US Army Corps of Engineers ®
Seattle District

PORT of SUNNYSIDE

Sunnyside Wetlands Section 206 Ecosystem Restoration Yakima County, WA

Detailed Project Report and Integrated Environmental Assessment

15 July 2011

This page intentionally left blank.

Sunnyside Wetlands Section 206 Ecosystem Restoration
Detailed Project Report and Integrated Environmental Assessment

Yakima County, WA

15 July 2011

Prepared for:
Seattle District
U.S. Army Corps of Engineers

Prepared by:
Tetra Tech
1420 5th Ave, Suite 550
Seattle, WA 98101

DISCLAIMER

These documents have been prepared for a specific project and shall neither be altered nor reused for any other purpose. Also, these documents do not represent as-built conditions. If these documents are altered intentionally or unintentionally, or reused without the design engineer's written approval, it will be at the sole risk and responsibility of the user. The act of altering or reusing is construed as indemnifying and holding the design engineering firm and its employees harmless from all claims, damages, and expenses, including attorney fees, arising out of such act.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Cover Photo Credit: Svetlana Makarova (public domain, source: commons.wikimedia.org)

This page intentionally left blank.

1.0 PROJECT BACKGROUND AND LOCATION

1.1 STUDY AUTHORITY

This study is being conducted under the authority of Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303), as amended. This authority allows the U.S. Army Corps of Engineers (USACE) to carry out aquatic ecosystem restoration projects if the project will improve environmental quality, is in the public interest, and is cost effective. The projects must be cost-shared with a non-federal sponsor. The federal share of the costs for any one project may not exceed $5,000,000.

On 12 February 2003, the Port of Sunnyside (Port) submitted a letter to the Seattle District USACE requesting federal assistance in restoring wetland and wildlife habitat adjacent to the Yakima River, located in Yakima County, Washington. The Port has already purchased the land on which the wetland project is to be constructed in the expectation that the Corps participation and construction of the 206 Wetlands will be completed. Additionally, as the treatment effluent is the sole water source for the wetlands it is the intent of the Port to commit sufficient treatment effluent as source water for the wetlands once the Corps has committed to construct the subject wetlands project.

1.2 STUDY PURPOSE AND NEED

The purpose of this study is to evaluate the feasibility of restoring historic riparian and floodplain wetland habitat functions along the Yakima River near Sunnyside Washington. The maximum amount of treated wastewater effluent currently available from the Port of Sunnyside for this purpose averages from 0.5 to 1.3 million gallons per day (mgd), with peak flows up to 2 mgd.

The need for this project stems from currently degraded wetland and riparian zones along the Yakima River. Wetlands and riparian zones are important features in the landscape, benefiting people, fish, and wildlife. Important wetland functions include fish and wildlife habitat, groundwater recharge, biological productivity, floodwater storage, water quality protection and improvement, and aesthetics.

An opportunity exists to construct wetlands and revegetate the riparian zone for habitat restoration and to promote groundwater recharge. This study is being conducted under the assumption that the project will utilize the Port's treated wastewater effluent as the sole water source, and will be located downstream of the Port of Sunnyside's treatment facility. *The project is independent of all wastewater treatment required to meet compliance with the Port's NPDES permit* (WDOE, 2010). The purpose of the project is to use the treated wastewater effluent as a resource to improve and restore riparian floodplain wetland habitat along the Yakima River.

The planning objectives of the Sunnyside wetland restoration project are four-fold:

1) Restore diverse floodplain wetlands for a variety of wetland species;
2) Restore the riparian zone along the Yakima River;

3) Remove non-native species; and
4) Recharge the groundwater table and hyporheic zone with cool, clean water.

Effluent infiltrated through the upper habitat ponds, habitat ponds, and the infiltration trenches to the underlying soils and aquifer will cool to the ambient temperature of the underlying aquifer. The infiltration process will provide an opportunity for the water to cool as it infiltrates into the project site soils.

The wastewater treatment plant will be the primary source of the water for the ecosystem restoration. The Port of Sunnyside operates an industrial waste water treatment facility permitted by the Washington State Department of Ecology, serving fifteen food or food-related industries and one pipe manufacturing plant (Port of Sunnyside, 2011).

The project described in this report is designed to accommodate *existing* effluent levels from Port treatment facilities. The effluent discharge rate varies seasonally; for the purposes of this study, it is assumed that between 1.3 and 2.0 mgd will be available to the site for wetland restoration and groundwater infiltration purposes.

1.3 PUBLIC SCOPING

[Placeholder. This section will be incorporated as information becomes available.]

1.4 LOCATION

The study area is located approximately 5 miles southwest of the City of Sunnyside, on the east side of the Yakima River in Yakima County, Washington. The specific project area under consideration is between River Mile 72.5 and 73.5 (see Figure 1 and Figure 2). Figure 3 illustrates the relative location of the study area to the Port treatment facility.

The Yakima River basin is located east of the Cascade crest and trends generally southeast and east towards the Columbia River. The Yakima River basin is approximately 6155 square miles in area and the river flows for 215 miles from Snoqualmie Pass to the Columbia River (Yakima Subbasin Fish and Wildlife Planning Board (YSPB), 2004). The project site is located along the Lower Yakima River, which has a broad floodplain and a highly meandering channel.

The Washington Department of Fish and Wildlife (WDFW) Sunnyside Wildlife Area is immediately adjacent to the proposed project site to the south. The project area and the WDFW lands are separated by an earthen roadway. The Sunnyside Wildlife Area comprises wetlands, managed ponds, and a riparian zone along the Yakima River that receives water from a variety of sources such as irrigation discharge and stormwater runoff. The WDFW has requested that any effects to groundwater levels or surface water runoff to their adjacent property be evaluated as part of the study.

The Yakama Indian Reservation encompasses nearly 1.4 million acres and includes the area on the west side of the river directly across from the project site. Some of the few remaining oxbows and old channel meanders along the entire river are still present across the river on tribal land, and much of the tribal floodplain land is used as habitat and hunting access.

The Port of Sunnyside currently owns seven parcels at the project site and its immediate vicinity, comprising a total of 230.7 acres (Figure 2). The original (circa 2008) 10 percent design concept project limits calculation did not include the 9.4-acre parcel adjacent to the Yakima River near the proposed outlet of the project (Parcel 17-99990-B) because so little of the parcel would be disturbed. Therefore, the original concept design involved six parcels and approximately 221.3 acres in all.

Because of its lower design flow rate, the 2010 conceptual design eliminated two parcels (Parcel ID 08-41002 and 08-41003) and 41.7 acres from the project limits on the west side of South Emerald Road. Including public right-of-way along South Emerald Road, the revised 10-percent conceptual design encompassed approximately 182.1 acres.

The 35 percent feasibility design analysis further consolidated the project site, removing a parcel (Parcel ID 09-32004) from the project limits on the east side of South Emerald Road, which had the additional advantage of avoiding the abandoned hop-pole creosote dip operation site and irrigation pump facilities located there. More detailed grading analysis put Parcel 08-41003 and approximately 6.0 acres of Parcel 08-41002 back within the project limits on the west side of South Emerald Road. The total project limits for the 35 percent feasibility design analysis are therefore approximately 171.2 acres.

The 2003 Preliminary Restoration Plan (PRP) proposed to restore approximately 70 acres (20 wetland and 50 riparian) of floodplain and riparian habitat; however, the quantity of water available to the site was not then known. Since the area of wetland and floodplain habitat that can be restored is correlated to the amount of water to be delivered to the site, for the purposes of this study, the entire site was considered for restoration. Approximately 7.8 acres of the site are currently described as freshwater pond or wetland by the U.S. Fish and Wildlife Service's National Wetland inventory (USFWS, 1981) (see discussion, Section 2.12). Restoration efforts and benefits would focus on the fallow farm areas of the project site.

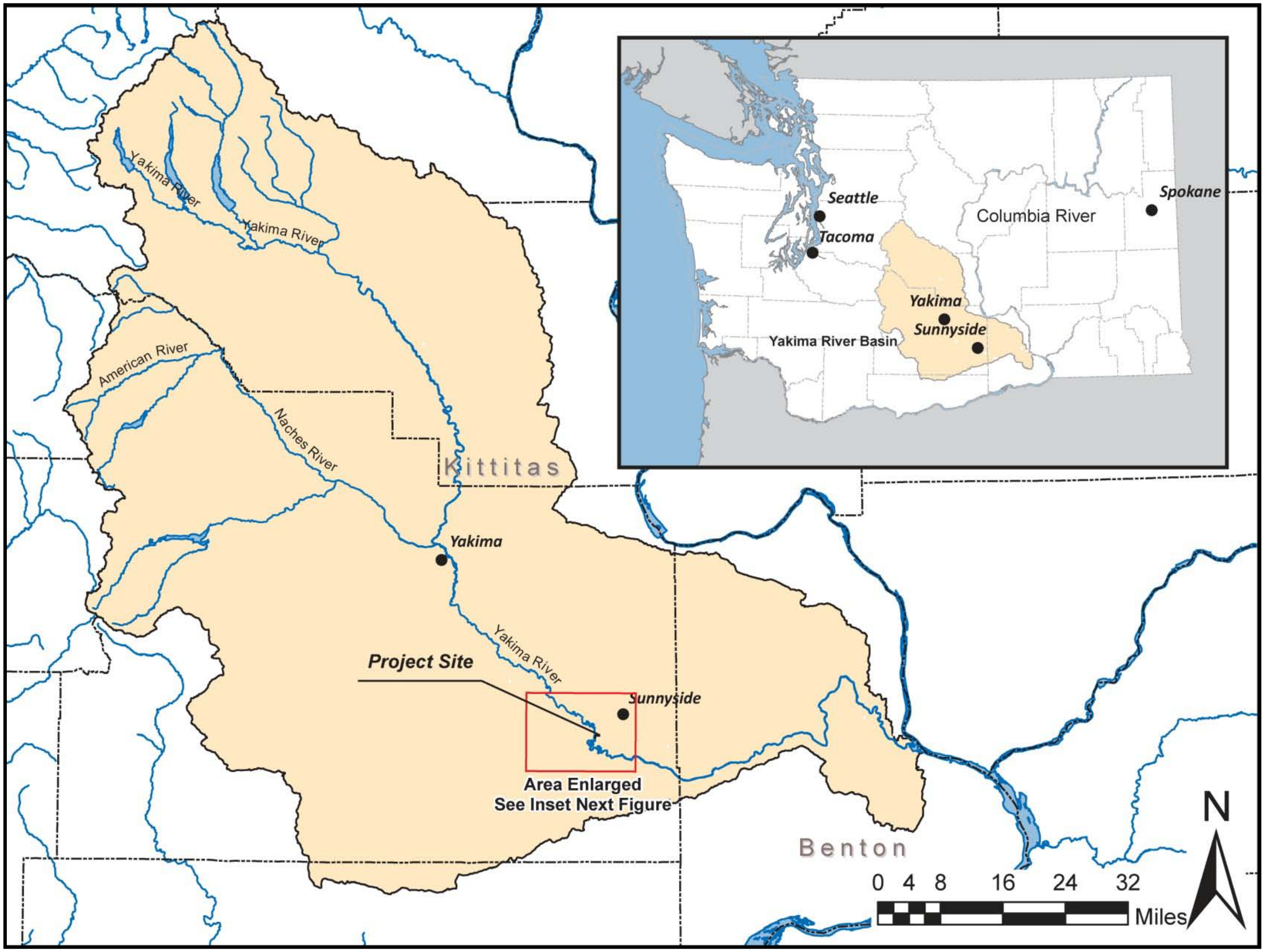

Figure 1. Site Vicinity Map.

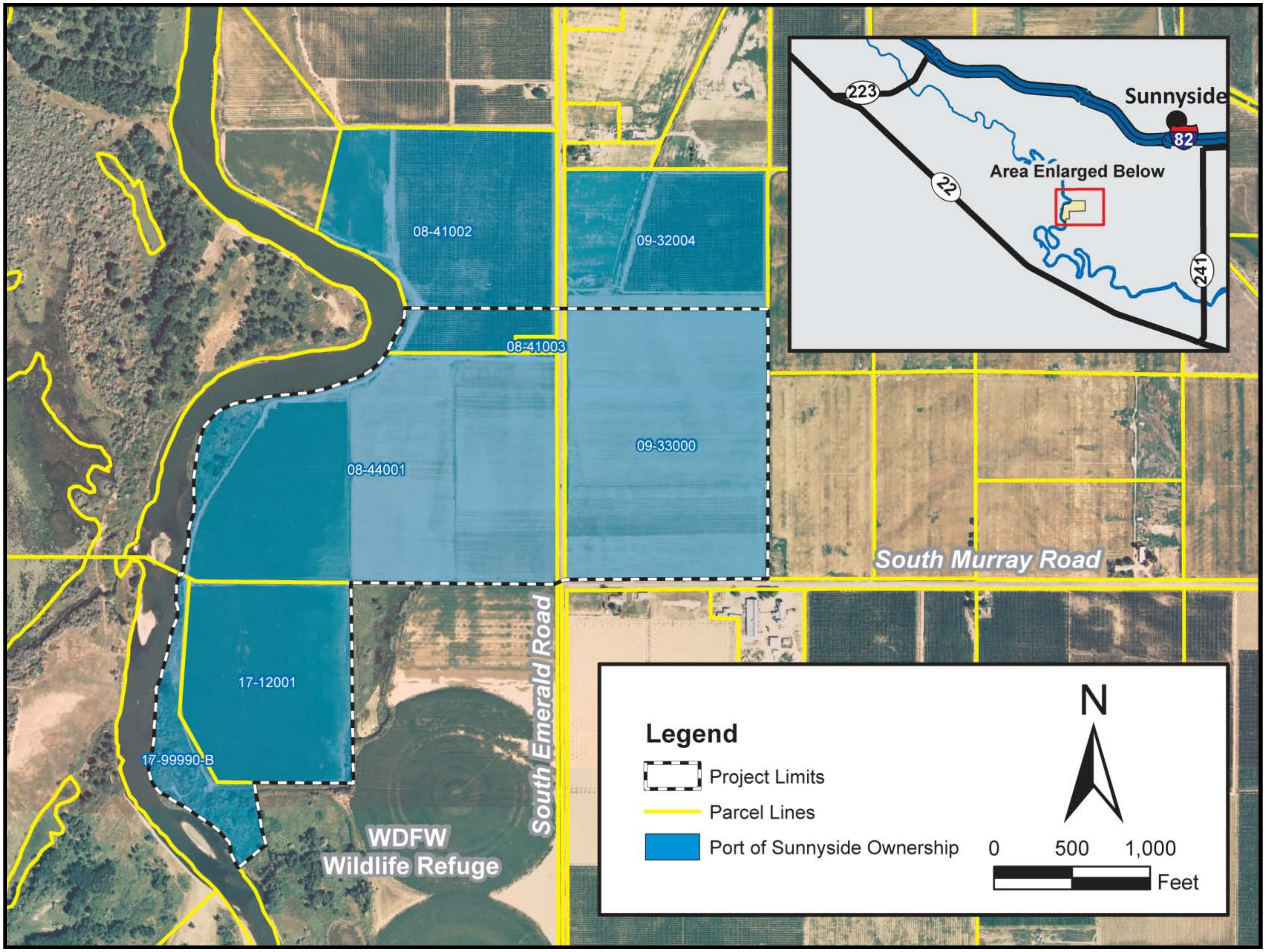

Figure 2. Project Site Map.

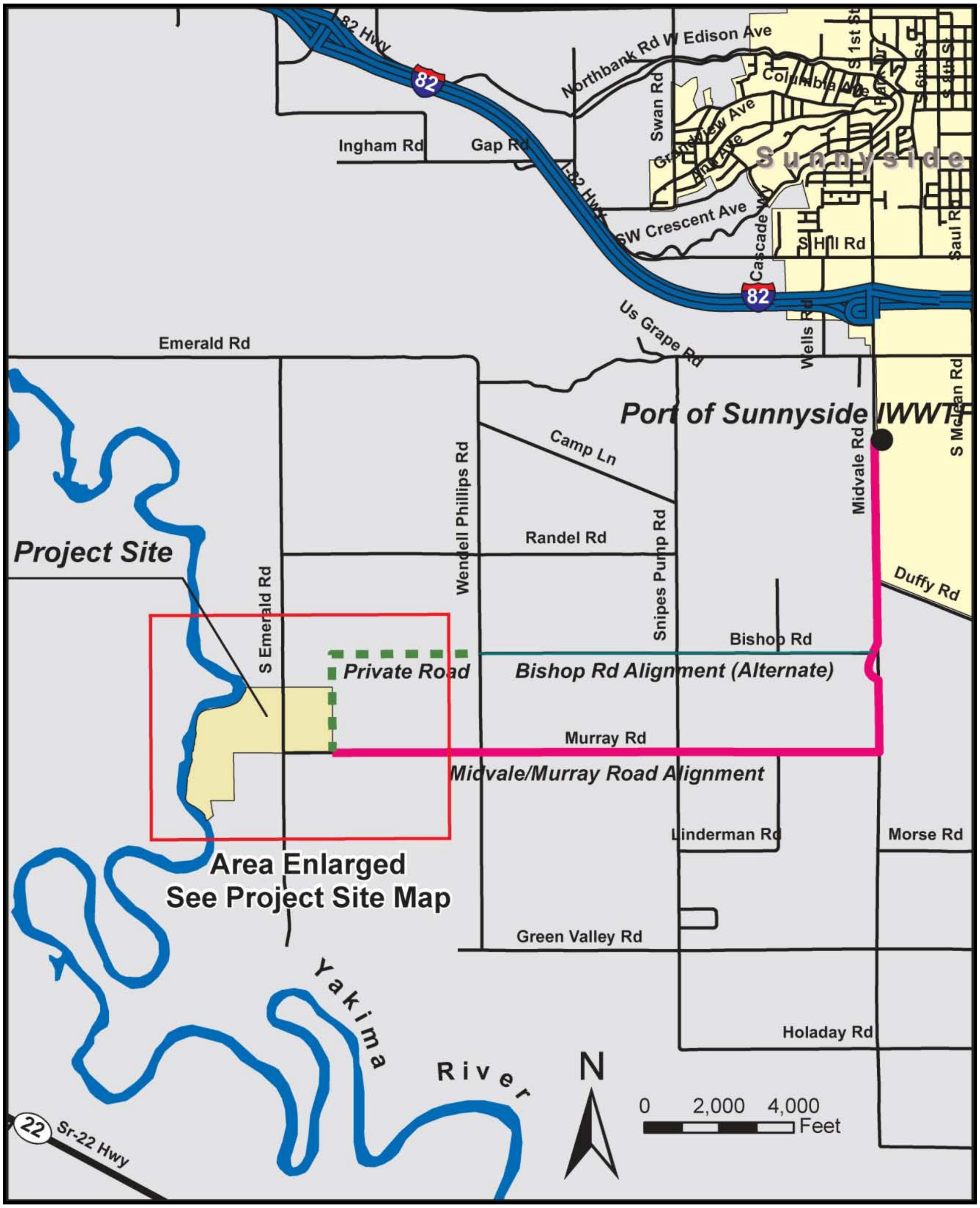

Figure 3. Proposed Alternative Alignments for Delivery Pipeline (To Be Built By Others).

1.5 RESOURCE PROBLEMS

Fish and wildlife populations and habitat have been dramatically reduced in the Yakima River basin. Restoration of key habitats such as floodplain and riparian wetlands will provide multiple benefits to numerous fish and wildlife species.

Native salmonid populations have significantly declined in the basin due to the construction of dams and diversions, loss of habitat, introduction of hatchery fish, and poor water quality. Several species have been listed under the Endangered Species Act including the Middle Columbia River populations of steelhead (threatened) and bull trout (threatened). Spring-run Chinook are significantly reduced in population, but have not yet been listed. Summer run Chinook and sockeye salmon have been extirpated from the basin; although in the past 5 years very small numbers of sockeye have been observed (YSPB, 2004).

Historically, the Yakima River flooded seasonally and meandered extensively over a wide floodplain downstream of Yakima Canyon, including the proposed project area, providing ample amounts of clean water on a frequent basis to floodplain wetlands and riparian habitat. The highly sinuous channel and remnant oxbow lakes that still exist demonstrate these historic processes.

Six major dams and water supply reservoirs exist in the basin, including Keechelus, Kachess, Cle Elum, Bumping, Rimrock (Tieton Dam), and Clear Lakes. The river and its tributaries are diverted to a significant extent for agricultural irrigation. Six major irrigation districts were formed in the early 1900s. For example, the Sunnyside and Wapato Irrigation Diversions together divert approximately half of the flow in the river during the irrigation season (May to October) (YSPB, 2004). The dramatic modification of natural hydrology has significantly reduced floodplain inundation and channel migration, thus eliminating off-channel habitats including side channels and wetlands.

Historically seasonal flooding and wetlands recharged the groundwater during the snowmelt runoff floods, and the groundwater then discharged to the river during the summer months. This allowed the Yakima River Basin to support large numbers of salmonids. The lack of winter and spring flooding and the subsequent runoff of warm irrigation wastewater have caused an increase in water temperatures in the Yakima River and adverse effects on native fish species.

Key wildlife habitats in the basin have been dramatically reduced in extent and distribution by human development, including shrub steppe, interior grasslands, and interior riparian wetlands. Shrub steppe was historically the most abundant habitat type in the basin. These habitats support a wide diversity of wildlife including more than 100 bird species that utilize sagebrush communities (YSPB, 2004).

1.6 CONSISTENCY WITH YAKIMA RIVER SUBBASIN PLAN

Riparian wetlands in the Yakima River basin have been lost on a large scale because floodplain habitats have been converted to human uses such as development, irrigated agriculture, pasture, or gravel mining. Such loss of riparian wetland habitat structure and hydrology reduces or eliminates ecological function, especially given that riparian wetlands support a higher diversity and abundance of fish and wildlife than any other interior Columbia Basin habitat.

The Yakima Subbasin Plan (YSPB, 2004) recommends the restoration ecologically functional floodplains and riparian wetlands by creating adequate hydrological conditions to reconnect habitats in tributary and mainstem floodplain areas by 2015. Strategies to achieve these objectives include:

1) immediately implementing protection and restoration activities in important areas;
2) educating landowners in best management practices and means of reducing impacts in focal habitats;
3) purchasing water rights from willing sellers in unregulated tributaries, and
4) exploring opportunities for alterations in hydrologic management.

The project directly addresses the first strategy by seeking to recreate historic floodplain and riparian wetlands that function both ecologically and hydrologically. While the strategy of "exploring opportunities for alterations in hydrologic management" usually implies adjusting the regulation of river flows to restore ecological function to the watershed, the project accomplishes the same objective by utilizing an otherwise untapped water source (treated effluent from the Port of Sunnyside) to restore wetland function. Finally, the project includes a small viewing area at its perimeter that provides an opportunity for public education about how agricultural practices can be improved to reduce negative effects on local habitat.

1.7 PRIOR STUDIES AND REPORTS

This report describes a scaled-down version of a 2009 design (Tetra Tech, 2009). The 2009 design accommodated future anticipated loading of 4 mgd. The current design matches the maximum amount of water (2 mgd) for the wetland project currently available from the Port of Sunnyside facilities. Other previous studies and reports include:

Joy, J. and B. Patterson. 1997. A Suspended Sediment and DDT Total Maximum Daily Load Evaluation Report for the Yakima River. Washington Department of Ecology Publication 97-321.

Skillings/Connolly. 2002. Constructed Treatment/Wetlands Feasibility Study. Prepared for the Port of Sunnyside.

Tetra Tech. 2009. Final Feasibility Design Report and Integrated Environmental Assessment, Sunnyside Wetlands Section 206 Ecosystem Restoration. September 2009.

US Army Corps of Engineers (USACE). 2003. Preliminary Restoration Plan, Port of Sunnyside Ecosystem Restoration.

Yakima Subbasin Fish and Wildlife Planning Board (YSPB). 2004. Final Draft Yakima Subbasin Plan. Prepared for the Northwest Power and Conservation Council.

1.8 FUTURE WITHOUT PROJECT CONDITIONS

Under the without project conditions, the project area would continue to be used for agricultural purposes, and runoff from the site would continue to contribute to the decline of habitat in the Yakima River. The project vicinity is dominated by irrigated agricultural crops such as hops, wheat, and corn, and other agricultural uses such as pastureland for dairy farms and cattle feed lots. The runoff of irrigation return water via surface and subsurface drains throughout the Yakima Valley is the major source of pollutants to the Yakima River including suspended sediments, high temperatures, pesticides, nutrients, fecal coliform, and metals (Joy and Patterson, 1997).

Without this project The Port will continue to discharge treated wastewater to the Yakima River, and will not likely use their wastewater to create and restore natural habitats. The Port currently discharges treated wastewater into the Yakima River or its tributaries, contributing to the temperature and nutrient problems in the river. While Total Maximum Daily Loading (TMDL) limits and stricter National Pollution Discharge Elimination System (NPDES) permit requirements will improve water quality in the basin over time, these regulations do not promote restoration of key habitats on agricultural lands. The Port will either divert the effluent to another area, or use the effluent to irrigate within an agricultural use the subject property. In either case, no wetland habitat will result from the use of the effluent under the Future Without Project Condition. The creation of wetlands using treated wastewater effluent from the Port as a water source represents a unique opportunity for recovery of fish and wildlife populations in the Yakima River Basin through restoration of key habitats.

This page intentionally left blank.

2.0 EXISTING CONDITIONS

2.1 GEOGRAPHY

The Yakima River is located in south Central Washington and flows southeasterly for 215 miles from its headwaters in the Cascade Mountains to its confluence with the Columbia River near Richland, Washington (Figure 1). Elevations range from 8184 feet in the Cascades to 340 feet at the confluence with the Columbia River. The basin is surrounded by the Cascade Mountains to the west, the Wenatchee Mountains to the north, the Rattlesnake Hills to the east, and Horse Heaven Hills to the south. Approximately half of the basin is within Yakima County. The upper portion of the basin is in Kittitas County, the southeastern portion in Benton County, and the southern portion extends into Klickitat County.

2.2 GEOLOGY

The Yakima River watershed has two distinct geologic regions: the Cascade Mountains and the Columbia River Plateau. The project area is located in the lowlands of the Columbia River Plateau. The Columbia Plateau was formed by a series of Miocene basalt flows. The Columbia River Basalt formation ranges from 9,000 to 12,000 feet in thickness in the lower Yakima valley, with individual flows of 25 to 100 feet thick. Pleistocene glacial outwash, glaciolacustrine, and alluvial deposits cover the basalt, or are layered between basalt flows, in many areas, particularly the Yakima Valley (YSPB, 2004; Franklin & Dyrness, 1988). The Pleistocene deposits consist of sands, silts, and gravels.

2.3 SOILS

According to soil mapping from the Natural Resources Conservation Service (NRCS; formerly Soil Conservation Service), the soils on the site are primarily composed of Esquatzel silt loam, with fingers of Umapine silt loam in the area east of South Emerald Road (USDA SCS, 1985). The western portion of the site, within the 100-year floodplain, includes bands of Zillah silt loam and Esquatzel silt loam, and a smaller area in the northwest corner includes Cleman very fine sandy loam. These soils are typically characterized as being deep, well-drained, floodplain alluvium, with designations as hydrologic soil group Type B, with moderate infiltration and transmission when wet. The Esquatzel soils are also characterized as highly erosive and have piping issues when used in construction and should be thoroughly protected when used as materials in construction (NRCS, 1994).

Esquatzel silt loam is a very deep, well-drained soil formed by silty alluvium. The permeability is moderate and water capacity is high. The Umapine silt loam is a very deep artificially drained salt- and alkali- affected soil found in floodplains and low terraces formed in alluvium. The soil permeability is moderate. The Zillah silt loam is a very deep artificially drained soil on floodplains formed in recent alluvium. Underlying material is gray silt loam and gray loamy sand, but sometimes quite gravelly. Permeability is moderate and water capacity is high. The Cleman very fine sandy loam is a very deep well drained soil found on floodplains and alluvial fans formed in alluvium. The surface to 10 inches is a very fine sandy loam; 10 to 60 inches is stratified fine sandy loam, sandy loam, very fine sandy loam, and silt loam. Some areas can be very gravelly below 30 inches. Permeability is moderate and available water capacity is high.

To assess percolation rates of surface soils throughout the study area, six double-ring infiltrometer tests were performed in the locations shown in Figure 4 (labeled DR-1 through DR-6). Double-ring procedures followed ASTM Standard D3385 (ASTM, 2006). Steady state infiltration rates for each test location are summarized in Table 1. The surface infiltration rates varied significantly between sample sites. Surface infiltration is not necessarily predictive of sub-surface conditions, but the design and implementation teams will need to pay close attention to the soil infiltration specification at and just below finished grade to ensure success of the wetland project.

It is also noted that historical land use activities have created some soil contamination issues. Appendix A describes the contaminants and potential risks for exposure further.

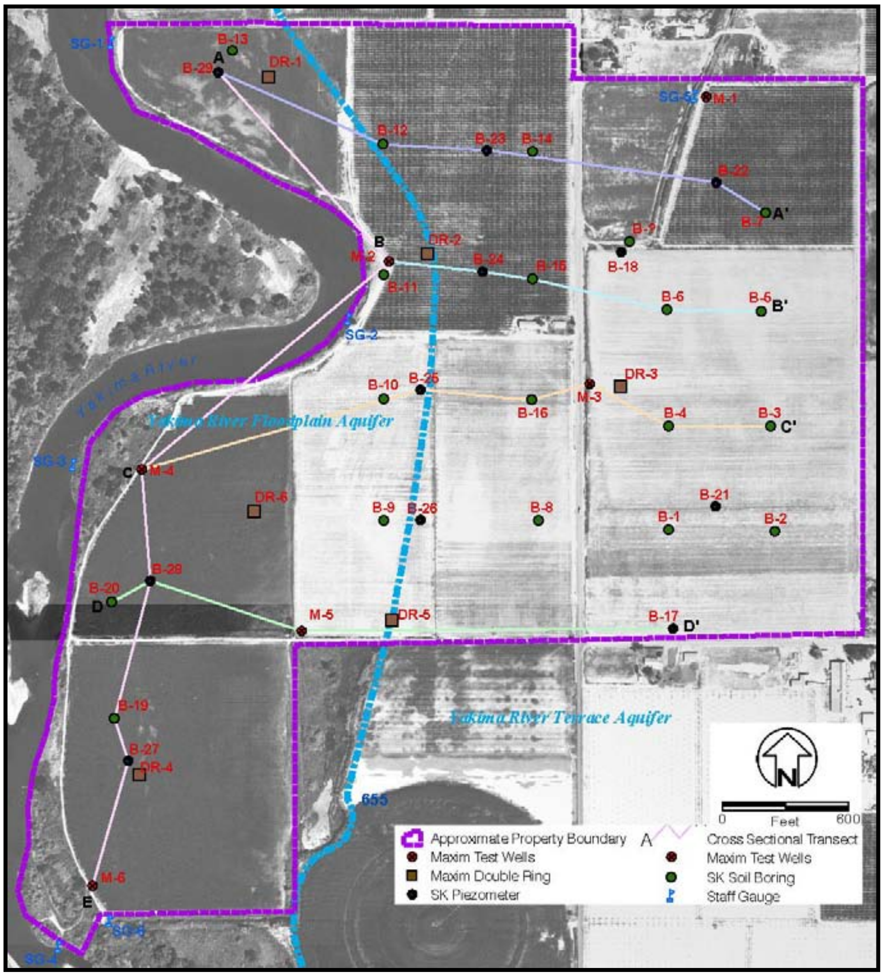

Figure 4. Soil Sampling Locations.

Table 1. Summary of Soil Infiltration Characteristics.

Location	DR-1	DR-2	DR-3	DR-4	DR-5	DR-6
Avg. Steady State Infiltration Rate (cm/hr)	4.06	9.88	0.65	0.70	7.73	2.10

2.4 CLIMATE

Climate records are available from 1948 through present from the Western Regional Climate Center (WRCC, 2006) for the Sunnyside gauging station (WRCC Gage #458207). The gage is located approximately six miles northeast of the project site at an elevation of 750 feet above sea level (approximately 75-100 feet higher in elevation than the project site). Recorded parameters include temperature, precipitation, and snow depth.

2.4.1 TEMPERATURE

The average daily maximum temperature is 65° F and the average minimum is 40° F. As shown in Figure 5, average temperatures range from a monthly minimum of 24° F in January to an average monthly maximum of 90° F in July. Extreme temperatures range from -20° F to 110° F.

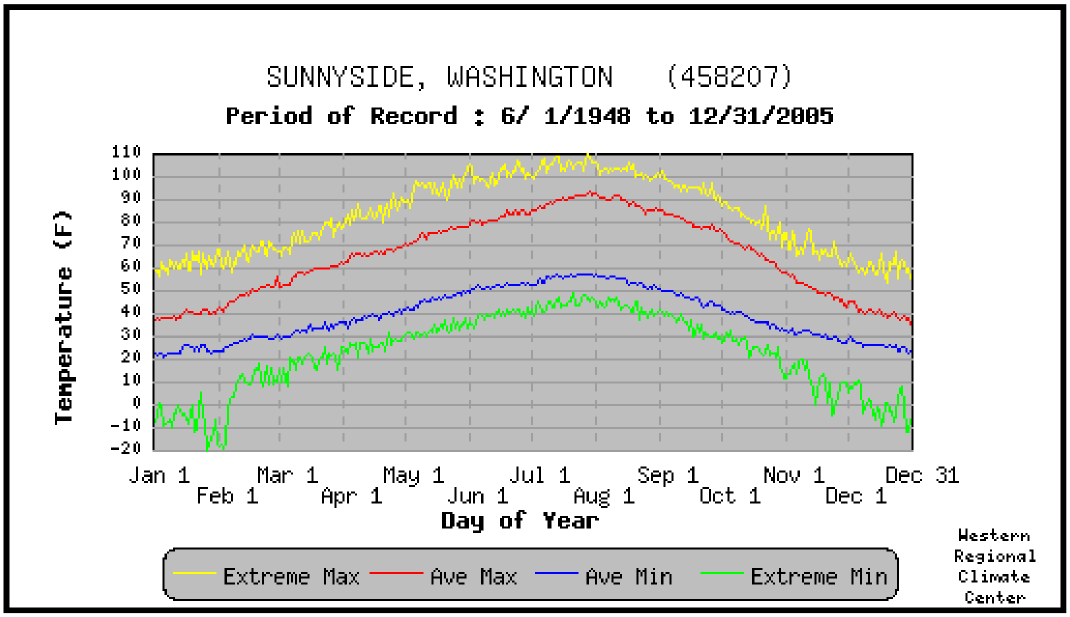

Figure 5. Air Temperatures in Sunnyside, Washington (WRCC, 2006).

2.4.2 PRECIPITATION

The Yakima Valley is arid, with an average of only 7 inches of precipitation recorded annually in Sunnyside. July, August, and September are markedly drier than the remaining months of the year. The daily chance of measurable precipitation ranges from 5% in July to 25% in December. Average total monthly precipitation depths range from 0.2 inches in July to 1 inch in December. The largest single precipitation events tend to occur during summer months. Eight storms exceeding one inch in 24 hours have been measured in Sunnyside since 1948; the highest measured daily rainfall depth was 1.6 inches. Figure 6 shows the average monthly precipitation recorded at the Sunnyside gauging station.

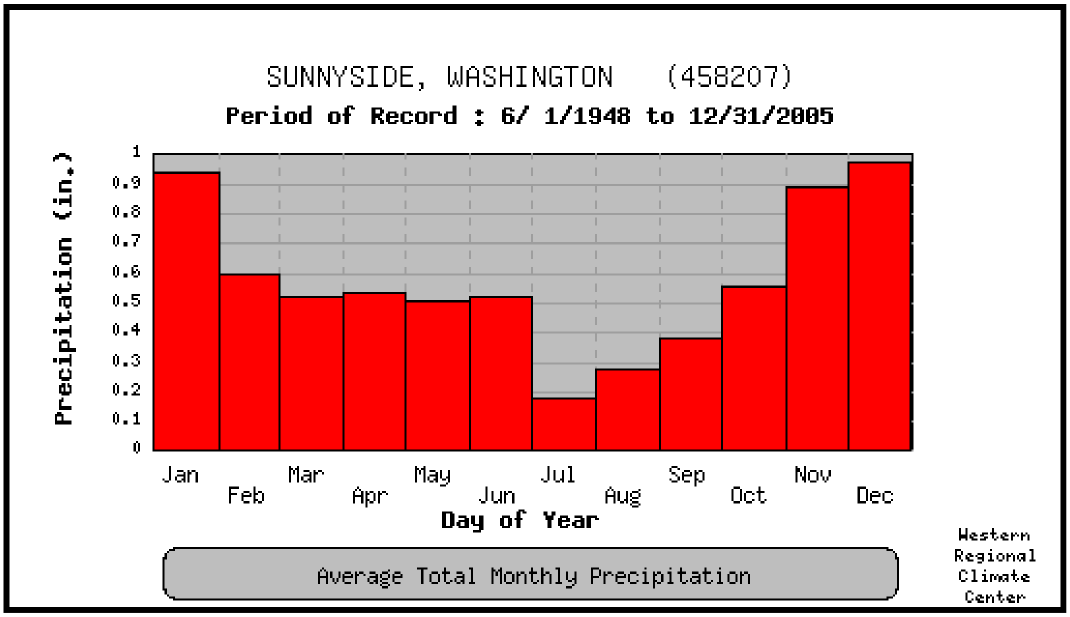

Figure 6. Precipitation in Sunnyside, Washington (WRCC, 2006).

2.4.3 SNOW DEPTH

Yakima River flows are derived primarily from snowmelt and rainfall in the Cascade Mountains. The maximum recorded snow depth at the Sunnyside gauging station was 12 inches. Average total annual snowfall is approximately 10 inches, generally occurring from November through February. The maximum single-day snowfall depth was 8 inches. Figure 7 shows the extreme and average daily snowfall for Sunnyside.

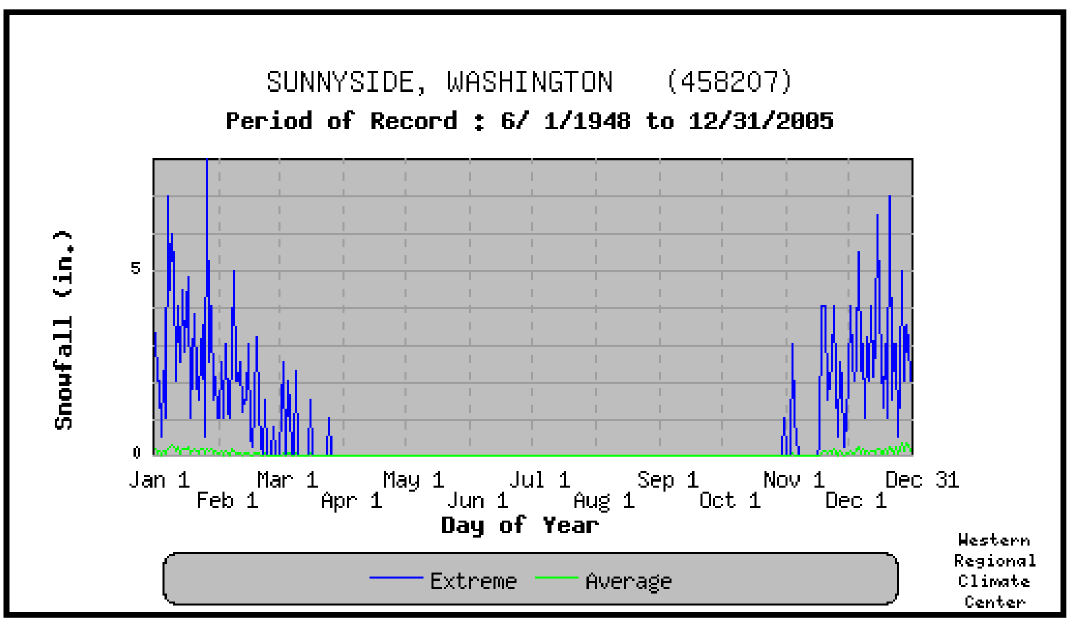

Figure 7. Snowfall in Sunnyside, Washington (WRCC, 2006).

Additional charts showing the seasonal variation in average and extreme temperatures, precipitation, and snowfall for the period of record are included in Appendix E. All climatological data in this report are summarized from measurements compiled by the Western Regional Climate Center (WRCC, 2006) and Washington State University (2010).

2.4.4 EVAPORATION & EVAPOTRANSPIRATION

Washington State University maintains an agricultural meteorological station at the Port of Sunnyside approximately 3.5 miles east of the project site.[1] Figure 8 is a box and whisker plot illustrating the maximum and minimum (whiskers), 25th and 75th percentile and mean (boxes) of data. Evapotranspiration varies from 0.6 inches in January to 8.5 inches in July. These data represent reference crop evapotranspiration of a "well-watered (i.e., soil water is not limiting ET), actively growing, erect standing alfalfa crop with at least 8-12 inches of top growth and occupying an extensive area" (Ley, 2010). The design analysis assumed this reference ET would be a reasonable surrogate for a functioning riparian and wetland system at the feasibility level. Actual evapotranspiration will depend on wetland layout, type of vegetation, and overall amount of vegetative cover (which will also vary seasonally and over the life of the project). Section 6.1.4 describes how these evapotranspiration data were used to size habitat ponds in more detail.

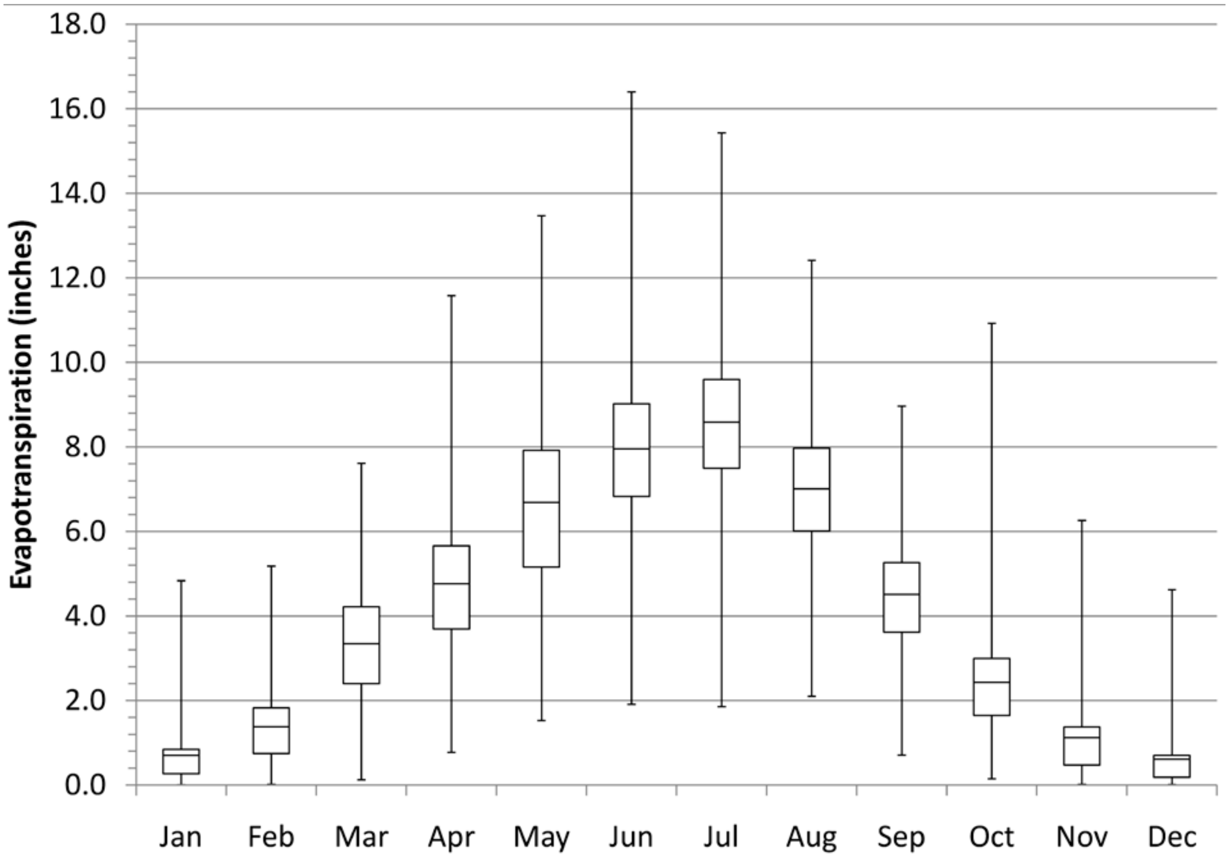

Figure 8. Port of Sunnyside Monthly Evapotranspiration, 1993-2010 (Max-Min-P75-P25-Mean).

[1] Data provided courtesy of Washington State University AgWeatherNet. Data are copyright of Washington State University; to access raw data for the AgWeatherNet network, go to the AgWeatherNet web site URL as follows: www.weather.wsu.edu.

Table 2. Port of Sunnyside Monthly Evapotranspiration Statistics, 1993-2010.

MONTH	Mean	Std Dev	Skew	Max	Min	Count	P95	P75	P25	P05
Jan	0.706	0.744	78.995	4.835	0.006	526	2.237	0.841	0.267	0.119
Feb	1.378	0.880	29.692	5.180	0.018	480	3.115	1.827	0.745	0.286
Mar	3.344	1.390	14.683	7.611	0.127	527	5.918	4.216	2.399	1.311
Apr	4.765	1.613	18.289	11.580	0.772	521	7.564	5.657	3.694	2.391
May	6.691	2.065	9.426	13.473	1.529	558	10.362	7.916	5.154	3.604
Jun	7.955	1.962	10.778	16.399	1.911	540	11.334	9.017	6.829	4.911
Jul	8.585	1.652	16.580	15.431	1.854	558	11.431	9.596	7.494	6.301
Aug	7.008	1.554	11.617	12.417	2.100	558	9.535	7.972	6.009	4.932
Sep	4.510	1.316	11.913	8.965	0.711	539	6.835	5.263	3.619	2.594
Oct	2.426	1.174	48.167	10.925	0.149	558	4.456	2.995	1.644	1.002
Nov	1.123	0.984	63.904	6.260	0.017	539	2.903	1.371	0.471	0.178
Dec	0.613	0.705	73.137	4.621	0.011	552	2.089	0.705	0.187	0.073
ANNUAL	49.372	37.305	172.939	199.108	0.070	6456	113.629	80.053	14.846	2.675

All data reported in inches per month (in/month).

Source: Washington State University. (2010). AgWeatherNet Daily Data Report: Port of Sunnyside 1993-2010. Retrieved December 29, 2010, from The Washington Agricultural Weather Network: www.weather.wsu.edu. Data provided courtesy of Washington State University AgWeatherNet. Data are copyright of Washington State University; to access raw data for the AgWeatherNet network, go to the AgWeatherNet web site URL as follows: www.weather.wsu.edu.

2.5 HYDROLOGY AND HYDRAULICS

The existing conditions analysis of the site's hydrologic and hydraulic characteristics evaluates the following areas of interest: Yakima River hydrology, local site drainage and runoff hydrology, and hydrogeologic characteristics and soil infiltration of the site.

2.5.1 YAKIMA RIVER MAIN STEM HYDROLOGY AND HYDRAULICS

The Yakima River drains approximately 6,155 square miles on the east slope of the Cascade Mountains in south-central Washington. The main stem of the Yakima is 215 miles long and wanders generally southeast toward its confluence with the Columbia River near Richland. The project site is located near River Mile 73; the Yakima River drains approximately 4,800 square miles upstream of the project site, or approximately 80% of its total drainage area. The Yakima River originates in the Cascade Mountains near Snoqualmie and Stampede Passes. It has several major tributaries from the Cascades, including the Cle Elum, Teanaway, Naches, and Tieton Rivers and smaller tributaries such as Ahtanum and Toppenish Creeks. There are six dams on the Yakima River owned and operated by the Bureau of Reclamation:

- Bumping Lake Dam
- Kachess Dam
- Keechelus Dam
- Clear Creek Dam
- Tieton Dam
- Cle Elum Dam

The authorized use and intended benefits of these dams are for irrigation, recreation and wildlife, hydroelectric power and flood control. There are a number of smaller drainages as well as irrigation infrastructure including small diversion dams, canal systems, laterals, drains, returns, wasteways and outfalls that enter the Yakima upstream of the project site. Several irrigation districts remove significant quantities of flow from the Yakima River from May through October. The effects of the irrigation system are to reduce snowmelt runoff flows during the spring and early summer and modify low flows through releases from the dams during periods of high irrigation demand. Peak flows during winter are also reduced to some extent due to flood control operations.

Peak flood flows typically occur from December through June and can occur from winter and spring snowmelt or heavy rainstorms in the mountains. Historical peak snowmelt runoff typically occurs during April through June and varies from approximately 7,000 cfs to 12,000 cfs. Low flows typically occur in September and October, with a minimum discharge of approximately 800 cfs (BOR, 2002). A flow frequency analysis was performed on the available historical records (see Appendix E); predicted peak flow events range from a 2-year flow of approximately 13,100 cfs to a 100-year flow of approximately 54,600 cfs (Table 3). The computed peak flow values were estimated using data from the Kiona gage, having a 90-year flow record, with a downstream flow adjustment for additional watershed areas. These discharges were compared with the Federal Emergency Management Act (FEMA) estimates and were generally within 15% of the published FEMA discharge. The computed flows were used in place of the adopted FEMA discharges due to the additional gaging record available for the at the Kiona gage. While the frequency analysis presented is adequate for this restoration project, flood plain management issues related to mainstem Yakima River hydrology should be referred to FEMA and/or Yakima County.

Table 3. Design Flood Frequency at the Project Site.

Annual Recurrence Interval (yrs)	Annual Exceedance Probability (%)	Peak Discharge (cfs)
500	0.2	74,700
100	1.0	54,600
50	2	46,500
20	5	36,600
10	10	29,400
5	20	22,400
2	50	13,100

A flow duration analysis was performed on available historical records. Results of the flow duration analysis are summarized in Table 4.

Table 4. Design Daily Flow Duration Values at the Project Site.

Flow Exceedance	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%
Discharge (cfs)	600	720	910	1090	1370	1700	2110	2850	4000	6310	8900

The typical daily flows at the site (50% exceedance) for various months range from a low of 960 cfs in August to a high of 3470 in March. Further details on the Yakima River flows and the flow duration analysis are presented in Appendix E.

The project site is located adjacent to the Yakima River; approximately one third of the project site area lies within the Yakima River 100-year FEMA floodplain (see Appendix E for the floodplain delineation). A hydraulic analysis of the main stem Yakima River was conducted to determine floodplain inundation and hydraulic characteristics for extreme events, to determine stage duration curves for riparian planting plans, and to provide boundary conditions for the groundwater model. HEC-RAS, a one-dimensional hydraulic modeling application developed by USACE, was used to determine the resulting hydraulic parameters including floodplain depths and velocities, flood inundation areas, and main channel water surface elevations. The water surface elevations were also used to evaluate potential groundwater and hydraulic gradient conditions. A typical cross section showing the existing project site grade relative to the opposite bank and Yakima River water surface elevations is shown in Figure 9. Results are summarized in Table 5.

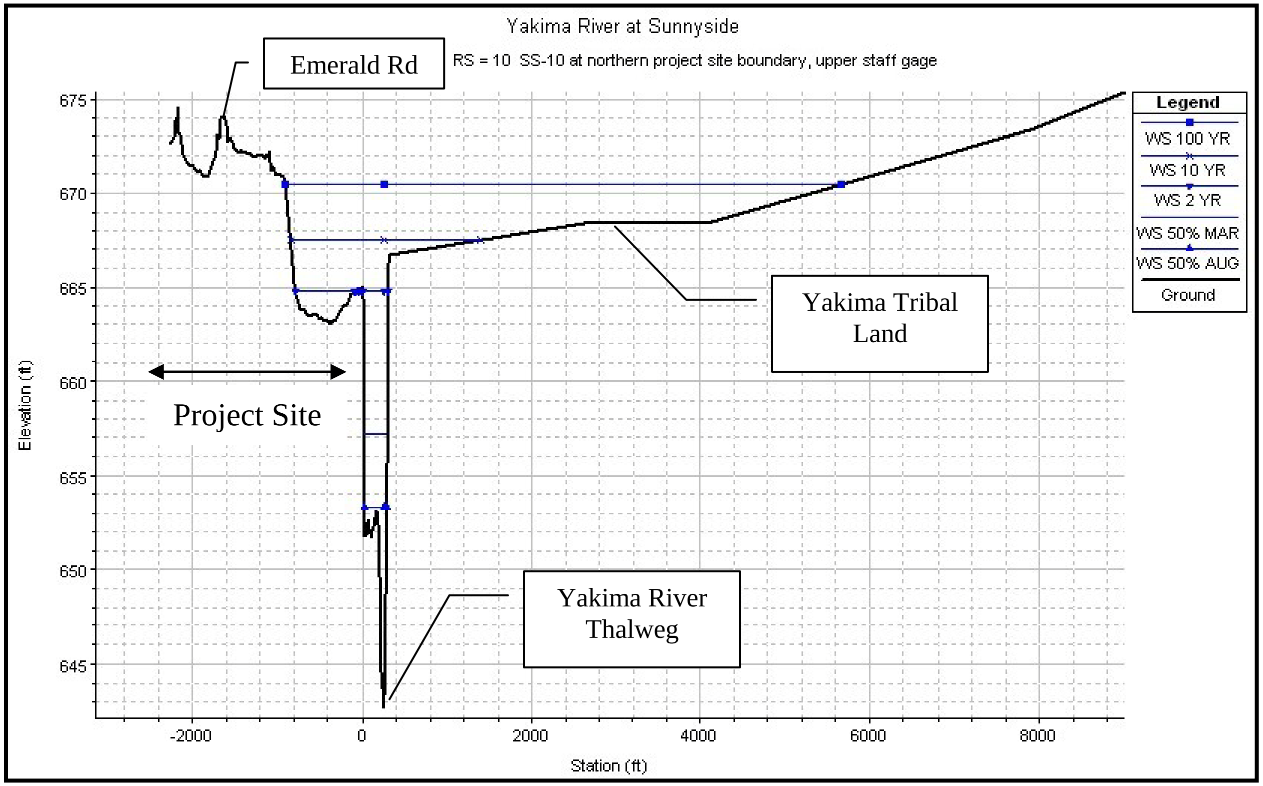

Figure 9. Typical HEC-RAS Cross-Section in the Project Vicinity (Looking Downstream).

Table 5. Summary of HEC-RAS Results for Yakima River at the Project Site.

Location	10-year Event				50-year Event				100-year Event			
	WSE (ft)	LOB Velocity (fps)	LOB Depth (ft)	LOB Width (ft)	WSE (ft)	LOB Velocit y (fps)	LOB Depth (ft)	LOB Width (ft)	WSE (ft)	LOB Velocit y (fps)	LOB Dept h (ft)	LOB Width (ft)
SS-8 (north site boundary)	667.13	1.26	5.90	19	669.32	1.41	6.99	177	670.16	1.47	7.41	299
SS-6 (between bend and Murray Road)	666.89	1.09	4.41	1604	669.13	1.26	6.15	1759	669.97	1.32	6.70	1843
SS-5 (Murray Road)	666.80	0.83	6.40	1371	669.04	0.92	7.48	1596	669.88	0.91	7.23	1852
SS-3 (southern site boundary)	666.61	1.37	5.64	1256	668.87	1.43	6.94	1440	669.71	1.37	6.57	1724

Notes:
WSE = Water Surface Elevation in feet NAVD88
LOB Velocity = Average velocity in the left overbank area (project site floodplain area) in feet per second
LOB Depth = Depth in feet at the left bank station
LOB Width = Total floodplain width in the left overbank area (project site floodplain area) in feet

2.5.2 LOCAL PROJECT SITE HYDROLOGY AND HYDRAULICS

The project site occupies farmed upland areas and low-lying areas adjacent to the Yakima River. Ninety percent of the existing land within the project site boundary is cultivated for farming. The low-lying areas include remnant channels, oxbows and swales within the 100-year Yakima River floodplain.

Local drainage is mostly isolated within the boundaries of the project site. Off-site drainage that historically flowed onto the project site currently follows ditches along surrounding roads (Emerald, Murray and the north farm road) towards the Yakima River. A drainage map is included in Appendix E.

Runoff estimates for local stormwater runoff were developed using the SCS Unit Hydrograph method, and a Type 1a Regional Storm hyetograph, as defined by the Washington Stormwater Management Manual for Eastern Washington (WDOE, 2004). The modified Type 1a Regional Storm has recently been updated to more closely represent observed data for eastern Washington. A summary of peak flow runoff estimates is included in Table 6. The peak flow runoff will flow through the pond systems and will experience significant attenuation. Final design of overflow outfall details will be sized based on the expected overflows from stormwater runoff, and flooding from the Yakima River.

Table 6. Existing Condition SCS Runoff Estimate.

Return Period, Duration	(NOAA, 1973)	SCS Runoff
	Depth (in)	Peak (cfs)
2 Yr, 24 Hour	0.80	2.8
10 Yr, 24 Hour	1.30	15.9
25 Yr, 24 Hour	1.60	28.5
50 Yr, 24 Hour	1.80	37.8
100 Yr, 24 Hour	2.00	47.8

2.5.3 SUNNYSIDE EFFLUENT INFLOWS

The Port of Sunnyside currently receives between 0.7 mgd and 1.4 mgd of influent to the treatment plant as calculated on a monthly average (Table 7). The proposed addition of treated wastewater effluent for the Port includes peak flows up to 2.0 mgd. The observed average daily flow rate from the Sequencing Batch Reactor (SBR) is 0.52 mgd. A minimum flow of nearly zero mgd was recorded on 24 January 2006. Otherwise, the flow rates from the plant have been fairly steady over the past 2-year period.

Table 7. Monthly Average SBR Influent and Effluent Flow Rates, 2002-2008.

Month	2002-2004 Influent	2006-2008 SBR Effluent	Temperature
	(mgd)	(mgd)	(°C)
Jan	0.71	0.51	15.6
Feb	0.71	0.51	15.6
Mar	0.72	0.52	17.9
Apr	0.79	0.52	21.4
May	0.75	0.52	24.6
June	0.81	0.49	26.9
July	0.89	0.51	29.8
Aug	0.74	0.52	28.8
Sept	1.16	0.50	25.9
Oct	1.43	0.52	21.8
Nov	0.97	0.52	18.1
Dec	0.83	0.53	16.7
Maximum	1.43	0.56	33.2
Minimum (1)	0.71	0.00	9.4
Average	**0.88**	**0.52**	**21.9**

Note: (1) Minimum effluent flow rate of 0 mgd for 1 day on Jan. 24th, 2006.

2.5.4 HYDROGEOLOGY

A field geotechnical investigation and groundwater assessment was performed in conjunction with hydrogeologic analysis to obtain information on existing subsurface soil and groundwater conditions at site. Field work included installation and aquifer testing of six groundwater monitoring wells, performing six surface water infiltration tests (double-ring infiltrometer), installing six surface water staff gauges, and analyzing select soil samples for geotechnical soil parameters.

The underlying stratigraphy of the Yakima River in the Toppenish Basin includes five hydrogeologic units (Figure 10, USGS, 2006). The upper two units (Unit 1 and Unit 2) have the most significant influence on the project site. The upper unit is described by the USGS report as follows: "Unit 1 consists of fine-grained unconsolidated surficial deposits that include Touchet, terrace, loess, and some alluvial deposits (pl. 5). The thickness of Unit 1 ranges from 0 to 80 ft, with a mean and median thickness of 10 ft." The underlying quaternary alluvial deposits of Unit 2 consist predominantly of coarse-grained unconsolidated deposits. This Quaternary Alluvium (Qal) can be characterized as well- to poorly sorted, well-rounded to subangular gravel and sand. The thickness of Unit 2 ranges from 0 to 270 ft, with a mean and median thickness of 90 and 80 ft, respectively.

The hydrostratigraphic characterization indicates two aquifers based primarily upon grain size and topographic surface expression. The principal water bearing zones that would be affected by the construction and operation of wetlands and the associated gravel infiltration trenches (see description in Section 6.0) are the Yakima River floodplain and terrace aquifers respectively. The underlying floodplain aquifer (likely associated with Unit 2 deposits) is comprised of well to poorly sorted gravels and is located within the 100-year floodplain of the Yakima River. The terrace aquifer consists of well to poorly sorted sand and is located outside of the 100-year floodplain, typically 15-20 feet in elevation above the current river elevation.

Groundwater in the area generally flows from the northeast portion to the southwest portion of the site under a hydraulic gradient that varies from 0.0026 ft/ft within the terrace aquifer to 0.00046 ft/ft within the floodplain aquifer. Groundwater gradients are significantly higher on portions of the site underlain by the Yakima River terrace aquifer relative to the Yakima River floodplain aquifer.

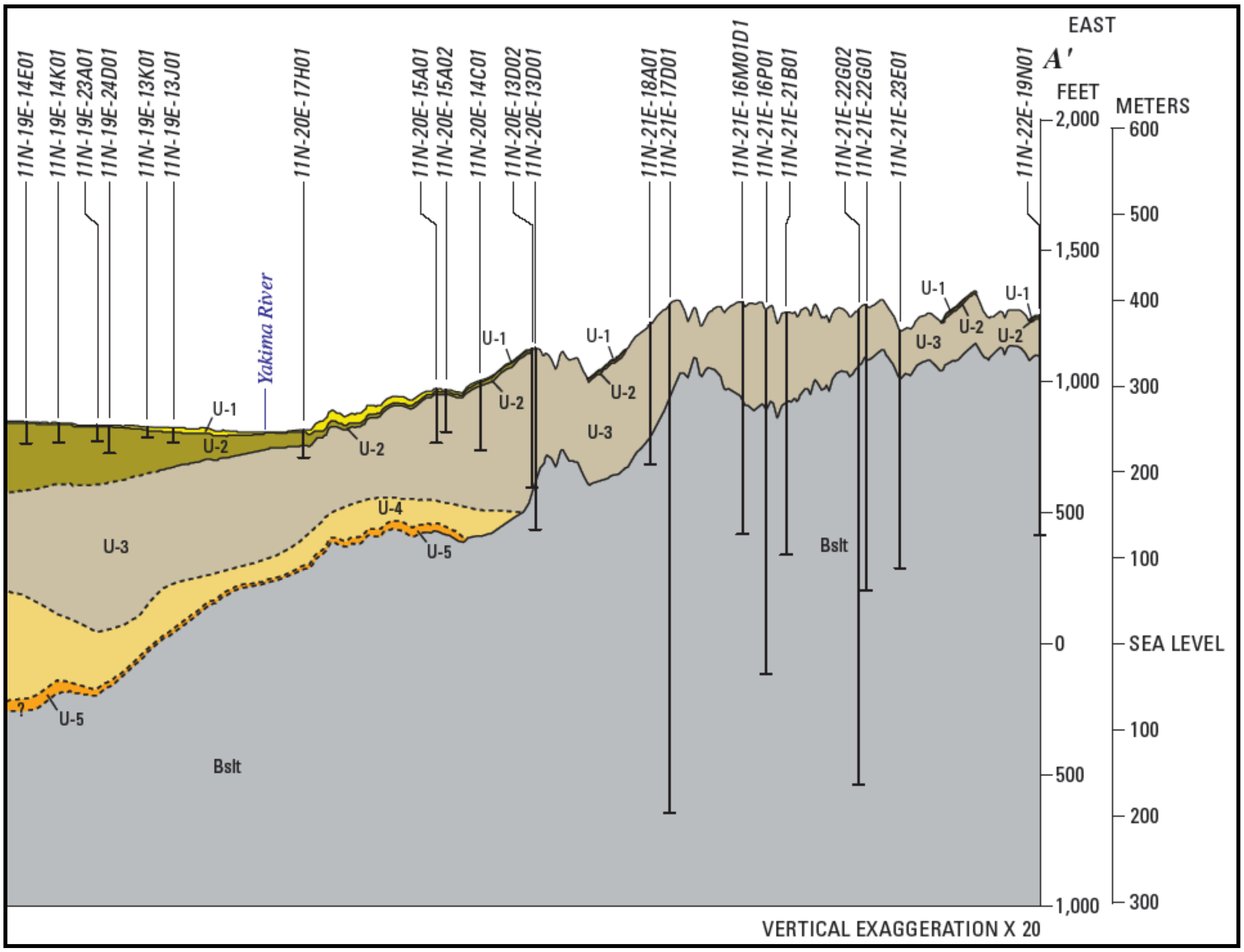

Figure 10. Subsurface Stratigraphy in the Project Vicinity (USGS, 2006).

Based on surface water gage information and water levels measured in site wells during the December 2003 monitoring event, surface water and groundwater appear to be in direct communication, with surface water elevations at or slightly above groundwater elevations. The Yakima River may be a losing reach during similar times of year and flow conditions, but in general is a gaining reach. This hypothesis is supported by the simple fact that groundwater discharge from the adjacent Yakima River floodplain and terrace aquifers must discharge to river at some point, as the groundwater elevations measured in upgradient site wells indicates flow towards the river.

The water table on the site ranged from 4 to 18 feet below the surface during geotechnical borings in December 2003 (see Appendix D), with the water table closest to the surface in the lower areas near the river. Monthly groundwater level monitoring of piezometers occurred from December 2004 through October 2006. Water levels ranged from 2 to 19 feet below the ground surface during monthly testing. The groundwater elevations are shown graphically in Figure 11. Groundwater profiles are shown along selected cross sections through the project site in Appendix D.

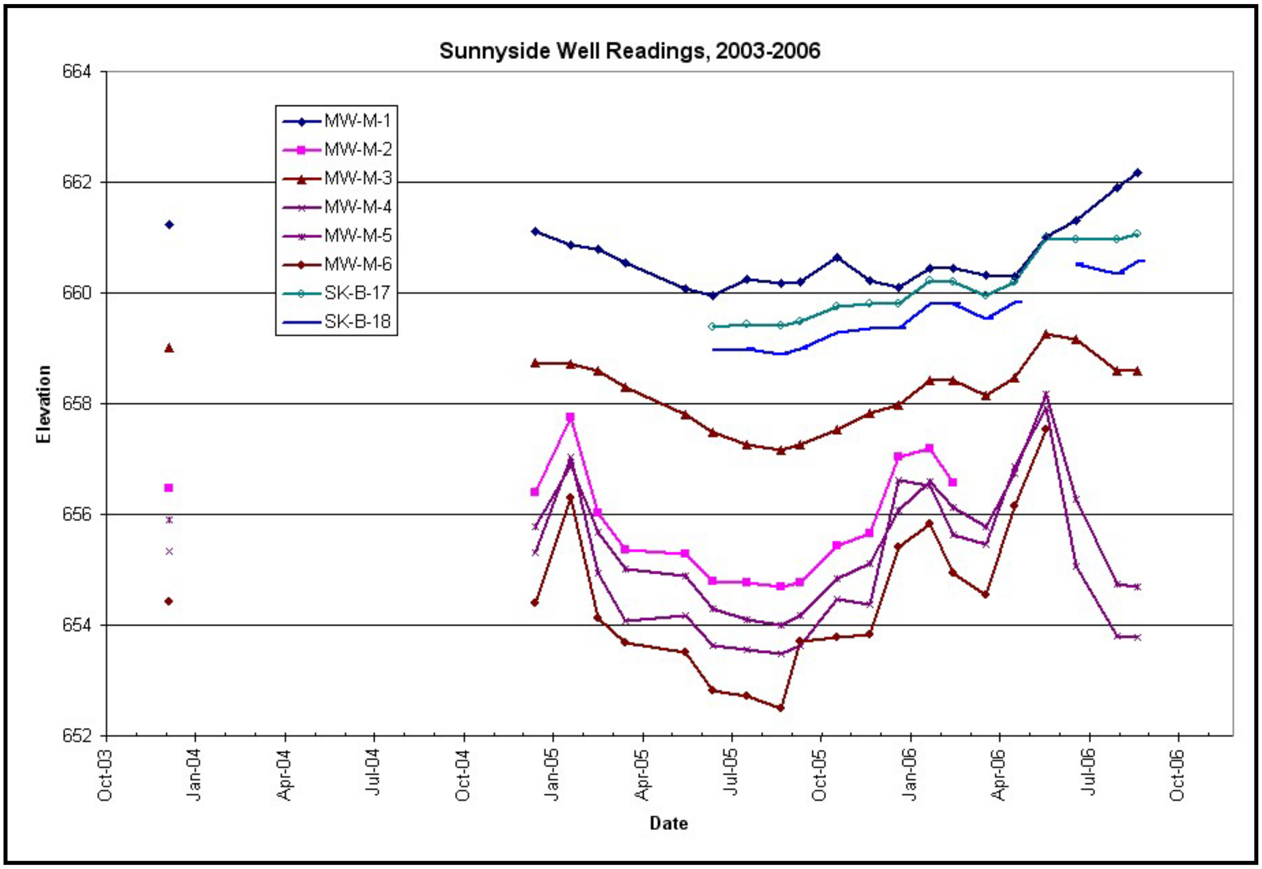

Figure 11. Sunnyside Well Readings, 2003-2006.

An average daily groundwater discharge estimate for the site was calculated for the December 2003 monitoring event. This event was chosen because it is the most complete data set with respect to groundwater elevation and river stage. The groundwater discharge estimate is based on Darcy's Law for groundwater flow (Q=KiA); where groundwater discharge (Q) equals hydraulic conductivity (K) multiplied by the surface area (A) of a cross section of the aquifer multiplied by the hydraulic gradient (i) across that cross section (Darcy 1856). Discharge estimates were developed for the various hydrostratigraphic units drawn along a longitudinal profile parallel to the river. The discharge was estimated at approximately 0.54 mgd. The proposed treated wastewater supply rate of 2 mgd is 4 times the current groundwater discharge.

2.6 GEOMORPHOLOGY

The Yakima River and its major tributaries arise in the Cascade Mountains. Keechelus, Kachess, and Cle Elum Lakes were all natural lakes which have been raised by Bureau of Reclamation dams. The Upper River generally flows through a narrow valley and falls rapidly to Cle Elum and then enters the wider Kittitas Valley through Ellensburg. The river then flows through Yakima Canyon for approximately 26 miles to Selah. From the Naches River confluence to Prosser the river flows through a broad alluvial valley (Yakima Valley). Historically, this area was highly dynamic and meandering, with multiple channels, and active floodplain features such as oxbow cutoff, meander scrolls, wetlands and riparian zones, some of which remain today especially on the western side of the river.

At the project site, the river is currently highly sinuous and many remnant oxbows remain on the floodplain (including Bos, Giffer, Horseshoe, and Round Lakes and many unnamed on the Yakama Indian Reservation). Currently, the floodplain area at the project site has been converted to agricultural uses, and minimal floodplain connectivity and channel migration exists (See Appendix E).

2.7 WATER QUALITY

An objective of the project is to use the treated wastewater effluent as a water resource, improve and restore riparian floodplain wetland habitat along the Yakima River. Since the original inception of this project, the Washington Department of Ecology (Ecology) has restructured regulations governing water quality under the Washington Authorized Code (WAC, 2003). Ecology adopted a use-based approach by which it assigns to water bodies more narrowly defined designated uses, such as “salmon and trout spawning, core rearing, and migration” and “extraordinary primary contact recreation.” For each designated use, Ecology assigns specific criteria, such as temperature, dissolved oxygen concentrations, bacteria or total phosphorus. Ecology assigns these designated uses and their criteria to specific water bodies. This new classification structure aims to more closely align the protective criteria to the uses and, in turn, to more accurately assign the uses and their associated criteria to specific water bodies.

The original classification of the Yakima River (receiving water body) was listed as a Class A waterbody by the Washington Department of Ecology (WAC, 1997). The most recent classification is as follows for the Yakima River:

- Aquatic Life Uses – Non-core salmon/trout
- Recreational Uses – Primary Contact
- Water Supply Uses – Domestic, Industrial, Agricultural, Stock Water
- Miscellaneous Uses – Wildlife, Harvesting, Commerce/Navigation, Boating, Aesthetics

The Yakima River is listed on the approved 2002/2004 303(d) list of impaired waterbodies for the following parameters: DDD, DDE, DDT, dieldrin, dissolved oxygen, endosulfan, fecal coliform, pH, and temperature. Several of the irrigation drains and tributaries that enter the Yakima River in the project vicinity are also listed on the 303(d) list for many of the same parameters (particularly turbidity, temperature, pesticides) including the Granger Drain, Marion Drain, Sulfur Creek Wasteway, Satus Creek, and Toppenish Creek. A suspended sediment and DDT Total Maximum Daily Load (TMDL) has been developed for the Lower Yakima River (WDOE, 1997) and a fecal coliform TMDL has been developed for the Granger Drain (WDOE, 2001). Irrigation return flows and runoff from agricultural fields and feed lots are the major source of pollutants to the Yakima River. The pesticides and bacteria bind to sediments and are transported into the river via erosion of soils. Land management actions to reduce erosion and runoff from agricultural fields are occurring and progress towards meeting the TMDLs has begun.

Immediately adjacent to the project site, the Yakima River suffers from high temperatures, low dissolved oxygen and low instream flows as a result of irrigation diversions of significant flows, return of warm irrigation water, and lack of shading and cool groundwater inputs.

The primary parameter of concern related to the project for the Yakima River is temperature. The Yakima has a special Class A exemption for temperature of 21°C, versus a typical Class A temperature of 18°C. The Port is responsible for meeting all required State water quality standards, including temperature, before the effluent enters the site.

2.8 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE (HTRW)

A Preliminary Assessment (PA) of the project footprint was conducted in 2009 to determine potential current and historical influence of contamination from activities in the area (Appendix A). The PA drew information from a Phase I Environmental Site Assessment (Phase I) conducted in 2001, a Phase II Environmental Site Assessment (Phase II) conducted in 2002, discussions with the Port's senior engineer, and a site reconnaissance. Based on the PA, it appears all necessary and prudent actions have been taken to address potential historical (and future) contamination at the sites identified in the PA.

The Phase I found the majority of the site to be free of environmental contamination with the exception of 10 specific sites of potential contamination. Based on these results, a limited Phase II was conducted on two sites. The first site was historically used to treat wood hops trellis poles. Groundwater and soil samples identified contamination by pentachlorophenol and a full clean-up of the site was conducted. At the second site, an underground storage tank (UST) that had historically stored petroleum products used as fuel for agricultural machines was removed. Future design plans will include delineation of a construction and excavation work limit buffer around the historic UST site. As for the other eight sites identified in the Phase I, the Port has removed an agricultural storage building, six illegal refuse dump sites, and a septic tank.

2.9 AIR QUALITY AND NOISE

In general, air quality in Yakima County is considered to be good during most of the year. A pollutant of concern during certain times of the year is particulate matter (PM) generated by wood-fueled home heating and traditional agricultural practices (Yakima Regional Clean Air Agency, 2011).

The project site is located adjacent to agricultural lands, a WDFW wildlife area, and the Yakima River. Elevated noise is produced by agricultural equipment during certain times of the year.

2.10 VEGETATION

In the arid and semi-arid habitats east of the Cascade Mountains of Washington, much of the historical vegetation has been converted to agricultural crops or utilized for livestock grazing. As a result the only remaining native communities are on steep slopes or rocky soils unfit for agriculture or where topography or remoteness from water has made livestock grazing impractical (Vander Haegen et al., 2001). In addition, land disturbance has facilitated the invasion of exotic vegetation. Most of the project site area has been used for agriculture for many years.

Tetra Tech staff conducted a vegetation survey in December 2004. The riparian zone is quite narrow, ranging from zero to about 75 feet in width. Trees were sparse in most locations and limited to cottonwood (*Populus balsamifera*) and maple (*Acer glabrum* var. *douglasii*). Shrub cover varied depending on bank height. Lower wetted banks were dominated by rose (*Rosa woodsii*), red-osier dogwood (*Cornus stolonifera*), and willows (*Salix exigua* or *S. lucida*). On the high vertical dry bank area, sagebrush (*Artemisia tridentata*) is the dominant shrub. Dominant herb species include reed canary grass (*Phalaris arundinaceae*) throughout the riparian zone, tall fescue (*Festuca arundinaceae*), poison water hemlock (*Conium maculatum*), nettles (*Urtica dioica*), horseweed (*Conyza canadensis*), lambs quarters (*Chenopodium berlandieri*) and several other weedy annuals. Purple loosestrife (*Lythrum salicarium*) is also present. The formerly fallow farm fields are periodically plowed to reduce invasive weeds and make the site less attractive for illegal trash dumping.

The natural riparian and floodplain communities that would have occurred in the area include cottonwood riparian forest, shrub wetlands and riparian zones (willow, spirea, etc.), emergent wetlands, and open water oxbows and other remnant channels.

2.11 INVASIVE SPECIES

Invasive plants on the project site are currently controlled by tilling. Washington state class C noxious weeds observed near the project site include reed canarygrass (*Phalaris arundinaceae*), yellow flag iris (*Iris pseudacorus*) and Canada thistle (C*irsium arvense*). Class C noxious weeds may be designated for control by the county weed board. Purple loosestrife (*Lythrum salicaria*), a Washington state class B noxious weed, has also been observed near the site. Purple loosestrife is designated by the Washington State Noxious Weed Control Board for control in Yakima County.

2.12 WETLANDS

National Wetland Inventory (NWI) maps (USFWS, 1981) maps several possible in the vicinity of the project site (Figure 12). Table 8 summarizes the wetland type and area found within the proposed project limits.

Table 8. National Wetland Inventory Areas within Project Limits.

Type	**Area (acres)**
Freshwater Emergent Wetland	0.33
Freshwater Forested/Shrub Wetland	7.18
Freshwater Pond	0.32
Riverine	4.05
Total	**11.88**

Most of the NWI wetlands are forested/shrub areas on the west perimeter of the project site adjacent to the river (7.2 acres). The only management measure that would be implemented along the river edge would be removal of invasive species. The NWI maps a small area of freshwater emergent wetland area adjacent to Murray Road (0.33 acres), and a freshwater pond area (0.32 acres) on the south side of the site. Overlaying the 35 percent grading plans, only the ponded area would be affected by the proposed project grading.

USACE staff recently (in May 2011) identified a potential wetland located adjacent to the WDFW site in the southeast portion of the project site. Due to current agricultural land use, this potential wetland appears of low quality. [Appendix J provides the 404(b)(1) wetland analysis for the project site, and describes the type, quality, and mitigation requirements for wetlands at the project site. Revised discussion of write up of existing condition wetlands will be inserted here by USACE after delineation is completed.]

The Washington Department of Fish and Wildlife (WDFW) Sunnyside Wildlife Area is immediately adjacent to the proposed project site to the south. The project area and the WDFW lands are separated by an earthen roadway. The Sunnyside Wildlife Area comprises wetlands, managed ponds, and a riparian zone along the Yakima River that receives water from a variety of sources such as irrigation discharge and stormwater runoff. The WDFW has requested that any effects to groundwater levels or surface water runoff to their adjacent property be evaluated as part of the study.

2.13 FISH AND WILDLIFE

Fish species present in the Yakima River and identified by the Washington Department of Fish and Wildlife (WDFW) as priority species include fall chinook, spring chinook, coho, summer steelhead, rainbow trout, western slope cutthroat trout, and bull trout. Other species that occur in the Yakima River include sockeye salmon (considered extirpated for 60 years, but small numbers have been observed in the past five years), kokanee (landlocked form of sockeye, found in upper basin lakes), Pacific lamprey, river lamprey, western brook lamprey, mountain whitefish, brown trout, chiselmouth, carp, peamouth chub, Northern pikeminnow, longnose dace, leopard dace, Umatilla dace, speckled dace, redside shiner, longnose sucker, bridgelip sucker, largescale sucker, mountain sucker, black bullhead, brown bullhead, channel catfish, mosquitofish, three-spine stickleback, pumpkinseed sunfish, bluegill, smallmouth bass, largemouth bass, black crappie, yellow perch, walleye, mottled sculpin, Paiute sculpin, and torrent sculpin (Wydoski and Whitney, 2003). The non-native species are likely the most common in the project reach where water temperatures are high. The salmonids pass through the project area, and spring chinook, steelhead, and coho may rear and overwinter in the project vicinity.

Wildlife likely to be present in the project area include great blue heron, bald eagle, red tailed hawk, Canada geese, mallard, common merganser, American coot, killdeer, turkey vulture, northern harrier, ferruginous hawk, American kestrel, barn owl, common night hawk, belted kingfisher, Western kingbird, horned lark, bank swallow, barn swallow, black-billed magpie, American crow, European starling, beaver, mink, garter snake and rattlesnake, and songbirds such as meadowlark and gold finch. The wildlife habitat on the project site is limited because the site is plowed with a very narrow riparian zone.

The adjacent WDFW Sunnyside Wildlife Area includes willow riparian areas and cattail marsh that are likely utilized by red-winged blackbird, marsh wren, American widgeon, Northern pintail, Northern shoveler, cinnamon teal, wood duck, canvasback, long-billed curlew, black tern, Cooper's hawk, ring-necked pheasant, yellow warbler, common yellowthroat, song sparrow, beaver, mink, long-toed salamander, and bullfrog are also likely to be present.

2.14 THREATENED AND ENDANGERED SPECIES

A species list was received from the U.S. Fish and Wildlife Service (USFWS) on December 15, 2004 and the NOAA Fisheries website was reviewed. Nine species listed as threatened may occur in the project area, including bald eagle (Haliaeetus leucocephalus), bull trout (Salvelinus confluentus), Middle Columbia steelhead (Oncorhynchus mykiss), Canada lynx (Lynx canadensis), grey wolf (Canis lupus), grizzly bear (Ursus arctos horribilis), marbled murrelet

(Brachyramphus marmoratus), northern spotted owl (Strix occidentalis caurina), and Ute ladies' tresses (Spiranthes diluvialis). In addition several candidate species and species of concern may be found in the project area.

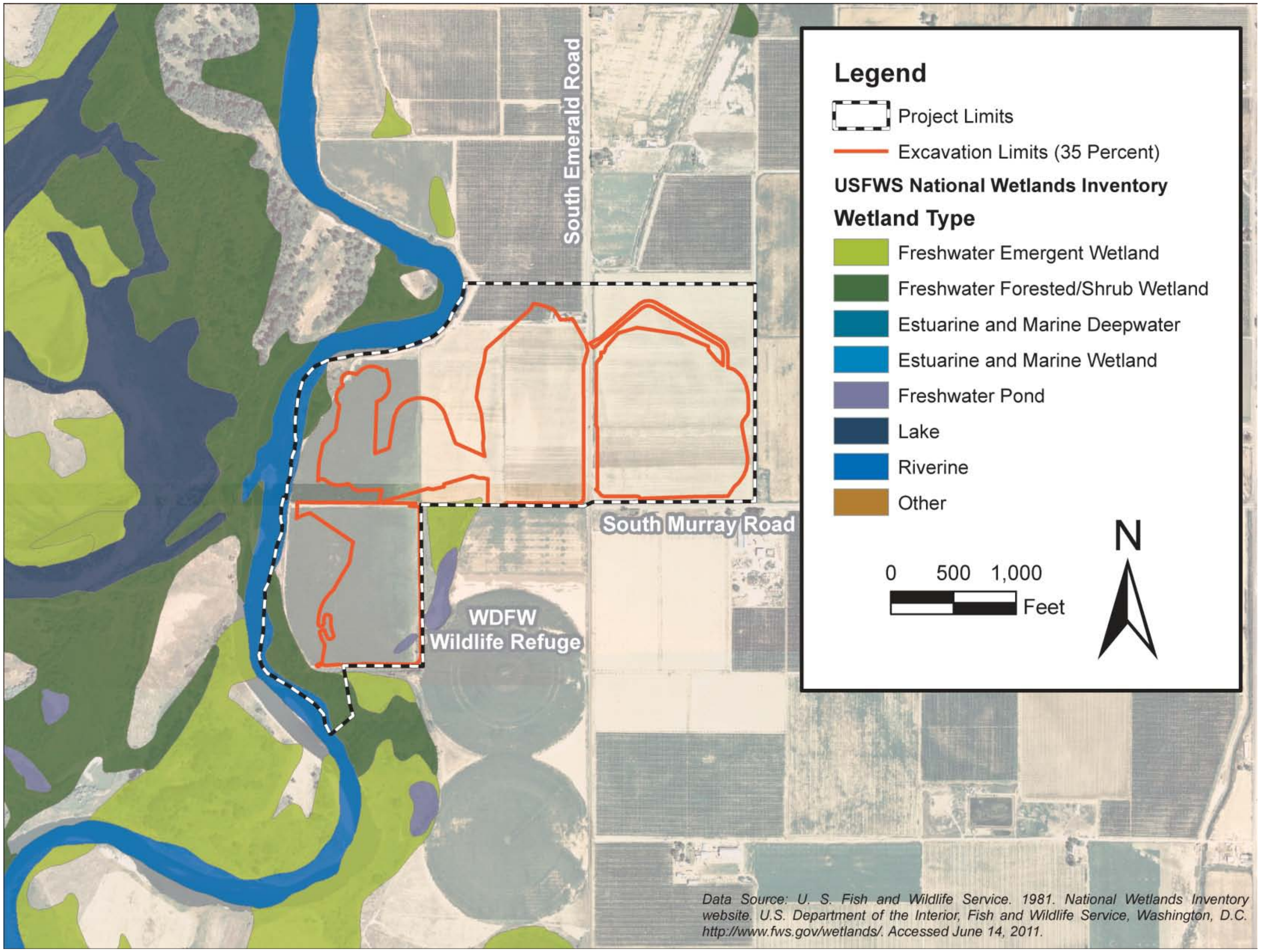

Figure 12. U.S. Fish and Wildlife Service National Wetlands Inventory at the Project Site.

2.14.1 BALD EAGLE

Although the bald eagle is no longer listed under the Endangered Species Act, it is still a fully protected species under the Bald and Golden Eagle Protection Act, which prohibits the taking or possession of either of these species. As a migrant species, eagles are also protected under the Migratory Bird Treaty Act. Effects on bald eagles are described in terms of the USFWS definition of “disturb”, which is as follows: *to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.*

The bald eagle wintering season extends from October 31 through March 31. Bald eagles winter along lakes, rivers, marshes and seacoasts in much of the lower 48 states (AOU, 1998). Availability of food is the essential habitat requirement affecting winter numbers and distribution of bald eagles. Other wintering habitat considerations are communal night roosts and perches.

The nesting season for bald eagle is typically between early January and mid-August. The characteristic features of bald eagle breeding habitat are nest sites, perch trees, and available prey. Bald eagles primarily nest in uneven-aged, multi-storied stands with old-growth components. Factors such as tree height, diameter, tree species, position on the surrounding topography, distance from water, and distance from disturbance also influence nest selection. Snags, trees with exposed lateral branches, or trees with dead tops are often present in nesting territories and are critical to eagle perching, movement to and from the nest, and as points of defense of their territory.

Birds and fish are the primary food source for eagles along large waterbodies, but bald eagles will also take a variety of mammals and reptiles (both live and as carrion) when fish are not readily available (Knight et al., 1990).

Bald eagles are likely to be present in the project vicinity in cottonwood riparian forest, such as that present across the river on tribal lands. However, on the project site, there is limited suitable habitat (only a couple of trees) for perching or nesting.

2.14.2 BULL TROUT

The Columbia River bull trout distinct population segment was listed as a threatened species under the Endangered Species Act of 1973, as amended, in 1998 (USFWS, 1998). Bull trout populations have declined throughout much of the species’ range. Some local populations are extinct, and many other stocks are isolated and may be at risk (Reiman and McIntyre, 1993). A combination of factors including habitat degradation, expansion of exotic species, and harvest has contributed to the decline and fragmentation of indigenous bull trout populations.

Bull trout spawning usually takes place in the fall during September and October. Initiation of breeding appears to be related to declining water temperatures. In Washington, Wydoski and Whitney (1979) reported spawning activity was most intense at 5 to 6^{o}C. Bull trout characteristically occupy high quality habitat, often in less disturbed portions of a drainage, as well as high elevation areas with low water temperatures. Necessary key habitat features include channel stability, clean spawning substrate, abundant and complex cover, cold temperatures, and lack of barriers, which inhibit movement and habitat connectivity (Reiman and McIntyre, 1993).

Juvenile bull trout, particularly young of year (YOY), have very specific habitat requirements. Small bull trout are primarily bottom-dwellers, occupying positions above, on or below the stream bottom. Bull trout fry are found in shallow, slow backwater side channels or eddies. The adult bull trout, like its young, is a bottom dweller, showing preference for deep pools of cold water rivers, lakes and reservoirs (Moyle, 1976).

Bull trout, in response to developmental and seasonal habitat requirements, make their movements difficult to predict both temporally and spatially. In the Yakima River basin, bull trout are primarily located in the high Cascade tributaries as resident or adfluvial populations. Critical habitat has been designated (USFWS, 2004) for bull trout in the Upper Yakima River and high elevation tributaries, down to the confluence of Ahtanum Creek (approximately 25 miles upstream of the project site). Bull trout are unlikely to occur in the project area, except very transiently during migrations.

2.14.3 MIDDLE COLUMBIA STEELHEAD

The Middle Columbia ESU of steelhead was listed as threatened on March 25, 1999 (NOAA Fisheries, 1999). The historic range of steelhead/rainbow trout was from northern Mexico to Alaska. Factors that have led to declines in populations include loss of access to important habitats (hydropower development and other barriers); modifications to natural hydrographs from water withdrawals, storage and flood control; loss of habitat diversity and connectivity; over-harvest; disease and predation; and climate conditions.

Middle Columbia steelhead are summer-run inland steelhead. They generally enter freshwater in June to August to then hold to spawn from December through March. Juveniles rear for two or more years in freshwater and then migrate to the ocean where they rear for an additional one or two years. Critical habitat has been designated that includes the Yakima River main stem up to the dams.

2.14.4 CANADA LYNX

The Canada lynx was first listed on March 24, 2000 (USFWS, 1998). It is currently designated as threatened throughout its larger range across the United States. The major cause of their decline is overexploitation by both regulated and unregulated harvest that occurred in the 1970s and 1980s as well as loss of suitable habitat due to forest management, urbanization, agriculture, and unnatural fire frequencies (NatureServe, 2005).

Lynx typically occur in moderate to high elevation boreal forest where significant quantities of snow fall, primarily lodgepole pine, Engelmann spruce, and sub-alpine fir forests in Washington, and are specialized predators on snowshoe hare. In the Yakima basin, lynx are likely to only occur in high elevations in the upper basin where suitable forested habitat and snowshoe hare occur, and are not likely to be present in the project area.

2.14.5 GRIZZLY BEAR

The grizzly bear was first listed on March 11, 1967 (USFWS, 1967). It is currently designated as threatened in the lower 48 states, except where listed as an experimental population. (USFWS, 2000). Grizzly bear historically occurred through much of the western United States. Grizzly bear are omnivorous and eat plant materials and fruits, along with fish, small to large mammals and carrion. It has been extirpated over much of its range and at the time of listing, was believed to only occur in Montana and Wyoming. Since listing, the population has expanded and more recent studies have documented grizzly bear presence in the North Cascades and other areas of northeastern Washington. If grizzly bear occur in the Yakima basin, they are only likely to occur sporadically at high elevations.

2.14.6 MARBLED MURRELET

The marbled murrelet was listed as a threatened species under the Endangered Species Act of 1973, as amended, in October 1992 (USFWS, 1992). Primary causes of population decline include the loss of nesting habitat, and direct mortality from gillnet fisheries and oil spills. Marbled murrelets forage in the near-shore marine environment and nest in inland old-growth coniferous forests of at least seven acres in size. Marbled murrelets nest in forests with multi-layered canopies and select large trees with horizontal branches of at least seven inches in diameter and heavy moss growth. Of 95 murrelet nests in North America during 1995, nine were located in Washington. Marbled murrelets spend most of their lives in the marine environment, where they forage in areas 0.3 to 2 km from shore.

Although marine habitat is critical to marbled murrelet survival, USFWS' primary concern with respect to declining marbled murrelet populations is loss of terrestrial nesting habitat. Critical habitat was designated for the marbled murrelet on May 24, 1996 (USFWS, 1996). Since marbled murrelet nesting habitat is in old-growth coniferous forests, they are not likely to be present in the project area.

2.14.7 NORTHERN SPOTTED OWL

The Northern spotted owl was first listed on June 26, 1990 and is currently designated as threatened in its entire range (USFWS, 1992). The Northern spotted owl is a forest bird that inhabits old-growth or late-successional coniferous and mixed conifer-hardwood forest over a range that extends from southwestern British Columbia south to San Francisco Bay (USFWS, 1992). Numbers have declined as a result of isolation and habitat fragmentation due to the harvest of old-growth habitats. Since northern spotted owl primarily occur in old-growth forests, they are not likely to occur in the project area.

2.14.8 UTE LADIES' TRESSES

The Ute ladies' tresses is an orchid that occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. It was listed on January 17, 1992 (USFWS, 1992) and is currently designated as threatened throughout its entire range (original range was Colorado, Utah and Nevada). However, the USFWS is currently conducting a status review to determine if delisting is warranted (USFWS, 2004). Substantial new information indicates that the population is much larger than originally determined and occurs in a significant number of additional areas, including Washington. Ute ladies' tresses occur in wet and mesic areas adjacent to streams, lakes, ponds, and within riparian areas. It occurs primarily in meadows with sparse to moderate vegetation cover and in open riparian areas with limited shading.

It is not known to occur in the project vicinity, which has been subject to significant disturbance and habitat modification, but may occur along the Yakima River or its tributaries in wet meadows.

2.15 SOCIO-ECONOMIC RESOURCES

Agricultural (including rangeland) and silvicultural land uses dominate the Yakima basin. About 30% of the basin land area is privately owned (YSPB, 2004), with other major landowners including the U.S. Forest Service, U.S. Army (Yakima Training Center), Washington

Department of Natural Resources, Washington Department of Fish and Wildlife, and the Yakama Indian Nation. The population of the basin is expected to significantly increase over the next 15-20 years, with towns in the project area increasing in population from 50-75% (YSPB, 2004).

The median household income in Yakima County is approximately 76% of the Washington State median at $34,828 and $45,776, respectively. The service sector is the major employment sector, with approximately 30% of all jobs; other important sectors include government, agriculture, trade, manufacturing, and construction (YSPB, 2004). Agricultural and urban/suburban land uses are dominant in the project vicinity.

2.16 TRANSPORTATION & IRRIGATION INFRASTRUCTURE

The project is located just southwest of the town of Sunnyside near the intersection of Murray Road and South Emerald Road, between I-82/US-12 to the north and SR-22 to the south. Murray Road is a 2-lane, asphalt County road with a 70-foot right of way. Murray Road runs east-west along the southeast edge of the project site. South Emerald Road is also a 2-lane, asphalt County road with a 50-foot right of way. South Emerald Road runs north-south and bisects the project site. With the exception of Emerald Road, all remaining roads within the project footprint are unimproved access roads.

Overhead power lines run along the east side of Murray Road, the north side of Murray Road, and the north side of the unimproved access road extending along the Murray Road alignment to the Yakima River. The power lines supply power to a pumping station along the Yakima River. Overhead power lines cross the road near the irrigation pump station locations.

There are also two related irrigation pump box and line facilities located on the northern side of the project near parcel number 09-32004, along South Emerald Road (SK1021D9A). These irrigation structures are part of the Sunnyside Valley Irrigation District (SVID) that provides water north-west of S. Emerald Rd. The systems are currently active, and will continue to provide irrigation water in the future. The likely alignment of the irrigation delivery pipes is along S. Emerald Rd and then along the north boundary of parcel number 09-32004.

In addition to the irrigation pump stations, there is an agricultural drainage ditch that runs north-south from parcel 09-23005 onto the project site parcel number 09-32004. This feature is part of Drainage Improvement District #16. At the end of the drainage ditch on the Port of Sunnyside restoration property, the ditch discharges into a corrugated metal riser pipe with two buried concrete drain lines. These drain lines (tiles) likely runs westerly towards the Yakima River. The current pipe outfall has been reported as collapsed, and there is no apparent outfall at the river.

The Snipes Mountain Pump Plant was located in the project area along the edge of the river, just north of Murray Road. The framework of the structure is still in place and the power is connected. However, the pump station has not been used since the Port of Sunnyside purchased the property.

A number of wellheads are also located throughout the site. The plan set in Appendix C illustrates these facilities.

3.0 PLAN FORMULATION

The planning objectives of this restoration study include:

1. To restore diverse floodplain wetlands for a variety of wetland species;
2. To restore the riparian zone along the Yakima River;
3. To remove non-native species; and
4. To recharge the groundwater table and hyporheic zone with cool, clean water.

An initial range of alternatives was developed from a primarily open water wetland on the majority of the site that would accommodate a significant quantity of water to a primarily riparian and channel system that would provide the maximum amount of shading on the site. An intermediate alternative was also considered that combined elements of open water wetlands with an extensive restoration of the riparian zone and buffers to provide a high diversity of habitat types.

In order to develop the concept designs for the alternatives and assist in the evaluation of the potential benefits from the alternatives, the following design criteria were developed.

3.1 DESIGN CRITERIA

The project team developed several civil, hydrologic, and environmental design goals to develop restoration alternatives at the project site.

3.1.1 CIVIL DESIGN

- Protect human life, health, and safety.
- Create a sustainable system that will minimize negative environmental effects during construction
  - Balance grading quantities ("cut and fill") to minimize the cost and CO_2 emissions required for off-site borrow or disposal.
  - Preserve and/or recycle existing infrastructure and materials, and preserve existing vegetation when practicable.
- Create a sustainable system that will minimize negative environmental effects over the project lifetime by functioning with minimal maintenance or human intervention.
  - Provide initial settling of sediments in areas that can be maintained without disturbing habitat functions and help prevent the site from filling in over the expected project lifetime.
  - Maintain slopes across site to allow continuous drainage towards the river.
  - Design the project to minimize potential flood damages.

3.1.2 HYDROLOGY

- Design site to take advantage of a maximum of 2 mgd of inflow, with adequate function at lower volumes (e.g., create overflow basins that only connect as water inputs increase, etc.).
- Maximize infiltration of water while still maintaining a diversity of wetland and riparian habitats.

3.1.3 ENVIRONMENTAL

- Maximize habitat diversity on the site as appropriate for region and to mimic natural wetlands of the area.
- Maximize shading as feasible to prevent additional heating of water before infiltration (include islands and riparian buffers).
- Provide overflow outlets to allow fish to return to the river after floods.
- Provide connections to adjacent habitats (i.e. Sunnyside Wildlife Area) for wildlife movement.

The project team developed specific design objectives and approaches to meet these design goals throughout feasibility design development, which are included in the narrative description of the recommended plan (Section 6.1).

4.0 RESTORATION ALTERNATIVES

This section discusses the restoration alternatives that were evaluated as part of the project planning process. This analysis, including the habitat evaluation and assessment of costs (see Section 5.0), was based upon the *10 percent conceptual design* of the restoration alternatives, as illustrated in Figure 14 through Figure 17 and the plan set found in Appendix B.

4.1 DESCRIPTION

In order to satisfy the planning objectives, the principal function of any alternative was to facilitate the controlled conveyance of discharge from the eastern boundary of the project site westward across Emerald Road, to the western edge of the site, discharging into the Yakima River. Absent of this base function, no alternative could satisfy all project objectives.

The project team developed several primary restoration alternatives based on a review of the type of riparian and floodplain wetland habitats that historically occurred in the Yakima Valley and physical characteristics at the project site. Each alternative provides a viable conveyance option and is comprised of a set of management measures that in combination satisfy the planning objectives. These restoration measures included: riparian re-vegetation; creation of emergent wetland; creation of shrub wetland; creation of forested wetland; and the creation of open-water ponds. Lastly, two culvert measures were identified to connect the east and west portions of the project area.

The three primary alternatives for the project site include: (1) **Wetland/Open Water:** a primarily open water wetland on the majority of the site that would accommodate a significant quantity of water; and (2) **Riparian:** a primarily riparian channel system that would maximize the amount of shading on the site that could potentially reduce water temperatures prior to surface or subsurface flow into the Yakima River, and (3) **Combination:** an intermediate system that combined elements of open water wetlands with an extensive restoration of the riparian zone and buffers to provide a high diversity of habitat types.

The project team then considered variations to each primary alternative to evaluate the relative merit of specific measures. The following two elements (measures) of the primary alternatives were identified as warranting further investigation: (a) upper habitat ponds at the upstream side of the project and (b) a wildlife passage culvert at South Emerald Road.

Figure 12 below illustrates a schematic of the base primary alternatives (at top) and subsequent action alternative variations that were evaluated. Including the no action, three primary alternatives, and seven additional variation alternatives, eleven alternatives were included in total.

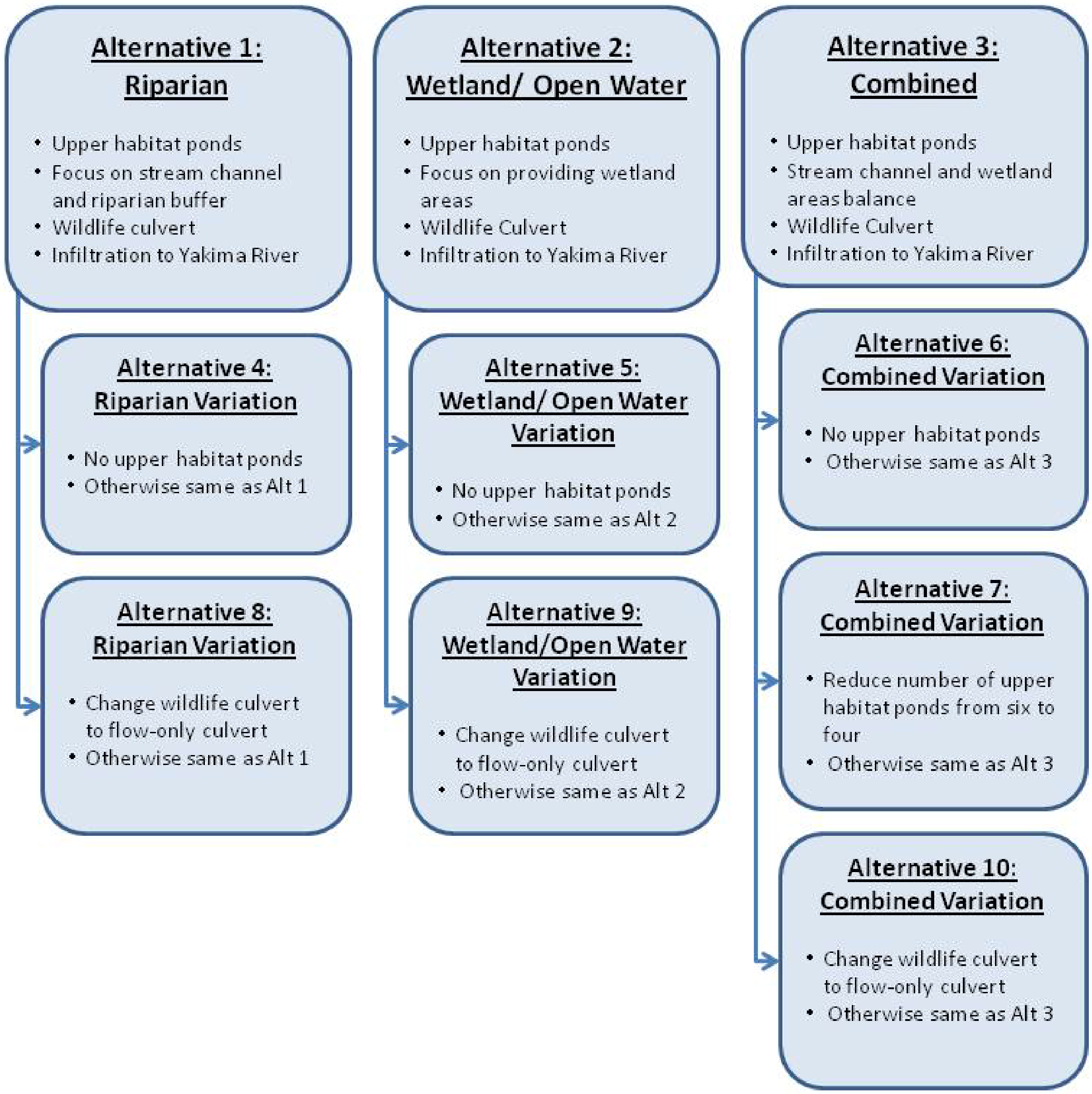

Figure 13. Summary of Alternatives Considered.

4.1.1 PRIMARY ALTERNATIVES

The alternatives described below include a (0) no action alternative; (1) a riparian restoration alternative; (2) an open-water and emergent wetland alternative; and (3) a combination riparian and emergent wetland alternative. These primary alternatives represent the range of habitat outputs from no action through riparian, wetland/open water and ultimately to the combined maximal habitat output.

4.1.1.1 No Action

The No Action alternative would not take any federal action to restore floodplain wetland or riparian habitats along the Yakima River.

There would be no added benefit to wildlife species or native vegetation communities under the No Action alternative. The Port of Sunnyside owns the proposed project site, and because their NPDES permit mandates the eventual cessation of surface water disposal of their treated effluent, they will likely use the project site as part of their treated effluent disposal program whether or not the project is realized. Under the No Action alternative, the Port will most likely convert the land to an alfalfa crop irrigated with treated effluent, which will have little or no benefit for local wildlife species or native vegetation. The next most likely alternative would be that the Port would keep their agricultural land fallow with regular cultivation to control noxious vegetation. Again, this use will have little or no benefit for local wildlife species or native vegetation.

The No Action alternative is used as a basis to evaluate alternatives over the period of analysis (50-year) project life, as such it also reflects the future without-project conditions. Under the existing condition, the NWI designates approximately 7.8 acres of freshwater wetland, open water, and riparian habitat along the Yakima River. The rest of the site (174.3 acres, for a total of 182.1 acres) is either Yakima River surface area or agricultural use (Table 9). This acreage is expected to remain unchanged with no action. Figure 14 illustrates the No Action alternative.

4.1.1.2 Riparian

The Riparian Alternative would provide a wide riparian buffer along the Yakima River on the project site and create a flowing channel and infiltration zone that would also have a wide riparian buffer.

The riparian base alternative would improve approximately 15.5 acres of currently degraded riparian, wetland, and open water habitat. In addition, the Riparian Alternative would create approximately 24.8 acres of riparian habitat, 9.3 acres of marsh habitat, and 12.5 acres of open water habitat. Also, approximately 107.2 acres of the project site would be converted to upland habitat. Table 9 tabulates the total habitat areas associated with the base Riparian Alternative. Figure 15 illustrates the base Riparian Alternative.

This alternative would provide extensive shading to the water and potentially reduce water temperatures as the water flows across the site. An infiltration zone along the lower end of the channel would promote groundwater recharge. This alternative would provide extensive shading of the water and a high quality riparian zone along the Yakima River. This alternative would not likely have a significant residence time of water on the site. Species that would utilize the riparian habitat include migratory songbirds, bald eagle, raptors, furbearers, and some waterfowl that utilize riparian zones (i.e. wood ducks). Wetland/Open Water

4.1.1.3 Wetland/Open Water Alternative

The Wetland/Open Water Alternative would provide large cells of open water to promote infiltration into the groundwater table.

The Wetland/Open Water Alternative would improve approximately 15.5 acres of currently degraded riparian, wetland, and open water habitat. In addition, the Wetland/Open Water Alternative would create approximately 20 acres of riparian habitat, 40.4 acres of marsh habitat, and 37.5 acres of open water habitat (Table 9). Also, approximately 59.0 acres of the project site would be converted to upland habitat. Table 9 tabulates the total habitat areas associated with the base Wetland/Open Water alternative. Figure 16 illustrates the base Wetland/Open Water alternative.

The open water would be surrounded by riparian buffers to provide shading and buffering from adjacent roadways and agricultural land uses. An infiltration zone along the lower end of the site would promote groundwater recharge. This alternative would accommodate the maximum volume of water that could be delivered to the site. Wildlife species that would particularly benefit include waterfowl and shorebirds, as well as aquatic mammals such as beaver and otter. Combination Wetland/Riparian

4.1.1.4 Combination Wetland/Riparian Alternative

The Combination Wetland/Riparian Alternative would combine elements of the open water alternative and the riparian alternative to maximize interspersion and diversity of habitat types including open water, shallow water/emergent wetland, shrub wetland, forested riparian, and upland habitats.

The Combination Wetland/Riparian Alternative would improve approximately 15.5 acres of currently degraded riparian, wetland, and open water habitat. In addition, the Combination Wetland/Riparian Alternative would create approximately 40 acres of riparian habitat, 32 acres of marsh habitat, and 23.8 acres of open water habitat. Also, approximately 81.0 acres of the project site would be converted to upland habitat. Table 9 tabulates the total habitat areas associated with the base Combination Wetland/Riparian alternative. Figure 17 illustrates the base Combination Wetland/Riparian alternative.

This alternative would include wide riparian buffers around the entire site and along the Yakima River, provide both channel and open water wetland areas and provide forested islands for shading. An infiltration zone along the lower end of the site would promote groundwater recharge. Wildlife species that utilize open water, marsh, shrub, and forested riparian habitats would utilize habitats in this alternative including waterfowl, shorebirds, bald eagle, raptors, songbirds, and small and large mammals.

Table 9. Base Alternative Habitat Area Tabulation.

Base Alternative	Upland Habitat	Riparian Habitat	Marsh Habitat	Open Water Habitat	Other [(a)]	Total [(b)]
	A_1	A_2	A_3	A_4	A_5	$\Sigma A_1 \ldots A_5$
	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
No Action [(c)]	0.0	15.5	0.0	0.0	166.6	182.1
#1 - Riparian	107.2	40.3	9.3	12.5	12.8	182.1
#2 - Wetland/Open Water	59.0	33.5	40.4	37.5	11.7	182.1
#3 - Combination Wetland/Riparian	66.0	55.5	32.0	23.8	4.9	182.1

Notes: (a) "Other" land use includes agricultural land use, public right-of-way (e.g., South Emerald Road), viewing point parking, and Yakima River surface area. (b) Rounding error is inherent in the calculation of total area. (c) "No Action" habitat areas estimated from National Wetlands Inventory: freshwater emergent wetland categorized as "marsh"; freshwater forested/shrub wetland categorized as "riparian"; freshwater pond categorized as "open water"; riverine area categorized as "other," (USFWS, 1981).

4.1.2 VARIATIONS TO ALTERNATIVES

As described above two measures were identified as being driving factors for restoration. These measures include (a) upper habitat ponds at the upstream side of the project and (b) wildlife passage culverts at Emerald Road. These alternatives represent varying measures that may enhance or detract from the overall project habitat value. The following paragraphs describe the characteristics of the driving measures making up the primary alternatives. Figure 13 (above) presented a schematic of all the alternatives in order to illustrate how the variations relate to the primary alternatives. Table 10 (at the end of this section) summarizes the measures included in each of the eleven alternatives.

4.1.2.1 Upper Habitat Ponds

Base Option: The base primary alternatives include up to six upper habitat ponds. The ponds will deliver a safe and clean source of water to the wetlands, in addition to maximizing the amount of habitat benefit. The primary benefits of the upper habitat ponds are three-fold: habitat creation, stabilization of water supply, and minimization of the maintenance footprint.

The ponds include both open water habitat, emergent wetland habitat, and riparian habitat. As currently laid out, each upper habitat pond has a 1.8-acre "island" of shallow-water habitat, as well as 0.7 acres of deeper water. Riparian vegetation will be planted along the edge of the ponds and on the islands located in the center of every pond. The riparian vegetation is designed to provide shade to cool and moderate the temperature of the water. In addition, the riparian areas will provide habitat for nesting and perching songbirds, as well as small mammals. The banks of the islands and the banks of the ponds themselves will be planted with emergent wetland species. The emergent wetlands provide habitat for amphibian species.

The upper habitat ponds equalize and stabilize flow delivery to the rest of the project. The treated effluent from the Port of Sunnyside is a stable water supply, but it is not without some variation. The upper habitat ponds also provide a hydraulic control to stabilize the water levels in the lower ponds. The more ponds, the greater the water stabilization and the more habitat that is consistently present.

Because there may be residual suspended solids in the treated effluent, the upper habitat ponds provide the opportunity for these solids to settle out and that, which will prevent the need for potentially disruptive maintenance downstream. Section 5.1.1.3.2 discusses the upper habitat pond’s benefit in reducing downstream maintenance in more detail. The habitat, water quality, and hydrologic functions make the upper habitat ponds a non-severable part of the overall project.

The islands serve as baffles to maximize detention time and prevent “short-circuiting” of flows through the pond. The ponds would generally be constructed with a combination of excavation for the bed, and placement of fill for the islands and for the berms around the perimeter of the ponds. Each pond is designed to exceed the minimum detention time of 24 hours. Each pond includes an outlet structure with a cast-in-place concrete headwall, spillway, and 12-inch PVC outlet pipe to serve as a flow control device and a drain for maintenance. The pond grading is designed for maintenance access from the perimeter berms.

No Ponds Option. The analysis compared the base primary alternatives to alternatives that did not include upper habitat ponds. Eliminating the upper habitat ponds reduces the construction and maintenance cost of the alternatives, but comes with a loss of riparian, wetland, and open-water habitat. In addition, eliminating the ponds reduces project function in ways that are not captured by the habitat benefit model. Eliminating the upper habitat ponds reduces operational flexibility, thereby potentially decreasing the quality of the project water source by removing settling capacity and an important buffer from hydrologic and effluent chemical extremes. Without the upper habitat ponds, the project owner should anticipate more complex maintenance procedures, as maintenance would take place without the isolation provided by the inlet and outlet structures of the upper habitat ponds. In addition, there would be less reliable open water habitat downstream due to a lack of water stabilization without the upstream habitat ponds.

4.1.2.2 South Emerald Road Culvert

Base Option: The base primary alternatives include a wildlife passage culvert that is a 12'x6' reinforced concrete box culvert under South Emerald Road with a gravel bed. The over-sized culvert with natural bottom design allows the culvert to serve as a habitat corridor, allowing for the safe movement of aquatic and terrestrial species.

Flow Only Culvert Option. The analysis compared the base alternatives to cases including a "flow only" culvert. This 56-inch corrugated metal arch culvert would reduce construction cost (URS, 2009), but comes with a loss of connectivity to riparian, wetland, and open-water habitat.

Table 10. Summary of Alternatives.

		Project Elements										
		Upper Habitat Ponds			Area West of Emerald Road			Culvert		Floodplain Area		
ID	**Short Description**	0 Pond	4 Pond	6 Pond	Open Water	Riparian	Combined	Flow Only Culvert	Wildlife Culvert	Open Water	Riparian	Combined
0	No Action											
	Primary Alternatives											
1	Original Riparian (4 ponds)		x			x			x		x	
2	Original Open Water (6 ponds)			x	x				x	x		
3	Original Combined (6 ponds)			x			x		x			x
	Upper Habitat Pond Options											
4	Riparian + No Ponds	x				x			x		x	
5	Open Water + No Ponds	x			x				x	x		
6	Combined + No Ponds	x					x		x			x
7	Combined (4 Ponds)		x				x		x			x
	Culvert Options											
8	Riparian + Flow Only Culvert		x			x		x			x	
9	Open Water + Flow Only Culvert			x	x			x		x		
10	Combined + Flow Only Culvert			x			x	x				x

Figure 14. No-Action Alternative.

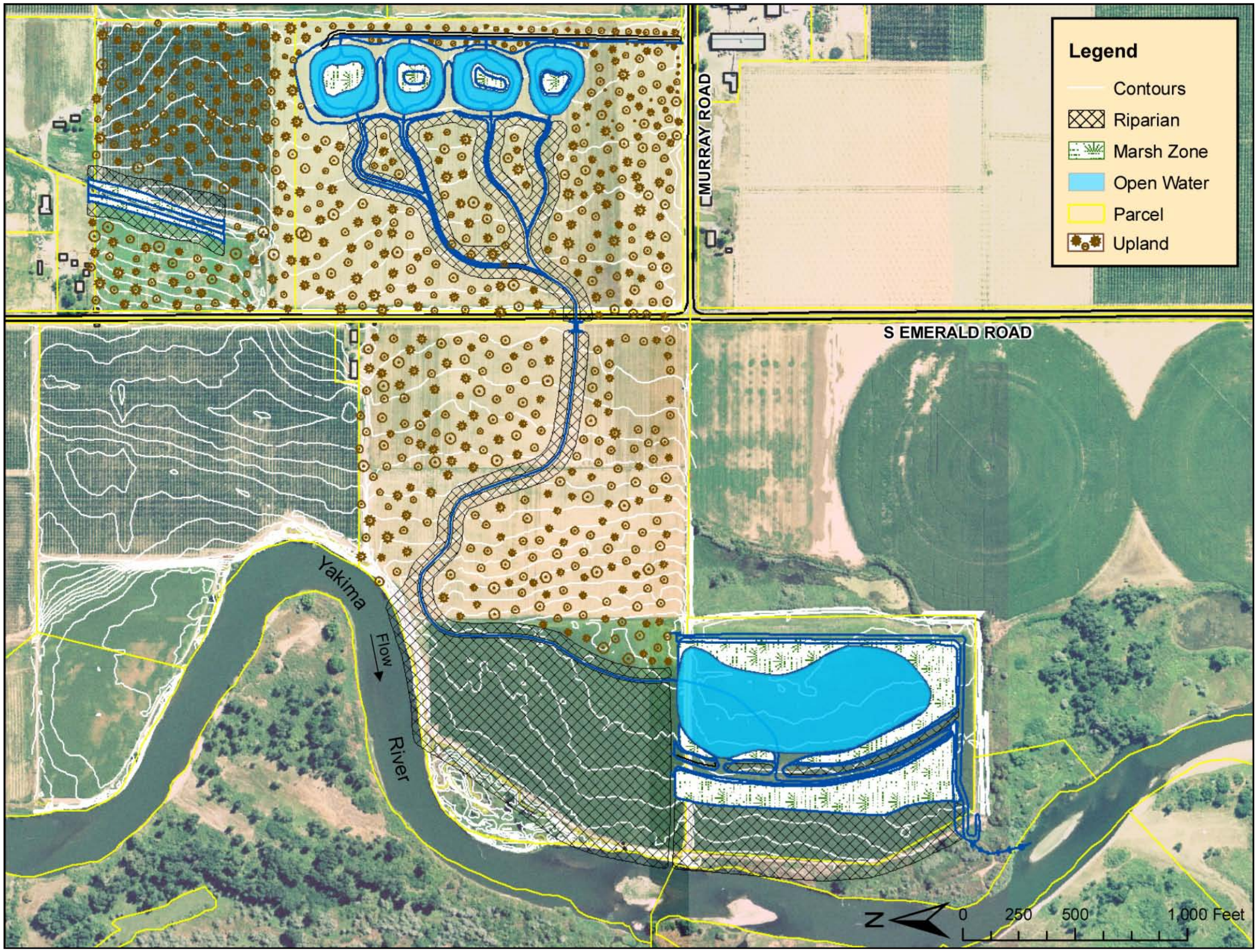

Figure 15. Riparian Alternative.

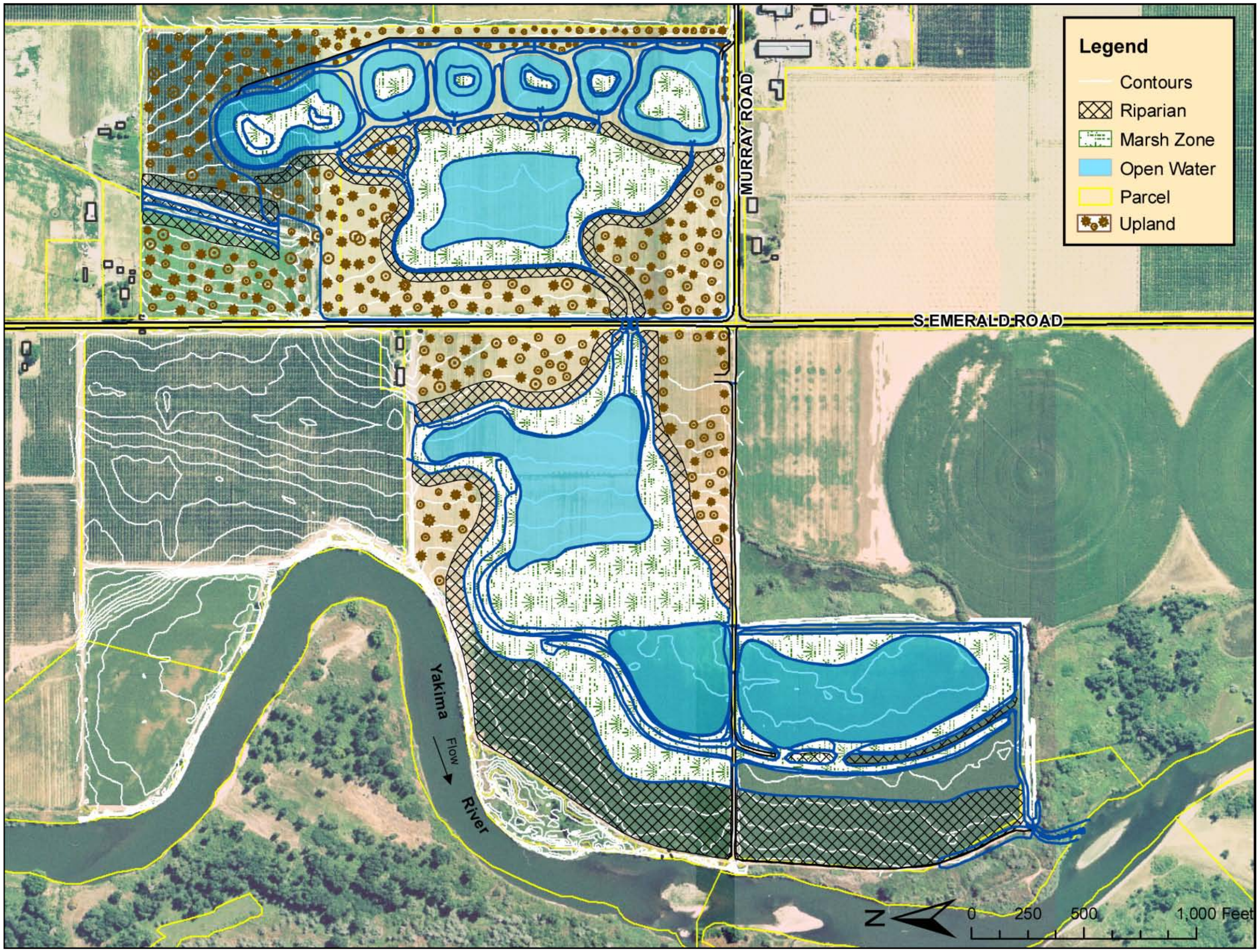

Figure 16. Wetland/Open Water Alternative.

Figure 17. Combined Wetland/Riparian Alternative.

This page intentionally left blank.

5.0 EVALUATION OF ALTERNATIVES

This discussion presents the evaluation of alternatives. This analysis was based upon the *10 percent conceptual design* of the restoration alternatives, as illustrated in Figure 14 through Figure 17 and the plan set found in Appendix B.

The analysis approach facilitates consideration of cost effectiveness and marginal cost in the selection of an alternative that reasonably maximizes environmental output. The analysis first evaluated each alternative for its total habitat benefit and its life-cycle cost (construction plus operation and maintenance). The analysis then ranks the alternatives to inform recommendation of a plan based on relative cost effectiveness using the CE/ICA methodology.

5.1.1 HABITAT EVALUATION

The habitat evaluation utilized the Habitat Evaluation Procedure (HEP) and Hydrogeomorphic Model (HGM) to assess the habitat benefit of each alternative. In order to select the most cost effective restoration plan, it is necessary to assign a quantitative numeric value to the habitat benefits for each action alternative. These habitat benefits, known as Habitat Unit (HU) outputs, are compared with costs to determine cost effective and incrementally justified alternatives. This project analysis computes HU output by applying the HEP to quantify riparian habitat benefits and the HGM to quantify wetland habitat benefit. This discussion introduces the HEP and HGM, and summarizes the results of the habitat evaluation. Appendix F provides more detailed information about the habitat analysis.

5.1.1.1 Habitat Evaluation Procedure

The HEP provides a means for designing a mathematical model based on the habitat suitability of the proposed restored habitats for one or more species that represent those habitats. A HEP comprises one or more Habitat Suitability Indices (HSI), which are models for calculating the habitat suitability of an area for a single species or assemblage of species. A set of variables that represent the life requisites for the species (e.g. percent cover, water depth, tree height) is combined into a mathematical model. The variables are then measured in the field and their corresponding index values are inserted into the model to produce a score that describes existing habitat suitability. The value is an index score between zero and one (0.0 – 1.0). The mathematical models used for this HEP are derived from existing models developed by the U.S. Fish and Wildlife Service (USFWS).

The HEP for this project was directed at the riparian species and habitats. Although only a few species were selected out of the many that could be present in the project area, the selected species are representative of guilds that currently do or could utilize habitats in the project area, or are representative of species of concern in the project area. Some of these species were also selected as focal wildlife species in the Yakima Subbasin Plan (Yakima Subbasin Fish and Wildlife Planning Board, 2004) because they represent keystone or sensitive riparian species. These species also have habitat requirements that could be affected by the proposed project.

The HEP model used for this project is a community-based, modified model with multiple species selected to represent other species that function similarly in riparian areas. The four species selected for the model are expected to be indicators of habitat conditions for a wide variety of additional species and include:

- yellow warbler (*Dendroica petechia)*,
- wood duck (*Aix sponsa)*,
- beaver (*Castor Canadensis)*, and
- mink (*Mustela vison)*.

Where possible, mathematical models have been taken directly from existing HSIs. However, some models have been modified to eliminate variables that will not be affected by the project or were not measurable at the project site. These variables were considered non-predictive as they had no impact on the results

The individual HSIs for various habitat parameters for each species were combined arithmetically or geometrically to yield an overall index score for the species. Scores for each species can be used individually or combined to yield an overall index score for a site for multiple species or species assemblages. The index score was multiplied by the area of habitat that may be affected by a project to derive an HU score. The final HU score can be calculated separately for each species or for a combined score for multiple species. The future with- and without-project HUs were compared to determine the net difference (either positive or negative) between alternatives. The difference in HUs was then combined with cost to get a HU per cost value, which is the final value used for determination of the most cost effective restoration alternative. For this project, the existing HUs were assumed to adequately represent the future without-project HUs because the project site would likely remain in an agricultural use if this project was not implemented.

Tetra Tech staff conducted habitat surveys in December 2004 to determine the existing riparian habitat conditions within the project area specific to the needs of several species of interest (yellow warbler, wood duck, beaver, and mink). The HEP model utilized HSIs for various habitat characteristics such as canopy cover, vegetation height, vegetation type, and other physical or biological data of importance to the target species. The HU outputs include an area component in order to evaluate the impacts/benefits offered by changing the acreage of habitat.

5.1.1.2 Hydrogeomorphic Model

The HGM provides a mathematical model based on the potential function of the restored wetland for multiple functions. The Washington State Wetland Function Assessment Project (Hruby, et al., 2000) developed an HGM to provide relatively rapid, scientifically acceptable methods for assessing functions at individual wetlands within the State of Washington to meet management needs. This method was based on the HGM developed by USACE (Brinson, et al., 1995), and will hereafter be referred to as the HGM model.

The HGM methods are intended to assess the level at which a wetland area performs a function (level of performance). Because wetlands are a major component of the proposed restoration project, the HGM method was used to assess the functions that will be created/restored and also to guide the wetland design to ensure that important functions are included in the design.

Because only a small area of marginal wetlands currently exist at the project site, it is not possible to compare wetland functions under existing conditions to with-project conditions. Therefore, HGM scores were not included for existing conditions. Future with-project scores were determined using best professional judgment of potential future conditions. For each action alternative, conditions that would result from its proposed restoration are calculated 5, 10, 25, and 50 years in the future.

The HGM models developed for the Columbia Basin of Eastern Washington include models for depressional wetlands that are either alkaline, freshwater – long duration, or freshwater – short duration. The wetlands that will be created/restored at the site will primarily be long-duration freshwater depressional wetlands. Thus, the functions and indicators were assessed for this type of wetlands.

Typically a field assessment of wetland indicators is conducted and the data is used to develop indices to produce a ranking of the wetlands performance in each of the function areas. We suggest that this assessment be conducted several times after the construction of the proposed wetlands for follow-up success monitoring. Maintenance of the project site should be performed to ensure the success of these functions as shown by the various indicators.

The authors of the HGM methodology (Hruby, et al., 2000) do not recommend combining the separate function scores into one overall average because the different functions are assessed at different scales. However, HGM is well suited to assessing different vegetation communities and interspersion of habitats on one site. HGM was used to assess the entire site as one large unit, with a separate HGM calculated for each alternative. Combining the individual function scores to create a single average type score is a technique that has been used successfully in the past so that the rating system can be used in the incremental cost analysis. The average index score is then multiplied by the acres of wetland habitat restored or created to yield wetland habitat units. This allows the direct comparison of HUs against the cost.

5.1.1.3 Multipliers and Weightings

The analysis applies multipliers to the acreage input to the habitat models to account for the effect of the upper habitat ponds have on water stabilization and maintenance footprint, and then weights the results to reflect the relative accessibility of the habitat created in each alternative. This section discusses these multipliers in more detail.

5.1.1.3.1 Water Level Stabilization Multiplier

The upper ponds function to stabilize the water levels at the site, in addition to other benefits. The water level of the downstream ponds are dependent on the presence of the upper ponds. The more upper ponds present, the more downstream habitat will also be consistently present. On the other hand, without the upper ponds, the downstream water levels will fluctuate and may even dry periodically. Simply stated the upper ponds provide flow equalization or a more stable rate of flow to the downstream ponds. The source water for the wetlands will vary daily, weekly and seasonally and this variance in flow volume will result in a downstream habitat stressor that will limit production and habitat functionality (subject to wetting and dying on a irregular basis) if not normalized by providing flow equalization of the daily and week's variability in flow via the upper ponds.

To address this fluctuation in water levels (flow variability) and therefore amount of habitat area that is functional the downstream ponded acreage was weighted to account for the amount of habitat that would be available with the fluctuating water levels. The alternatives that included six upper ponds were weighted 100%, of the area had available habitat, the alternatives that included four upper ponds were weighted as having 85% of available habitat and the no ponds alternatives were weighted as having 60% available habitat.

5.1.1.3.2 Maintenance Reduction Factors

In order to account for maintanence work that would be required for removing sediment in the downstream ponds, the analysis applied a factor to determine the amount of habitat that would be available over time. This equation addresses the depreciation of habitat due to sedimentation and habitat recovery after dredging.

For alternatives with upper habitat ponds, the analysis subtracted approximately 950 square feet from the open-water area of each upper habitat pond to account for the low quality and periodic disturbance of open-water habitat in the maintenance forebay of each upper habitat pond.

For alternatives without upper habitat ponds, sedimentation (and therefore periodic maintenance) would take place in the habitat areas downstream of South Emerald Road. The increased nutrient load due to residual suspended solids would also significantly increase biological growth response in the open water and marsh habitat areas below South Emerald Road, and consequently amplify the volume of material needing periodic removal.

Based on average residual sediment loading rates from the treated effluent, the analysis estimated that there would be approximately 3 acres of effective habitat depreciation due to sedimentation every eight years. The analysis did not directly account for the volume of material due to increased biological growth. The analysis then assumed that it would take two years for the habitat to recover from the trauma of periodic maintenance activities. The analysis then averaged the depreciation and trauma-recovery cycles over the 50-year project life span to calculate a reduction factor to apply to the areas downstream of South Emerald Road, bounded by the Yakima River on the west and the maintenance road (Murray Road extension) to the south, most likely to require periodic maintenance. For the riparian-only alternative, the analysis applied the reduction factor to the riparian area; for open water and composite alternatives, the analysis applied the reduction factor to the sum of open water and marsh areas. Table 11 summarizes the habitat reduction factors calculated and then applied to the open water and marsh habitat areas.

Table 11. Habitat Area Maintenance Reduction Factors

Alternative	Habitat Area Downstream Emerald Rd. [(a)]	Maintenance Reduction Factor	Habitat Area
	(acres)		(acres)
	A	K	A_{EFF}=K*A
#4 - Riparian No Ponds [(b)]	24.77	0.93	23.16
#5 - Open Water No Ponds [(c)]	35.04	0.95	33.43
#6 - Combined No Ponds [(c)]	20.68	0.92	19.07

Notes: (a) Habitat area downstream of Emerald Road is defined as the area within the project boundaries bounded by the Yakima River on the west and the maintenance road (Murray Road extension) to the south; further, (b) for riparian-only alternative, habitat area is defined as riparian areas; (c) for wetland-only and composite alternatives, habitat area is defined as the sum of open-water and marsh areas.

5.1.1.3.3 Wildlife Habitat Multiplier

Because the wildlife culvert does not have habitat benefits directly measurable by area, the analysis considered the option outside the HEP and HGM framework in order to account for wildlife connectivity between areas provided by the wildlife culvert. The analysis approach was to apply a multiplier to the habitat output resulting from the area-based methods (HEP and HGM) to help quantify the habitat benefit of this option.

The multiplier for habitat passage culvert versus flow-only culvert was based upon the ratio of additional habitat area accessible because of the larger culvert. As shown in Table 12, the wildlife culvert has a connectivity benefit of 58% based on additional area made accessible to wildlife. To convey anticipated design flow of 2 mgd, the culvert under South Emerald Road only would need to be approximately a 21-inch corrugated metal pipe (CMP), leaving little or no connectivity for terrestrial wildlife species across South Emerald Road. The wildlife culvert is instead an 8-ft rise by 10-ft span rectangular concrete box culvert with and invert counter-sunk 1-2 feet below grade. The additional cross-section area in the culvert will enable small and medium-size terrestrial wildlife species to more easily access the areas upstream of South Emerald Road. Table 12 summarizes the multipliers applied to the culvert options.

Table 12. Culvert Option (Wildlife Habitat) Multipliers.

Culvert Option	Multiplier
Habitat Passage	1.58
Flow-Only	1.00

5.1.1.4 Habitat Analysis Results

Tables 16 through 19 summarize the results of the habitat analysis. The non-monetary benefits of the environmental restoration action alternatives are measured in average annual environmental outputs. In this case, the environmental outputs are measured as average annual HUs, using a 50-year period of analysis. Table 19 (Page 66) summarizes the average annual habitat units assigned to each action alternative. It should be noted that the average annual HUs listed represent the net increase in output above and beyond the without-project condition (i.e., the no-action alternative).

5.1.2 COST ANALYSIS

The design team developed a preliminary estimate of life-cycle costs (construction and operation and maintenance) for each of the action alternatives. The project team updated the original cost analysis (Tetra Tech, 2009), completed in the Second Quarter of FY 2005, using the USACE Civil Works Construction Cost Index System (CWCCIS) (USACE, 2010). Indices for Fish and Wildlife Facilities were used to update costs from Q2 FY05 to Q1 FY11. Additionally, a 3 percent fuel surcharge was incorporated. Table 13 summarizes the factors used to update the cost analysis. The cost input to the CE/ICA did not include contingency, design, or administration costs. Because these costs are assumed to be a percentage of base construction costs, neglecting them did not affect the rank-order of the results.

More importantly, the revised cost analysis scales down the quantities used in the previous cost analysis (Tetra Tech, 2009) to match existing available flows from Port of Sunnyside facilities. The project team also updated the cost analysis to use the FY 2011 discount rate of 4.125 percent.

Table 13. Cost Update Factors.

Cost Analysis Factor	Value
Cost Index FY05 Q2	597.76
Cost Index FY11 Q1	708.39
FY11/FY05 Cost Index Ratio	1.185
Fuel Surcharge	+ 3 percent
Cost Update Multiplier	1.221

5.1.3 CONSTRUCTION COSTS

The original project cost analysis broke the project into several elements, including: (1) general items (fixed costs such as mobilization, demobilization); (2) upper habitat ponds (pipeline and valves, pond excavation, and outlet structures); (3) project elements east of South Emerald Road; (4) culverts under South Emerald Road; and (5) project elements west of South Emerald Road.

The break-down of the construction cost estimate facilitated mixing and matching various project options, to find a cost basis for each action alternative. Briefly, the changes included:

Restoration Area West of Emerald Road. The scaled-down cost estimate reflects the reduced restoration area west of South Emerald Road, including the elimination of the north river outlet.

Upper Habitat Ponds. The scaled-down cost estimate reduces the number of upper habitat ponds from eight to six. Because the overall grading footprint remains similar, the cost adjustment mainly reflects a reduction in the amount of supply pipe and the number of inlet and outlet structures.

Culverts. The scaled-down cost estimate eliminates one of the two culverts from the 2009 design. The flow-only culvert option referenced the cost reported in the Value Engineering Report (URS, 2009).

Fixed Costs. The scaled-down cost estimate assumed that the general (fixed) costs would remain essentially the same as the 2009 project estimate. This is because the costs of mobilization, demobilization, and other general costs are somewhat more independent of project scale. Because the general costs are applied across all alternatives, this assumption should not influence the outcome of the CE/ICA analysis.

Table 20 (Page 67) summarizes the annual costs associated with each project action alternative. Appendix G provides a more detailed summary of the estimated project cost.

5.1.4 OPERATION AND MAINTENANCE COSTS

The project team developed annualized operation and maintenance (O&M) costs for the cost analysis. These costs included:

- First-year vegetation establishment, monitoring, and replacement program;
- Follow-up vegetation establishment, monitoring, and replacement program (First 5 years);
- Regular annual maintenance (Year 6 through Year 50);
- Periodic structural maintenance and/or replacement (Every 10 years); and
- One-time maintenance and replacement (Year 25)

This stream of O&M costs varied by alternative. For alternatives with the upper habitat ponds, O&M costs were minimized due to the sediment capture forebays on each pond. For alternatives without the upper habitat ponds, O&M requirements were increased downstream of Emerald Road to account for the additional sediment removal that would be required periodically in the wetland areas.

5.1.5 ANNUALIZED COST

In order to compare life cycle costs with average annual environmental outputs, it is necessary to convert implementation costs to average annual costs. The stream of costs associated with the project occurs at various points in time. Therefore, all costs were converted to present value at the beginning of the period of analysis, amortized at the current (fiscal year 2011) federal project discount rate of 4.125 percent over the 50-year period of analysis. The project costs are expressed in terms of average annual dollars per average annual environmental output.

5.2 SELECTION PROCESS

Evaluation of the alternatives is based primarily on a comparison of the without-project condition to each of the with-project alternative conditions. The benefits of the alternatives are measured as the net gain (change) in environmental outputs over the existing condition. The costs of implementing each of the alternatives are then compared with the benefits of each alternative, using both a cost-effectiveness analysis and an incremental cost analysis as described in USACE Evaluation of Environmental Investments Procedures Manual IWR Report #95-R-1, *Cost Effectiveness and Incremental Cost Analyses*. USACE software program IWR-PLAN was used to help conduct the analyses.

5.3 COST EFFECTIVENESS AND INCREMENTAL COSTS ANALYSES

Cost effectiveness and incremental cost analyses (CE/ICA) have different methods and purposes. A c*ost effectiveness analysis* is conducted to ensure that the least-cost solution is identified for various levels of environmental output. The purpose of the cost effectiveness analysis is to eliminate inefficient alternatives based on comparing environmental outputs and total costs of alternatives. An *incremental cost analysis* is conducted to show changes in costs for increasing levels of environmental output. It provides data for decision-makers to address the question "Is the next level worth it?" The incremental cost analysis measures the incremental or *additional cost* of the next additional level of environmental output.

In the *cost effectiveness analysis*, a solution is *cost effective* when no other solution provides the same level of output at less cost and no other solution provides a higher level of output at the same or less cost.

In the *incremental cost analysis*, *"best buy"* solution are identified. In an array of all *cost effective* solution, there are multiple *best buy* solutions. The first *best buy* is identified by noting the solution that produces the greatest increase in output for the least increase in cost. This is the solution with the lowest incremental cost per unit output. The next *best buy* is the solution that produces the next greatest increase in output for the least increment of cost, and so on.

Tables 16 through 21 summarize the input to the CE/ICA evaluation. Table 21 (Page 68) summarizes the average annual costs, average annual environmental outputs, and the average annual cost per environmental output for each alternative. The average annual habitat outputs are calculated by dividing the HU score for each alternative by 50 in order to assess the average annual cost each alternative will have over the 50-year period of analysis.

This implementation of CE/ICA was conducted on alternatives defined by the PDT. As such, no solutions are combinable in the CE/ICA model because each alternative is a complete plan. Costs and outputs for each alternative were calculated first, then input to the model. This approach identified which alternatives were cost effective and which were "best buy" plans.

The analysis identified five of the eleven alternatives as cost-effective, including the no-action alternative. Of these five cost-effective alternative plans, two were identified as "best buy" plans, including the No Action. All non-cost effective plans were dropped from further consideration and the five cost effective plans were carried forward. Table 14 summarizes the cost-effective and best buy alternatives. Figure 18 (Page 69) illustrates the cost-effectiveness of all the alternatives.

Table 14. CE/ICA Output

Alternatives[1]	Annualized Cost ($)	AAHUs	Cost Effective
#0 - No Action Plan	$0	0.0	Best Buy
#8 - Riparian + Flow Culvert	$160,458	42.1	No
#4 - Riparian + No Ponds	$138,559	45.7	Yes
#6 - Combined + No Ponds	$179,262	59.6	No
#5 - Open Water + No Ponds	$195,701	60.0	No
#1 - Original Riparian (4 ponds)	$164,713	67.5	Yes
#10 - Combined + Flow Culvert	$216,614	69.7	No
#9 - Open Water + Flow Culvert	$233,062	77.5	No
#7 - Combined (4 Ponds)	$205,412	89.1	Yes
#2 - Original Open Water (6 ponds)	$237,317	126.6	No
#3 - Original Combined (6 ponds)	$221,060	135.9	Best Buy

[1] *Alternatives are numbered consistent with Figure 13*

The analysis compared the alternatives, including the no action alternative, to evaluate the marginal cost of additional environmental output. Table 15 summarizes the identified "cost effective" alternatives. Figure 18 (Page 69) illustrates the results of the incremental cost analysis.

Table 15. Summary of Cost Effective Plans and Incremental Cost

Alternatives	Annualized Cost ($)	AAHU	Cost Effective
#0 - No Action Plan	$0	0.0	Best Buy
#4 - Riparian + No Ponds	$138,559	45.7	Yes
#1 - Original Riparian (4 ponds)	$164,713	67.5	Yes
#7 - Combined (4 Ponds)	$205,412	89.1	Yes
#3 - Original Combined (6 ponds)	$221,060	135.9	Best Buy

5.4 SELECTION AND JUSTIFICATION OF PREFERRED ALTERNATIVE

For ecosystem restoration, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective is identified as the National Ecosystem

Restoration (NER) Plan. The selected plan should be cost effective and justified in achieving the desired level of output.

Results of the CE/ICA inform the selection of an alternative. The CE/ICA allows comparison of successive levels of output and their incremental costs between alternatives. For this study, preferred alternative is also the NER plan.

Of the eleven (including No Action) alternatives included in the CE/ICA, six alternatives were screened out because they did not satisfy the requirement of cost effectiveness. In order to select from the most efficient plans, only the five "cost effective" alternatives were considered for selection as the preferred alternative. The preferred alternative should be one that meets the planning objectives. The institutional, public, and technical significance of the alternative is also considered. Justification and selection of an alternative is described below:

- #0 No Action Alternative: The No Action alternative does not achieve the planning objectives because it provides zero net habitat output relative to future without project conditions. This alternative was not selected.
- #4 Riparian + No Ponds: This alternative is cost effective. It provides 45.7 AAHUs at an equivalent annual cost of $138,600, or about $3,000 per habitat unit. This alternative would yield only riparian habitat, failing to maximize habitat diversity, and failing to provide regionally scarce open water wetland habitat that is provided in other cost-effective alternatives. Without upper habitat ponds, this alternative does not provide an effective means of controlling water levels downstream of Emerald Road, putting the littoral zone of the downstream habitat features at unnecessary risk of loss due to fluctuating water levels. This alternative was not selected.
- #1 Original Riparian (4 ponds): This alternative is also cost effective. It provides 67.5 AAHUs at an equivalent annual cost of $164,700, or about $2,400 per habitat unit. The incremental cost and output of this alternative is due to the addition of four upper habitat ponds. These ponds allow control of water levels to alleviate the risk of damage to downstream habitat. Presence of four upper habitat ponds also reduces the impact of O&M on the habitat features. While this alternative improves upon the first cost effective plan it still fails to provide scarce open water wetland habitat and does not maximize diversity of habitat at the site. This alternative was not selected.
- #7 Original Combined (4 Ponds): This alternative is cost effective. It provides 89.05 AAHUs at an equivalent annual cost of $205,400, or about $2,300 per habitat unit. Relative to the previous alternative, incremental cost per unit output decreases significantly to the addition of four upper habitat ponds. Habitat output benefits from the addition of the ponds, as does the O&M stream, which is reduced to the presence of maintenance forebays on the habitat ponds. However, while this alternative provides a decrease in cost per unit output versus the previous alternative, this alternative still does not maximize efficiency at the site. Addition of two more upper habitat ponds would minimize the O&M stream and provide the optimum diversity of habitat at the site. As such, this alternative was not selected.
- #3 Original Combined (6 Ponds): The combined wetland/riparian alternative, with a full complement of six upper habitat ponds and wildlife passage culvert reasonably maximizes ecosystem benefits compared to costs. It produced 135.9 AAHU at an

equivalent annual cost of $221,100, or about $1,600 per habitat unit. This alternative is a cost-effective "best buy," minimizing incremental cost per unit output among all the alternatives. This alternative maximizes habitat diversity. This alternative is the highest best buy alternative among the alternatives. The amount of source water available from the Port of Sunnyside limits the amount of riparian, marsh, and open water habitat that can be re-created sustainably at the project site. Additionally, the Port has limited real estate assets at the project site upon which to implement wetland restoration, though the constraint did not govern the design. As such, this alternative represents the maximum possible alternative at site given identified constraints. This alternative was formulated to optimize each habitat type. With six upper habitat ponds, O&M cost, as well as habitat impact, is minimized. A full six upper habitat ponds also allows maximum operational flexibility at the site, ensuring viability of habitat downstream of Emerald Road. These benefits justify the added cost of the upper habitat ponds relative to other alternatives. This alternative is recommended.

The added cost associated with the upper habitat ponds over that of the "no pond" option is justified for several reasons.

- The upper habitat ponds create more habitat output than the without-pond option, with more (13.7 acres) of marsh and open-water habitat than the without-pond alternative.
- This alternative maximizes the diversity of habitat. Increased habitat diversity is a significant indicator for overall habitat quality that is not necessarily captured in the habitat models. The increased cost of the alternative is justified based on the increase in total output as well as the additional value of a diverse habitat that is afforded only by this alternative. Additionally, implementation of the upper habitat ponds results in the lowest incremental cost per unit output among the cost effective alternatives.
- The upper habitat ponds increase operational flexibility and help deliver water to the lower wetlands by providing settling buffering functions.
- The upper habitat ponds facilitate maintenance by isolating settling of solids in one area of the project, and allow the temporary shut-down of ponds for maintenance while still maintaining flows to the lower wetland.

In short, the upper habitat ponds create a more diverse, complex, and robust restoration plan. The Original Combined (6 Ponds) alternative is selected as the preferred alternative.

5.5 ATTAINMENT OF PLAN OBJECTIVES

The recommended restoration plan attains the project plan objectives to a significant extent. The matrix below briefly summarizes the planning goals and the project features that address these goals and objectives.

Objective	Project Feature
Restore diverse floodplain wetlands for a variety of wildlife species	Wetlands, ponds, and riparian areas will be established to transform the current agricultural landscape to a more natural riparian floodplain system, similar to historical conditions.
Restore the riparian zone along the Yakima River.	Wetlands, ponds, and riparian areas will be established to transform the current agricultural landscape to a more natural riparian floodplain system, similar to historical conditions.
Remove non-native species.	Planting plan will specifically identify removal of non-native species.
Recharge the groundwater table and hyporheic zone with cool, clean water.	Wetland pond infiltration and the infiltration trench will cool surface discharge and allow for groundwater infiltration and recharge.

Overall, the recommended plan meets each of the five planning objectives, with some uncertainty about the total capacity of the project as it relates to local infiltration rates. However, among the potential alternatives, the selected alternative would most effectively meet the planning objectives. Additionally, the selected alternative is most efficient, minimizing incremental cost per habitat unit. It is anticipated that this alternative is acceptable, meeting the requirements of all applicable laws, regulations, and public policies. The alternative is also complete.

The Significance (Institutional, Public, and Technical) of the recommended plan was also considered:

- Institutional Significance: The recommended plan is institutionally significant in that it restores regionally scarce open water wetland habitat along the Yakima River. Additionally, the plan provides a unique opportunity to work with the Port of Sunnyside to re-use clean treatment plant effluent in an environmentally positive way. While it is not quantified in the habitat analysis, the project may enhance fish habitat by increasing cool hyporheic flow to the Yakima River.. The project contributes progress on the goals of the Yakima Subbasin Plan (YSPB, 2004).
- Technical Significance: The recommended plan restores wetland and riparian habitat along the Yakima River that has become a scarce resource in the basin (YSPB, 2004). Additionally, open space areas such as the adjacent WDFW reserve and areas across the river from the project site would benefit from the project because it provides connectivity to additional habitat area near locations where some species are known to exist presently.
- Public Significance: The project has public significance due to the location along the Yakima River. The positive reuse of effluent from the local treatment plant has received public support. Some local interests remain ambivalent about the project, noting that the opportunity cost of restoring the site includes loss of potential revenue if the site were returned to agricultural use.

The selected restoration plan is the Combination Wetland and Riparian alternative. The next chapter describes the project features of the selected plan, along with the associated construction quantities and costs at a 35% design level.

5.6 EXPECTED SUCCESS OF THE PROJECT

The proposed project has a high likelihood of success because the primary hydrologic source (Port of Sunnyside wastewater treatment plant) has a known quantity meeting water quality Class A standards, discharging as low as 0.5 mgd but more likely between 1.3 to 2 mgd to the site. The water will be treated to comply with NPDES discharge permits and be sufficiently clean to allow a high level of functioning of the wetlands. The riparian and wetland plantings associated with the project will have a steady irrigation source during establishment and thus an expected high survival rate. The types of habitats included in the proposed project will be designed to mimic natural floodplain wetlands in the Yakima Valley. This will provide suitable habitat for a wide diversity of wildlife species. The project will not directly provide fish habitat, except during large floods, but will provide infiltration of significant quantities of water that will provide clean, cool groundwater inputs to the Yakima River and thus indirectly improve fish habitat. The restored riparian zone will further benefit the Yakima River by providing shading and input of large and small woody debris and other detritus and insects, further contributing to cover, habitat diversity, and the riverine food web.

5.7 RISK AND UNCERTAINTY

5.7.1 5.7.1 INFILTRATION RATES

As discussed in Sections 6.1.2 and 6.1.4, there is some uncertainty with regards to how quickly water will infiltrate throughout the site. If infiltration occurs more rapidly than anticipated, ecosystem benefits would still accrue, but there could be a different combination of acreages of open water, emergent wetland and riparian zone. The project delivery team recommends further field investigation during the design to better characterize near-subsurface infiltration at the proposed location and base elevation of the wetland. The design analysis can then adjust the pond size, or recommend soil amendment to all or parts of the site soils to meet a specified infiltration rate. During the abbreviated risk analysis, a 33% contingency was added to the earthwork line item largely to cover this uncertainty.

After construction, vegetation survival at the site should be monitored. Depending on monitoring results, the operation and maintenance activities (solely the responsibility of the non-federal sponsor) would include replanting as necessary with a species list informed by the as-built hydrology at the site. A monitoring plan and an operation and maintenance plan will be developed during the design phase, as detailed in Section 8.5.

5.7.2 CULTURAL RESOURCES

The Corps, in order to comply with Section 106 of the National Historic Preservation Act of 1966 (NHPA), has conducted a pedestrian survey, archival and background research; a search of the State of Washington Department of Archaeology and Historic Preservation (DAHP) database and is consulting with the Yakama Nation. These initial investigations did not reveal any known cultural resources at the project site. However, due to the possible presence of archaeological material within the Area of Potential Effects and the lack of ground surface visibility through large sections of the project area, archaeological monitoring is recommended and a monitoring plan is presented in Appendix B of the Cultural Resources Survey (Appendix K).

5.7.3 EMBANKMENTS IMPOUNDING WATER

The proposed project includes construction of embankments that would hold water in the 6 upper habitat ponds, the habitat pond west of Emerald Road, and the infiltration area. All ponded areas have an average design depth of 5 feet.

The water would flow from the upper habitat ponds into two channels (three ponds emptying into each), which would join together and pass under West Emerald Road through a culvert, and into the habitat pond west of Emerald Road. From there the water would flow through a channel into the infiltration area pond. During floods, water would overflow from the infiltration area pond, via a rock spillway, into the Yakima River.

The 6 upper habitat ponds would hold about 9 acre-feet of water each, with a maximum embankment height of 6 feet.

The habitat pond west of Emerald Road would hold about 34 acre-feet, with a maximum embankment height of about 6 feet.

The infiltration area pond would also hold about 34 acre-feet, with a maximum embankment height of about 6 feet.

If any of the embankments failed, the impounded water would flood across the site, through the spillway and into the Yakima River. If the spillway were overwhelmed by the volume of water, it is possible that water would back up into the Washington Department of Fish and Wildlife wetlands to the south and southeast. There are no structures between the project site and the Yakima River. The potential to impact life safety appears very small.

This page intentionally left blank.

Table 16. HEP Scores for Alternatives.

	No Action (Future-Without Project)				Alt 1 - Original Riparian - 4 Ponds				Alt 2 - Original Open Water - 6 Ponds				Alt 3 - Original Combined - 6 Ponds				Alt 4 - Riparian + No Ponds				Alt 5 - Open Water + No Ponds			
Years	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**
Yellow Warbler	0.46	0.52	0.52	0.52	0.53	0.69	0.78	0.86	0.53	0.69	0.78	0.86	0.53	0.69	0.78	0.91	0.53	0.69	0.78	0.86	0.53	0.69	0.78	0.86
Wood Duck	0.20	0.30	0.30	0.30	0.30	0.35	0.40	0.50	0.35	0.50	0.80	0.80	0.35	0.80	1.00	1.00	0.30	0.35	0.40	0.50	0.35	0.50	0.80	0.80
Beaver	0.33	0.35	0.57	0.57	0.78	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.78	1.00	1.00	1.00
Mink	0.50	0.50	0.50	0.50	0.55	0.80	1.00	1.00	0.60	0.80	1.00	1.00	0.60	0.80	1.00	1.00	0.55	0.80	1.00	1.00	0.60	0.80	1.00	1.00
Riparian HEP Score	*0.37*	*0.42*	*0.47*	*0.47*	*0.54*	*0.71*	*0.80*	*0.84*	*0.57*	*0.75*	*0.90*	*0.92*	*0.57*	*0.82*	*0.95*	*0.98*	*0.54*	*0.71*	*0.80*	*0.84*	*0.57*	*0.75*	*0.90*	*0.92*
Acres	15.50	15.50	15.50	15.50	40.30	40.30	40.30	40.30	33.50	33.50	33.50	33.50	55.50	55.50	55.50	55.50	32.40	32.40	32.40	32.40	24.80	24.80	24.80	24.80
Annual HU's	**5.79**	**6.48**	**7.32**	**7.32**	**21.80**	**28.57**	**32.09**	**33.88**	**18.98**	**25.00**	**30.02**	**30.68**	**31.44**	**45.59**	**52.52**	**54.29**	**17.54**	**22.97**	**25.79**	**27.24**	**14.04**	**18.51**	**22.23**	**27.71**
Total HU's				**354.07**				**1580.34**				**1437.21**				**2530.33**				**1270.54**				**1063.96**
Average Annual HU's				**7.08**				**31.61**				**28.74**				**50.61**				**24.41**				**21.28**

continued.

	Alt 6 - Combined + No Ponds				Alt 7 - Combined + 4 Ponds				Alt 8 - Riparian + Flow Culvert				Alt 9 - Open Water + Flow Culvert				Alt 10 - Combined + Flow Culvert			
Years	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**	**1- 5**	**6 - 10**	**11 - 25**	**26 - 50**
Yellow Warbler	0.53	0.69	0.78	0.91	0.53	0.69	0.78	0.91	0.53	0.69	0.78	0.86	0.53	0.69	0.78	0.86	0.53	0.69	0.78	0.91
Wood Duck	0.35	0.80	1.00	1.00	0.35	0.80	1.00	1.00	0.30	0.35	0.40	0.50	0.35	0.50	0.80	0.80	0.35	0.80	1.00	1.00
Beaver	0.78	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.78	1.00	1.00	1.00
Mink	0.60	0.80	1.00	1.00	0.60	0.80	1.00	1.00	0.55	0.80	1.00	1.00	0.60	0.80	1.00	1.00	0.60	0.80	1.00	1.00
Riparian HEP Score	*0.57*	*0.82*	*0.95*	*0.98*	*0.57*	*0.82*	*0.95*	*0.98*	*0.54*	*0.71*	*0.80*	*0.84*	*0.57*	*0.75*	*0.90*	*0.92*	*0.57*	*0.82*	*0.95*	*0.98*
Acres	26.10	26.10	26.10	26.10	32.30	32.30	32.30	32.30	40.30	40.30	40.30	40.30	33.50	33.50	33.50	33.50	40.50	40.50	40.50	40.50
Annual HU's	**14.79**	**21.44**	**24.70**	**25.54**	**18.30**	**26.53**	**30.56**	**31.60**	**21.82**	**28.57**	**32.09**	**33.88**	**18.98**	**25.00**	**30.02**	**30.68**	**22.94**	**33.27**	**38.32**	**39.62**
Total HU's				**1189.94**				**1472.61**				**1580.34**				**1437.21**				**1846.46**
Average Annual HU's				**23.79**				**29.45**				**31.61**				**28.74**				**36.93**

Table 17. HGM Model Scores for Alternatives.

	Alt 1 - Original Riparian - 4 Ponds				Alt 2 - Original Open Water - 6 Ponds				Alt 3 - Original Combined - 6 Ponds				Alt 4 - Riparian - No Ponds				Alt 5 - Open Water - No Ponds			
Function	**5**	**10**	**25**	**50**	**5**	**10**	**25**	**50**	**5**	**10**	**25**	**50**	**5**	**10**	**25**	**50**	**5**	**10**	**25**	**50**
Removing Sediments	9.05	9.05	9.05	9.05	8.94	8.94	8.94	8.94	9.05	9.05	9.05	9.05	9.05	9.05	9.05	9.05	8.94	8.94	8.94	8.94
Removing Nitrogen	3.81	3.81	3.81	3.81	3.11	3.11	3.11	3.11	2.69	2.69	2.69	2.69	3.81	3.81	3.81	3.81	3.11	3.11	3.11	3.11
Removing Phosphorus	6.79	6.79	6.79	6.79	6.71	6.71	6.71	6.71	6.79	6.79	6.79	6.79	6.79	6.79	6.79	6.79	6.71	6.71	6.71	6.71
Removing Toxics	6.77	6.38	6.19	6.19	6.54	6.33	6.23	6.23	6.62	6.33	6.19	6.19	6.77	6.38	6.19	6.19	6.54	6.33	6.23	6.23
Reducing Erosion/Flows	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Recharging Groudwater	0.61	0.61	0.61	0.61	0.63	0.63	0.63	0.63	0.56	0.56	0.56	0.56	0.61	0.61	0.61	0.61	0.63	0.63	0.63	0.63
General Habitat	6.13	8.06	8.45	8.45	6.51	8.84	8.84	8.84	7.42	8.84	8.84	8.84	6.13	8.06	8.45	8.45	6.51	8.84	8.84	8.84
Habitat for Invertebrates	8.45	8.45	8.45	8.45	8.63	8.63	8.63	8.63	7.92	7.92	7.92	7.92	8.45	8.45	8.45	8.45	8.63	8.63	8.63	8.63
Habitat for Amphibians	5.58	7.80	8.40	8.40	5.50	8.04	8.04	8.04	7.69	8.09	8.09	8.09	5.58	7.80	8.40	8.40	5.50	8.04	8.04	8.04
Habitat For Aquatic Birds	6.66	7.97	8.53	8.53	6.96	8.83	8.83	8.83	8.28	8.84	8.84	8.84	6.66	7.97	8.53	8.53	6.96	8.83	8.83	8.83
Habitat for Mammals	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Native Plant Richness	8.66	7.79	7.79	7.79	8.66	8.66	8.66	8.66	8.66	8.66	8.66	8.66	8.66	7.79	7.79	7.79	8.66	8.66	8.66	8.66
Supporting Food Webs	8.74	9.08	9.22	9.22	8.47	8.96	8.96	8.96	9.02	9.17	9.17	9.17	8.74	9.08	9.22	9.22	8.47	8.96	8.96	8.96
Sum	*91.25*	*95.80*	*97.29*	*97.29*	*90.67*	*97.67*	*97.56*	*97.56*	*94.70*	*96.94*	*96.80*	*96.80*	*91.25*	*95.80*	*97.29*	*97.29*	*90.67*	*97.67*	*97.56*	*97.56*
Sum/Total Possible	**0.68**	**0.71**	**0.72**	**0.72**	**0.67**	**0.72**	**0.72**	**0.72**	**0.70**	**0.72**	**0.72**	**0.72**	**0.68**	**0.71**	**0.72**	**0.72**	**0.67**	**0.72**	**0.72**	**0.72**
Acres	21.8	21.8	21.8	21.8	78.0	78.0	78.0	78.0	55.7	55.7	55.7	55.7	11.1	11.1	11.1	11.1	29.5	29.5	29.5	29.5
Annual HGM Habitat Units	15.8	15.5	15.7	15.7	52.4	56.4	56.3	56.3	39.1	40.0	40.0	40.0	7.5	7.9	8.0	8.0	19.8	21.3	21.3	21.3
Total HGM HUs				***780.9***				***2797.1***				***1993.9***				***397.6***				***1058.2***
Average Annual HGM HUs				**15.6**				**55.9**				**39.9**				**8.0**				**21.2**

Table 17 continued.

	Alt 6 - Combined - No Ponds				Alt 7 - Combined - 4 Ponds				Alt 8 - Riparian + Flow Culvert				Alt 9 - Open Water - Flow Culvert				Alt 10 - Combined - Flow Culvert			
Function	**5**	**10**	**25**	**50**	**5**	**10**	**25**	**50**	**5**	**10**	**25**	**50**	**5**	**10**	**25**	**50**	**5**	**10**	**25**	**50**
Removing Sediments	9.05	9.05	9.05	9.05	9.05	9.05	9.05	9.05	9.05	9.05	9.05	9.05	8.94	8.94	8.94	8.94	9.05	9.05	9.05	9.05
Removing Nitrogen	2.69	2.69	2.69	2.69	2.69	2.69	2.69	2.69	3.81	3.81	3.81	3.81	3.11	3.11	3.11	3.11	2.69	2.69	2.69	2.69
Removing Phosphorus	6.79	6.79	6.79	6.79	6.79	6.79	6.79	6.79	6.79	6.79	6.79	6.79	6.71	6.71	6.71	6.71	6.79	6.79	6.79	6.79
Removing Toxics	6.62	6.33	6.19	6.19	6.62	6.33	6.19	6.19	6.77	6.38	6.19	6.19	6.54	6.33	6.23	6.23	6.62	6.33	6.19	6.19
Reducing Erosion/Flows	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Recharging Groudwater	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.61	0.61	0.61	0.61	0.63	0.63	0.63	0.63	0.56	0.56	0.56	0.56
General Habitat	7.42	8.84	8.84	8.84	7.42	8.84	8.84	8.84	6.13	8.06	8.45	8.45	6.51	8.84	8.84	8.84	7.42	8.84	8.84	8.84
Habitat for Invertebrates	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	8.45	8.45	8.45	8.45	8.63	8.63	8.63	8.63	7.92	7.92	7.92	7.92
Habitat for Amphibians	7.69	8.09	8.09	8.09	7.69	8.09	8.09	8.09	5.58	7.80	8.40	8.40	5.50	8.04	8.04	8.04	7.69	8.09	8.09	8.09
Habitat For Aquatic Birds	8.28	8.84	8.84	8.84	8.28	8.84	8.84	8.84	6.66	7.97	8.53	8.53	6.96	8.83	8.83	8.83	8.28	8.84	8.84	8.84
Habitat for Mammals	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Native Plant Richness	8.66	8.66	8.66	8.66	8.66	8.66	8.66	8.66	8.66	7.79	7.79	7.79	8.66	8.66	8.66	8.66	8.66	8.66	8.66	8.66
Supporting Food Webs	9.02	9.17	9.17	9.17	9.02	9.17	9.17	9.17	8.74	9.08	9.22	9.22	8.47	8.96	8.96	8.96	9.02	9.17	9.17	9.17
Sum	*94.70*	*96.94*	*96.80*	*96.80*	*94.70*	*96.94*	*96.80*	*96.80*	*91.25*	*95.80*	*97.29*	*97.29*	*90.67*	*97.67*	*97.56*	*97.56*	*94.70*	*96.94*	*96.80*	*96.80*
Sum/Total Possible	**0.70**	**0.72**	**0.72**	**0.72**	**0.70**	**0.72**	**0.72**	**0.72**	**0.68**	**0.71**	**0.72**	**0.72**	**0.67**	**0.72**	**0.72**	**0.72**	**0.70**	**0.72**	**0.72**	**0.72**
Acres	25.8	25.8	25.8	25.8	43.9	43.9	43.9	43.9	24.6	24.6	24.6	24.6	78.0	78.0	78.0	78.0	55.7	55.7	55.7	55.7
Annual HGM Habitat Units	18.1	18.5	18.5	18.5	30.8	31.6	31.5	31.5	16.6	17.5	17.7	17.7	52.4	56.4	56.3	56.3	39.1	40.0	40.0	40.0
Total HGM HUs				***921.3***				***1572.1***				***880.3***				***2797.1***				***1993.9***
Average Annual HGM HUs				**18.4**				**31.4**				**17.6**				**55.9**				**39.9**

Table 18. Habitat Area by Alternative.

Action Alternative	Description	**Upland (acre)**	**Riparian [(a)] (acre)**	**Marsh [(a)] (acre)**	**Open Water [(a)] (acre)**	**Other [(b)] (acre)**	**TOTAL (acre)**
0	**No Action**	**0.0**	**15.5**	**0.0**	**0.0**	**166.6**	**182.1**
	Base Alternatives						
1	Original Riparian (4 ponds)	107.2	40.3	9.4	12.5	12.8	182.1
2	Original Open Water (6 ponds)	59.0	33.5	40.4	37.5	11.7	182.1
3	Original Combined (6 ponds)	66.0	55.5	32.0	23.8	4.9	182.1
	Upper Habitat Pond Options						
4	Riparian + No Ponds	42.2	32.4	5.5	5.6	96.4	182.1
5	Open Water + No Ponds	15.0	24.8	16.2	13.3	112.9	182.1
6	Combined + No Ponds	28.0	26.1	16.2	9.6	102.3	182.1
7	Combined (4 Ponds)	93.0	32.3	25.7	18.3	12.9	182.1
	Culvert Options						
8	Riparian + Flow Only Culvert	107.2	40.3	10.7	13.9	10.0	182.1
9	Open Water + Flow Only Culvert	59.0	33.5	40.4	37.5	11.7	182.1
10	Combined + Flow Only Culvert	81.0	40.5	32.0	23.8	4.9	182.1

Notes: (a) Riparian, marsh,and open water habitat areas are adjusted for for the effect of the upper habitat ponds have on water stabilization and maintenance footprint; please see Section 5.1.1.3 for more detail. (b) The land use category "Other" includes agricultural land use, public right-of-way (e.g., South Emerald Road), viewing point parking, and Yakima River surface area. It also includes areas substracted out from base habitat areas (see Section 5.1.1.3).

Table 19. Habitat Units by Alternative.

Action Alternative	Description	Ave. Ann. Riparian HU	Ave. Ann Wetland HU	Ave. Ann. TOTAL HU	w/ Culvert Multiplier(1)	Total AAHU	Δ from Exist Condition
0	**No Action**	**7.1**	**0**	**7.1**	**7.1**	**7.1**	**0**
	Base Alternatives						
1	Original Riparian (4 ponds)	31.6	15.6	47.2	74.6	74.6	67.5
2	Original Open Water (6 ponds)	28.7	55.9	84.6	133.7	133.7	126.6
3	Original Combined (6 ponds)	50.6	39.9	90.5	143.0	143.0	135.9
	Upper Habitat Pond Options						
4	Riparian + No Ponds	25.4	8.0	33.4	52.8	52.8	45.7
5	Open Water + No Ponds	21.3	21.2	42.5	67.2	67.2	60.0
6	Combined + No Ponds	23.8	18.4	42.2	66.7	66.7	59.6
7	Combined (4 Ponds)	29.5	31.4	60.9	96.2	96.2	89.1
	Culvert Options						
8	Riparian + Flow Only Culvert	31.6	17.6	49.2	49.2	49.2	42.1
9	Open Water + Flow Only Culvert	28.7	55.9	84.6	84.6	84.6	77.5
10	Combined + Flow Only Culvert	36.9	39.9	76.8	76.8	76.8	69.7

Notes: (1) Alternatives with wildlife culvert have multiplier of 1.58.

Table 20. Costs by Alternative.

Action Alternative	Description	Fixed Cost	Construction Cost	O&M Cost	Total Cost (NPV)	Annualized Total Cost[1]
0	**No Action**	**$0**	**$0**	**$0**	**$0**	**$0**
	Base Alternatives					
1	Original Riparian (4 ponds)	673,800	1,868,200	921,900	3,463,900	164,700
2	Original Open Water (6 ponds)	673,800	3,515,600	801,400	4,990,800	237,300
3	Original Combined (6 ponds)	673,800	3,092,100	883,000	4,648,900	221,100
	Upper Habitat Pond Options					
4	Riparian + No Ponds	673,800	1,135,100	1,105,000	2,913,900	138,600
5	Open Water + No Ponds	673,800	2,457,300	984,500	4,115,600	195,700
6	Combined + No Ponds	673,800	2,033,800	1,062,300	3,769,900	179,300
7	Combined (4 Ponds)	673,800	2,766,900	879,100	4,319,800	205,400
	Culvert Options					
8	Riparian + Flow Only Culvert	673,800	1,778,700	921,900	3,374,400	160,500
9	Open Water + Flow Only Culvert	673,800	3,426,100	801,400	4,901,300	233,100
10	Combined + Flow Only Culvert	673,800	3,002,500	879,100	4,555,400	216,600

Notes: (1) Costs amortized at 4.125 percent over 50 years.

Table 21. Cost per Habitat Unit by Alternative.

Action Alternative	Description	Annualized Cost	ΔAAHU Over Existing Condition	Annualized Cost per AAHU
0	**No Action**	**$ 0**	**0.0**	**$ 0**
	Base Alternatives			
1	Original Riparian (4 ponds)	164,700	67.5	2,440
2	Original Open Water (6 ponds)	237,300	126.6	1,874
3	Original Combined (6 ponds)	221,100	135.9	1,627
	Upper Habitat Pond Options			
4	Riparian + No Ponds	138,600	45.7	3,032
5	Open Water + No Ponds	195,700	60.0	3,261
6	Combined + No Ponds	179,300	59.6	3,009
7	Combined (4 Ponds)	205,400	89.1	2,307
	Culvert Options			
8	Riparian + Flow Only Culvert	160,500	42.1	3,811
9	Open Water + Flow Only Culvert	233,100	77.5	3,006
10	Combined + Flow Only Culvert	216,600	69.7	3,107

Notes: (1) Annualized ΔHU is the total ΔHU (compared to the existing condition) divided by 50 years.

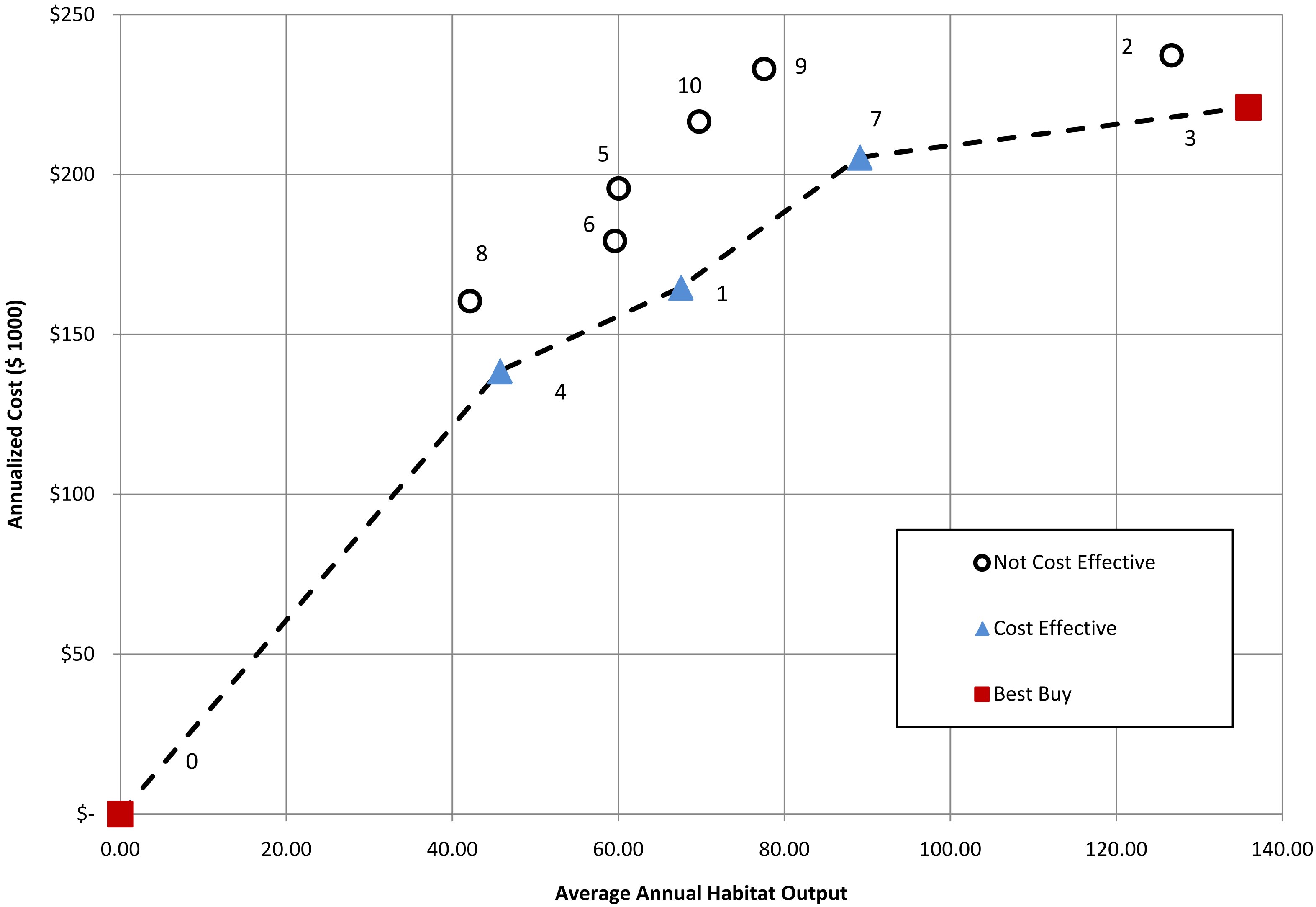

Figure 18. Cost Effectiveness Analysis Summary (All Alternatives).

This page intentionally left blank.

6.0 RECOMMENDED RESTORATION PLAN

This section describes the recommended restoration plan, i.e., the combined wetland/riparian alternative with a full complement of upper habitat ponds and wildlife passage culvert. The *35 percent feasibility plans* found in Appendix C supplement this discussion. Figure 23 (page 80) provides a reference figure for the following discussion.

6.1 PROJECT FEATURES

The 2011 Sunnyside wetlands project scales down a previous 2009 design with an inflow capacity of 4 mgd (Tetra Tech, 2009) to match the 2 mgd of existing available flow from the Port of Sunnyside facilities. This discussion highlights the elements of the project plan.

6.1.1 PIPELINE AND VALVES

Design and construction of the pipe delivery system along Murray Road will proceed separately from construction of the Sunnyside 206 habitat restoration project. The project scope assumes the pipeline constructed by others will deliver the effluent to the southeastern corner of the project site. It has been estimated that a 22,000-foot transmission pipe would be required to transport the effluent from the plant to the project site (Skillings/Connolly, 2002). Currently, this pipeline is not part of the feasibility study and will be designed and constructed separately by the Port of Sunnyside. The actual size of the pipeline will be further refined as the pipeline design proceeds. Figure 3 (page 6) shows the relative location of the treatment plant to the project site.

This project will connect delivery pipelines to the main pipeline to route the effluent to the upper habitat ponds. Manually operated valves would be placed at the inlets to the upper habitat ponds to allow closure for maintenance and varying flow rates; the delivery pipeline would become progressively smaller as the capacity requirements decrease.

6.1.2 UPPER HABITAT PONDS

The 2011 design proposes six upper habitat ponds, sized to accommodate the revised design flow rate. The 2011 design also consolidates the ponds into the southeast part of the site in order to decrease the length of effluent transmission pipe and streamline the project footprint. The upper habitat ponds will be used in different combinations depending on inflow rates, influent water chemistry and required hydraulic retention time. Multiple ponds also ensure that the system can remain in operation during temporary maintenance closures of one or more ponds. Figure 19 illustrates one possible operational scenario where four ponds are operational at any given time, with one pond being drained down but available for emergency “overflows” and one closed for maintenance. Under this scenario, each pond would be required to handle a maximum of 0.5 mgd.

For each pond, the preliminary design analysis estimated 200,500 cubic feet of detention volume would be required to achieve minimum hydraulic residence time (HRT) of 72 hours, and an additional 3785 cubic feet of storage volume would be needed to account for potential deposition of suspended solids in the effluent stream. The upper habitat ponds would be 4-6 feet deep, which should be adequate to inhibit macrophyte growth. Each pond is configured like a "racetrack," with a large island in the middle. This configuration prevents flow from short-circuiting through the pond, and provides additional habitat area. The current preliminary design specifies the upper habitat ponds as having a circular or ellipsoid shape; future design refinements can provide a more natural effect to the shoreline of these ponds. The design proposes a perforated riser pipe for the upper habitat pond outlet structure, which has the ability to decant water from a larger portion of the water column without re-suspending materials in the pond.

The perennial water source from the Port of Sunnyside and the option of lining the ponds will serve to help preserve the habitat benefit of the upper habitat ponds. The design plans do not specify pond liners at this time. This is because preliminary water balance calculations based on extreme drought conditions (that is, minimum average inflow of 0.5 mgd with no precipitation and maximum recorded monthly evapotranspiration) and the range of infiltration conditions found across the site indicate that the upper habitat ponds will likely be able to maintain a permanent pool during extreme drought conditions. As with the habitat pond (see Section 6.1.4), the design team recommends further field investigation to better characterize near-subsurface conditions at the proposed location and base elevation of the upper habitat wetlands. The design analysis can then adjust the pond size, or recommend soil amendment to all or parts of the site soils to meet a specified infiltration rate.

Each upper habitat ponds includes a maintenance forebay. The maintenance forebay consolidates the pond's maintenance footprint by localizing the deposition of residual suspended solids that might be present in the water supply, thus reducing disturbance to wildlife present in the upper habitat pond area.

Each maintenance forebay measures approximately 30 feet wide by 30 feet long at its base, with permeable weirs constructed of gabion rock baskets at each end. Figure 19 illustrates a conceptual engineering sketch of the maintenance forebay. The design places the inlet pipe approximately 4 feet above the invert of the upper habitat pond; gabion baskets with concrete grouted surface provide energy dissipation for pond inflows.

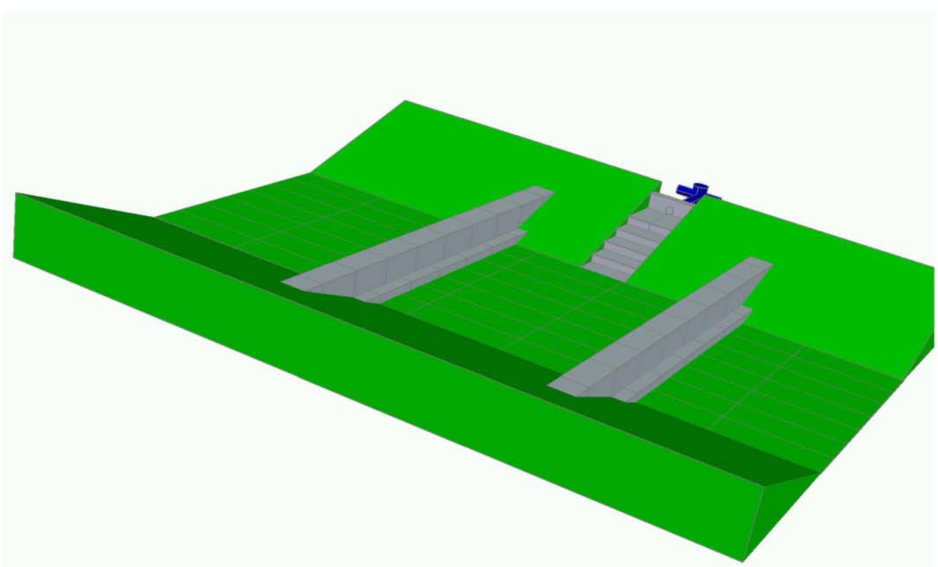

Figure 19. Concept Sketch for Upper Habitat Pond Maintenance Forebay.

The design team anticipates that the scheduled drainage and maintenance periods for the upper habitat ponds would be short, infrequent, and localized enough so as to not significantly impact their habitat benefit. Selection of vegetation will be for species tolerant of periodic dryness. Preliminary deposition estimates, based on total suspended solids (TSS) from Port of Sunnyside effluent data, anticipate a potential for 3785 cubic feet of residual deposition annually in each 0.5 mgd pond. Therefore, the approximately 5040 cubic feet of volume below the inlet pipe and between the permeable weirs would need to be cleaned out approximately every 16 months.

The issue of deposition and maintenance protocols will be addressed and refined further in future design phases.

Period	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6
1	In Use	In Use	In Use	In Use	Out of Service	Overflow
2	Overflow	In Use	In Use	In Use	In Use	Out of Service
3	Out of Service	Overflow	In Use	In Use	In Use	In Use
4	In Use	Out of Service	Overflow	In Use	In Use	In Use
5	In Use	In Use	Out of Service	Overflow	In Use	In Use
6	In Use	In Use	In Use	Out of Service	Overflow	In Use

Figure 20. Conceptual Operation Plan for Upper Habitat Ponds.

6.1.3 TRANSITION CHANNELS AND SOUTH EMERALD ROAD CULVERT

The design specifies two "transition channels" carrying flow from the upper habitat ponds to the lower wetland areas, each servicing three of the upper habitat ponds. Each of these ponds will have a maximum outflow of approximately 0.5 mgd (0.8 ft^3/s, say 1 ft^3/s), so the design flow rate for the transition channels was specified as 3 ft^3/s. The transition channel will be configured as a "pilot channel" within a larger channel generally trapezoidal in shape (Figure 21). The longitudinal slope of the transition channel will be approximately 0.2 percent, and will have a meandering planform. Because design flow rates are extremely low and highly controlled, the design assumes no freeboard will be required.

The channel design was chosen in order to provide maximum aquatic and riparian habitat. The channels themselves will provide habitat to aquatic macroinvertebrates, periphyton, and potential resident native fish species. The flowing water will create turbulence that will increase the amount of dissolved oxygen in the water. The riparian vegetation will provide shade that will further reduce and maintain cool water temperatures. The riparian area will also create habitat to various nesting and perching songbirds and provide a travel corridor for small mammals and amphibians.

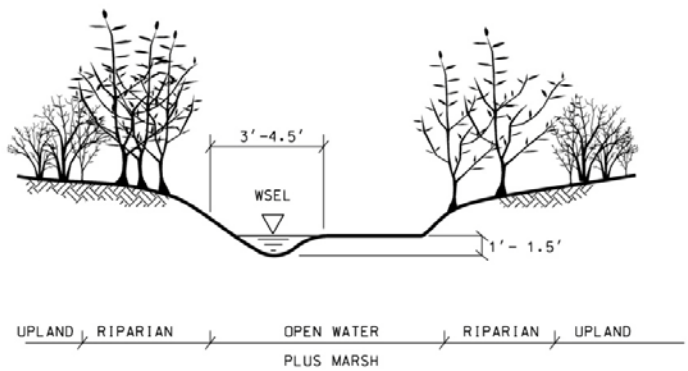

Figure 21. Typical Transition Channel Cross-Section.

The transition channels direct flow from the upper habitat ponds to a single culvert under South Emerald Road. The design proposes a 12-ft x 8-ft reinforced concrete box (RCB) culvert counter-sunk into grade with a gravel bed (Figure 22). The over-sized culvert with natural bottom allows the culvert to serve as a habitat corridor, allowing for the safe movement of aquatic and terrestrial species. For a consistent hydraulic gradient through the culverts, the channel would be constructed with 2-3 feet of fill at the entrance, and 3-4 feet of excavation at the outlet. The culvert structures are assumed to be precast concrete, and the wingwalls and headwalls are assumed to be cast-in-place concrete. Some utility relocation should be anticipated during construction.

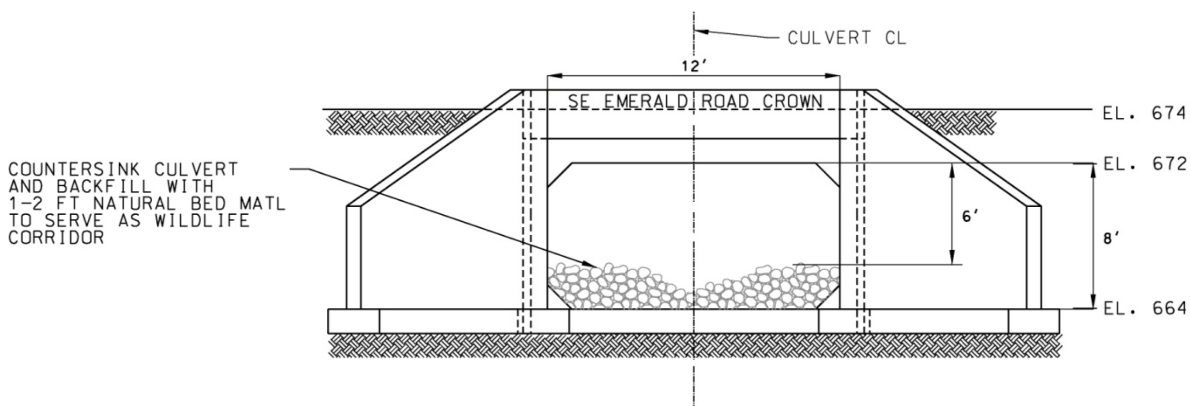

Figure 22. Emerald Road Culvert Design.

6.1.4 HABITAT POND

The habitat pond is located immediately west of S Emerald Road. While the upper habitat ponds (Section 6.1.2) and infiltration area (Section 6.1.6) will also have habitat benefits, this area and the riparian floodplain channel with overflow ponds (Section 6.1.5) have the single purpose of habitat creation.

The size of the habitat wetland is based on a water balance of available source water, estimated soil infiltration rates, and climatic factors. The wetland has been sized to maintain its permanent pool of approximately 6.8 acres even during extreme drought conditions (no precipitation and maximum evapotranspiration). Deep water areas will be 4-6 feet deep, and shallow marsh areas will be approximately 1-2 feet deep. The project seeks to balance cuts and fills, with the excess excavated material from the wetlands area used to balance the areas east of Emerald Road. The design proposes a weir outlet structure for the habitat pond, with stop logs to allow adaptive management of the water depth according to actual operating conditions. The habitat pond is located outside the FEMA Special Flood Hazard Area (SFHA, commonly known as the 100-year floodplain) to reduce the risk of habitat damage during large flow events.

The habitat pond design analysis considered a "worst-case" scenario to determine the maximum perennial wetland surface area at the project site. This worst-case scenario considered water balance components during the hottest, driest month of July:

- 0.48 mgd (minimum July average daily inflow from Port of Sunnyside)
- 0.00 in precipitation of (minimum recorded July precipitation)
- 15.43 in/month evapotranspiration (maximum recorded July evapotranspiration)

The habitat pond analysis used a representative permeability of 25 ft/day, characteristic of sand layers at the project site as recommended in the Hydrogeologic Summary Report (Appendix D, page 7). The permeability was converted to an infiltration rate of approximately 22.2 in/month per acre using Darcy's equation and measured hydraulic gradient of 0.00237 ft/ft across the site.

Under the worst-case scenario, the maximum permanent pool of deep-water habitat that could be sustained during severe summer drought conditions would be approximately 14.6 acres. Because 14.6 acres is comparable to almost the entire zone between the Yakima River and Emerald Road that is outside of the 100-year flood area on the site, the design analysis concluded that the pond sizing would be governed by grading considerations. The proposed habitat wetland has approximately 6.8 acres of surface area.

Wetland design parameters, especially infiltration rates, have a high degree of uncertainty. To acknowledge this uncertainty, the design analysis conducted a sensitivity analysis based on the range of expected soil infiltration values at the project site. Hydrogeologic investigations included six slug tests to characterize subsurface hydraulic conductivity. The calculated infiltration rates across the project site ranged from 14.8 inches/month per acre to 339 inches/month per acre, with rates generally larger nearer the Yakima River. Coincidentally, the two closest explorations to the proposed habitat pond (M-3 and M-5) corresponded to the maximum and minimum infiltration rates. The corresponding range in maximum perennial pond surface areas was 1.5 and 18 acres, respectively. At 6.8 acres, the proposed habitat pond falls within the expected range of sustainability.

Because the habitat pond impounds more than 10 acre-feet of water, the project may be subject to review by the State of Washington Department of Ecology, Dam Safety Office (DSO). Revised Code of Washington Section RCW 90.03.350 states that anyone intending to construct or modify any dam or controlling works for the storage of 10 acre-feet or more of water shall submit plans and specification therof to Department of Ecology (Ecology, 2004).

Approaches that might be used to reduce the uncertainty of wetland sustainability due to infiltration rates include further field investigation during design, construction contingency, and adaptive management. During the next design phases, the design team recommends further field investigation to better characterize near-subsurface infiltration at the proposed location and base elevation of the wetland. The design analysis can then adjust the pond size, or recommend soil amendment to all or parts of the site soils to meet a specified infiltration rate. Construction contingency would entail including a budget line item to account for such soil amendment during construction. Lastly, adaptive management strategies can be used to modify the water elevation using outlet structure, or re-planting vegetation to take advantage of actual post-project hydrologic conditions.

Several acres of deepwater habitat, shallow marsh emergent wetland habitat, shrub wetland, riparian habitat, and upland habitat will be created within the wetlands area. Open water wetland habitat is very beneficial to waterfowl and migratory birds. The riparian habitat of the wetland is designed to provide shade to cool and maintain the temperature of the water. The riparian area will also create habitat to various nesting and perching songbirds and provided a travel corridor for small mammals and amphibians. The wetland vegetation will provide excellent cover habitat for amphibian species. The upland habitat will provide excellent natural upland habitat beneficial to small mammal and bird species. Because the upland habitat improvements proposed as part of this project provide a necessary buffer to other habitat and continuity to wildlife corridors, USACE cost-sharing for this upland habitat is appropriate for this project.

6.1.5 RIPARIAN FLOODPLAIN CHANNEL WITH OVERFLOW PONDS

The riparian channel and overflow ponds are located west of the habitat area within the floodplain of the Yakima River. The purpose of the riparian channel and overflow ponds is to provide additional habitat on the project site, and transmit water to the infiltration area next to the river. The riparian channel will be configured as a “pilot channel” within a larger channel generally trapezoidal in shape. The longitudinal slope of the transition channel will be approximately 0.2 percent, and will have a meandering planform. Because design flow rates are extremely low and highly controlled, the design assumes no freeboard will be required.

The channel design was chosen in order to provide maximum aquatic and riparian habitat. The channels themselves will provide habitat to aquatic macroinvertebrates, periphyton, and potential resident native fish species. The flowing water will create turbulence that will increase the amount of dissolved oxygen in the water. The riparian vegetation will provide shade that will further reduce and maintain cool water temperature. The riparian area will also create habitat to various nesting and perching songbirds and provide a travel corridor for small mammals and amphibians.

The overflow ponds will be inundated intermittently, primarily during periods where the Yakima River overtops its banks or during local runoff events. The overflow ponds will provide additional floodplain storage and increase available riparian or wetland-type habitat at the project site. The overflow ponds also provide a practical construction purpose of serving as borrow areas that help balance the grading of the site.

6.1.6 INFILTRATION AREA

This feature has the hydrologic purpose of infiltrating water into groundwater as it drains the wetlands. However, it was also designed to maximize habitat value. The open water pond area will provide habitat to migratory birds and waterfowl along the Yakima River corridor. In addition the edges of the ponds will be lined with emergent wetland vegetation that will provide habitat for amphibians. Riparian plantings along the banks will also provide shade to cool the water.

The infiltration trenches will be constructed to connect surface water to the underlying groundwater table. The infiltration trenches would be created by excavating the overlying silts and sands to expose the native gravels. Gravel backfill would then be placed in the trenches to an elevation that allows the formation of adjacent ponds prior to seepage into the trench. The trench is designed to allow seepage under the typical hydrologic conditions. Some plugging is anticipated as finer materials deposit in the gravels. For continued functionality, some periodic replacement of gravels is anticipated.

The dimensions shown on the plan set in Appendix C are preliminary based upon initial geotechnical explorations and preliminary estimates of infiltration rates. Final dimensions (length, width, and depth) of the infiltration trenches will be specified during the design implementation phase based upon more detailed geotechnical and hydraulic characterization of the soils at the infiltration site. The trench is also designed to be as wide as most heavy equipment, and the trench surface will remain clear of vegetation for maintenance purposes. The gravels can be replaced by driving along the surface of the infiltration trenches.

Like the habitat wetland, size of the ponding area is based on a water balance of available source water, estimated soil and gravel infiltration rates, and climatic factors. The wetland has been sized to maintain its permanent pool even during extreme drought conditions (no precipitation and maximum evapotranspiration). Deep water areas will be 4-6 feet deep, and shallow marsh areas will be approximately 1-2 feet deep. The project seeks to balance cuts and fills, with the excess excavated material from the wetlands area used to balance the areas east of Emerald Road.

The design proposes a weir inlet to each of the three infiltration trench segments and the outlet of the infiltration area. The weirs will feature stop logs to allow adaptive management of inflow to the infiltration trenches and the water depth according to actual operating conditions, and facilitate maintenance of the infiltration trenches.

6.1.7 SPILLWAY AND CHANNEL

Water that does not infiltrate in the trenches, including peak effluent periods, local rainfall events, or during periods where the Yakima River overtops its banks, travels over a rock weir and down a constructed channel to the Yakima River. The channels downstream of the spillway include buried rock weirs to prevent scour during overtopping events.

6.1.8 CONSTRUCTED BERM

Under the current design, a berm separates the ponded effluent from the wetlands on the adjacent parcel to the east. The berm is considered an interim solution that prevents impacts to adjacent parcels; solutions that allow the ponds to function as a single hydrologic feature may be considered in future design refinements.

6.1.9 MAINTENANCE ACCESS ROADS AND PARKING AREA

Maintenance access roads will be located throughout the site. These are unimproved roads that will be used to access the project area, and perform basic maintenance and operations activities. The roads will be kept clear of vegetation and remain accessible during summer maintenance periods. Periodic grading, placement of road surfacing and potholing will be required to maintain the road surfaces.

A parking and recreational viewing area will be located, west of Emerald Road and outside of the 100-year floodplain, and is accessed to the north of Murray Road. The parking area will have an access gate and be either fenced or confined using large rock or bollards. The intent of the parking area is to provide recreational and educational access for viewing of the wetland restoration area.

6.1.10 YAKIMA RIVER RIPARIAN CORRIDOR

The riparian corridor along the bank of the Yakima River will be planted with native vegetation and exotic species will be removed. Noxious weeds (such as reed canarygrass, yellow flag iris, and Canada thistle, purple loosestrife) will be removed on other portions of the project site as part of standard construction preparation (i.e., clear and grub) activities. Compliance with the Shoreline Management Act requires a 200-foot buffer along the Yakima River (Skillings/Connolly, 2002). The riparian buffer zone will serve the purpose of providing habitat to perching and nesting birds and serves as a migratory corridor for mammals. In addition, the riparian vegetation will provide shade and cover along the Yakima River to benefit the cold water salmonids and other native fish species.

6.2 CONSTRUCTION QUANTITIES AND COST

Appendix H for the 35 percent feasibility design provides a detailed summary of preliminary engineer's opinion of the probable construction cost.

[Appendix H AND THE DISCUSSION IN THIS SECTION WILL BE DETAILED OUT IN THE SUBSEQUENT DRAFTS OF THE REPORT.]

6.3 FINAL DESIGN

Several design considerations related to project conditions including hydrology, hydraulics, civil, and structural design will need to be further addressed during final design.

6.3.1 HYDROLOGIC AND HYDRAULIC RECOMMENDATIONS

Several areas of analysis and design need to be completed during final phase of design. The following is a summary of these items.

- Infiltration load testing to finalize size of infiltration trenches and infiltration pond.
- Infiltration load testing to better characterize infiltration rates at the location and proposed elevation of the habitat pond.
- Update local hydrologic water budget model using Dupuit calculations and evapotranspiration estimates and calibrations to aquifer load testing.
- Estimate percent reductions in effluent temperatures.
- Evaluate necessary periods for maintenance flushing related to potential for salt, sediment and organic buildup in ponds and infiltration trenches.
- Develop hydraulic model of pond and outlet structures and finalize design details of hydraulic structures.

To determine the potential effects of groundwater loading to the Yakima River and its associated floodplain, a pilot infiltration trench test is recommended to simulate and further test the characteristics of the project's infiltration capacity. The pilot test would involve constructing a small scale infiltration trench in a similar fashion and location to the proposed infiltration trenches. A single piezometer and temperature gage would be installed in the pilot test infiltration trench, with additional piezometers installed down the hydraulic gradient from the pilot infiltration trench to monitor head and temperature of groundwater. Water for the pilot test would be pumped from the Yakima River into the pilot infiltration trench at scaled rate equivalent to the proposed loading rate of 0.5 mgd to 2 mgd planned for the wetlands. The test would be run for 48 to 72 hours. The hydraulic properties determined from infiltration pilot test would then be used in conjunction with groundwater monitoring data and engineering designs to simulate the effect of the constructed wetlands and infiltration trenches on the Yakima River system.

6.3.2 CIVIL AND STRUCTURAL DESIGN RECOMMENDATIONS

Several areas of analysis and design for civil and structural project features are needed to finalize the design. The following is a summary of these items.

- Structural and geotechnical design of all culvert crossings at site.
- Civil and hydraulic design of the overflow outfalls based on final infiltration trench sizing.
- Civil design of effluent conveyance and pipe structures to the site.
- Civil design of on-site hydraulic conveyance and control structures (risers, pipes, stop logs, gates).
- Irrigation flushing system hydraulic controls and connection for flushing of ponds to remove potential salt buildup.
- Infiltration load testing to finalize size of infiltration trenches.
- Develop a detailed construction sequence for habitat restoration site and link with effluent pipeline construction schedule.
- Develop and identify historical underground storage tank (UST) location and zone of contamination (reference Appendix A). Design plans should avoid this area for excavation.

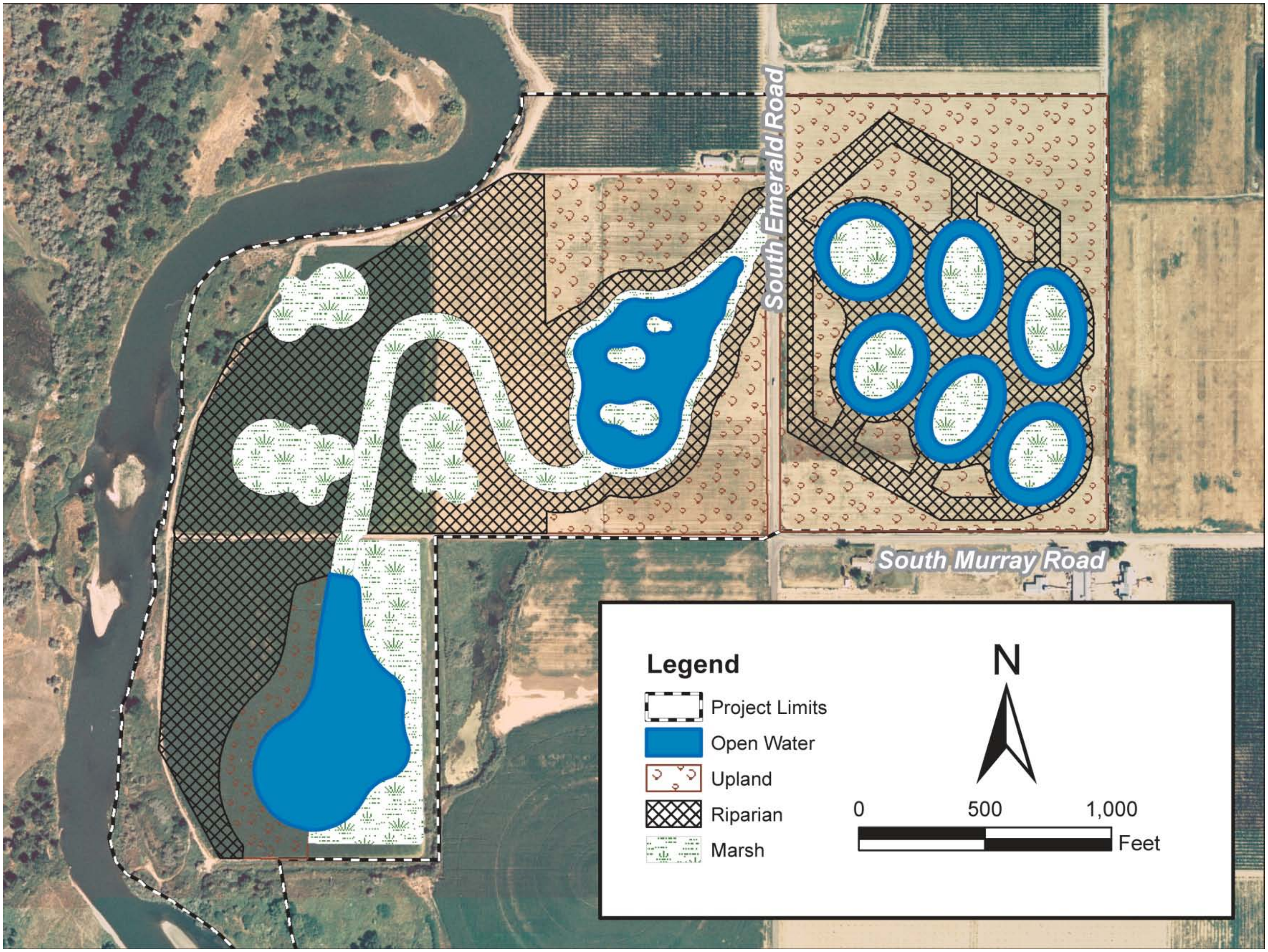

Figure 23. Recommended Restoration Plan (35 Percent Feasibility Design).

7.0 EFFECTS OF THE CONSIDERED ALTERNATIVES

7.1 EFFECTS SUMMARY OF NON-SELECTED ALTERNATIVES

The following alternatives were considered but not selected. Effects of these alternatives are summarized in this section. Table 22 provides a matrix of effects for all eleven alternatives. Following that, the effects of the No Action and the two unselected base alternatives (introduced in Section 4.1) are discussed in detail in the subsections below.

Table 22 first identifies whether or not an alternative satisfied each planning objective. For each alternative, the table notes whether the objective was not satisfied, insufficiently satisfied, partially satisfied, or completely met.

The second portion of Table 22 notes six significant affected resources (water quality, vegetation, invasive species, wetlands, fish and wildlife, and threatened and endangered species). For each resource, the table notes the degree of beneficial effect each alternative would have, from none, to moderate, to high.

Maximization of ecosystem diversity was a key consideration in Table 22. A complete restoration project should seek to maximize ecosystem diversity in order to mimic historic wetland and riparian areas.

This page intentionally left blank.

Table 22. Effects of Considered Alternatives

	Alternatives										
	Alt 0. No Action	**Alt 1. Original Riparian 4 Ponds**	**Alt 2. Original Open Water 6 Ponds**	**Alt 3. Original Combined 6 Ponds**	**Alt 4. Riparian + No Ponds**	**Alt 5. Open Water + No Ponds**	**Alt 6. Combined + No Ponds**	**Alt 7. Combined + 4 Ponds**	**Alt 8. Riparian + Flow Only Culvert**	**Alt 9. Open Water + Flow Only Culvert**	**Alt 10. Combined + Flow Only Culvert**
Study Objectives (No, Minimal, Partial, or Complete attainment of the objective)											
1. Restore diverse floodplain wetlands for a variety of wetland species	No	Minimal	Minimal	Complete	No	Minimal	Partial	Partial	No	Minimal	Partial
2. Restore the riparian zone along the Yakima River	No	Complete	Partial	Complete	Partial	Complete	Complete	Complete	Complete	Partial	Complete
3. Remove non-native species	No	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete
4. Recharge the groundwater table and hyporheic zone with cool, clean water	No	Complete	Partial	Complete	Complete	Partial	Complete	Complete	Complete	Partial	Complete
Significant Affected Resources Affects (No, Moderate, or High beneficial effects)											
Water Quality	No	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Vegetation	No	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Invasive Species	No	High	High	High	High	High	High	High	High	High	High
Wetlands	No	Moderate	Moderate	High	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate
Fish and Wildlife	No	Moderate	Moderate	High	Moderate	Moderate	High	High	Moderate	Moderate	Moderate
Threatened and Endangered Species	No	Moderate	Moderate	High	Moderate	Moderate	High	High	Moderate	Moderate	Moderate

This page intentionally left blank.

7.1.1 NO ACTION

Under the No Action alternative there would be no effects to geography, geology, climate, cultural resources, transportation and irrigation infrastructure, and environmental justice.

Soils and water quality at the site will continue to degrade due to agricultural practices at the site and lack of riparian filtration and groundwater infiltration. No changes would occur to the hydrology and hydraulics of the site. The disconnection of the floodplain from the Yakima River, lack of floodplain storage, and the lack of groundwater recharge would persist.

Vegetation will not improve at the site as the land-use will keep the area under agricultural production. Invasive species will spread in the non-productive areas. Habitat for fish and wildlife would continue to be lacking in the project area.

Employment and revenue for contracting companies will not be generated as a result of the project, however, the land will remain in agricultural production and the tax base will be maintained at the local level. Recreational opportunities would not be created.

With the no action alternative there will be continued degradation of habitat from human developments and activities and watershed processes would continue have reduced function, including the lack of Yakima River wetland floodplain connectivity would not be remedied.

7.1.2 ORIGINAL RIPARIAN (ALT 1)

Under the Riparian Alternative, there would be no effects to geography, climate, cultural resources, transportation and irrigation infrastructure, and environmental justice both during construction and long term, as a result of the implementation of the selected plan.

Effects on geomorphology, water quality, socio-economic resources would be similar to that of the selected alternative both under construction and long-term effects.

Effects on soils would be similar to that of the selected alternative with the exception that less excavation would be required during construction. Conversely, less area would be converted to wetland thus less area would be restored to the historic natural soil conditions at the site.

No effects are anticipated on the Yakima River hydrology, however, the hydrology at the site will be affected dramatically. The local drainage area will change as runoff will decrease and storage will increase. Groundwater hydrology will also change due to increased infiltration.

Effects on vegetation would be similar to that of the selected alternative and provide a significant beneficial effect on native plant communities and wetlands, with the exception that less area will be affected.

Effects on fish and wildlife and threatened and endangered species would improve similarly to the improvements noted for the Selected Plan. Habitat for native fish, eagles, waterfowl, amphibians, and reptiles will be created and improved at the project site. Construction would be timed to avoid bald eagle nesting periods and in-water work will be conducted within the fish window.

Cumulative effects of this alternative would be similar to the Selected Alternative. It would also provide restoration of ecosystem processes and functions. Under this alternative, the lack of Yakima River wetland floodplain connectivity would not be remedied, but other wetland functions such as groundwater recharge and habitat would be improved.

7.1.3 ORIGINAL OPEN WATER (ALTS 2)

Under the Open Water Alternative, there would be no effects to the geography, climate, cultural resources, transportation and irrigation infrastructure, and environmental justice both during construction and long term, as a result of the implementation of the selected plan.

Effects on soils, geomorphology, water quality, socio-economic resources would be similar to that of the selected alternative both under construction and long-term effects.

No effects are anticipated on the Yakima River hydrology, however, the hydrology at the site will be affected dramatically. The local drainage area will change as runoff will decrease and storage will increase. Groundwater hydrology will also change due to increased infiltration.

Effects on vegetation would be similar to that of the selected alternative and provide a significant beneficial effect on native plant communities and wetlands, with the exception that less area will be affected.

Effects on fish and wildlife and threatened and endangered species would improve similarly to the improvements noted for the Selected Plan. Habitat for native fish, eagles, waterfowl, amphibians, and reptiles will be created and improved at the project site. Construction would be timed to avoid bald eagle nesting periods and in-water work will be conducted within the fish window.

Cumulative effects of this alternative would be similar to the Selected Alternative. It would also provide restoration of ecosystem processes and functions. Under this alternative, the lack of Yakima River wetland floodplain connectivity would not be remedied, but other wetland functions such as groundwater recharge and habitat would be improved.

7.2 EFFECTS SUMMARY OF SELECTED ALTERNATIVES

This section summarizes the effects of the selected alternative, specifically addressing: geography; geology; soils; climate; hydrology and hydraulics; geomorphology; water quality; vegetation; fish and wildlife; threatened and endangered species; socio-economic resources; transportation and irrigation infrastructure; cumulative effects; and environmental justice.

7.2.1 GEOGRAPHY

No effects on geography, both during construction and long term, are expected to occur as a result of the implementation of the selected plan.

7.2.2 GEOLOGY

No effects on geology, both during construction and long term, are expected to occur as a result of the implementation of the selected plan.

7.2.3 SOILS

7.2.3.1 Construction Effects

The project will involve the excavation of soil at the site to create upper habitat ponds, wetland habitat, and infiltration areas. The excavated material will be redistributed to create additional project features. The project grading plan attempts to balance the cuts and fills to minimize net import or offsite disposal of materials to the extent that is practical; future design phases will be able to refine the grading plan further. Gravel will be imported and placed in the infiltration trenches, to facilitate infiltration into the groundwater table. If excess material is removed from the project site, it will be hauled to an approved upland location for disposal.

Care of construction is necessary to protect from over excavation of the silt topsoil layer in the habitat ponds, which could expose underlying gravel soils and increase infiltration rates, and decrease the amount of hydrologic inundation for the adjacent wetland and riparian plant root structure. The treatment of soils and excavation depths need to be actively managed during construction, through reporting and inspections.

7.2.3.2 Long-term Effects

The restoration of wetlands at the site will involve the flooding of large areas. When soil is flooded, a rapid depletion of oxygen occurs and an anaerobic environment is created. Under these conditions, the soils at the site will take on the characteristics of hydric soils. This is similar to the soil condition that existed prior to agricultural land-use and river hydrologic modifications, when the site was a floodplain wetland. This will be a beneficial effect of restoring natural soil conditions to the site.

Sediment will need to be periodically removed from the site, particularly in the upper habitat ponds and infiltration trenches. The maintenance work will be of short duration and not affect the overall conditions on the site.

7.2.4 CLIMATE

There will be no measurable effects on climate either during construction or as a result of long term operation of the selected plan. According to the United States Global Change Research Program, the Northwest region’s average temperature is projected to rise 3 to 10°F in this century, with higher emissions scenarios resulting in warming in the upper end of this range. Increases in winter precipitation and decreases in summer precipitation are projected by many climate models, though these projections are less certain than those for temperature. The construction associated with this project is not anticipated to have a significant impact on regional climate change.

7.2.5 HYDROLOGY AND HYDRAULICS

The proposed project has several features that will change the existing surface and groundwater hydrologic characteristics of the site. The habitat ponds, in conjunction with the transition channels, infiltration trenches and outfall structures will route treated wastewater effluent from east to west towards the Yakima River. A majority of flow will be infiltrated through the porous materials in the cells aligned several hundred feet from the edge of the Yakima River. These cells will be directly connected to the underlying Yakima River floodplain aquifer. This aquifer connection will allow infiltration of the treated wastewater effluent, and will provide further reductions in water temperatures as the effluent travels through subsurface soils and mixes with the existing groundwater table. Relatively minor amounts of groundwater are expected to infiltrate through the pond areas to the shallower Yakima River terrace aquifer, and a portion of overflow is expected during larger storm runoff events.

7.2.5.1 Yakima River Mainstem Hydrology

The constructed project is not anticipated to affect the overall Yakima River hydrology. The excavation in the infiltration area will increase the available storage volume during times when the Yakima River overflows its banks; however, the area would quickly fill with water and the overall effect on the Yakima River discharge would be negligible. The maximum peak discharge of treated water from the project to the Yakima River is approximately 3 cfs is approximately 0.1 percent of the average Yakima River flow at the project site, which is considered negligible. The Yakima River will affect the site during major flood events. The westernmost portion of the site is within the 100 year floodplain of the Yakima River, but will only infrequently be inundated. The project will have negligible effects on the Yakima River system, although the River during food conditions could potentially cause damages to the wetland, pond and infiltration treatment system that need consideration during design, operations and maintenance.

7.2.5.2 Local Project Site Hydrology

The project will affect the local drainage area by decreasing the areas of runoff and increasing storage. It will affect the local groundwater hydrology by increasing the amount of groundwater infiltration on the order of 0.5-2.0 mgd and raise the underlying groundwater table. The radius of the groundwater mounding is undetermined, but will likely extend beyond the limits of the project boundary. More complex numerical groundwater modeling is recommended to estimate the extent of mounding. It is also recommended that further testing of infiltration capacity be performed to support final design of the project to further refine infiltration capacity estimates. Local drainage patterns will be altered by the constructed features and stormwater will be detained in the large ponds.

The hydrologic analyses included a basic water balance to ensure that the habitat and infiltration areas would be able to sustain a permanent pool during extreme drought conditions (i.e., no precipitation and maximum evapotranspiration). This water balance analysis should be refined further to reduce uncertainties associated with the assumed soil infiltration rates.

7.2.5.3 Local Hydrogeology

Based on the results of the field investigation and previous site investigations, a conceptual model of the groundwater system was developed. The intent of the hydrogeologic analysis was to evaluate the feasibility of infiltrating from 0.5 to 2 mgd of wastewater treated effluent at the proposed site as a means to reduce thermal loading and benefit the receiving water body, the Yakima River.

Based on preliminary infiltration trench size of 10-ft wide by 10-ft deep, and an aquifer thickness of 26 feet with a hydraulic conductivity of 600 ft/day, the initial analysis 2200 gallons per day per linear foot infiltration trench. 1250 ft of infiltration trench would be able to infiltrate 2.75 mgd. Because this analysis assumed that the infiltration trench would not fully penetrate the Yakima River floodplain aquifer, a sensitivity analysis was performed to see how conservative or non-conservative the estimated infiltration rate was. The analysis involved narrowing the Yakima River floodplain aquifer depth down from 26 feet to 3 feet. Using this case the maximum capacity of the trench is about 0.63 mgd. The 0.63 mgd to 2.75 mgd of infiltration capacity indicates that the infiltration trenches could likely infiltrate most if not all of the 0.5-2 mgd of effluent loading to groundwater flow. The size, location and connectivity of the trench (and some pond features) may be modified to increase infiltration areas and discharge rates to the floodplain aquifer if future analysis indicates a need for higher infiltration capacity.

Groundwater mounding is expected to occur at the site. For upstream areas, it is assumed that the ground will become fully saturated over time and groundwater elevations will rise from approximately 660 ft up to the proposed upper habitat pond and wetland water surface elevations. The groundwater mound will extend out beyond the project boundary at a gradient similar to existing spring runoff and summertime irrigation conditions as a result of the additional hydrologic loading on the site.

Overall, the project can meet the infiltration requirements of the project. Adjustments in the size and configuration of the trench, wetland, and pond systems can be modified to meet the infiltration requirements of the project. Also, groundwater mounding is expected at the project site and beyond the boundary. The level of effect could be further evaluated using a more complex numerical groundwater model.

7.2.6 GEOMORPHOLOGY

There will be no effect on the overall geomorphology of the Yakima River, either during construction or over the long term. Part of the project site is out of the River's active floodplain, and the remaining portions of the project on the active floodplain will not likely change river meandering or other natural sediment transport or hydraulic processes. The river meander has been stable over the last 50 years and the likelihood of avulsion or excessive meandering is low. The project will improve floodplain storage through construction of pond features that will replicate natural floodplain features including oxbow ponds and wetlands areas.

The amount of water entering the river through the additional groundwater discharge created by the restored wetlands plus the removal of the direct discharge of the effluent water under current conditions will not have a significant effect on the flows of the Yakima River. The Yakima River will likely influence the function of the wetland, pond and treatment system over time. The River will likely deliver fine sediments to the area during flood conditions, which could contribute to clogging of the wetland, pond and infiltration system. This will require maintenance following flooding (see Section 8.5).

7.2.7 WATER QUALITY

The proposed use of treated wastewater effluent to meet the project objectives will be delivered to the site meeting current water quality standards (WAC, 2003). Water infiltrated through the upper habitat ponds, habitat ponds, and the infiltration trenches will recharge the underlying aquifer. The organics in the effluent will provide energy and nutrients to the wetland system that will fuel the wetland primary production and sustain the habitat in this reach of the river.

The effluent will carry some total dissolved solids to the site. Due to evapotranspiration, there will be a salt build-up over time in the wetland soils. To prevent any potential adverse impact on vegetation and wildlife populations, the project site should be flooded every five to ten years with irrigation water to flush the salts from the soils following standard agricultural practices guidelines.

A priority pollutant screen was performed for metals on the Port of Sunnyside effluent. The lab analysis results indicate that all metals were below detection, except total zinc and total copper. Observed levels of these constituents are low, not dissolved, and totally non-bio-available. Therefore, these do not pose a problem for water quality pollution.

7.2.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

The HTRW report produced for the project followed American Society for Testing and Materials (ASTM) guidance by attempting to identify the potential for hazardous waste to be present on the project site (Appendix A). The ten specific sites of concern identified in the Phase I and

Phase II assessments have been remediated. However, future design plans will include the delineation of a construction and excavation work limit buffer around the historic underground storage tank site. If any waste material is encountered during construction, it will be removed and disposed of in an appropriate landfill. Washington State Department of Ecology will be contacted in the event any hazardous or toxic materials are encountered during construction.

7.2.9 AIR QUALITY AND NOISE

The operation of heavy equipment during construction activities will result in increased vehicle emissions, and earth moving occurring as part of the project will result in an increase in dust. These effects will be localized and temporary. Emissions will not exceed EPA's de minimis threshold levels (100 tons/year for carbon monoxide and 50 tons/year for ozone) or affect the implementation of Washington's Clean Air Act implementation plan. Therefore, impacts will be insignificant.

During construction, noise associated with the usage of heavy machinery may disturb residents in close proximity to the site; however, residents should be accustomed to similar noise levels associated with agricultural equipment. These impacts will be temporary and highly localized, and are not expected to result in significant impacts.

7.2.10 VEGETATION

Based on 10 percent project plans, the project will restore approximately 51 acres of native riparian vegetation and create approximately 55 acres of marsh and open-water wetlands. The project also includes approximately 81 acres of native buffer plantings. The project is expected to have a significant beneficial effect on native plant communities and wetlands.

7.2.11 INVASIVE SPECIES

Non-native species currently present on the site will be removed or significantly reduced in population and area. Invasive species will be removed as part of standard clearing and grubbing activities at the initiation of project construction. For instance, noxious weeds (such as reed canarygrass, yellow flag iris, Canada thistle, and purple loosestrife) will be removed as part of standard construction site preparation (i.e., clear and grub) activities. Invasive species along shoreline of the Yakima River will be removed, while preserving existing native species. The shoreline will be revegetated with supplemental riparian vegetation as needed.

The native plant communities will be diverse including deep water habitats with floating leaved plants (*Potamogeton* sp., etc.), shallow marsh habitats (*Typha* and *Carex* species), shrub wetlands (*Spirea* and *Salix* species), riparian forested (*Populus*), and uplands (with sage scrub species).

7.2.12 WETLANDS

[Appendix J provides the 404(b)(1) wetland analysis for the project site, and describes the type, quality, and mitigation requirements for wetlands at the project site. Revised discussion of write up of existing condition wetlands will be inserted here by USACE after delineation is completed.]

The WDFW Sunnyside Wildlife Area is located immediately south and east of the infiltration basin portion of the project site (see Appendix C, Plate V-101, Parcel No. 17-11001-B). The WDFW has requested that any effects to groundwater levels or surface water runoff to their adjacent property be evaluated as part of this study. Formal or quantitative analysis of WDFW site hydrology is beyond the scope of the current project; therefore, this discussion addresses potential effects to groundwater levels and surface water qualitatively.

There is no surface water connectivity between the project site and the adjacent site because of the berm along the perimeter of the proposed infiltration basin area. Therefore, the proposed project should have little effect on the surface water hydrology of the WDFW site. It is reasonable to assume that there is groundwater connectivity between the project site and the WDFW site. By increasing the water table between the WDFW site and the Yakima River, the infiltration basin may decrease the hydraulic gradient and thus moderate groundwater table fluctuations at the WDFW site. This moderation in groundwater table fluctuations may consequently result in a wetter wetland regime than currently present at the WDFW site. It is expected that a wetter regime will benefit the WDFW reserve, since they often need to irrigate to keep the site functioning as a wetland.

7.2.13 FISH AND WILDLIFE

Nesting bald eagles can be disturbed by construction activities if the nest is within 0.25 miles (0.4 km) of the construction site (Brown, 1999). Areas of the project site are contained within the Washington Department of Fish and Wildlife priority habitat and species polygon for riparian zones. This polygon is described as the Yakima River and riparian area south of Union Gap and was designated due to the presence of wintering bald eagles, waterfowl, beaver, other furbearers and song birds. Based on this designation, it is assumed that bald eagles nest near the project site. Construction will be timed to avoid the bald eagle nesting period and therefore should only have minor temporary effects on bald eagles.

The selected plan will significantly improve the condition of native habitat for fish and wildlife. The removal of non-native vegetation and replanting of native vegetation will improve the quality of riparian habitat for birds and other wildlife. The restoration of a functioning riparian zone will improve wildlife migratory corridors and provide cover and nesting/foraging habitats.

Bald eagles would benefit from the eventual availability of nest trees and perching/wintering sites along the river, which currently do not exist at the site. The placement of LWD in the wetland features would also provide potential perching sites. In addition improvement of fish habitat within the river may also increase fish populations over time increasing the food source for bald eagles.

Waterfowl, amphibian and reptile habitat would especially be improved through the creation of wetland features by providing a perennial water source and a diversity of habitats and complex structures, including LWD.

Fish species will not be negatively affected by this project. The project site has been specifically designed to exclude fish, and therefore fish are not anticipated to use the project directly. Specifically, there is no direct connection to the Yakima River during non-flood flows, and no riverine water is used as water supply. While it is not quantified in the habitat analysis, the project would enhance fish habitat by increasing cool hyporheic flow to the Yakima River. The shade produced from the restored riparian zone will also tend to reduce heating of the water temperatures in the river in the project vicinity, and the riparian restoration will promote eventual recruitment of large woody debris (LWD) habitat structure in the river, further improving habitat conditions for native cold-water fish species, including salmonids,.

7.2.14 THREATENED AND ENDANGERED SPECIES

During construction there is potential for the disturbance of threatened and endangered species present at the project site. Of the listed threatened and endangered species, only the salmonid species have the potential to be directly affected by project actions during construction.

Construction of the overflow outlets will occur below the Ordinary High Water Mark (OHWM) of the Yakima River. Construction will occur during low flows and all actual work will be out of the water. Best management practices will be employed to prevent the runoff of sediment or pollutant laden water into the river. All disturbed areas will be seeded or otherwise protected from erosion at the end of construction to prevent any potential for increased turbidity or other runoff after construction is complete.

This project has been designed to benefit threatened, endangered, and native species through the restoration of riparian and wetland habitats and the infiltration of large quantities of water into the groundwater table that will recharge into the river during low flows. The riparian zone along the Yakima River will be restored to a native plant community and provide riparian functions such as shade to reduce water temperature and LWD recruitment for habitat structure to benefit salmonids. The restored riparian and wetland habitats will additionally provide cover and foraging opportunities for many threatened and endangered species. Temporary trapping of fish may occur as floodwaters recede on the project site in pond areas. The overflow channels created to drain the wetlands during flood occurrences will be accessible to fish therefore avoiding stranding and trapping scenarios.

Overall, the project will have no effects on Canada lynx, gray wolf, grizzly bear, marbled murrelet, Northern spotted owl, or Ute ladies' tresses. The project may affect but is not likely to adversely affect bull trout, or Middle Columbia River steelhead during construction of the project. There are expected to be long-term beneficial effects for these species from the restoration of riparian and wetland habitats at the project site.

Appendix I includes the Draft Biological Evaluation for reference.

7.2.15 SOCIO-ECONOMIC RESOURCES

As a result of the implementation of the selected plan, minor effects on the socio-economic resources will occur both in the construction phase and in the long-term. During construction, the project will generate employment and revenue for contracting companies. In the long term the removal of the acreage from agricultural production will have a slight reduction in tax base at the local level. However, the site will impact socio-economic resources in a beneficial way by providing a recreational opportunity in an area where such a resource is lacking.

7.2.16 CULTURAL RESOURCES

In accordance with Section 106 of the National Historic Preservation Act, a cultural resource investigation was performed by USACE Seattle District, in consultation with the Washington State Department of Archaeology and Historic Preservation and in coordination with the Yakama Indian Nation. The cultural resources survey report is included as Appendix K of this document. Based on the negative findings of this study, a determination of No Historic Properties Affected was made. However, due to poor ground visibility through much of the project area and the high potential for archaeological material to be present, USACE recommended archaeological monitoring of all areas where there will be disturbance of previously undisturbed native soils. The 29 January 2009 cultural resources inventory report summarizes the investigation and provides a monitoring plan as Appendix B to the report. The Washington State Department of Archaeology and Historic Preservation and the Yakama Indian Nation concur with the determination of No Historic Properties Affected conditioned upon implementation of the archaeological monitoring plan.

7.2.17 TRANSPORTATION & IRRIGATION INFRASTRUCTURE

South Emerald Road will be temporarily closed or partially closed during construction and will likely necessitate detours for local residents. Murray road will likely have increased construction related traffic. This is not expected to be a significant effect as the project area is sparsely populated and there are numerous alternate roads.

Utilities will need to be temporarily relocated and there may be short-term disruptions in service. This includes provisions for care, protection and temporary measures for the irrigation delivery infrastructure along South Emerald Road and along the northern property boundary of the project site. This should be coordinated with the SVID.

The Drainage Improvement District DID#16 drainage channel has been excluded from the project and will be protected during construction and will not be affected. However, the drain tile and pipe leading west to the river is within the project excavation areas, and not functioning. The final design will likely need to accommodate protection, or even replacement of the structure for which it is assumed coordination with DID#16 will be necessary. The protection or replacement of the pipe does not directly affect the functions and output of the project.

Overall, these design items are not expected to be a significant impact.

7.2.18 CUMULATIVE EFFECTS

Cumulative impacts result from the incremental impact of a proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative adverse impacts in the Yakima Basin have occurred over the past 150 years, as Euro-American settlement has changed the structure and function of the watershed. This project is specifically intended to assist in the incremental reversal of these cumulative impacts.

This project would provide wetland, riparian, and aquatic restoration, which would address cumulative impacts to some degree. The project is specifically designed to benefit species of concern in the area, including fish, birds, mammals, and amphibians. Creating functioning wetlands and connected floodplains offer the opportunity to improve watershed processes, improve both fish and wildlife habitats, and introduce a diversity of habitats for various life stages. But possibly more importantly, functioning wetlands and connected floodplains also provide a sustainable component to the existing system. It is within these habitats that rivers and streams naturally form habitats, such as from the recruitment of LWD and gravel, provide flood storage, groundwater recharge and create wetlands, and scour side-channels where a variety of species forage and find refuge. Wetlands buffer flooding and purify waters passing through vertically or downstream. Both of these habitats act as crucial buffers to the river itself, not only rejuvenating the rivers that flow through them, but providing critical buffering protection from ongoing human development and activity. It is when these habitats are present and functioning that cumulative adverse impacts can most effectively be reversed.

The project will have minimal off-site effects. There are no current or future construction projects slated for this area, excepting the pipeline that will deliver source water to the site (see

Figure 3). This pipeline is not a part of the current project (i.e., it will be built by others) and will be constructed within existing irrigation easements and/or through public right-of-way. The future expansion of Port of Sunnyside treatment capacity depends strictly on demand from their industrial clients and regulatory requirements, and is totally independent of whether this wetland project is built. Because treated effluent must meet Washington State Department of Ecology Discharge standards prior to being used at the site, it by definition meets all NPDES and TMDL requirements (see letter from Ecology in Appendix M), and therefore the construction of any additional Port treatment facilities to meet regulatory standards would be independent of this wetland project as well.

7.2.19 ENVIRONMENTAL JUSTICE

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The federal government has this goal for all communities and persons across this nation. It would be achieved when everyone enjoys the same degree of protection from environmental and health hazards, equal access to the decision-making process, and the opportunity to have a healthy environment in which to live, learn, and work.

This project will not have a disproportionate effect on ethnic minority, low-income, or subsistence populations. Subsistence populations may benefit from the proposed improvements to fish habitat and fish populations.

7.3 ENVIRONMENTAL COMPLIANCE

A review of pertinent environmental laws and regulations was performed and a consistency statement developed as shown in Table 22.

Table 23. Summary of Environmental Compliance

LAWS AND REGULATIONS RELATING TO THE PROPOSED PROJECT	ISSUES ADDRESSED	CONSISTENCY OF PREFERRED ALTERNATIVE
National Environmental Policy Act (NEPA), 42 U.S.C. 4321 et seq.	Requires all federal agencies to consider the environmental effects of their actions and to seek to minimize negative impacts.	Consistent per EA document.
Clean Water Act (CWA), 33 U.S.C. 1251 et seq., Section 404	Requires federal agencies to protect waters of the United States. Disallows the placement of dredged or fill material into waters (and excavation) unless it can be demonstrated that it is the least environmentally damaging practicable alternative.	Project will be consistent with 404(b)(1) guidelines. If fill into waters of the U.S. would occur for the project, USACE will evaluate the proposed work for substantive compliance with the 404(b)(1) guidelines and follow the necessary public coordination procedures under Section 404.
Clean Water Act, Section 401	Requires federal agencies to comply with state water quality standards.	If fill into waters of the U.S. would occur for the project, USACE will obtain a water quality certification prior to construction.
Clean Water Act, Section 402	Requires federal agencies to permit pollutant discharges.	Likely will require Port of Sunnyside to update to existing NPDES permit from Ecology.
Rivers and Harbors Act, Section 10	Requires federal agencies to protect and preserve the navigability of navigable waters	Consistent – no new structures that might impact or obstruct navigation are to be placed in navigable waters
Clean Air Act, 42 U.S.C 7401 et seq.	Requires states to develop State implementation plans (SIP) for eliminating or reducing the severity and number of violations of National Ambient Air Quality Standards (NAAQS) while achieving expeditious attainment of the NAAQS. The Act also requires Federal actions to conform to the appropriate SIP.	Consistent - The area is in attainment or unclassified for all pollutants. Emissions of pollutants from the limited equipment used will be negligible

LAWS AND REGULATIONS RELATING TO THE PROPOSED PROJECT	ISSUES ADDRESSED	CONSISTENCY OF PREFERRED ALTERNATIVE
Endangered Species Act, 16 U.S.C. 1531 et seq.;	Requires federal agencies to protect listed species and consult with US Fish & Wildlife or NOAA Fisheries regarding the proposed action.	Consistent per consultation.
National Historic Preservation, Act 16 U.S.C. 461;	Requires federal agencies to identify and protect cultural and historic resources.	USACE to do SHPO consultation.
Coastal Zone Management Act (CZMA), 16 USC 1451 et seq.	Compliance with CZMA for protection of the coastal zone; may need certification by state.	Not Applicable - The sites are not in the coastal zone.
Wild and Scenic Rivers Act 16 USC 1271-1278	Requires federal agencies to protect the free-flowing condition and other values of designated rivers and consult with the federal agency charged with administering the act.	Not applicable – This reach of the Yakima River is not listed as a wild and scenic river (NPS, 2007).
Executive Order 11988: Floodplain Management Guidelines	Requires federal agencies to evaluate the potential effects of actions on floodplains and to avoid undertaking actions that directly or indirectly induce growth in the floodplain or adversely effect natural floodplain values.	Consistent - not encouraging development in the floodplain.
Executive Order 11990: Protection of Wetlands	Encourages federal agencies to take actions to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands when undertaking federal activities and programs.	Consistent – Currently degraded wetlands will be improved at the project site.
Executive Order 12898: Environmental Justice	Requires federal agencies to consider and address environmental justice by identifying and assessing whether agency actions may have disproportionately high and adverse human health or environmental effects on minority or low-income populations.	Consistent – No adverse human health or environmental effects on minority or low-income populations in local area.
Executive Order 11593, Protection and Enhancement of the Cultural Environment	Requires federal agencies to preserve, restore, and maintain the historic and cultural environment of the U.S.	USACE to do consultation.
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	Requires federal agencies to consult and coordinate with the appropriate tribal governments.	USACE to do consultation.

LAWS AND REGULATIONS RELATING TO THE PROPOSED PROJECT	ISSUES ADDRESSED	CONSISTENCY OF PREFERRED ALTERNATIVE
Native American Graves Protection and Repatriation Act	Protects Native American and Native Hawaiian cultural items.	USACE to do consultation.
Indian Treaty Rights	Protect Indian tribes' property, water rights and usual and accustomed fishing areas.	USACE to do consultation.
American Indian Religious Freedom Act 42 U.S.C. 1996	Requires federal agencies to insure that religious rights of Native Americans are accommodated during project planning, construction, and operation.	USACE to do consultation.
Washington Water Quality Standards	Requires that actions that may affect water quality of waterbodies in the state comply with water quality regulations.	Consistent.
Washington Threatened and Endangered Species	Requires an evaluation of effects on listed threatened and endangered species	Consistent.
Washington Hydraulic Code	Requires an evaluation of effects on waterbodies within the state of Washington	The Washington Department of Fish and Wildlife (WDFW) may be required if the local sponsor elects to apply for this permit, although it is not required with USACE of Engineers as a project sponsor.

This page intentionally left blank.

8.0 PLAN IMPLEMENTATION

8.1 COST SHARING

As described in Section 6.2, the total estimated present value cost for the recommended restoration plan, is $[TO BE UPDATED]. This cost reflects the preferred plan accommodating existing available source water conditions and *35 percent feasibility design plans*.

This sum does not include the cost of the Project Restoration Plan (PRP), real estate, or future operation and maintenance (O&M). Table 23 provides an estimate of these costs, including a breakdown of federal and non-federal share. In general, project costs are shared with a 65% Federal and 35% non-Federal share; however, cost-share percentages for the project costs vary by item.

Table 24. General Cost Breakdown for the Recommended Plan. [TO BE UPDATED PER REVISED COST ESTIMATE]

PHASE	TOTAL COST	FEDERAL SHARE	NON-FEDERAL SHARE
PRP*	$	$	$ 0
FEASIBILITY			
PED			
CONSTRUCTION (1)			
S&A			
MONITORING			
TOTALS			
LERRD CREDIT			
FEASIBILITY REVIEW CREDIT			
SUBTOTAL LOCAL SPONSOR CREDITS			$
LOCAL SPONSOR CASH REQUIREMENT			$

The total construction cost for the recommended Restoration Plan includes a 25 percent construction contingency. Planning, engineering, and design costs (PED) are assumed to be 10 percent of the construction cost. Supervision and Administration costs (S&A) are assumed to be 8 percent of the construction cost, contingency and PED.

8.2 SCHEDULE

The majority of the construction will occur above the OHWM of the Yakima River. Thus, construction does not have to be limited to the accepted fish window for the Yakima River with the exception of activities below the OHWM and within the river areas, such as the outlet connections to the river. Work periods to protect spawning and incubation for steelhead and Chinook are June 15th through October 1st. Upland construction schedules need to avoid the bald eagle nesting season of January through mid-August.

The overall estimated schedule (Table 24) is 26 weeks in length. Provisions in the specifications will be necessary to ensure the construction contractor completes the work within the allowable work windows.

Table 25. Estimated Construction Schedule.

Construction Item	**Duration**
1. Mob/Demob	1 week
2. Clearing, Grubbing, TESC	1 week
3. Demolition/Disposal	1 week
4. Rough Grading/Excavation	8 weeks (Total)
4.1 Ponds (Cut)	2 week
4.2 Infiltration Trenches (Cut)	2 week
4.3 Channel Connections (Cut)	1 week
4.4 Floodplain Grading (Fill)	1 week
4.5 Infiltration Trench (Fill)	2 week
5. Structure Installation	6 weeks (Total)
5.1 Culverts	4 weeks
5.2 Rock Weirs	1 week
5.3 Head Gates	1 week
6. Finish Grading	2 weeks
7. Plantings	4 weeks
8. Cleanup/Disposal	1 weeks
9. Project Startup and Construction Contract Closeout	2 weeks
Total Duration (1)	**26 weeks**

Notes: (1) Total duration is less than cumulative sum of all work due to assumption that some tasks can be performed in parallel.

8.3 LAND, EASEMENTS, RIGHTS-OF-WAY, RELOCATION, AND DISPOSAL AREAS (LERRD)

The Port of Sunnyside owns the majority of the lands required for the project. The Port owns 240 acres, which covers the entire project footprint with the exception of approximately 2 acres along South Emerald Road, where Yakima County maintains a 50-foot right-of-way easement. An easement from WDFW may be considered during the next phase of design to allow this project to function hydrologically with the WDFW Wildlife Area. There are no USACE lands or former projects directly located within the project area. The Port of Sunnyside has spent to date $1,214,536 in acquiring the land and an additional $545 in testing and analysis for HTRW and groundwater studies. Some utility relocation is anticipated during construction.

8.4 ENVIRONMENTAL COMPLIANCE REQUIREMENTS

This project is not expected to have any significant adverse effects on the environment as documented in this Integrated Detailed Project Report/Environmental Assessment. A Finding of No Significant Impact (FONSI) will be completed and appended upon completion of this draft report. Consultation under Section 7 of the Endangered Species Act (ESA) is on-going.

8.5 MONITORING AND OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION (OMRRR)

Monitoring, maintenance, and contingency plans are integral to the success of restoration projects because they assess project performance, determine whether ecological success has been achieved, or whether adaptive management is needed. To ensure success of the plantings and the eventual development of the targeted plant communities and habitats, monitoring, maintenance and contingency activities will be conducted. The proposed restoration site will be monitored by the Corps and the Port during construction and throughout the specified monitoring period. The federal share of the monitoring costs shall not exceed one percent of the total first cost of ecosystem restoration features (USACE, 2000). The Port will be responsible for the long-term maintenance and adaptive management of the site.

Following construction, project success will be monitored and evaluated, and changes will be made to operation and maintenance practices, as necessary, to ensure project objectives are met without adverse ecosystem impacts. Performance standards and adaptive management activities will be developed for parameters such as the following: 1) native vegetation survival; 2) native vegetation aerial cover; 3) native vegetation diversity; 4) invasive species aerial cover; and 5) hydrology.

Development of an Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRRR) and a Monitoring Plan will occur in the design and implementation phase. Uncertainty in groundwater infiltration rates will affect the potential sustainability of the project's wetland features. Therefore, the OMRRR should include provisions to re-vegetate the site based on actual system performance if necessary.

8.6 VIEWS AND RESPONSIBILITIES OF THE SPONSOR

The Port of Sunnyside is the local sponsor and would assume full responsibility for all future project related operation, maintenance, rehabilitation and replacement needs. The local sponsor has committed in principle to funding the project and has received a grant from the Washington Department of Ecology towards implementing this project. The local sponsor has committed to providing adequate water to the site to sustain ecosystem benefits for the life of the project, assumed to be at least 50 years.

This page intentionally left blank.

9.0 RELATIONSHIP TO OTHER STUDIES

The Sunnyside Ecosystem Restoration Section 206 project was initiated in response to the Preliminary Restoration Plan (PRP) report developed by the Seattle District, COE (USACE, 2003). The PRP provides an overview of project location; description; historic, current, and future conditions; project alternatives; costs/benefits; financing obligations; sponsorship views; and a preliminary project schedule. The results of the feasibility study have increased the acreage to be restored from 70 acres to 220 acres in order to provide more benefits to the aquatic ecosystem.

The feasibility of constructing wetlands was analyzed in the Skillings/Connoly (2002) report for the Port of Sunnyside. The selected plan is consistent with the recommendations of that study.

Another important study is the Yakima Subbasin Plan (YSPB, 2004) that identifies interior riparian wetland habitat as a high priority for preservation and restoration and achievement of salmon recovery goals. This restoration project will contribute significantly towards the goal of restoring riparian wetland habitat (see also Section 1.5).

This page intentionally left blank.

10.0 REFERENCES

American Ornithological Union (AOU). 1998. Check-List of North American Birds. Seventh Edition. American Ornithologists' Union, Washington, D.C. 829pp.

Brinson, M. M., Hauer, F. R., Lee, L. C., Nutter, W. L., Rheinhardt, R. D., Smith, R. D., and Whigham, D. (1995). "A guidebook for application of hydrogeomorphic assessments to riverine wetlands," Technical Report WRP-DE-11, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. NTIS No. AD A308 365.

Brown, N.L. 1999. California State University, Stanislaus Endangered Species Recovery Program. As retrieved from:.

Doorenbos, et al., 1977. Crop Water Requirements, Irrigation and Drainage Paper, 24, UN Food and Agriculture Organization, Rome, Italy, 1977.

Franklin, J.F. and C.T. Dyrness. 1988. *Natural Vegetation of Oregon and Washington*. Oregon State University Press. 452 pp.

Johnson, D.H. and t.A. O'Neil. 2001. *Wildlife-Habitat Relationships in Oregon and Washington*. Oregon State University Press, Corvallis, Oregon. 736 pp.

Hruby, T, S. Stanley, T. Granger, T. Duebendorfer, R. Friesz, B. Lang, B. Leonard, K. March, and A. Wald. 2000. Methods for Assessing Wetland Functions. Volume II, Part 1: Assessment Methods – Depressional Wetlands in the Columbia Basin of Eastern Washington. WA State Department of Ecology Publication #00-06-47.

Knight, R. L., P. J. Randolph, G. T. Allen, L. S. Young, & R. J. Wigen. 1990. Diets of nesting bald eagles, Haliaeetus leucocephalus, in western Washington. Can. Field-Nat. 104:545-551.

Ley, Thomas W. 2011. "Notes on Evapotranspiration Data Calculated on the PAWS System," Washington State University Extension, Pullman, Washington. http://www.weather.wsu.edu/AgWeatherNet/awn_et.html

Moyle, P. B. 1976. Inland fishes of California. University of California Press, Berkeley. 405 pp.

NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.2. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 1, 2005).

Port of Sunnyside, Washington. (2011). Port of Sunnyside Waste Water Treatment Facility - Overview of Plant. Retrieved April 26, 2011, from http://www.portofsunnyside.com/plant.asp

Reiman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Dep. Agric., For. Serv. Intermountain Res. Sta., Odgen, UT. Gen. Tech. Rep. INT-302.

Skillings/Connolly. 2002. Constructed treatment wetlands feasibility study. Prepared for the Port of Sunnyside, Washington.

Tetra Tech. 2009. *Sunnyside Wetlands Section 206 Ecosystem Restoration: Final Feasibility Design Report and Integrated Environmental Assessment*. September 2009.

Thornthwaite, C. W. 1948. An approach toward a rational classification of climate. Geographic Review 38:55-94

United States Army Corps of Engineers (USACE). 1999. Ecosystem Restoration Supporting Policy Information, EP-1165-2-502.

United States Department of Agriculture Soil Conservation Service (USDA SCS). 1985. Soil Survey of Yakima County Area, Washington. Washington, D.C.

United States Fish and Wildlife Service (USFWS). 2004. Federal Resister: Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition To Delist the Ute Ladies'-Tresses Orchid and Initiation of a 5-Year Review. 69 FR 60605.

United States Fish and Wildlife Service (USFWS). 2004. Federal Resister: Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Klamath River and Columbia River Populations of Bull Trout; Final Rule. 59 FR 59996.

United States Fish and Wildlife Service (USFWS). 2003. Federal Resister: Endangered and Threatened Wildlife and Plants; Final Rule To Reclassify and Remove the Gray Wolf From the List of Endangered and Threatened Wildlife in Portions of the Conterminous United States; Establishment of Two Special Regulations for Threatened Gray Wolves; Final and Proposed Rules. 68 FR 16052.

United States Fish and Wildlife Service (USFWS). 2000. Federal Resister: Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Contiguous U.S. Distinct Population Segment of the Canada Lynx and Related Rule; Final Rule. 65 FR 16052.

United States Fish and Wildlife Service (USFWS). 2000. Federal Resister: Endangered and Threatened Wildlife and Plants: Establishment of a Nonessential Experimental Population of Grizzly Bears in the Bitterroot Area of Idaho and Montana. 65 FR 69623-69643.

United States Fish and Wildlife Service (USFWS). 1998. Federal Resister: Endangered and Threatened Wildlife and Plants; Determination of Threatened status for the Klamath River and Columbia River Distinct Population Segments of Bull Trout. 63 Federal Register 31647.

United States Fish and Wildlife Service (USFWS). 1996. Federal Resister: Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for the Marbled Murrelet. 61 FR 26255-26320.

United States Fish and Wildlife Service (USFWS). 1992. Federal Resister: Endangered and Threatened Wildlife and Plants; Determination of Critical Habitat for the Northern Spotted Owl. 55 FR 26114-26194.

United States Fish and Wildlife Service (USFWS). 1992. Federal Resister: Endangered and Threatened Wildlife and Plants; Final Rule to List the Plant Spiranthes diluvialis, Ute Ladies'-Tresses, as a Threatened Species. 57 FR 2053.

United States Fish and Wildlife Service (USFWS). 1992. Federal Resister: Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Washington, Oregon and California Population of the Marbled Murrelet. 57 FR 45328 4533.

United States Fish and Wildlife Service (USFWS). 1967. Federal Resister: Endangered Species List - 1967. 32 FR 4001.

Vander Haegen, W. M., S. M. McCorquodale, C. R. Peterson, G. A. Green, and E. Yensen. 2001. Wildlife of eastside shrubland and grassland habitats. Pages 474-500 *in* D. H. Johnson and T. A. O'Neil, editors. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, Oregon, USA.

Washington Authorized Code, 1997. Water Quality Standards for Surface Waters of the State of Washington. WAC 173-201A.

Washington Authorized Code. Amended 2003. Water Quality Standards for Surface Waters of the State of Washington. WAC 173-201A.

Washington Department of Ecology (WDOE). 1997. A suspended sediment and DDT Total Maximum Daily Load evaluation report for the Yakima River. Publication Number 97-321.

Washington Department of Ecology (WDOE). 2001. A fecal coliform bacteria Total Maximum Daily Load assessment and evaluation. Publication Number 01-10-012.

Washington Department of Ecology (WDOE), 2004. Stormwater Management Manual for Eastern Washington. Publication No. 04-10-076.

Washington Department of Ecology (WDOE), 2004. Dam Safety Guidelines. Publication No. 92-55A.

Washington Department of Ecology (WDOE). 2010. Re: Port of Sunnyside Industrial Wastewater Treatment Facility. Correspondence from Charles McKinney (WDOE) to Christopher Behrens (USACE), 13 October 2010.

Washington Department of Fish and Wildlife (WDFW). 2002. Salmon and Steelhead Stock Inventory. Accessed at http://wdfw.wa.gov/fish/sasi/

Washington State University. (2010). *AgWeatherNet Daily Data Report: Port of Sunnyside 1993-2010*. Retrieved December 29, 2010, from The Washington Agricultural Weather Network: www.weather.wsu.edu.

Western Regional Climate Center. 2006. Office of the Washington State Climatologist website for Sunnyside, Washington station #: 458207. http://www.wrcc.dri.edu/cgi-bin/cliRECtM.pl?wasunn

Wydoski, R.S. and R.R. Whitney. 2003. *Inland Fishes of Washington*. American Fisheries Society in association with University of Washington Press, Seattle, Washington. 322 pp.

Yakima Regional Clean Air Agency. 2011. http://www.yakimacleanair.org/index.html

Yakima Subbasin Fish and Wildlife Planning Board (YSPB). 2004. Final Draft Yakima Subbasin Plan. Prepared for the Northwest Power and Conservation Council, Portland, Oregon.

This page intentionally left blank.

THIS PAGE BUILDS TABLE OF APPENDICES

DO NOT DELETE THIS PAGE

DO NOT INCLUDE THIS PAGE IN FINAL PUBLISHED DOCUMENT

THE FOLLOWING PAGES PROVIDE COVER SHEETS FOR APPENDICES

This page intentionally left blank.

APPENDIX A

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

This Page Intentionally Left Blank

APPENDIX B

10 PERCENT CONCEPTUAL DESIGN PLANS

This Page Intentionally Left Blank

APPENDIX C

35 PERCENT FEASIBILITY DESIGN PLANS

This Page Intentionally Left Blank

APPENDIX D

PRELIMINARY GEOTECHNICAL ENGINEERING

This Page Intentionally Left Blank

APPENDIX E

HYDROLOGY AND HYDRAULICS

This Page Intentionally Left Blank

APPENDIX F

HABITAT ANALYSIS

This Page Intentionally Left Blank

APPENDIX G

10 PERCENT COST ESTIMATE AND BACK-UP DATA

This Page Intentionally Left Blank

APPENDIX H

35 PERCENT COST ESTIMATE AND BACK-UP DATA

This Page Intentionally Left Blank

APPENDIX I

DRAFT BIOLOGICAL EVALUATION

This Page Intentionally Left Blank

APPENDIX K

CULTURAL RESOURCES

This Page Intentionally Left Blank

APPENDIX L

REAL ESTATE

This Page Intentionally Left Blank

APPENDIX M

AGENCY COORDINATION

This Page Intentionally Left Blank

APPENDIX N

PROJECT REVIEW SUMMARY

This Page Intentionally Left Blank