusven	1987	Periphyton Response to a Gasoline Spill in Wolf Lodge Creek, Idaho
064	Rice, S.D, D Moles et al.	1984	Effects of Petroleum Hydrocarbons on Alaskan Aquatic Organisms

065	Schultz, D., and L. Tebo	1975	Boone Creek Oil Spill
066	Sharr, S., Moffitt, S.D., and A.K Craig	1996	Effects of the Exxon Valdez on Pink Salmon Embryos and Preemergent Fry
067	Stein, J.E, Krahn, M.M., Collier, T.K. and J.P. Meador	1998	Oil Spill Response: Assessing Exposure and Effects in Fishery Resources
068	Swartz, R.C. Schults, D., Oxretich, R., Lamberson, J., Cole, F., DeWitt, T., Redmond, M., and S. Ferraro	1995	Σ PAH: A Model to Predict the Toxicity of Polynuclear Aromatic Hydrocarbon Mixtures in Field-Collected Sediments
069	Wakehan, S., Davis, A., and J. Karas	1983	Mesocosm Experiments to Determine the Fate and Persistence of Volatile Organic Compounds in Coastal Seawater
070	Walsh, D., Armstrong, J., Bartley, T., Salman, H., and P. Frank	1977	Residues of Emulsified Xylene in Aquatic Weed Control and their Impact on Rainbow Trout
071	Neff, J.	2000	Appendix B- Development of Petroleum Fraction Specific Toxicity Values for the Protection of Aquatic Receptors
072	Neff, J.	2002	Monocyclic Aromatic Hydrocarbons.
073	AMOCO Oil	1999	Amoco Regular Lead-Free Gasoline-Gasoline Automotive, Material Safety Data Sheet
074	Landis, W.	1999	Consensus, Site Specific Action Levels for BETX, Gasoline and Naphthalene. August 18, 1999 JRC Meeting
075	Huyck, V., and E. Paulson (Eds.)	1997	Petroleum in the Freshwater Environment: An Annotated Bibliography.
076	NOAA	1995	Physical Process Affecting the Movement and Spreading of Oils in Inland Waters.
077	Taylor, E., Steen, A., and D. Fritz	1995	A review of environmental effects from oil spills into inland waters
078	Roni, P., and A. Fayram	2000	Estimating winter salmonid abundance in small western Washington Streams: a comparison of three techniques
079	Geiger, D., Brooke, L., and D. Call	1990	Acute Toxicities of Organic Chemicals to Fathead Minnows (*Pimephales promelas*).
080	Ball, R.	1948	Recovery of marked fish following a second poisoning of the population in Ford Lake, Michigan
081	NOAA	2000	Habitat Equivalency Analysis: An Overview
082	City of Bellingham	1998	Conservation and Public Easement: Padden Creek Gorge Area 78943
083	City of Bellingham	1998	Conservation and Public Easement: Padden Creek Gorge Area 78944
084	Labay, A.B. and D. Buzan	1998	A Comparison of Fish Kill Counting Procedures on a Small, Narrow Stream
085	Baker, D., and Everhope, L.	1999	Wildlife Surveys for Whatcom Creek Incident, June 12 - 14, 1999.
086	OPLC	1999	Whatcom Creek Sampling and Chemical Analytical Analysis Plan, June 10, 1999
087	R2 Consultants	2000	Whatcom Creek Snorkel Observations
088	GeoEngineers	1999	Site Characterization and Remediation Report, Pipeline Release Areas, Whatcom Creek Incident, Bellingham, Washington, Volume I of II
089	GeoEngineers	1999	Site Characterization and Remediation Report, Pipeline Release Areas, Whatcom Creek Incident, Bellingham,

			Washington, Volume II of II
090	City of Bellingham	1999	Closure Notice for Whatcom Falls Park and Trails
091	French-McKay, D.	2000	Preassessment Modeling of Fates and Marine Injuries Resulting from the June 1999 Gasoline Spill into Whatcom Creek
092	Locke, Gary	1999	Designation of City of Bellingham as a Natural Resource Trustee
093	Internet Information	1999	Compilation of Internet Information from Whatcom County, City of Bellingham, the OPLC, and others
094	Bellingham Herald	1999	Compilation of Newspaper Articles
095	Seattle Post Intelligencer	1999	Compilation of Newspaper Articles
096	Seattle Times	1999	Compilation of Newspaper Articles
097	Oregonian	1999	Compilation of Newspaper Articles
098	Washington State DNR	1999	Whatcom Creek Fire Department of Natural Resources Photo Interpretation of Burn Zone- ArcView Shape Files (Digital Original and brief text description)
099	Pentilla, D.	1999	Observations made around the mouth of Whatcom Creek, Bellingham, June 15, 1999.
100	Manifold, S., Colebrook, B., Baldwin, L. Grace, L., and C. Behee	2000	Whatcom Creek Invasives Survey Report, February 2000 (Digital Original, printed copy of text)
101	WDFW	1999	Emergency Closure Notice
102	WDFW	1999	Extension of Emergency Closure
103	Belt, G., Laughlin, J., and T. Merrill	1992	Design of Forest Riparian Buffer Strips for the Protection of Water Quality: Analysis of Scientific Literature.
104	Waples, R., and C. Do.	1994	Genetic risk associated with supplementation of Pacific salmonids: Captive broodstock programs.
105	Minshall, G., Robinson, C., and D Lawrence	1997	Postfire responses of Lotic Ecosystems in Yellowstone National Park, U.S.A.
106	Waters, T.F	1995	Sediments in Streams: Sources, Biological Effects, and Control.
107	Everest, F., Beschta, R., Scrivener, J., Koski, K., Sedell, J. and C.J. Sederholm.	1987	Fine Sediment and Salmonid Production: A Paradox. pp 98-142 in Salo, E., and T. Cundy (Eds.) Streamside Management: Forestry and Fisheries Interactions.
108	City of Bellingham Park Department	2000	Comments on Tree Planting Plan Summary Whatcom Falls Park Area, 2/24/00
109	Cantrell and Associates	2000	Tree Planting Plan Summary Whatcom Falls Park Area, 2/17/00
110	Clark, J.	2001	Proposed Park Improvements
111	Helfield, J. and R. Naiman. 2001.	2001	Nutrients from salmon carcasses enhance streamside forest growth and long-term salmon production. (Ecology)
112	Michael, Hal	2000	Use of carcasses to enhance stream productivity
113	Michael, Hal	2000	Protocols and Guidelines for Distributing Salmonid Carcasses to Enhance Stream Productivity in Washington State
114	Hyatt, T. and R. Naiman	2001	The Residence Time of Large Woody Debris in the Queets

			River, Washington
115	WDFW	1997	Policy of Washington Department of Fish and Wildlife and Western Washington Treaty Tribes Concerning Wild Salmonids
116	Ball, J., and D, Graper	1993	Planting a Tree with a Tree Moving Machine
117	WDOE	1999	Whatcom Watersheds Pledge Project
118	Inter-Fluve	2001	Salmon Park and Cemetery Creek Enhancement Plan for Fisheries Habitat, Draft Preliminary Design Report, 12/13/01
119	Inter-Fluve	2001	Salmon Park and Cemetery Creek Conceptual Enhancement Plan for Fisheries Habitat, 10% Design Report, 1/01
120	Inter-Fluve	2001	Salmon Park and Cemetery Creek Enhancement Plan for Fisheries Habitat, Draft Preliminary Design Report, 3/22/01
121	Inter-Fluve	2001	Salmon Park and Cemetery Creek Enhancement Plan for Fisheries Habitat, Preliminary Design Report, 4/11/01
122	Inter-Fluve	2001	Salmon Park and Cemetery Creek Enhancement Plan for Fisheries Habitat, Draft Preliminary Design Report, 11/30/01
123	Roni, Phil	2001	Responses of Fishes and Salamanders to Instream Restoration Efforts in Western Oregon and Washington
124	Ronald Jepson and Associates	1998	Binding Site Plan for Haskell Corporation Business Park
125	City of Bellingham	1998	Letter and attachments from Patricia Decker to Al Jansen Regarding planned development for Whatcom Reach Property
126	Inter-Fluve	2001	Wetland Delineation for the Salmon Park and Cemetery Creek; Enhancement Plan for Fisheries Habitat, 5/01
127	Bonneville Power Administration	1990	Analysis of Salmon and Steelhead Supplementation
128	Brown, J., Smith, J., and J. Kapler (eds.)	2000	Wildland fire in ecosystems: effects of fire on flora
129	Robichaud, P., Beyers, J., and D. Neary	2000	Evaluating the Effectiveness of Postfire Rehabilitation Treatments
130	Spina, A., and D. Tormey	2000	Postfire Sediment Deposition in Geographically Restricted Steelhead Habitat
131	Gresswell, R.	1999	Fire and Aquatic Ecosystems in forested Biomes of North America
132	Rinne, J.	1996	Short-term effects of wildfire on fishes and aquatic macroinvertebrates in the southwestern United States
133	Smith. J. (ed.)	2000	Wildland Fire in Ecosystems: Effects of Fire on Fauna
134	Roper, B., Konnoff, D., Heller, D., and K. Wieman	1998	Durability of Pacific Northwest Instream Structures Following Floods
135	Adams, S., Frissell, C., and B. Rieman	2001	Geography of Invasion in Mountain Streams: Consequences of Headwater Lake Fish Introductions
136	Schmetterling, D., Pierce, R.	1999	Success of Instream Habitat Structures After a 50-Year

			Flood in Gold Creek, Montana.
137	Co-Trustees	2002	Notice of Intent to Conduct Restoration Planning
138	U. S Government	1855	1855 Point Elliott Treaty Area for the Lummi Nation and Nooksack Tribe
139	Helton, D.	2002	Request to State Office of Archaeology and Historic Preservation for Section 106 Review
140	Whitlam, R.	2002	Response to Request for Section 106 Review
141	Jefferson, M.	2002	Letter regarding Tribal Participation

9.3 Summary of the Emergency Restoration Actions

A number of early remediation and emergency restoration activities were implemented and were coordinated with the emergency response and cleanup and oriented at reducing injuries to natural resources or restoring injured resources. Many of these activities have generated restoration benefits to the natural resources and resource services affected by the Incident. The emergency restoration activities that have been completed or are ongoing include:

- **Stream and Soil Remediation**—Agitation of stream sediments to release trapped gasoline. Contaminated soils were removed and treated.
- **Stream Restoration**—Replacement and rearrangement of stream gravel and cobble and introduction of large woody debris to create a stream physiography that is more conductive to fish production.
- **Invasive-Plant Control**—Removal of non-native vegetation and control of burned areas to facilitate re-establishment of a native plant community.
- **Tree Planting**—Thousands of tree seedlings have been planted throughout the burn zone to help re-establish a tree canopy.
- **Soil Erosion and Sedimentation Mitigation**—Areas at high risk to erosion after the fire were closed to pedestrian traffic. Native groundcovers were planted.
- **Valencia Street Bridge Improvements**—The Company rebuilt the Valencia Street Bridge, reconstructed the confluence of Fever Creek and Whatcom Creek to improve fish passage, and built a recreational trail bridge over Fever Creek at its intersection with Whatcom Park trail.

9.4 Calculation of "Discounted Service Acre Years" Created

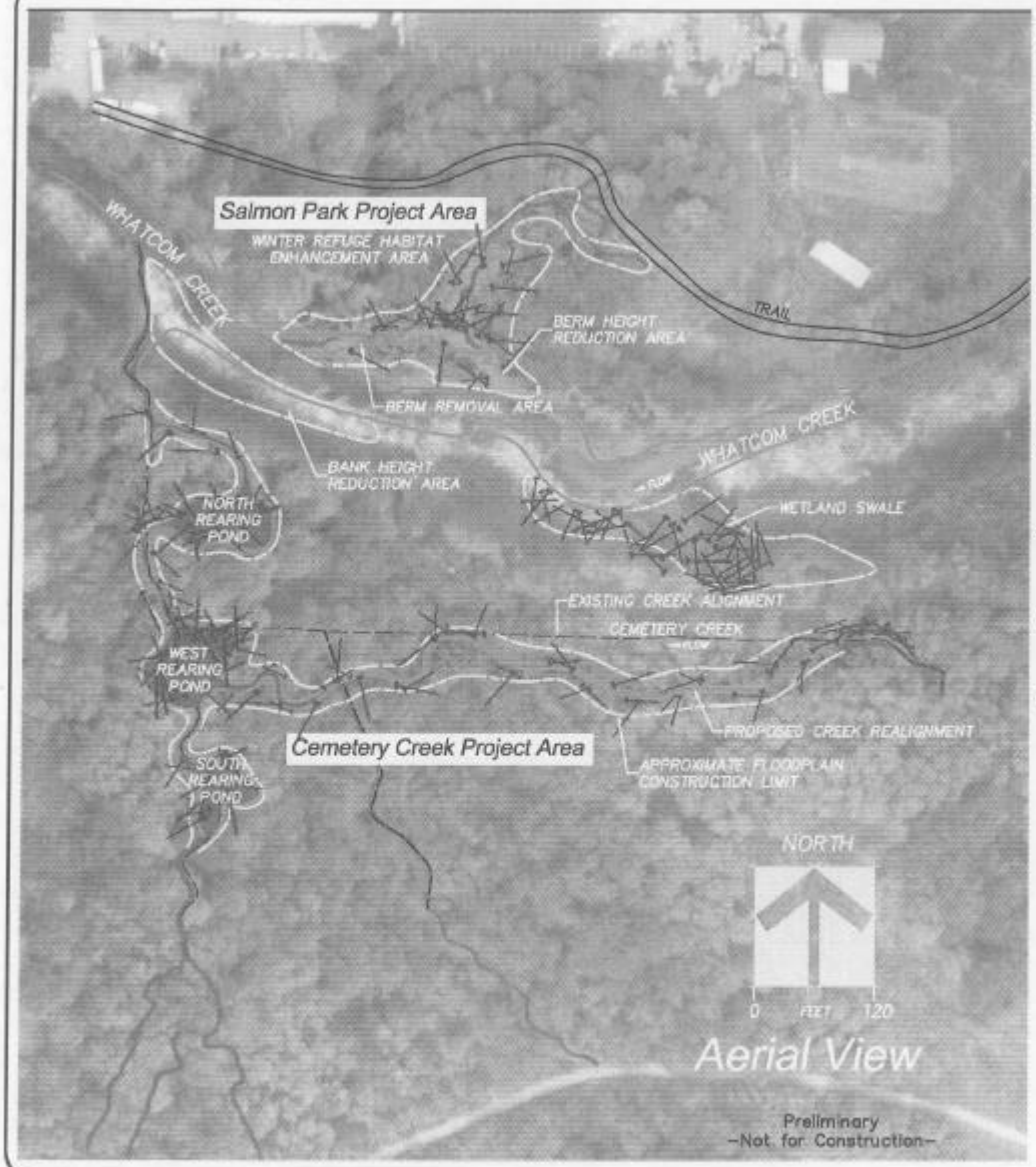
Table 4: Calculation of "Discounted Service Acre-Years" Created for Salmon Park and Cemetery Creek Proposed Projects

A	B	C	D	E	F	G
Year	Percent Services Provided	Affected Area (Project Size in acres)	Service-Acres Gained Per Year (B x C)	Discount Factor (@ 3% per annum)	Present Value of Service-Acres Gained Per Year (D x E)	Cumulative Discounted Service Acre-Years (DSAYs)
2002	0.00	0.9	0.000	1.000	0.000	0.000
2003	0.05	0.9	0.045	0.970	0.044	0.044
2004	0.10	0.9	0.090	0.941	0.085	0.128
2005	0.15	0.9	0.135	0.913	0.123	0.252
2006	0.20	0.9	0.180	0.885	0.159	0.411
2007	0.25	0.9	0.225	0.859	0.193	0.604
2008	0.30	0.9	0.270	0.833	0.225	0.829
2009	0.35	0.9	0.315	0.808	0.255	1.084
2010	0.40	0.9	0.360	0.784	0.282	1.366
2011	0.45	0.9	0.405	0.760	0.308	1.674
2012	0.50	0.9	0.450	0.737	0.332	2.005
2013	0.55	0.9	0.495	0.715	0.354	2.359
2014	0.60	0.9	0.540	0.694	0.375	2.734
2015	0.65	0.9	0.585	0.673	0.394	3.128
2016	0.70	0.9	0.630	0.653	0.411	3.539
2017	0.75	0.9	0.675	0.633	0.427	3.967
2018	0.80	0.9	0.720	0.614	0.442	4.409
2019	0.85	0.9	0.765	0.596	0.456	4.865
2020	0.90	0.9	0.810	0.578	0.468	5.333
2021	0.95	0.9	0.855	0.561	0.479	5.812
2022	1.00	0.9	0.900	0.544	0.489	6.302
2023	1.00	0.9	0.900	0.527	0.475	6.776
2024	1.00	0.9	0.900	0.512	0.460	7.237
2025	1.00	0.9	0.900	0.496	0.447	7.683
2026	1.00	0.9	0.900	0.481	0.433	8.117
2027	1.00	0.9	0.900	0.467	0.420	8.537
2028	1.00	0.9	0.900	0.453	0.408	8.945
2029	1.00	0.9	0.900	0.439	0.395	9.340
2030	1.00	0.9	0.900	0.426	0.384	9.724

2031	1.00	0.9	0.900	0.413	0.372	10.096
2032	1.00	0.9	0.900	0.401	0.361	10.457
2033	1.00	0.9	0.900	0.389	0.350	10.807
2034	1.00	0.9	0.900	0.377	0.340	11.146
2035	1.00	0.9	0.900	0.366	0.329	11.476
2036	1.00	0.9	0.900	0.355	0.320	11.795
2037	1.00	0.9	0.900	0.344	0.310	12.105
2038	1.00	0.9	0.900	0.334	0.301	12.406
2039	1.00	0.9	0.900	0.324	0.292	12.697
2040	1.00	0.9	0.900	0.314	0.283	12.980
2041	1.00	0.9	0.900	0.305	0.274	13.255
2042	1.00	0.9	0.900	0.296	0.266	13.521
2043	1.00	0.9	0.900	0.287	0.258	13.779
2044	1.00	0.9	0.900	0.278	0.250	14.029
2045	1.00	0.9	0.900	0.270	0.243	14.272
2046	1.00	0.9	0.900	0.262	0.236	14.508
2047	1.00	0.9	0.900	0.254	0.229	14.736
2048	1.00	0.9	0.900	0.246	0.222	14.958
2049	1.00	0.9	0.900	0.239	0.215	15.173
2050	1.00	0.9	0.900	0.232	0.209	15.382
2051	1.00	0.9	0.900	0.225	0.202	15.584
2052	1.00	0.9	0.900	0.218	0.196	15.780
2053	1.00	0.9	0.900	0.212	0.190	15.971
2054	1.00	0.9	0.900	0.205	0.185	16.155
2055	1.00	0.9	0.900	0.199	0.179	16.334
2056	1.00	0.9	0.900	0.193	0.174	16.508
2057	1.00	0.9	0.900	0.187	0.169	16.677
2058	1.00	0.9	0.900	0.182	0.163	16.840
2059	1.00	0.9	0.900	0.176	0.159	16.999
2060	1.00	0.9	0.900	0.171	0.154	17.153
2061	1.00	0.9	0.900	0.166	0.149	17.302
2062	1.00	0.9	0.900	0.161	0.145	17.447
2063	1.00	0.9	0.900	0.156	0.140	17.587
2064	1.00	0.9	0.900	0.151	0.136	17.723
2065	1.00	0.9	0.900	0.147	0.132	17.855
2066	1.00	0.9	0.900	0.142	0.128	17.983
2067	1.00	0.9	0.900	0.138	0.124	18.108
2068	1.00	0.9	0.900	0.134	0.121	18.228
2069	1.00	0.9	0.900	0.130	0.117	18.345
2070	1.00	0.9	0.900	0.126	0.113	18.458

2071	1.00	0.9	0.900	0.122	0.110	18.568
2072	1.00	0.9	0.900	0.119	0.107	18.675
2073	1.00	0.9	0.900	0.115	0.104	18.779
2074	1.00	0.9	0.900	0.112	0.100	18.879
2075	1.00	0.9	0.900	0.108	0.097	18.977
2076	1.00	0.9	0.900	0.105	0.094	19.071
2077	1.00	0.9	0.900	0.102	0.092	19.163
2078	1.00	0.9	0.900	0.099	0.089	19.252
2079	1.00	0.9	0.900	0.096	0.086	19.338
2080	1.00	0.9	0.900	0.093	0.084	19.421
2081	1.00	0.9	0.900	0.090	0.081	19.503
2082	1.00	0.9	0.900	0.087	0.079	19.581
2083	1.00	0.9	0.900	0.085	0.076	19.658
2084	1.00	0.9	0.900	0.082	0.074	19.732
2085	1.00	0.9	0.900	0.080	0.072	19.804
2086	1.00	0.9	0.900	0.077	0.070	19.873
2087	1.00	0.9	0.900	0.075	0.068	19.941
2088	1.00	0.9	0.900	0.073	0.066	20.006
2089	1.00	0.9	0.900	0.071	0.064	20.070
2090	1.00	0.9	0.900	0.069	0.062	20.132
2091	1.00	0.9	0.900	0.066	0.060	20.191
2092	1.00	0.9	0.900	0.064	0.058	20.249
2093	1.00	0.9	0.900	0.063	0.056	20.306
2094	1.00	0.9	0.900	0.061	0.055	20.360
2095	1.00	0.9	0.900	0.059	0.053	20.413
2096	1.00	0.9	0.900	0.057	0.051	20.465
2097	1.00	0.9	0.900	0.055	0.050	20.515
2098	1.00	0.9	0.900	0.054	0.048	20.563
2099	1.00	0.9	0.900	0.052	0.047	20.610
2100	1.00	0.9	0.900	0.051	0.045	20.655
2101	1.00	0.9	0.900	0.049	0.044	20.699
2102	1.00	0.9	0.900	0.048	0.043	20.742

9.5 Design Information for Cemetery Creek and Salmon Park Projects



PROJECT PURPOSES/USES

~ ENHANCE AVAILABLE REARING AND SEASONAL REFUGE HABITATS TO ONE OF THE PRIMARY SALMONID SPAWNING AREAS IN WHATCOM CREEK

~ IMPROVE HABITAT CONDITIONS PRIMARILY FOR CUTTHROAT TROUT, WITH ADDITIONAL BENEFITS FOR COHO SALMON AND OTHER NATIVE FISH SPECIES

SALMON PARK

~ CREATE HIGH–FLOW FISH REFUGE AND REARING HABITAT ALONG WHATCOM CREEK

~ STREAMSIDE BERMS TO BE REMOVED AND THE STREAM BANKS MODIFIED TO RESTORE CHANNEL MIGRATION RATES, INCREASE FLOODPLAIN AREA, IMPROVE FLOOD STORAGE CAPACITY, AND FACILITATE NATURAL GENERATION OF SALMONID HABITAT

CEMETERY CREEK

~ CREATE A NEW STREAM CHANNEL AND THREE COLD WATER FISH REARING PONDS IN LOWER CEMETERY CREEK

~ IMPROVE THERMAL REFUGE HABITAT DURING PERIODS OF ELEVATED STREAM TEMPERATURES IN WHATCOM CREEK (SUMMERTIME)

~ PLACE LARGE WOODY DEBRIS IN PORTIONS OF CEMETERY CREEK AND WHATCOM CREEK TO IMPROVE HABITAT DIVERSITY AND COVER

~ CREATE MORE NATURALLY FUNCTIONING STREAM CORRIDORS

1 of 6

Aerial View
Enhancement Areas

PREFERRED DESIGN ALTERNATIVE

WHATCOM CREEK LONG TERM ENHANCEMENT PLANS FOR SALMONID HABITAT

PROJECT NO: 05-03-23

inter-fluve, inc.

PREFERRED DESIGN ALTERNATIVE

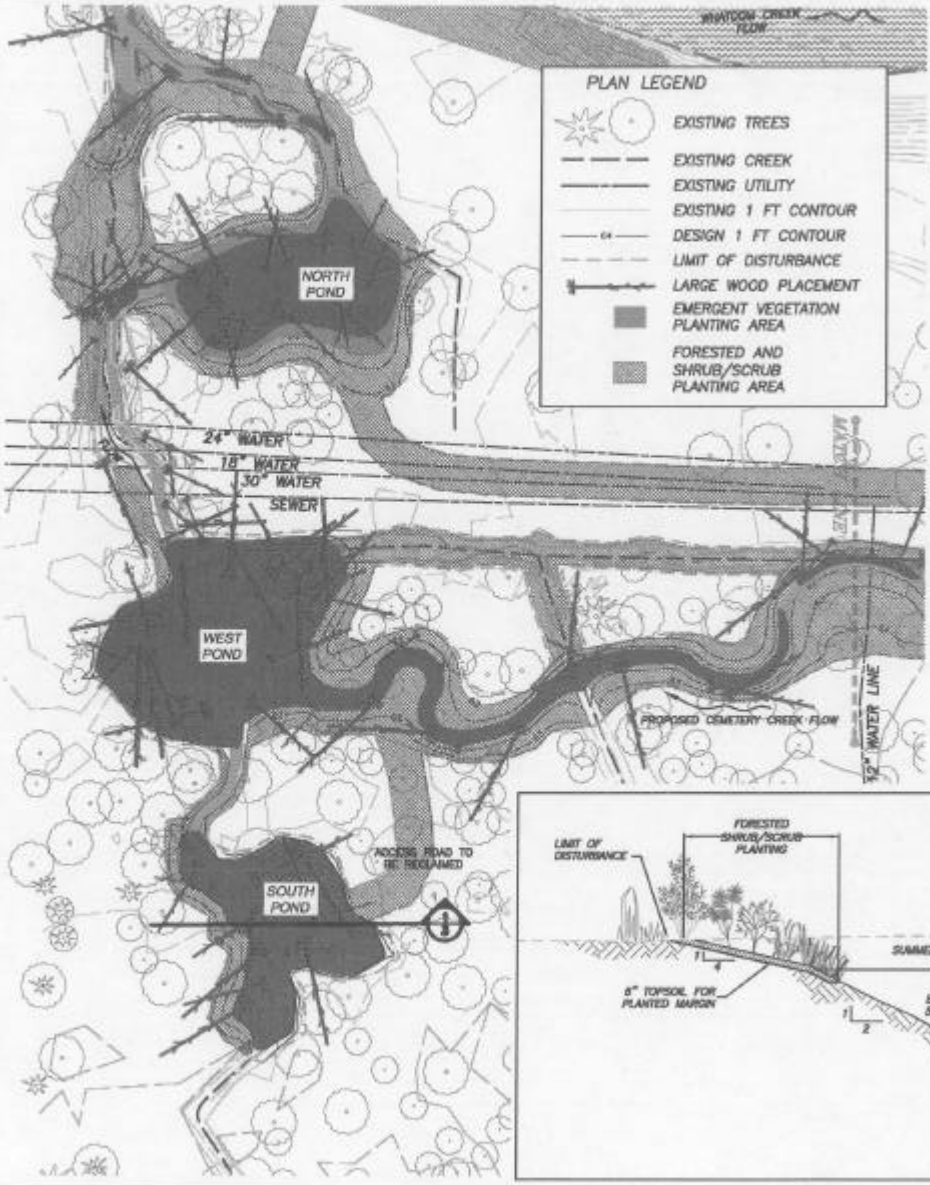
WHATCOM CREEK LONG TERM ENHANCEMENT PLANS FOR SALMONID HABITAT

PROJECT NO: 00-02-23

inter-fluve, inc.

DESIGNED BY	CHECKED BY
MM	LM
DRAWN BY	DATE APPD.
NS	11-30-01

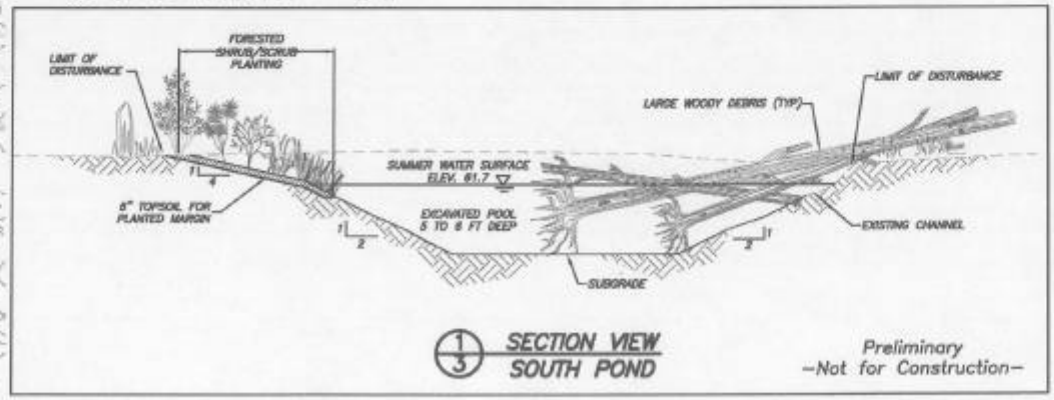
SALMON PARK
PLAN VIEW
HABITAT ENHANCEMENT



PLAN VIEW
CEMETERY CREEK
HABITAT ENHANCEMENTS

SALMONID HABITAT FEATURES

- ~ CREATION OF A MORE NATURALLY FUNCTIONING STREAM CORRIDOR AND THREE COLD-WATER FISH REARING PONDS IN LOWER CEMETERY CREEK
- ~ PROVIDES ADDITIONAL THERMAL REFUGE HABITAT DURING PERIODS OF ELEVATED WATER TEMPERATURES IN WHATCOM CREEK (SUMMERTIME)
- ~ NEAR STREAM VEGETATION PROVIDES SHADE AND FOOD CHAIN SUPPORT
- ~ LARGE WOOD PLACEMENTS FOR COVER, REFUGE, AND HABITAT DIVERSITY
- ~ ENLARGED CAPACITY FOR NATIVE SALMONIDS



1/3 SECTION VIEW
SOUTH POND

Preliminary
-Not for Construction-

Cemetery Creek
Plan View
Habitat Plan West

DESIGNED BY	DRAWN BY	CHECKED BY
MM	LM	
DATE APPR.		
NS	11-30-01	

3 of 6

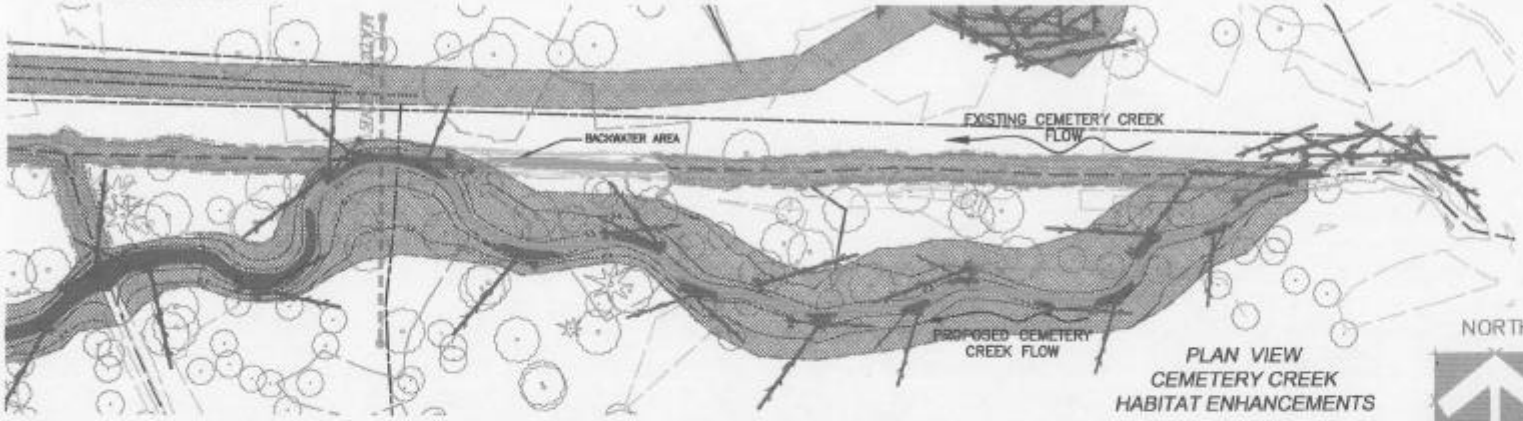
PREFERRED DESIGN ALTERNATIVE

WHATCOM CREEK LONG TERM
ENHANCEMENT PLANS FOR
SALMONID HABITAT

PROJECT NO. 00-02-23

inter-fluve, inc.

Preliminary
-Not for Construction-



PLAN VIEW
CEMETERY CREEK
HABITAT ENHANCEMENTS

NORTH

0 FEET 50
PLAN SCALE

PLAN LEGEND

- EXISTING TREES
- EXISTING CREEK
- EXISTING UTILITY
- EXISTING 1 FT CONTOUR
- DESIGN 1 FT CONTOUR
- LIMIT OF DISTURBANCE
- DESIGN POOL
- LARGE WOOD PLACEMENT
- FORESTED AND SHRUB/SCRUB PLANTING AREA

CEMETERY CREEK HABITAT FEATURES

~ CREATION OF A MORE NATURALLY FUNCTIONING STREAM CORRIDOR

~ LARGE WOOD PLACEMENTS FOR COVER AND HABITAT DIVERSITY

~ BANK VEGETATION PROVIDES FOOD CHAIN SUPPORT, BANK STABILITY AND SHADE

~ EXISTING OVERHANGING TREES PROVIDE SHADE AND KEEP WATER TEMPERATURES LOW

~ IMPROVED NATURAL STREAM FUNCTION AND RIPARIAN INTERACTION

~ ENLARGED CAPACITY FOR CUTTHROAT TROUT

CEMETERY CREEK
PLAN VIEW
HABITAT PLAN EAST

4 of 6

PREFERRED DESIGN ALTERNATIVE

WHATCOM CREEK LONG TERM
ENHANCEMENT PLANS FOR
SALMONID HABITAT

PROJECT NO: 00-02-23

inter-fluve, inc.

PLAN VIEW CHANNEL DETAILS

TYPICAL SECTION VIEW POOL

TYPICAL VIEW OF ESTABLISHED CHANNEL FOLLOWING CONSTRUCTION

PREFERRED DESIGN ALTERNATIVE

WHATCOM CREEK LONG TERM ENHANCEMENT PLANS FOR SALMONID HABITAT

PROJECT NO: 00-02-23

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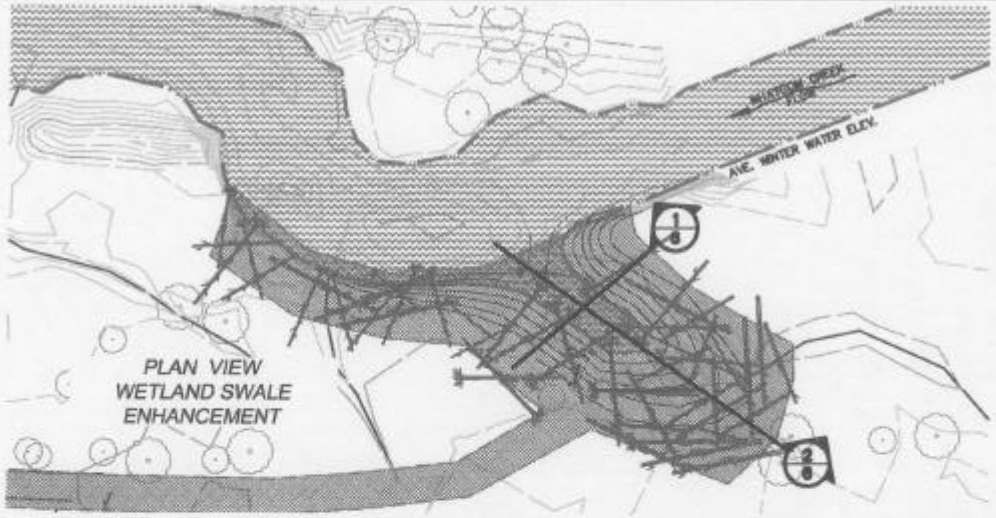
DESIGNED BY	DRAWN BY
MM	LM
CHECKED BY	DATE APPD.
NS	11-30-01

CEMETERY CREEK TYPICAL CHANNEL DETAILS



PLAN LEGEND

- EXISTING TREES
- EXISTING CREEK
- EXISTING UTILITY
- EXISTING 1 FT CONTOUR
- DESIGN 1 FT CONTOUR
- LIMIT OF DISTURBANCE
- LARGE WOOD PLACEMENT
- FORESTED AND SHRUB/SCRUB PLANTING AREA

NORTH

0 FEET 50

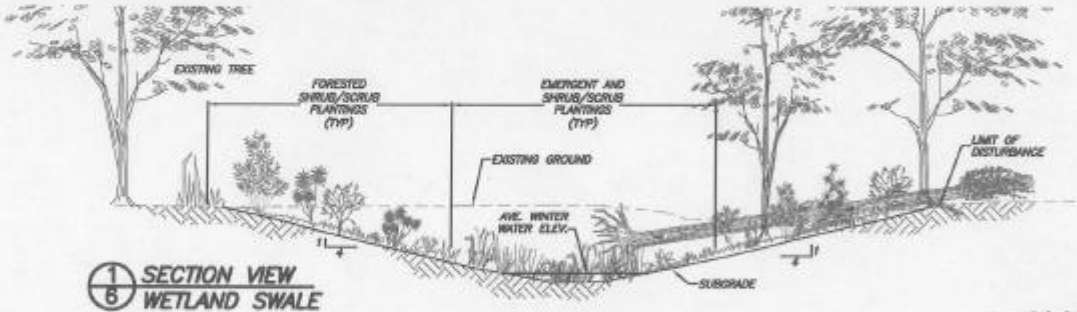
PLAN SCALE

HABITAT ENHANCEMENT AREA FEATURES

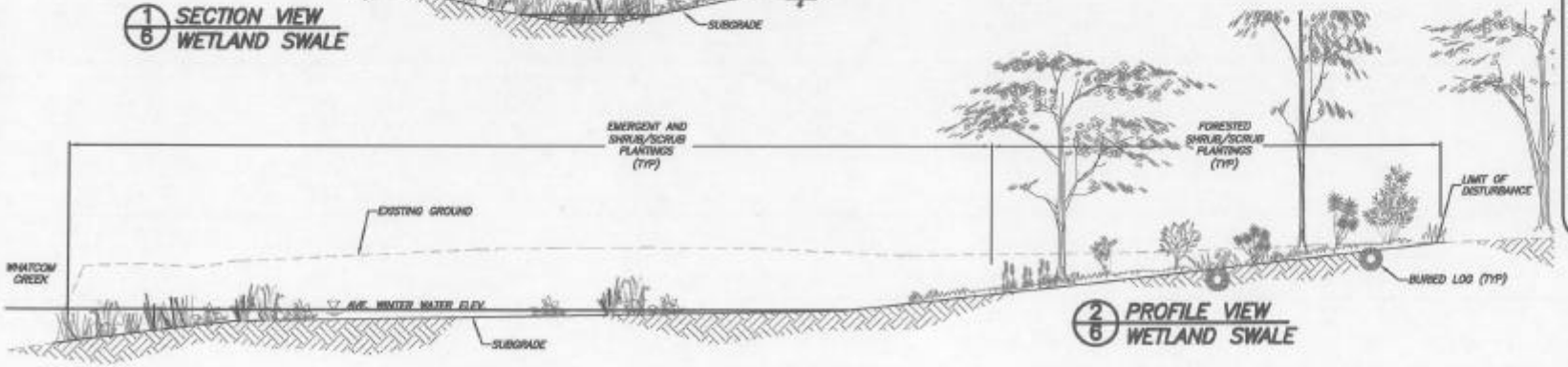
~ CREATION OF HIGH-FLOW FISH REFUGE HABITAT

~ TRANSITION VEGETATION PROVIDES SHADE AND FOOD CHAIN SUPPORT

~ ENHANCED WETLAND AREA ALONG WHATCOM CREEK



1/6 SECTION VIEW WETLAND SWALE



2/6 PROFILE VIEW WETLAND SWALE

DESIGNED BY	DRAWN BY	CHECKED BY	DATE APPR.
MM	LM	NS	11-30-01

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Cemetery Creek
Plan View
Wetland Swale Enhancement

PREFERRED DESIGN ALTERNATIVE

WHATCOM CREEK LONG TERM ENHANCEMENT PLANS FOR SALMONID HABITAT

PROJECT NO: 00-02-23

inter-fluve, inc.

9.6 Proposed Finding of No Significant Impact (FONSI)

(To be completed after consideration of public comments)

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