Calapooia River - Albany Assessment and Project Implementation Plan

Final Report

Site Assessment on the Willamette River.

Submitted To:
Ms. Tara Davis, Executive Director
Calapooia Watershed Council
PO Box 844
Brownsville, Oregon 97327

Submitted By:
River Design Group, Inc.
311 SW Jefferson Avenue
Corvallis, Oregon 97333

April 29, 2011

EXECUTIVE SUMMARY

The Calapooia Watershed Council and the City of Albany retained River Design Group, Inc. to complete an existing conditions assessment and restoration opportunities prioritization plan for several waterbodies in the vicinity of Albany, Oregon. The assessment reaches include the lower 3 miles of the Calapooia River, the Willamette River and adjacent agricultural areas from RM 114 to RM 122, lower Periwinkle Creek, Thornton Lake, and the Albany oxbow lakes adjacent to the Willamette River. This effort follows the Calapooia River Watershed Assessment (CWC 2004) which provided an evaluation of the drainage at the watershed scale, and the Middle Calapooia Assessment (RDG 2007). This document serves two purposes; one, as an assessment, it presents information on historical and existing conditions based on field data collection, remote sensing, and existing data review. Secondly, the document serves as a river corridor restoration project prioritization plan that highlights restoration actions to address limiting factors and achieve restoration goals. Individual opportunities are identified for each of the target waterbodies.

TABLE OF CONTENTS

TABLES

FIGURES

GLOSSARY

Active Floodplain: Lowlands bordering a river, which are subject to flooding on a periodic basis. Floodplains are composed of sediments carried by rivers (alluvium) and deposited on land during flooding. The active area is characterized by recently deposited river-borne debris, limited terrestrial vegetation, and recent scarring of trees by material transported by floodwaters.

Aggradation: The geologic process by which streambeds, floodplains and the bottoms of other water bodies are raised in elevation by the deposition of material eroded and transported from other areas. It is the opposite of degradation.

Alluvial: Deposited by running water.

Anadromous: Fish that breed in freshwater but live their adult life in the sea. On the Pacific coast, anadromous fish include all the Pacific salmon, steelhead trout, some cutthroat trout and Dolly Varden char, lampreys and eulachons.

Avulsion: An abrupt change in the course of a stream whereby the stream leaves its old channel for a new one.

Bankfull (Stage): Water surface elevation at which a stream first overflows its natural banks, spilling water onto the floodplain.

Base Flow: Streamflow coming from sustained subsurface sources, not directly from surface runoff.

Bedload: Sediment particles transported on or near the streambed by rolling and bouncing.

Beltwidth: The distance of a stream measured from outside of channel to outside of channel.

Bifurcate: The division of a stream channel into two branches or a fork in the stream channel.

Channelization: Straightening and (or) deepening a pre-existing channel, or constructing a new channel, for the purpose of runoff control or navigation.

Degradation: Removal of materials from one place to another via erosion, causing lowering of the elevation of streambeds and floodplains over time.

Floodplain: A level, low-lying area adjacent to streams that is periodically flooded by stream water. It includes lands at the same elevation as areas with evidence of moving water, such as active or inactive flood channels, recent fluvial soils, sediment on the ground surface or in tree bark, rafted debris, and tree scarring.

Groundwater: Subsurface water in the zone of saturation below the level of the water table, where the hydrostatic pressure is equal to or greater than the atmospheric pressure.

Large Woody Debris: Coarse woody material (conventionally greater than 10 cm in diameter and 1 m long), such as twigs, branches, logs, trees, and roots, that falls into a stream.

Meander: A sinuous channel form in flatter river grades formed by the erosion on one side of the channel (pools) and deposition on the other side (point bars).

Meander Length: Distance in the general course of the meanders between corresponding points of successive meanders of the same phase. Twice the distance between successive points of inflection of the meander wave.

Off-channel: Bodies of water adjacent to the main channel that have surface water connections to the main river channel at summer discharge levels.

Riffle: A shallow section of a stream or river characterized by rapid current and a surface broken by completely or partially submerged obstructions such as gravel or boulders.

Riparian (Area): An area of land adjacent to a stream, river, lake or wetland that contains vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas. The riparian area is influenced by and influences the adjacent body of water.

Riprap: A layer of large, durable material such as coarse rock used to protect exposed surfaces and slopes susceptible to erosion such as fills and streambanks

Salmonid: Refers to a member of the fish family *Salmonidae*, including the salmons, trouts, chars, whitefishes and grayling.

Sinuous: Characterized by a serpentine or winding form, typically referring to stream channels.

Substrate: The basic surface on which material adheres, typically mineral and (or) organic material that forms the bed of a stream.

Watershed: Also referred to as a drainage basin or catchment area. Watersheds are the natural landscape units from which hierarchical drainage networks are formed. Watershed boundaries typically are the height of land dividing two areas that are drained by different river systems.

1 Introduction

1.1 Purpose of Effort

The Calapooia Watershed Council (CWC) retained River Design Group, Inc. (RDG) to complete the *Calapooia-Albany Assessment and Project Implementation Plan* (Plan). The Plan scope of work included reviewing existing information, completing a field assessment, and identifying potential restoration, conservation, and/or resource protection opportunities on the lower 3 miles of the Calapooia River, the Willamette River and adjacent agricultural areas from RM 114 to RM 122, lower Periwinkle Creek, Thornton Lake, and the Albany oxbow lakes north of the City of Albany. Figure 1-1 shows the project site locations within the Plan project area.

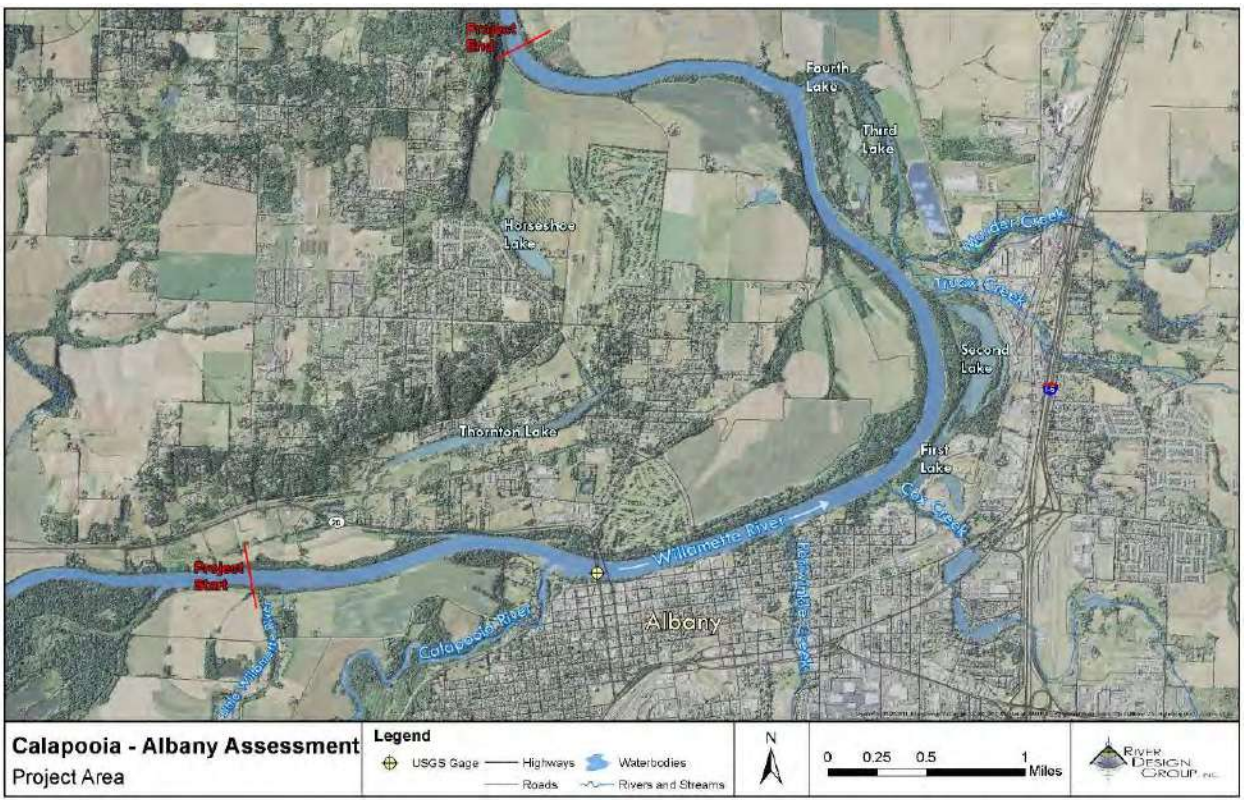


Figure 1-1. The assessment reach and the highlighted waterbodies that were reviewed as part of the assessment.

The purpose of the Plan is to provide an overview of river corridor conditions and recommendations for restoring, conserving, and protecting resources in the study area, and increasing public education on the importance of aquatic and riparian resources. Although there are numerous reasons for restoring river corridor conditions, target priorities outlined in existing planning documents (e.g, Willamette River TMDL, Statewide Planning Goal 5) include:

- Improving habitats that are necessary to recover federally-listed fish populations, including Upper Willamette River spring Chinook salmon and winter steelhead (NMFS 2008).
- Addressing impaired water quality as directed by the Willamette River TMDL (ODEQ 2006). Water quality impairment in the assessment area includes elevated water temperature on the Willamette River and lower Calapooia River, and bacteria levels and mercury concentration on the Willamette River.
- Identifying natural resources including wetlands, riparian corridors, and wildlife habitat inside the City of Albany's urban growth boundary and adopting measures to protect significant resources (Pacific Habitat Services, Inc. 2009).

RDG and CWC developed the following project objectives for the Plan.

- Assess the lower Calapooia River from the SW Queen Avenue Bridge downstream to the confluence with the Willamette River, delineating the western Albany urban growth boundary (UGB) with special focus on the Calapooia-Willamette confluence for potential habitat restoration opportunities.
- Assess the Periwinkle Creek confluence area for potential habitat improvement and community education opportunities.
- Evaluate rural agricultural areas in Greater Albany and the Willamette River floodplain to identify high priority restoration and conservation opportunities. Examples include the North Albany floodplain side channels and Thornton Lake.
- Evaluate the Albany oxbow lakes and consider potential restoration and conservation opportunities for the Willamette River corridor northeast of Albany.

These objectives were expanded slightly to better account for potential opportunities that would integrate with the City of Albany's plans for the Talking Water Gardens, possible transition of the International Paper industrial wastewater cooling ponds to a more natural environment, and potential water temperature mitigation measures being investigated by the City of Albany on tributaries to the Willamette River within the UGB as part of the State of Oregon 303(d) and the Goal 5 program.

Three project tasks were developed to achieve the stated objectives. The tasks included:

- Task 1: Stakeholder Meeting and Information Review
- Task 2: Field Reconnaissance
- Task 3: Project Identification and Prioritization

One intent of the project was to include Albany personnel, CWC members, and Oregon Department of Fish and Wildlife (ODFW) personnel in the data collection effort. A second project intent included incorporating information from other on-going restoration and conservation efforts that are currently being pursued by the City of Albany and the Friends of

East Thornton Lake (FETL). RDG worked closely with CWC to structure the data collection program. RDG also met with City of Albany staff to acquire spatial data (GIS data sets) and historical air photos, and to better understand the environmental programs that the City of Albany already has underway or plans to pursue in the future. In addition to the CWC and City of Albany efforts, RDG also collaborated with FETL to understand past and ongoing efforts to preserve remaining undeveloped shoreline and uplands surrounding Thornton Lake. RDG met with the FETL and toured Thornton Lake by boat. Information provided by FETL is incorporated in this document.

1.2 Report Structure

The report is compiled in sections according to the project methods, an overview of the project reach, more specific information on each of the waterbodies of interest, and finally a discussion pertaining to restoration and conservation opportunities in the project area. We focus on linking the existing conditions discussion with a limiting factors analysis that tiers to the restoration and conservation opportunities. This effort was pursued to provide the CWC and City of Albany with a step-wise approach of observation, analysis, and opportunity development that would resolve identified limiting factors. The time frame and scale of potential limiting factors solutions vary in accordance with the degradation and potential project risk. For example, replacing an undersized culvert that currently creates a fish passage barrier is an easily implementable project that is relatively low risk and can have a high reward (establish stream connectivity and fish passage). Alternatively, a substantially eroding streambank on the outside of a river meander that's condition has been exacerbated by riparian vegetation removal, may require both an immediate solution in order to stabilize the bank, but will benefit from a more long-term process of riparian vegetation establishment.

As these approaches vary both spatially and temporally, solutions will also vary by cost and risk. CWC requested that the opportunity prioritization plan provide a reach or system-scale vision so that recommendations work in concert with existing river processes, or at a minimum, are not contradictory to river function.

2 Methods

The following section outlines the methods that were employed for evaluating the historical and existing project reach conditions. Assessment methods are categorized as either field or remote sensing techniques. CWC completed data collection on the Willamette River, Calapooia River, and Periwinkle Creek in August of 2010. RDG completed field data collection during the fall and winter of 2010-2011 on the Willamette River, Calapooia River, Periwinkle Creek, Thornton Lake, and north Albany floodplain. Field data compiled in Excel spreadsheets and the GIS directory are included on the companion data CD. Data maps are included in appendices following this report as well as on the companion data CD.

2.1 Site Reconnaissance and Field Data Collection

Data collection intensity varied by waterbody. The Willamette River, Calapooia River, and Periwinkle Creek were more intensely surveyed than the other waterbodies in the project reach. CWC, City of Albany employees, and ODFW oversaw the more intensive data collection efforts. Field data forms were used to log observations and record measurements pertaining to the variables of interest. Quantitative field data were collected by the CWC-led team on the following waterbodies.

- The Willamette River from river mile (RM) 114 to RM 122.
- The Calapooia River from the SW Queen Avenue Bridge downstream to the confluence with the Willamette River.
- Periwinkle Creek from the Santiam Highway bridge downstream to the confluence with the Willamette River.

The following tasks were completed during the site reconnaissance and field data collection.

- Bank stabilization structure and floodplain levee inventory and mapping.
- Bank erosion site mapping.
- Infrastructure location mapping.
- Invasive plant species location mapping.
- Evaluation of existing instream and riparian habitat conditions.
- Photographic documentation of river corridor conditions.

Air photo panels were prepared with centerline alignments with stationing so that personnel could spatially relate on the ground features. Data collection sheets were completed in the field and transferred into Microsoft Excel for processing. Spatial data collected with handheld GPS units or related to the air photo panel stationing were plotted in ArcGIS on 2009 NAIP air photo imagery. Reach maps are included in Appendix A – Field Panels. Photographs documenting the existing conditions at the project sites are stored on RDG's server and will be provided on a DVD with this report. Summary information from the field data collection is included in Section 3 and 4 of this report.

Site visits were also made to Thornton Lake, the north Albany floodplain, and the Albany oxbow lakes. Ground photos and observations were made during these trips.

2.1.1 Bank Stabilization Structures and Floodplain Levee Mapping

Bank stabilization structures and floodplain levees were delineated on the air photo base maps during the field reconnaissance. Bank stabilization maps are included for each assessment reach in the respective appendices.

2.1.2 Bank Erosion Site Mapping

Prominent bank erosion sites were noted on the air photo base maps and photographed during the site assessments. Bank lengths were measured with a laser rangefinder when possible and visually estimated in all other cases. Bank erosion GIS layers were developed for the Willamette River, Calapooia River, and Periwinkle Creek. The bank erosion layer is included in the assessment maps in the appendices.

2.1.3 Infrastructure Location Mapping

Pertinent infrastructure within each assessed waterbody was mapped with handheld GPS or noted on the air photo panels and photographed. Infrastructure ranged from abandoned concrete abutments to power poles, incorporating a wide variety of artificial structures in the river environment. Compared to bank stabilization and erosion sites that typically had a longitudinal distance component, infrastructure was typically a discrete location or had a relatively small footprint. The infrastructure GIS layer is included in the assessment maps in the appendices.

2.1.4 Habitat Conditions

Typical river corridor conditions were noted during the reconnaissance. Impaired condition sections of the river were noted by stabilized banks, low in-channel habitat diversity, narrowed riparian zones, and proliferation of invasive plant species. High quality habitats for target fish species including spring Chinook salmon and winter steelhead were generally characterized by large wood, intact riparian zones, floodplain channels and ponds, and diverse instream habitat units.

2.2 Remote Sensing

ArcGIS programs were used to develop field base maps and visualization figures. Programs included ArcGIS Version 9.3 (ESRI 2009a) and ArcGIS extensions, Spatial Analyst (ESRI 2009b) and 3D Analyst (ESRI 2009c). Historical air photos were obtained from the U.S. Army Corps of Engineers (USACE) and geo-rectified for interpretation. Channel planform measurements including belt width, meander length, and radius of curvature, were based on current and historical air photo interpretation. Riparian areas were measured based on current and historical air photos. Spatial data were acquired from multiple city, state, and federal agency sources. An ArcGIS database is provided on DVD along with this report.

2.3 Inundation Mapping

Under a contract with the Meyer Memorial Trust, RDG prepared an inundation model for the Willamette River using the regulated 2-year discharge to evaluate floodplain inundation between Eugene and Albany. As the Calapooia-Albany Assessment project reach overlaps with the Willamette River inundation mapping reach, data from the mapping effort are incorporated in this report.

For the inundation mapping, RDG used flood frequency curves obtained from the U.S. Army Corps of Engineers (USACE) and Light Detection and Ranging (LiDAR) data obtained from the Oregon Department of Geology and Mineral Industries (DOGAMI) to create water surface profiles and depict predicted floodplain inundation for the 2-year regulated flow event on the Willamette River. Stream gage data from four gages in the Upper Willamette Basin and USACE flood frequency analyses were used to calculate best fit curves for the 2-year water surface slope from Eugene to Albany. The resulting water surface profile was then used to create a 2-year flood water surface layer that was overlaid onto the LiDAR surface model incorporating the river and floodplain.

Seven reach maps depicting the predicted floodplain inundation were created to be used for restoration project planning. Water depths shown on the reach maps represent the difference between the regulated 2-year water surface above the land or water surface captured during the LiDAR acquisition. Therefore, these depths are not a true representation of water depth in areas, such as the main river channel, that were inundated during LiDAR acquisition. As a result, floodplain inundation predicts depths of water in all areas of the floodplain that are lower in elevation than the modeled 2-year water surface elevation, but does not necessarily indicate actual channel connection to predicted inundated areas. Predicted water surface elevations were validated at two locations in the project reach (Bowers Rock and Harkens Lake) to verify model accuracy. At Bower's Rock, water surface elevations were compared at six different cross sections spread over approximately three river miles. The mean difference between the floodplain inundation model and the more intensive 1-dimensional hydraulic model water surface elevations was 0.175 ft, with a range of -0.002 ft to 0.366 ft. A similar result was determined for the Harkens Lake site where observed water surface elevations (based on the 2-year discharge measured at the Harrisburg gage) were less than 0.2 ft different from the predicted water surface elevation from the Willamette floodplain inundation modeling. The inundation maps will be used as a restoration planning tool for investigating potential restoration areas in the Willamette River corridor between Eugene and Albany.

Inundation mapping was also completed for the lower Calapooia River from the SW Queen Avenue Bridge downstream to the Willamette River. Two data points were used to calculate the water surface slope for the Calapooia River. The water surface elevation for the 2-year discharge at the discontinued USGS SW Queen Avenue Bridge gage was used for the upstream water surface elevation. The water surface elevation for the USGS Albany gage on the Willamette River was used for the downstream water surface elevation. The resulting water surface profile was then used to create a 2-year flood water surface layer in GIS that was overlaid onto the LiDAR surface model incorporating the river and floodplain.

Inundation exhibits for the Calapooia – Albany Assessment project reach are included for the pertinent waterbodies in the appendices.

3 Project Area Overview

The following section presents an overview of the Calapooia-Albany assessment reach. More detailed information for the focus waterbodies is presented in *Section 4 Waterbody Descriptions*.

3.1 Introduction

The Calapooia-Albany Assessment project reach spans 7.8 miles from the confluence of the Little Willamette River at Bowers Rock State Park, downstream to Springhill Road north of the City of Albany (Figure 3-1). A number of tributaries and other waterbodies are located in the assessment reach. Table 3-1 includes a list of the waterbodies and the respective degree of focus for this assessment. Primary waterbodies were outlined in the project's original scope of work. Secondary waterbodies were remotely evaluated and are suggested for further evaluation.

Table 3-1. Waterbodies in the Calapooia-Albany Assessment project reach.

Waterbody	Focus for Assessment
Cox Creek	Secondary
Murder Creek	Secondary
Periwinkle Creek	Primary
Truax Creek	Secondary
Burkhart Creek	Secondary
Horseshoe Creek	Not included
Calapooia River	Primary
Willamette River	Primary
Albany Oxbow Lakes	Primary
Thornton Lake	Primary
Horseshoe Lake	Not included

Waterbodies in the project reach exhibit varying degrees of alteration due to agricultural development, rural residential development, urbanization, and industrialization. Despite the altered landscape, these waterbodies continue to provide habitat for native and introduced fish species, offer recreational opportunities, and provide other ecosystem benefits including clean water, floodwater storage, and riparian habitat.

3.2 Historical River Corridor and Founding of Albany

The historical Willamette River upstream from Albany was broad with an expansive riparian corridor. The confluence of the Calapooia River was likely a dynamic section in the project reach. Other tributary confluences including Periwinkle Creek and Cox Creek provided diverse habitat conditions in close proximity to the Willamette River. Thornton Lake and the Albany oxbow lakes contributed lentic habitats that would have provided slow water conditions for native fish species, turtles, and other terrestrial and avian wildlife.

With the arrival of European-Americans in the 1840s, the native river corridor was altered to meet the needs of the settlers. One of the early families to arrive on the eastern shores of the Willamette River at the mouth of the Calapooia River, the Monteith family laid out the town lots that were to become Albany, so named after the Monteith's home state capitol, Albany, New York (City of Albany 2011). Native riparian forests surrounding Albany were cleared for agricultural production and timber milling. Figure 3-1 includes the 1852 General Land Office map of the Calapooia River and Willamette River confluence.

First arriving in 1871, the railroad has long been an important means for trade and passenger travel. The railroad connected Albany with the rest of Oregon, Portland most importantly. Transporting agricultural products and manufactured goods from Albany to Portland fostered a burgeoning industry in the central Willamette Valley by the turn of the twentieth century. The railroad quickly replaced the steamboat and stage coach as the most efficient transportation for connecting Albany with Portland and more distant cities including Sacramento and San Francisco.

With a growing population and an increasing need to protect residents from frequent flooding, flood protection devices included filling historical floodplain areas and stabilizing the eastern bank of the Willamette River became necessary. These efforts protected city residents from flooding on both the Willamette River and the Calapooia River.

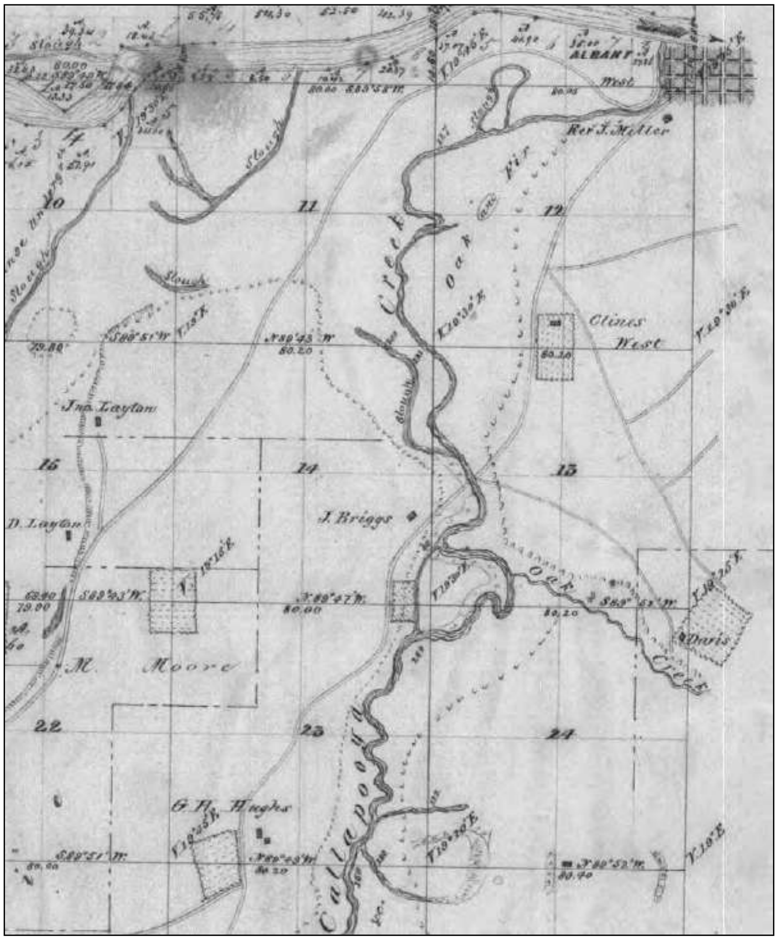


Figure 3-1. The 1852 General Land Office (GLO) map showing the confluence of "Callapooya Creek" and the Willamette River. Features of note include the early Albany town site, roads, developed farms and the numerous sloughs that are noted in relation to the Calapooia and Willamette rivers. "Oak and Fir" were noted as the predominant vegetation on the Calapooia River floodplain.

3.3 Contemporary Land Uses

Contemporary land use in the project reach is mixed, dominated by agriculture, urbanized areas, rural residential development, and industrial uses. Predominant agricultural uses include grass seed farming. The City of Albany is the primary urban area in the project reach. Outlying areas surrounding Albany have varying densities of rural residential development with most home sites on properties exceeding an acre. The eastern floodplain in the vicinity of the Albany Oxbow Lakes is dominated by industrial land uses including the International Paper containerboard facility, the ATI-Wah Chang specialty metals and chemicals facility, and the Flakeboard-Duraflake particle board manufacturing facility (Figure 3-2). The International Paper facility was recently closed and future operation of the facility will likely be a different use than paper product manufacturing.

Figure 3-2. The industrialized eastern floodplain of the Willamette River. Industrial development has influenced tributary streams and the oxbow lakes located north of Albany.

Historical and contemporary land uses have affected the project reach in a number of ways. Displacement of native vegetation communities first by agriculture and the development of Albany, has been followed by expanding rural residential development. To accommodate the growing population, riparian forests have narrowed and former agricultural land has been improved. Smaller streams have been straightened and stabilized to facilitate floodwater conveyance and control erosion. Surface water diversions on the Willamette River and tributary streams withdrawal water to meet rural development and industrial needs. The Albany waste water treatment facility, ATI-Wah Chang, and until recently, International Paper, discharge treated wastewater to the Willamette River corridor in the downstream portion of the project reach.

The road system extending from Albany influences stream connectivity, fish passage, and flow conveyance. Streams through more urbanized areas, such as Cox Creek and Periwinkle Creek, have been substantially manipulated to facilitate urban development. Modified streams enable rapid draining of the urban landscape, but are also problematic for maintaining native ecological systems.

3.4 Fisheries

The fish communities inhabiting the waterbodies in the project reach include both native and introduced fish species. Table 3-2 includes brief descriptions of the fish species in the project reach. Native salmonids include winter steelhead, cutthroat trout, spring Chinook salmon, and mountain whitefish. Non-salmonid fish present in the watershed include a variety of minnow and sculpin species, largescale sucker, and Pacific lamprey. There is also a variety of non-native fish in the watershed. These fish have been "introduced" (either accidentally or intentionally) to the Willamette River and tributary streams. Most of the documented use by non-native fish is in the systems where warmer water temperatures and altered habitat have provided ideal conditions for many of these fish.

Table 3-2. Native salmonids, native non-salmonids, and introduced fish species in the Calapooia-Albany Assessment project reach.

Fish Species	Notes
Native Salmonid Species	
Winter steelhead, *Oncorhynchus mykiss* Spring Chinook salmon, *Oncorhynchus tshawytscha* Cutthroat trout, *Oncorhynchus clarki clark* Mountain whitefish, *Prosopium williamsoni*	Willamette spring Chinook and winter steelhead (both anadromous species) were listed as threatened under the federal Endangered Species Act (ESA) in 1999. Factors contributing to their decline include habitat loss, fish passage barriers, altered flow regimes, water quality, and the negative impacts of hatchery fish.
Native Non-salmonid Species	
Lamprey Pacific lamprey, *Lampetra tridentata* Other species	Pacific lamprey are anadromous (adults reside in the ocean and return to rivers and streams to spawn) and brook lamprey are resident species. Pacific lamprey was listed as an Oregon state sensitive species in 1993 due to a serious decline in abundance.
Minnows Speckled dace, *Rhinichthys osculus* Longnose dace, *Rhinichthys cataractae* Northern pikeminnow, *Ptycheilus oregonensis* Redside shiner, *Richardsonius balteatus* Chiselmouth, *Acrocheilus alutaceus* Peamouth, *Mylocheilus caurinus* Oregon chub, *Oregonichys crameri*	Dace occur throughout the watershed, primarily in the Calapooia River and the lower portions of tributaries. *Oregon chub* is a small minnow native to the Willamette River basin. Oregon chub were listed as endangered under the Federal ESA. Chub prefer low gradient tributaries and off-channel habitats such as side-channels and sloughs. Their decline has been attributed to loss of habitats, altered flow regimes, and predation.
Suckers Largescale sucker, *Catostomus macrocheilus* Mountain sucker, *Catostomus platyrhynchus*	
Sculpins Mottled sculpin, *Cottus baurdi* Paiute sculpin, *Cottus beldingi* Prickley sculpin, *Cottus asper* Shorthead sculpin, *Cottus confusus* Reticulate sculpin, *Cottus perplexus* Torrent sculpin, *Cottus rhotheus*	Sculpins occupy streams throughout the watershed, with the greatest abundance in the upper Calapooia River and tributaries.
Sticklebacks Three-spine stickleback, *Gastrosteus aculeatus*	
Troutperch	Sand rollers are rare and endemic to the lower

Table 3-2. Native salmonids, native non-salmonids, and introduced fish species in the Calapooia-Albany Assessment project reach.

Fish Species	Notes
Sand roller, *Percopsis transmontana*	Columbia River drainage, including the Willamette River and its tributaries.
Non-Native Species (all non-salmonid)	
Largemouth bass, *Micropterus salmoides* Smallmouth bass, *Micropterus dolomieui* Yellow bullhead, *Ameiurus natalis* Bluegill, *Lepomis macrochirus* Pumpkinseed, *Lepomis gibbosus* Crappie (black), *Pomoxis nigromaculatus* Common carp, *Cyprinus carpio* Brown bullhead, *Ameiurus melas* Western mosquito fish, *Gambusia affinis* Goldfish*, Carassius auratus*	Non-native species prey on or compete with native species for food and habitat space. Non-natives typically proliferate in warm water and disturbed habitats.

Oregon Department of Fish and Wildlife (ODFW) and the City of Albany completed fish sampling on tributaries in the project reach. Sampling was completed using a backpack electrofisher or minnow traps at selected sampling sites. The goal of the sampling was to determine presence/absence of fish species with particular interest pertaining to native species' use of tributary streams. Sampling was limited in extent and effort and results suggest the species assemblage at that point in time, rather than over a broader range of seasons and conditions. Table 3-3 includes a summary of the fish species that were found during the 2001/2002 sampling. All tributaries had at least four fish species while Periwinkle Creek and Cox Creek (Figure 3-3) maintained the most diverse fish assemblages. Periwinkle Creek had the greatest number of native species (12). Chinook salmon and steelhead were found in three and two waterbodies, respectively. Dace and sculpin were the native species that inhabited the greatest number of waterbodies. Bluegill and yellow bullhead were the introduced species found in the greatest number of waterbodies.

Table 3-3. Native and introduced fish species presence in waterbodies located in the Calapooia-Albany Assessment project reach (Hummon 2003). Results are from spatially and temporally limited sampling.

Species	Cox Creek	Murder Creek	Periwinkle Creek	Truax Creek	Burkhart Creek	Thornton Lake	Horseshoe Lake	# of Waterbodies
Native								
Chinook salmon	X	X	X					3
Steelhead	X		X					2
Chiselmouth	X	X	X					3
Cutthroat trout			X					1
Dace species	X	X	X	X	X		X	6
Lamprey species	X							1
Largescale sucker	X		X	X	X			4
Northern pikeminnow	X	X	X	X	X			5

Table 3-3. Native and introduced fish species presence in waterbodies located in the Calapooia-Albany Assessment project reach (Hummon 2003). Results are from spatially and temporally limited sampling.

Species	Cox Creek	Murder Creek	Periwinkle Creek	Truax Creek	Burkhart Creek	Thornton Lake	Horseshoe Lake	# of Waterbodies
Peamouth	X							1
Redside shiner	X	X	X	X	X			5
Sandroller			X					1
Sculpin species	X	X	X	X	X		X	6
Sucker species			X					1
Threespine stickleback		X	X	X			X	4
Introduced								
Bluegill	X	X	X	X	X		X	6
Black bullhead				X	X			2
Brown bullhead	X						X	2
Black crappie		X						1
Common carp						X	X	2
Largemouth bass	X		X	X		X		4
Pumpkinseed	X		X	X	X			4
Smallmouth bass			X					1
Yellow bullhead	X	X	X	X	X	X		6
Yellow perch						X		1
Western mosquitofish		X			X	X		3
Number of Species	15	11	16	11	10	5	6	

Figure 3-3. Example stream conditions on lower Perwinkle Creek (left) and lower Cox Creek (right). Both streams were sampled in 2001 and 2002 by ODFW in an effort to determine fish use of Albany creeks.

Other notable results from the sampling effort are paraphrased below (Hummon 2003).These results should be reviewed in the context of the limited sampling effort and use of biased fishing gear in the case of baited minnow traps.

- Salmonids were found in the following creeks. Juvenile Chinook and steelhead had never been documented in Albany creeks prior to the 2001 and 2002 surveys and trapping. Steelhead were only documented in minnow traps.
  -juvenile Chinook (Periwinkle, Cox, and Murder creeks)
  -juvenile steelhead (Periwinkle and Cox creeks)
  -cutthroat trout (Periwinkle, Cathey, Cox creeks)
  -mountain whitefish (Oak Creek)
- Pacific lamprey were found in Periwinkle, Cox, and Burkhart creeks. Redds were found in Periwinkle Creek above Water Avenue. Water Avenue is a fish barrier for juvenile Chinook and steelhead (with a $60,000 OWEB grant to provide passage), but it is clearly not a barrier for lamprey. Lamprey were also found far upstream in Cox Creek, about 400 meters below the Albany-Santiam canal, but these may have come in from the canal.
- Sand rollers were more abundant than expected. This species may be on the decline, and prefers intact habitats. Sand rollers were found in Periwinkle and Cox creeks.
- In most cases, where there's water, there are fish.
- The fish trapping effort was successful overall, but at times individual traps had problems, including: damage from debris in high flows, vandalism (damage and stealing of trap components), high flows (trap inaccessible), and low flows (trap could not catch fish).
- Through the survey and fish traps, several issues were brought to the attention of City staff, including: creek signs were found in the creek, pollutants were reported, previously unknown fish passage barriers were identified, including lower Cox Creek – old meat packing plant and Crocker Creek (Horseshoe Lake drainage) – natural barrier that probably controls upstream fish distribution.
- The proportion of native species tends to be higher downstream, with more introduced species upstream. Species diversity also tends to be higher downstream. These trends may be because the lower ends of the creeks are in the Willamette 100-year floodplain where there have been fewer impacts from development. Upstream the creeks tend to be severely channelized and have significant impacts from urban development and agricultural practices.

3.5 Project Area Hydrology

The following section summarizes the general hydrology for the waterbodies in the project reach. The Willamette River has an active U.S. Geological Survey (USGS) gaging station at Albany. The Calapooia River formerly had a USGS gaging station located immediately downstream from the SW Queen Avenue Bridge, which also marked the upstream extent of the Calapooia River assessment reach. Data from these two gages were used to characterize the hydrology of these rivers. Smaller streams and other waterbodies without accessible flow or stage data have summary information pertaining to their hydrologic conditions.

Inundation maps are included in the appendices for the primary waterbodies.

3.5.1 Willamette River Hydrology

The Willamette River is the 13th largest river in the contiguous United States in terms of stream Flow, and generates the greatest discharger per unit of land area of any river in the nation (OWEB 2010). This large river system historically flooded on an annual basis covering much of the Willamette Valley floor (Figure 3-4). As the most densely populated valley in Oregon, managing annual flooding became a necessity for agriculture and the development of the valley's growing towns and cities. Thirteen federal dams in the greater Willamette River basin provide flood control for the Willamette Valley. Dam operations reduce the height and volume of flow during peak flood events, but also extend the duration of high flows as reservoir managers release impounded water to maintain appropriate reservoir capacity.

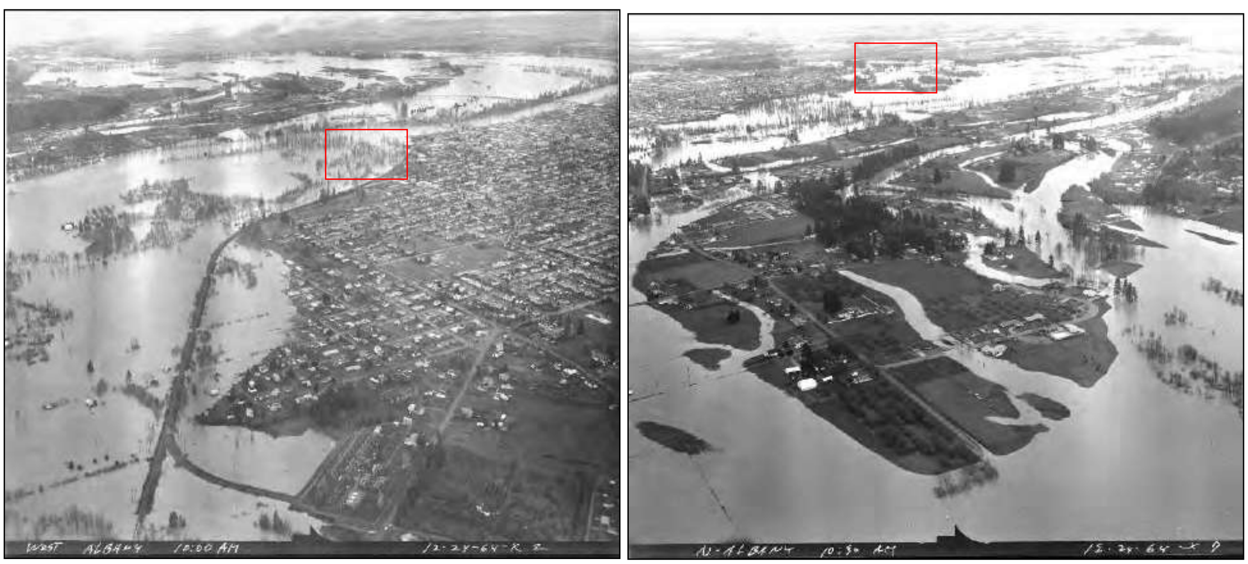


Figure 3-4. Views of the December 24, 1964 flood including a view to the northwest including the confluence of the Calapooia River and the Willamette River (left, in red box) and a view to the southeast from North Albany towards the Calapooia River confluence (right, in red box). Thornton Lake is in the middle of the photo. Photos courtesy of the City of Albany.

The following provided by Hulse et al. (2002) summarizes the basic changes that dam operations have had on the Willamette River system.

> The most fundamental process altered by dam construction and operation is stream discharge (which we also refer to as flow). Dam operations modify all aspects of the natural hydrologic regime, including timing of discharge, flow magnitude, periodicity, and duration (Lytle and Poff 2004). Dams may be operated to provide navigable

waterways, generate electrical power, dampen flood flows, provide recreational opportunities, improve downstream water quality, supply water for agriculture or municipal uses, or some combination (USACE 2000). An additional important function of the Willamette dams is to augment flows during dry periods for water quality improvement and protection of aquatic habitat. The modification of the natural hydrologic regime has impacts on an array of processes and organisms, both upstream and downstream of the structure itself.

Mean daily average discharge data were acquired from the USGS Albany gage to assess how the flood control dam network has modified the Willamette River hydrograph. The Albany gage's period of record spans from 1898 to present. The analysis included three periods:

- **Period of record (1898 to 2010):** The period of record data set portrays the mean daily discharge hydrograph built with data from the pre-regulation and regulation eras.
- **Pre-dams (1898 to 1942):** The first Willamette River basin dams went on-line in 1942. The pre-dam data set suggests the Willamette River's natural pre-flood control program hydrograph.
- **Post-dams (1968 to 2010):** The final Willamette River basin dam was completed in 1968. The post-dam data set illustrates the regulated Willamette River hydrograph.

Figure 3-5 includes the mean daily average hydrographs from the three periods. Flood control operations have reduced mean daily peaks that historically occurred from January through March, while increasing summer and fall base flows spanning from July through November. As highlighted by Hulse et al., the regulated hydro system has also reduced the sharp peaks and troughs that were associated with the historical hydrograph, suggesting a dampening of event peaks and more prolonged recession of storm event flows.

Elevated summer flows associated with the regulated system facilitate recreation and water withdrawals from the river. Higher late summer and fall flows are also related to increasing storage capacity ahead of winter storms.

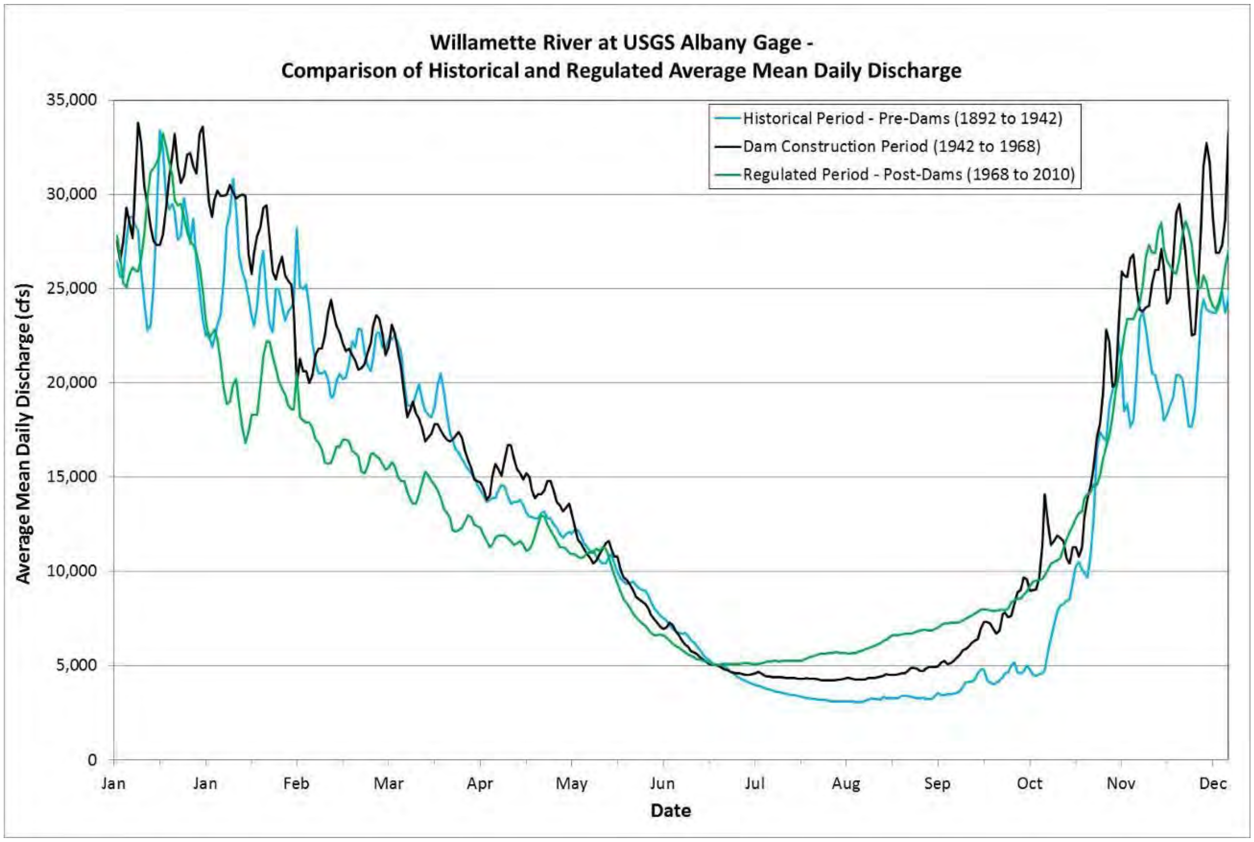


Figure 3-5. A comparison of average mean daily hydrographs for the Willamette River representing the historical, dam construction, and regulated periods. The historical period predates the inception of flood control projects in the Willamette River basin. The regulated period follows the completion of the final federal flood control dam in the basin. The regulated hydrograph is distinguished from the historical hydrograph by lower winter and spring average mean daily flows and higher summer and early fall flows.

The flood control dams have had a similar impact on the Willamette River's instantaneous peak events. Figure 3-6 includes a plot of instantaneous peak events from 1877 to 2010. The three periods, again, the historical, dam construction, and regulated periods, have unique peak flow patterns. The historical period has substantially higher peaks and a broader range of peak events relative to the regulated period. Peak events during the regulated period are substantially lower and less variable compared to the two earlier periods.

Table 3-4 includes the regulated flood frequency analysis for the Albany gage. The regulated 2-year event was used for the inundation mapping RDG completed for the Willamette River from Eugene to Albany.

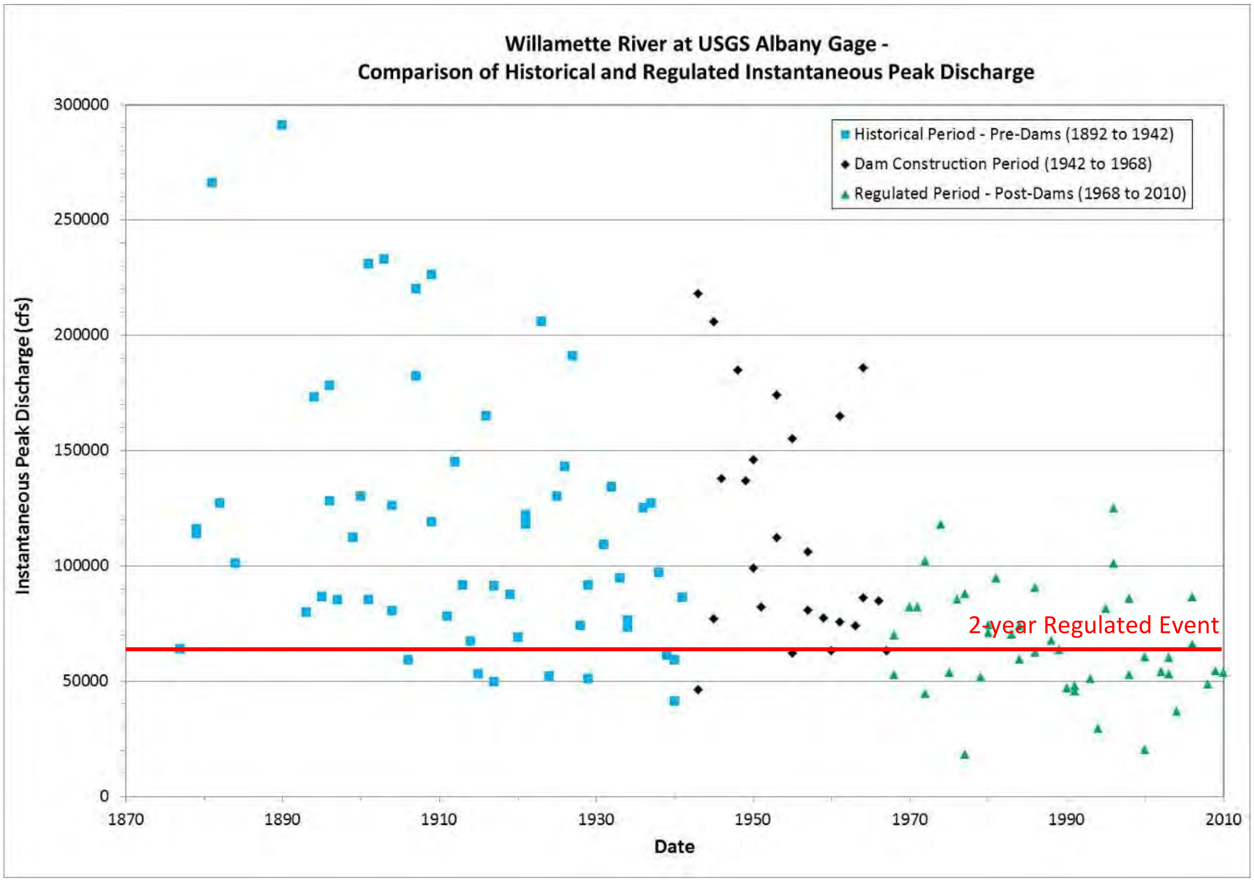


Figure 3-6. A comparison of annual instantaneous peak floods on the Willamette River measured at the Albany gage. The three eras of interest include the historical, dam construction, and regulated periods. The regulated period is marked by lower instantaneous peaks and diminished peak flow variability relative to the historical and dam construction periods.

Table 3-4. The flood frequency for the Willamette River at the USGS Albany gage. The flood frequency is based on instantaneous peak discharge data from 1976 through 2009, representing the regulated period following the completion of the Willamette River basin federal flood control dam network.

			Confidence Limits Flow (cfs)	
Percent Chance Exceedence	Return Interval (yr)	Computed Flow (cfs)	0.05	0.95
0.2	500	122,800	153,047	104,949
0.5	200	118,093	145,936	101,435
1	100	113,829	139,566	98,225
2	50	108,799	132,143	94,400
4	25	100,601	120,268	88,067
10	10	92,771	109,211	81,885
20	5	82,807	95,602	73,784

Table 3-4. The flood frequency for the Willamette River at the USGS Albany gage. The flood frequency is based on instantaneous peak discharge data from 1976 through 2009, representing the regulated period following the completion of the Willamette River basin federal flood control dam network.

			Confidence Limits Flow (cfs)	
Percent Chance Exceedence	Return Interval (yr)	Computed Flow (cfs)	0.05	0.95
50	2	63,286	70,826	56,808
80	1.25	44,924	50,318	39,091
90	1.11	36,390	41,508	30,523
95	1.05	30,063	35,075	24,239
99	1.01	20,124	24,849	14,797

In summary, the federal flood control dam network has affected Willamette River flows by reducing the magnitude and variability of peak flood events. Mean daily flows have also been influenced by the dam network, resulting in lower winter and spring flows as the reservoirs dampen peak events, and higher summer flows to meet recreation and water use needs.

3.5.2 Calapooia River Hydrology

Flows in the Calapooia River vary greatly throughout the year due to seasonal precipitation and summer use of water (CWC 2004). The average monthly January flow in Albany is 55 times the average August monthly flow. Nearly 90% of the runoff occurs during the six wettest months (November through April). The magnitude of annual runoff also varies. Rain-on-snow flood events have been responsible for the largest floods of record. These events typically occur between December and February when warm storms rain on the snowpack. Figure 3-7 includes the average mean daily discharge for the Calapooia River at the former USGS gage (14173500) located at the SW Queen Avenue Bridge. The gage was active from 1941 until 1981 when it was abandoned. The hydrograph shows the dramatic range of discharge previously mentioned. Summer time low flows are typically less than 50 cfs while spring flows are typically over 1,000 cfs. Fall rains from November through December also create dramatic spikes in river discharge.

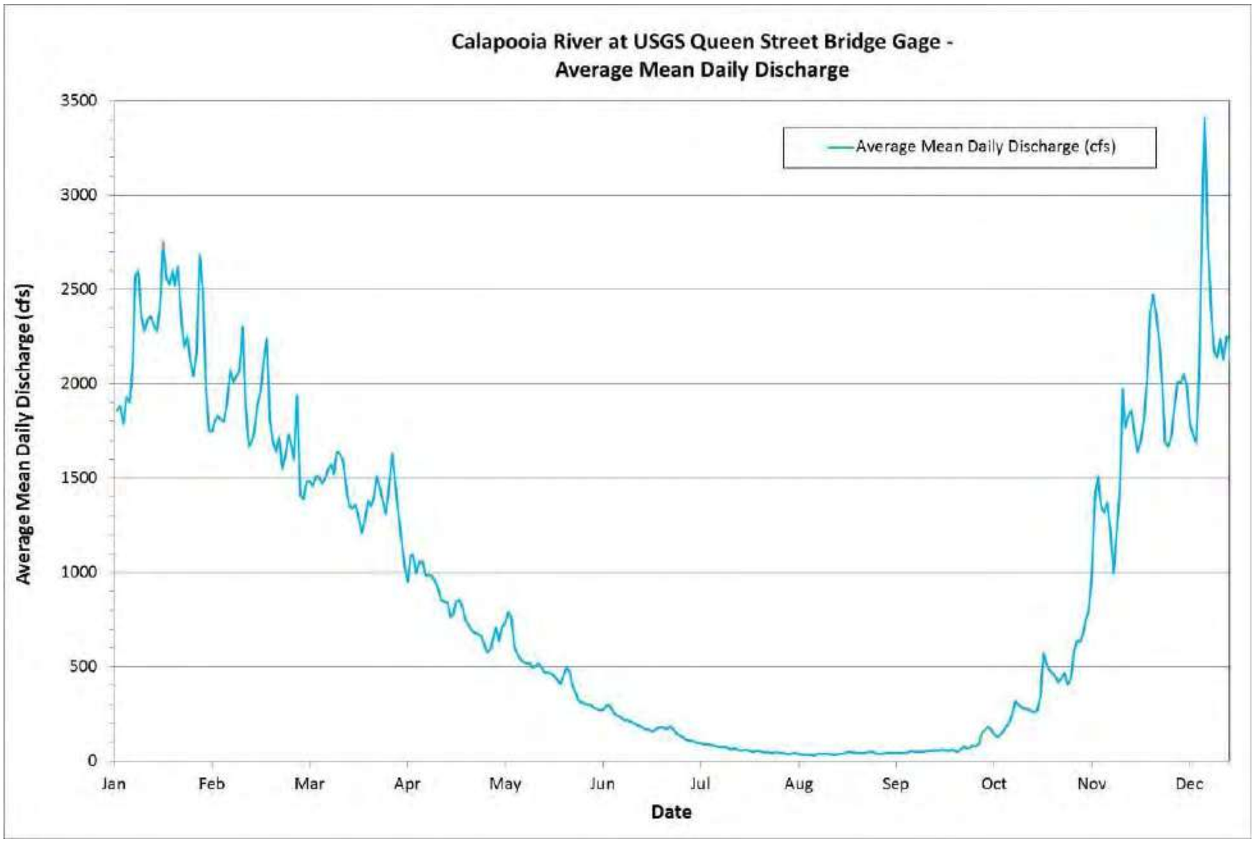


Figure 3-7. Average mean daily discharge for the Calapooia River measured at the former USGS gage station at SW Queen Avenue Bridge. The graph illustrates the large difference between low summer time flows and winter and spring high flows. The average mean daily discharge calculations are based on the 41 year period of record (1941 to 1981).

Figure 3-8 includes a plot of instantaneous peak discharge measurements also from the USGS SW Queen Avenue Bridge gage. The 1956 and 1961 floods are the largest peaks in the period of record, topping 30,000 cfs. Most peak events ranged from 5,000 cfs to 20,000 cfs, or approximately a 5 year event. A log-Pearson III flood frequency analysis was completed using the annual peak flow data. The flood frequency for the Calapooia River is included in Table 3-5.

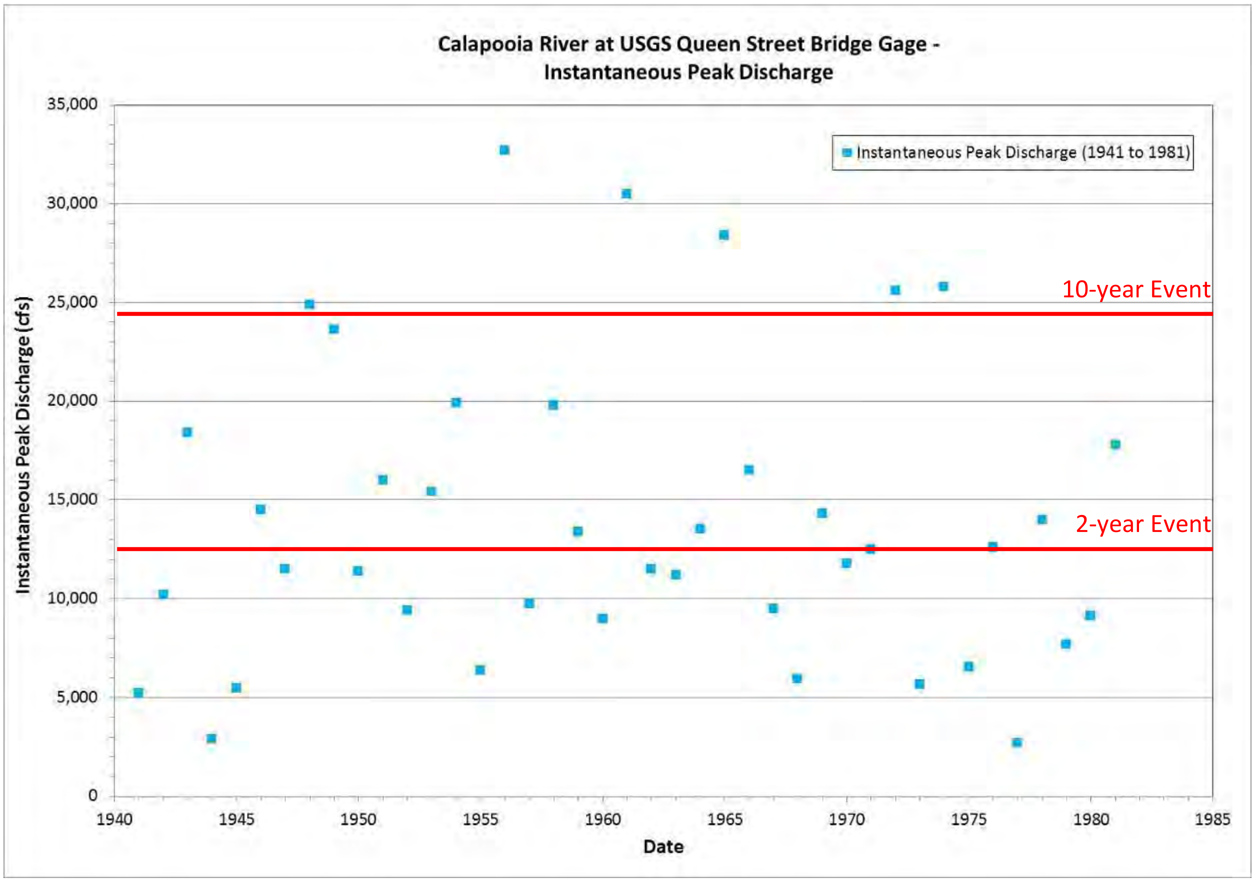


Figure 3-8. Instantaneous peak discharges for the Calapooia River as measured at the USGS SW Queen Avenue Bridge gage. The 41 year period of record spanned from 1941 to 1981 when the gage was discontinued.

Table 3-5. The flood frequency for the Calapooia River from the discontinued USGS gage at SW Queen Avenue Bridge. The 41 year period of record spanned from 1941 to 1981.

			Confidence Limits Flow (cfs)	
Percent Chance Exceedence	Return Interval (yr)	Computed Flow (cfs)	0.05	0.95
0.2	500	45,446	64,063	35,392
0.5	200	41,095	56,798	32,412
1	100	37,610	51,103	29,987
2	50	33,938	45,232	27,389
4	25	30,050	39,173	24,583
10	10	24,494	30,840	20,452
20	5	19,853	24,226	16,854
50	2	12,610	14,738	10,827
80	1.25	7,454	8,764	6,133
90	1.11	5,497	6,624	4,319

Table 3-5. The flood frequency for the Calapooia River from the discontinued USGS gage at SW Queen Avenue Bridge. The 41 year period of record spanned from 1941 to 1981.

			Confidence Limits Flow (cfs)	
Percent Chance Exceedence	Return Interval (yr)	Computed Flow (cfs)	0.05	0.95
95	1.05	4,207	5,217	3,152
99	1.01	2,448	3,250	1,649

In summary, Calapooia River flows exhibit substantial variation from high winter and spring flows to low summer flows. A comparison of low and moderate flows is included in Figure 3-8. Because the Calapooia River is unregulated by dams, the contemporary hydrograph is similar to historical conditions. Agricultural water use in the watershed is minimal as the dominant crop, grass seed, requires minimal irrigation.

Figure 3-9. A comparison of river conditions associated with low (left) and moderate (right) flows on the Calapooia River downstream from SW Queen Avenue Bridge. The height of the eroding bank is masked by moderate flows but the magnitude was apparent during the summer field data collection.

3.5.3 Thornton Lake Hydrology

Thornton Lake is an ungaged waterbody within the project reach. Thornton Lake is the former location of the Willamette River located to the northwest of the river's current location. The lake's water level remains within a consistent range that is influenced by groundwater and surface water inputs. There are likely multiple groundwater pathways to Thornton Lake. Bordered by the Willamette River on three sides, groundwater inputs via paleochannels are likely the primary water source to the lake. Surface water inputs include seasonal connection with the Willamette River via a backwater channel that links Thornton Lake with the Willamette River. Recent work evaluating the Thornton Lake area as a Willamette River floodway found that the lake connects with the Willamette River 9 days on average per year from November through March (Pacific Water Resources, Inc. 2010). The lake would connect twice as frequently if the lake outlet were lowered to the elevation of the connector channel immediately downstream from the outlet embankment.

Floodplain inundation modeling completed by RDG included mapping the predicted regulated 2-year event on the Willamette River (see Section 4.4). Inundation mapping suggested the Willamette River backwaters into Thornton Lake at the 2-year event. Periodic higher magnitude events such as the 1996 flood, result in a flow through system with Willamette River flood water flowing through Thornton Lake before returning to the Willamette River proper north of Thornton Lake. This flow path inundates Thornton Lake, Horseshoe Lake, and agricultural and residential properties.

In addition to flood water inputs, surface water runoff from the watershed surrounding Thornton Lake also contributes flow to the lake. Residential development including home sites, roads, and other impervious surfaces (e.g. asphalt parking lots), accelerate stormwater delivery to Thornton Lake. Stormwater delivers suspended sediment and contaminants to the lake, potentially degrading water quality.

3.5.4 Periwinkle Creek Hydrology

Periwinkle Creek is an ungaged tributary to the Willamette River. With its headwaters in the foothills east of Albany, Periwinkle Creek flows in a westerly direction to the Willamette River. The watershed has been thoroughly developed for agriculture and the City of Albany. System hydrology is driven by stormwater runoff making Periwinkle Creek a flashy system that rapidly responds to storm events. Runoff from agricultural land delivers fine sediment to the stream. Stormwater runoff from impervious surfaces in the more urbanized area of the watershed contributes suspended sediment and contaminants to the creek.

Figure 3-10. Periwinkle Creek downstream from the SE 9th Avenue Bridge. This reach marks the start of the more urbanized reach of Periwinkle Creek. The riparian zone has been narrowed to a fringe and Impervious surfaces such as roads and parking lots accelerate stormwater discharge to the creek. Stream corridor modifications have allowed development to expand to the stream edge while protecting against flooding.

The mouth of Periwinkle Creek is backwatered by the Willamette River when river flows are elevated. Inundation modeling results suggest the 2-year event on the Willamette River inundates lower Periwinkle Creek, creating a low velocity backwater.

3.5.5 Albany Oxbow Lakes Hydrology

The Albany oxbow lakes are located east of the Willamette River and north of the City of Albany. The oxbow area is an historical location of the Willamette River and maintains groundwater and surface water connections to the river. The primary waterbodies comprising the Albany oxbow lakes include First Lake, Second Lake, Third Lake, and Fourth Lake. Four tributaries historically either flowed into the lakes or joined the Willamette River in the immediate vicinity. These tributaries include, from south to north, Cox Creek, Burkhart Creek, Truax Creek, and Murder Creek. Each of these tributaries has been substantially altered by urban and industrial development that dominates this area of the project reach. The City of Albany's waste water treatment plant, the International Paper facility, ATI-Wah Chang, and the Duraflake facility discharge treated water to the Albany oxbow lakes area. The City of Albany is currently bringing online the Talking Water Gardens, an innovative integrated wetlands system designed to provide an additional level of natural treatment for a combined municipal and industrial treated wastewater discharge.

No gage or surface water elevation data were found for the Albany oxbow lakes. However, peak flows were measured on Cox Creek downstream from SE Salem Avenue from 1953 to 1968, a period of 16 years. Although this area has experienced considerable development since the 1960s, the Cox Creek flood frequency is presented in Table 3-6 for reference. The short period of record results in relatively broad confidence limits event for lower, more frequent flows.

Table 3-6. The flood frequency for Cox Creek from the discontinued USGS gage downstream from SE Salem Avenue. The 16 year period of record spanned from 1953 to 1968.

			Confidence Limits Flow (cfs)	
Percent Chance Exceedence	Return Interval (yr)	Computed Flow (cfs)	0.05	0.95
1	100	1,324	2,038	1,028
2	50	1,196	1,771	946
4	25	1,026	1,435	832
10	10	893	1,192	740
20	5	754	956	636
50	2	542	644	457
80	1.25	387	459	306
90	1.11	324	391	242
95	1.05	279	344	198
99	1.01	210	272	134

Limited discharge measurements and water quality samples results were found in the USGS on-line database for Burkhart and Truax creeks.

3.6 Riparian Corridor

The riparian corridor varies in the project reach, primarily influenced by land use. A riparian fringe borders much of the Willamette River with inland area predominantly agriculture, rural residential, or urban. Intact riparian zones on the lower Calapooia River and portions of the Willamette River, including the Albany oxbow lakes area, support hardwood species including Oregon ash, black cottonwood, bigleaf maple, and red alder. Native species comprising the shrub layer include the listed hardwood species in addition to willows, dogwood, rose, currants, and other riparian shrubs. Invasive species inhabiting the riparian corridor include English ivy, Himalaya blackberry, Japanese knotweed, clematis, butterfly bush, and Scotch broom among others. Invasive plant species often form monocultures that displace native vegetation, changing the local ecology.

More upland areas bordering project reach riparian zones included prairies and oak savannas. These features were often maintained by indigenous native populations that used fire to manage vegetation at the landscape scale. Prairie and oak savanna habitats have largely been converted for agricultural use and rural, urban, and industrial development. Remaining prairie and oak savannas have been compromised by invasive species and conifer encroachment.

River and stream modifications, flood control structures, and regulation of the Willamette River have modified the historical processes that maintained native riparian communities. Over time, the native riparian stands have shrunk either due to deliberate alteration or depressed natural processes that created diverse riparian corridors in the past.

3.7 Summary

Section 3 Project Reach Overview provided a broad discussion of the Calapooia-Albany Assessment project reach. The Willamette River is the arterial river that bisected the project reach. Other waterbodies ranging from the Calapooia River to Fourth Lake present a diverse collection of streams and oxbow lakes that amplify the ecological importance of the project reach to the Willamette River ecosystem. Although human alteration of the river corridor has resulted in a substantial departure from pre-settlement conditions, reviewed waterbodies remain connected to the Willamette River and provide the range of habitats that native species require to complete their life histories.

4 Waterbody Descriptions

The following section elaborates on the individual waterbodies that were reviewed as part of the Calapooia-Albany Assessment.

4.1 Calapooia River

The lower 3 miles of the Calapooia River from the SW Queen Avenue Bridge downstream to the Willamette River were reviewed as part of the assessment. The Calapooia River is characterized as a meandering riffle-pool gravel bed river in this reach. Forming the southern border of the Albany urban growth boundary (UGB) the Calapooia River retains its historical nature despite its proximity to an urbanized area.

4.1.1 Historical River Corridor Analysis

An historical river corridor analysis was completed to evaluate historical channel locations, riparian vegetation conditions, and the influence of land use on the river and adjacent floodplain. River alignments from four air photo series including the 1936, 1950, 1971, and 2009, and from the 1852 Governmental Land Office (GLO) map, were digitized and overlaid on to the 2009 air photo (Figure 4-1). The mapped river alignment from the GLO map was questionable, as the mapped alignment was considerably straighter than later alignments, and the mapped channel location occupied higher elevation ground surfaces that on field inspection, did not appear to have been influenced by channel processes.

A comparison of the river alignments from the air photo series suggests the contemporary river occupies a location similar to the river captured in the 1936 air photo. Primary changes include down-valley meander migration and lateral belt width expansion. As the river approaches the more urbanized southern neighborhoods of Albany, the channel planform straightens due to the constriction between the railroad and terrace on river-right, and the high terrace on river-left. The geologic control has limited the lateral expansion of the Calapooia River since the 1936 air photo. Once within the influence of the Willamette River, historical locations of the river channel have been more variable. The broad expanse that is today’s riverfront Bryant Park, is the Calapooia River’s historical delta.

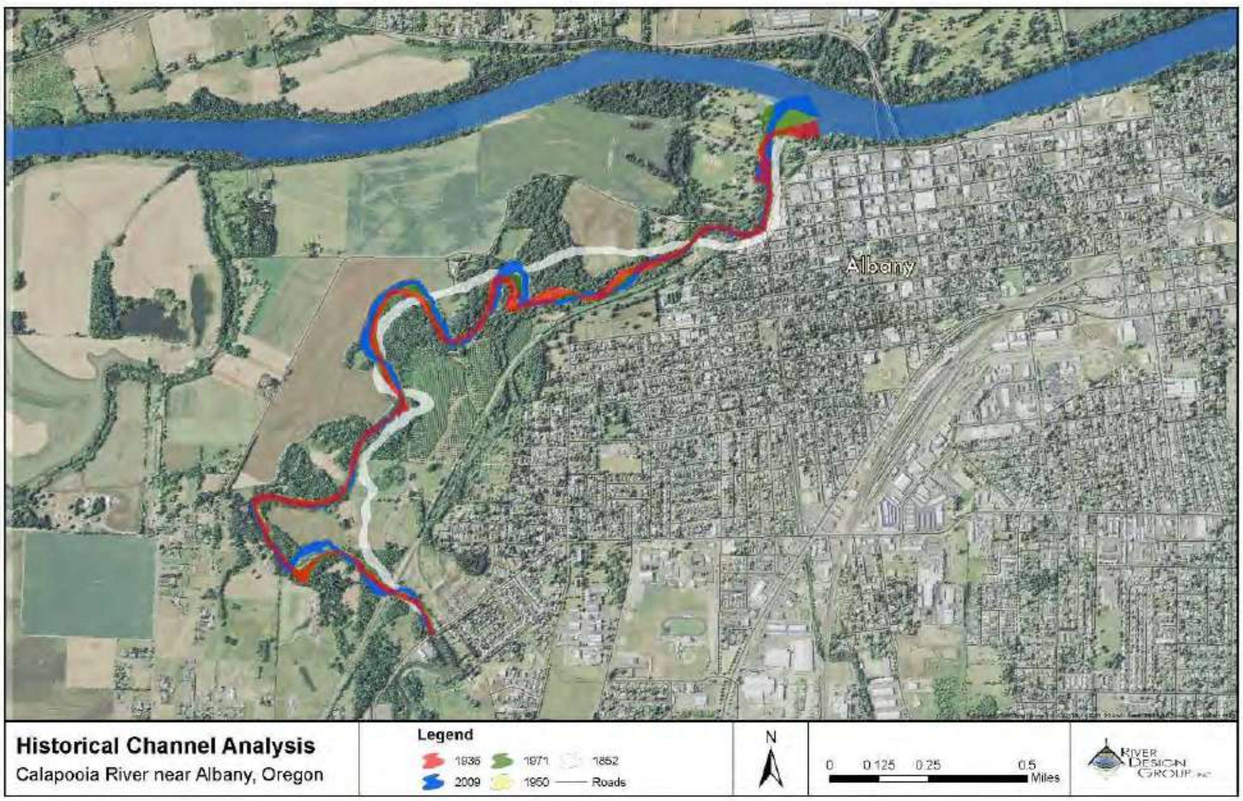


Figure 4-1. The historical channel analysis for the lower 3 miles of the Calapooia River adjacent to the City of Albany. River alignments were digitized from historical air photos and overlaid on the 2009 air photo for comparison.

The 1936 and 2009 air photos were also used to map the riparian corridor bordering the Calapooia River to assess how the corridor has changed over time in light of agricultural development and river migration. Contiguous riparian areas that bordered the river were mapped. Results suggest there has been a 20 percent reduction in riparian coverage from 1936 (261 acres) to 2009 (208 acres). Three areas account for most of the riparian coverage depletions.

- Bryant Park has largely been converted from native riparian to managed landscapes dominated by non-native grasses.
- Conversion of riparian stands to hazelnut orchards on the eastern floodplain near the mid-point of the assessment reach.
- Conversion of riparian stands to pastureland and grass seed farming in the upstream extent of the assessment reach.

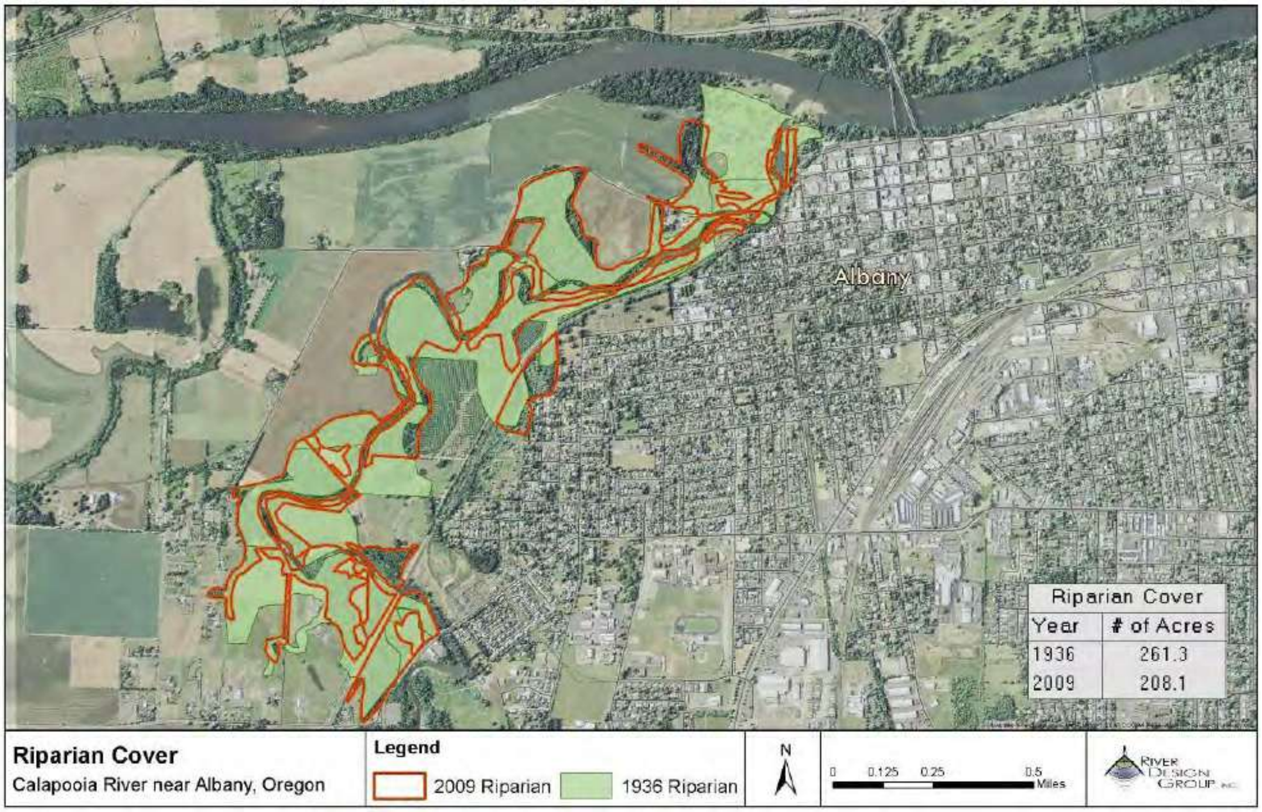


Figure 4-2. Changes in riparian cover from 1936 to 2009. Riparian conversion is attributed to land use changes and expansion of agricultural and recreational uses.

4.1.2 Inundation Mapping

Inundation mapping suggests the high degree of connectivity between the Calapooia River and the adjacent floodplain. Figure 4-3 includes the predicted water depths associated with the 2-year event on the Calapooia River. Potential flooding extends from the river-right terrace marking the eastern extent of Albany's neighborhoods, to the agricultural fields bordering the western river margins. Historical channel segments that are connected at more frequent runoff events, are enveloped by the 2-year event. Floodplain swales that border the primary floodway, are low elevation features that could potential convey floodwater or would at a minimum, be inundated if not blocked by roads or other infrastructure.

The confluence of the Calapooia River and the Willamette River is almost entirely flooded during a 2-year event. Bryant Park, located to the west of the confluence was inundated during the 2010/2011 winter when both rivers overtopped their banks and accessed the floodplain (Figure 4-4).

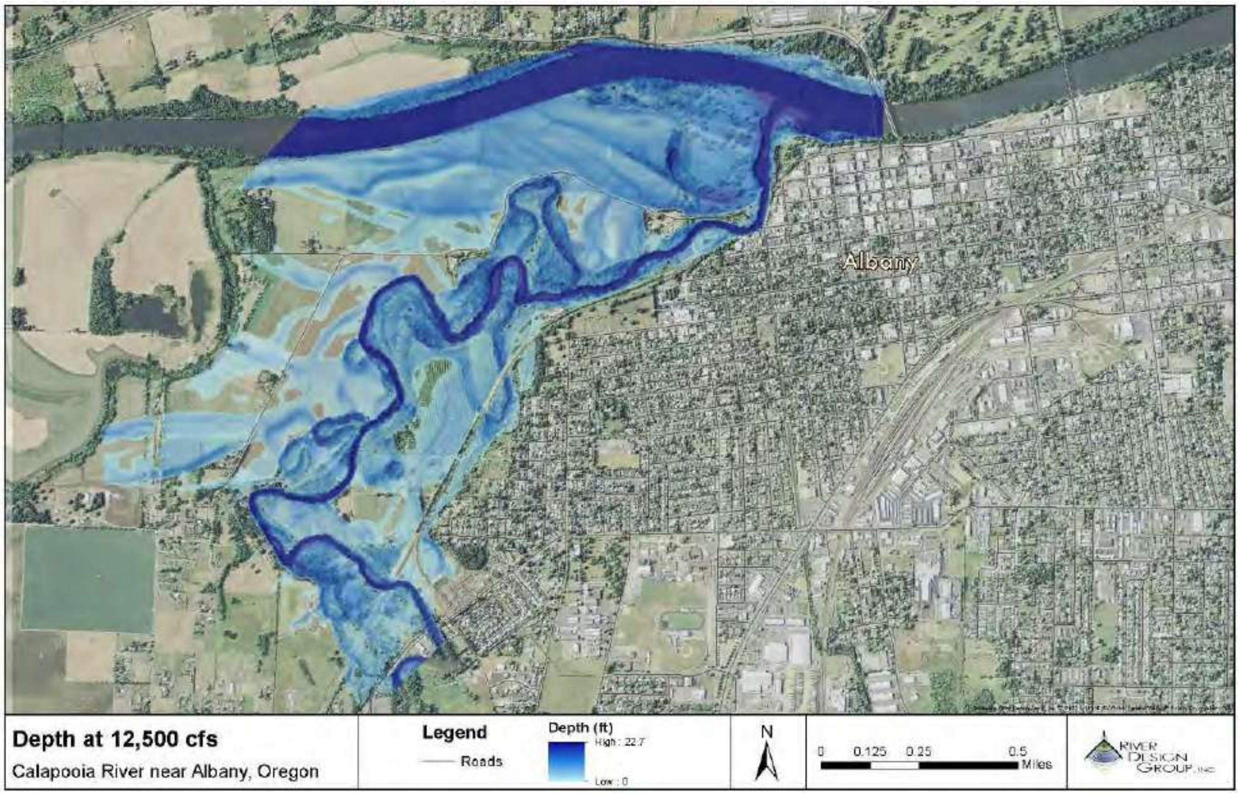


Figure 4-3. The predicted 2-year inundation map for the lower Calapooia River. The predicted 2-year flood would inundate much of the river corridor spanning from the eastern terrace marking the extent of Albany's neighborhoods, to the western grass seed fields that border the active channel.

Figure 4-4. Views of Bryant Park from December 31, 2010 showing inundation from the Calapooia River.

4.1.3 River Corridor Observations

The CWC completed a field data collection effort and RDG followed with a reconnaissance of the lower 3 miles of the Calapooia River. CWC highlighted bank erosion and bank stabilization sites, infrastructure, and high quality habitat components. Field data collection was completed during July low flows. RDG's reconnaissance was completed in December during typical winter flows. Observing the river at these two stages allowed for assessing streambank conditions and habitat during the base flow period and river-floodplain connectivity during an elevated flow.

Data collection maps and tables are presented in Appendix A. The following is a field data summary.

Habitat

The lower Calapooia River is a dynamic river environment characterized by alternative riffle and pool habitats, backwater and alcove habitats, frequent large wood, and morphological features that are annual modified by high flows. Whole trees and accumulated large wood were common habitat-forming structures in the reach. Trees appeared to be recruited from both upstream sources and the adjacent floodplain. While large wood was typically located in channel margins, whole trees were also found mid-channel. Based on discussions with a local landowner, although wood is common in the reach, it is a transitory feature that changes in response to nearly annual high flows (Figure 4-5).

The residence time of wood in the system would be dependent on flow levels, wood position in the channel, and structure size. A multi-year period of lower wintertime flows would likely slow both the recruitment of wood to, and loss of wood from the assessment reach. Whole trees that recruit from the adjacent floodplain would be more likely to remain within the reach for an extended period of time relative to smaller pieces of wood that are recruited from upstream or that temporarily deposit on gravel bars. Finally, aggregations of logs tend to be more stable due to the additional drag and weight that multiple stems and rootfans provide. Immobile structures also collect smaller debris, expanding the structure's footprint and influence on the river environment.

Table 4-1 includes the feature number, channel alignment station, location (e.g., river-right, center, or river-left) and dimensions of large wood features identified in the lower Calapooia River assessment reach.

Figure 4-5. A large wood aggregation on the lower Calapooia River. Aggregations accumulate smaller debris over time but may also mobilize during higher magnitude runoff events.

Table 4-1. Wood structures located in the lower Calapooia River assessment reach. Stationing relates to the field data collection maps in Appendix A.

Number	Starting Station	Location	Length (ft)	Height (ft)	Width (ft)	Comment
H1	168	RR	10	2	20	Wood jam
H2	161	RL	50	2	20	Wood jam
H3	159	RL	80	7	40	Wood jam
H5	156	RL	30	4	10	Wood jam
H6	156	RC	40	2	15	Wood jam
H10	144	RR	50	4	10	Wood jam
H12	142	RC	200	NA	NA	Split channel w/ wood
H14	119	RR	30	10	15	Wood jam
H15	117	RL	60	8	15	Wood jam, green tree
H17	108	RC	120	NA	100	Split channel w/ wood
H18	102	RR	70	4	20	Wood (treefall)
H24	73	RR	40	10	15	Wood jam, high water only
H26	60	RL	200			Multiple treefall wood jam, channel spanning
H28	43	RL	100	3	10	Wood (treefall)
H29	38	RR	50	8	25	Wood jam
H30	32	RL	60	3	20	Wood jam complex
H31	24	RR	50	4	10	Treefall with pool and rootwad

Side Channels and Alcoves

Side channels include tributaries and floodplain swales that are temporally connected to the Calapooia River. Perennial tributaries discharge to the river year-round while floodplain swales may only activate during winter and spring when river flows are at the annual maximum. These features generally provide habitat characteristics that differ from the mainstem river. For example, narrow straight tributary channels would provide higher water velocities and potentially coarser channel bed substrates. Alternatively, low gradient, broad floodplain swales that occupy historical channel locations may be characterized by standing water and silty beds. Broad habitat conditions that are provided by diverse floodplain environments expand the number of species these environments can support. Figure 4-6 captures the confluence of a floodplain side channel and the Calapooia River.

Alcoves are characterized by smaller floodplain ponds proximate to the river channel. Similar to side channels, alcove activation is often dependent on river stage. Low elevation alcoves would be connected year-round while higher elevation features may be inundated only during storm flows. Like side channels, alcoves provide habitats that complement the mainstem channel, providing refuge from high velocity flood flows.

Figure 4-6. A low velocity channel margin area marks the confluence of a floodplain side channel with the Calapooia River. These areas provide refuge for fish during high water events.

Table 4-2 includes the feature number, channel alignment station, location (e.g., river-right, center, or river-left) and dimensions of Side Channels and Alcoves identified in the lower Calapooia River assessment reach.

Table 4-2. Side Channels and Alcoves located in the lower Calapooia River assessment reach. Stationing relates to the field data collection maps in Appendix A.

Number	Starting Station	Location	Length (ft)	Height (ft)	Width (ft)	Comment
H4	161	RR	400	14	6	Side channel
H7	151	RL	100	NA	10	Side channel
H8	150	RL	100	NA	15	Alcove w/ small fish
H11	144	RL	100	20	40	Backwater w/ trib junction
H12	142	RC	200	NA	NA	Split channel w/ wood
H13	138.5	RR	40	5	20	Alcove w/ wood
H17	108	RC	120	NA	100	Split channel w/ wood
H19	99	RR	150	10	50	Backwater, 10' deep, with rootwad
H21	93	RR	25	NA	20	Alcove
H22	85.5	RR	40	NA	20	Alcove, 6' deep
H25	65	RC	400	NA	100	Split channel, main flow left

Pools and Split Channels

Deep pools and split channels add diversity to the river corridor. Adult fish migrating through the lower Calapooia River may use deep pools as holding habitat. Pools with large wood, overhanging vegetation, and undercut banks can provide additional cover and protection for adult fish that could include steelhead and Chinook salmon. Split channels typically provide shallower, faster water habitats that provide cover for juvenile fish and individuals of smaller-body species. Large wood in split channel habitat units create flow obstructions, interstitial spaces, and varied velocity microhabitats that are used by juvenile fish, physically separating them from larger predatory fish.

Table 4-3 includes the locations of deep pools and split channels in the lower Calapooia River.

Table 4-3. Deep pools and split channels located in the lower Calapooia River assessment reach. Stationing relates to the field data collection maps in Appendix A.

Number	Starting Station	Location	Length (ft)	Height (ft)	Width (ft)	Comment
H9	146	RC	400	20	80	20' deep pool
H12	142	RC	200	NA	NA	Split channel w/ wood
H16	111	RC	400	20	80	20' deep pool
H17	108	RC	120	NA	100	Split channel w/ wood
H20	99	RL				10' deep pool, 3 trees, with multiple wood jams
H23	85	RL	60	NA	50	20' deep pool
H25	65	RC	400	NA	100	Split channel, main flow left
H27	55	RR				< 15' deep pool w/ mulitple wood and backwater
H32	14	RC	400	NA	200	20' deep pool w/ wood

Infrastructure

Infrastructure in the lower Calapooia River included erosion control structures, bridges, and broken concrete and riprap. Erosion control treatments were typically located on outside meanders where lateral channel migration led to streambank erosion. Treatments generally appeared to have been in place for a period of time based on vegetation colonization of the stabilized sizes. Crossings in the reach include SW Queen Avenue Bridge, two railroad crossings, Bryant Way and a water pipeline. Multiple power line crossings are also located in the reach. Table 4-4 includes infrastructure locations.

Table 4-4. Infrastructure located in the lower Calapooia River assessment reach. Stationing relates to the field data collection maps in Appendix A.

Number	Starting Station	Location	Length (ft)	Height (ft)	Comment
I1	162	RR	30	10	Railroad Trestle
I2	160	RL	30	10	Railroad Trestle
S1	147	RR	20	6	Erosion control
S2	135	RL	100	8	Erosion control, outside of bend, trailer frame
S3	122	RR	20	8	Erosion control, outside of bend, trailer frame
S4	95	RC	40	-	Failed rip rap in river
S5	93	RL	700	8	Riprap outside bend, failed between 88-87

Table 4-4. Infrastructure located in the lower Calapooia River assessment reach. Stationing relates to the field data collection maps in Appendix A.

Number	Starting Station	Location	Length (ft)	Height (ft)	Comment
S6	85	RL	500	8	Riprap
S7	32	RR	300	20	Riprap soil lifts, plantings, eng. log structure
S8	24	RL	40	10	Old concrete
S9	24		30	8	Old concrete/asphalt
I3	23	RL	300	8	Old concrete/asphalt
I4	20	RR	300	12	Canal/hydroplant structure/protection
S10	16	RR	250	4	Trestle protection
S11	16	RL	250	4	Trestle protection
I5	12	RR	60	6	Drainage outflow w rocks
I6	7	RR	20	-	Concrete

Figure 4-7 includes two bank stabilization treatments found in the assessment reach. Rock riprap is a common treatment on the Calapooia River. Riprap was typically end-dumped over eroding streambanks to stabilize the toe of the slope and upper banks as necessary. Riprapped banks on the Calapooia River date to the 1950s although treatments on the lower Calapooia appear to be more recent. Himalaya blackberry typically colonizes these sites, competing with native plant species. Vegetation conditions shown in the lower left photo are common for stabilized banks on the lower Calapooia River.

The City of Albany completed a bioengineering and large wood structure project in 2009 to stabilize an eroding bank adjacent to a settling pond located at STA 32+00. The project included removing blackberry, grading the eroding bank, and stabilizing the streambank with a rock toe, vegetated soil lifts, and large wood structures. Native willows and shrubs were planted to facilitate vegetation colonization.


Figure 4-7. Two examples of bank stabilization treatments in the assessment reach. The left photo shows older rock riprap and a revegetating streambank at STA 85+00. Bioengineering and large wood structures were used to stabilize an eroding bank adjacent to City of Albany settling ponds at STA 32+00.

Bank Erosion

Bank erosion sites were also noted during the field data collection. Sites typically exceeded 100 ft in length and ranged from 5 ft to 15 ft high from the top of the bank to the toe of the slope. Eroding banks were generally defined by fine bank materials, steep bank slopes, and poor vegetation conditions. The most sizeable eroding banks were on the outside of meanders where the river is laterally migrating into adjacent floodplain surfaces. A review of the historical channel alignments suggests that areas where the channel is migrating

Table 4-5 includes bank erosion sites on the lower Calapooia River. Figure 4-8 includes photos of E1 and E3. Bank erosion at these two sites appears to be related to both river processes (e.g. outside meanders) and riparian vegetation removal. The proximity of the two sites is presented Figure 4-8.

Table 4-5. Bank erosion sites located in the lower Calapooia River assessment reach. Stationing relates to the field data collection maps in Appendix A.

Number	Starting Station	Location	Length (ft)	Height (ft)	Comment
E1	165	RR	600	15	Eroding bank by powerline tower
E2	160	RL	600	13	Bank erosion site by power pole
E3	151	RR	600	11	
E4	133	RL	25	25	Yard debris dumped overbank
E5	126	RR	600	9	Less active bank erosion site.
E6	120	RR	225	14	
E7	114	RL	50	10	Bank erosion site
E8	103	RR	30	8	Bank erosion site
E9	101	RR	40	12	Bank erosion site
E10	96	RL	250	14	Bank erosion, farmed to top of

Table 4-5. Bank erosion sites located in the lower Calapooia River assessment reach. Stationing relates to the field data collection maps in Appendix A.

Number	Starting Station	Location	Length (ft)	Height (ft)	Comment
					bank
E11	87	RL	40	10	Bank erosion site between riprap
E12	84	RL	15	5	Bank erosion site
E13	74	RR	120	12	
E14	61	RL	200	13	
E15	59	RL	600	16	
E16	52		75	13	
E17	48	RR	250	11	Blackberry and reed canary-grass
E18	45	RR	100	11	
E19	42	RR	650	13	Blackberry and reed canary-grass
E20	35	RL	250	13	
E21	19	RR	200	50	Santiam Canal
E22	11	RR	250	10	Downstream of lower railroad trestle

Figure 4-8. Eroding bank sites E1 (left) and E3 (right). Both sites are actively retreating as the river laterally migrates. The vertical banks, fine bank materials, and poor vegetation conditions increase the streambank erosion potential.

Figure 4-9. The location of E1 and E3 on the Calapooia River. Both sites are located on outside bends. The river is migrating down-valley at E3. Vegetation removal at both sites for power line protection, is likely influencing channel stability.

4.1.4 Ecological Considerations

The lower Calapooia River maintains much of its historical character. A broad riparian zone borders most of the river, providing a large wood source, floodplain habitats for fish and wildlife, and a buffer for channel migration. Wood recruitment in the reach includes both upstream and in-reach sources. As the channel migrates within the riparian corridor, trees will be recruited to the river. River-adjacent floodplains provide transitory storage for large wood, fine sediment, and other debris that is transported by the river. These features create and maintain dynamic environments that support native species.

In reaches where the historical floodplain has been modified for agriculture, eroding and stabilized streambanks are more common. These areas also coincide with the extent of the contemporary channel migration zone. The recent history of channel migration in the assessment reach suggests the lower Calapooia River has migrated 200-300 ft at several locations identified as having the greatest channel change from 1936 to 2009. Conserving and expanding riparian forests throughout the reach is one recommendation for reducing future land loss associated with channel migration.

The lower Calapooia River provides habitat for migratory and resident fish species. Federally threatened (USFWS 1999) anadromous Upper Willamette River (UWR) winter steelhead and spring Chinook salmon move through the lower watershed during spawning migrations to the upper Calapooia River. Deep pools, large wood, and low velocity off-channel and channel margin habitats provide cover and resting areas for migratory fish. Outmigrating juvenile steelhead and salmon also benefit from these habitat features on the downstream migration to the Willamette River and ultimately the Pacific Ocean (Colvin et al. 2005).

The resident fish population includes native and introduced species. Summertime elevated water temperatures coincide with low river flows. The USGS calculated a mean summer water temperature of 68ºF in the lower Calapooia River at Albany (ODFW 1992). Native cyprinid, minnow, and sucker species are more tolerant than the native salmonid species to warm water temperatures. Introduced warmwater fish species such as carp, largemouth bass, and sunfishes prosper in the higher water temperatures and low velocity environment that characterizes the lower Calapooia River from July through September.

4.1.5 Summary

Considering the proximity of the Calapooia River to the City of Albany and the relatively long history of agricultural and urban development in the lower watershed, the Calapooia River has largely maintained its historical character. Although bank erosion is a prominent process in the reach, the historical air photo review suggests the river has only experienced moderate channel migration over the past 80 years. Bank stabilization on outside meanders, particularly at the extent of the channel migration zone, have likely contributed to the minimal channel planform changes. More rapid bank erosion is occurring at two outside meanders that have been affected by riparian vegetation removal for power line protection and agriculture.

High quality habitat is common in the lower Calapooia River. Large wood accumulations, a mostly intact riparian zone, and river-floodplain connectivity provide diverse habitats for fish and wildlife. Introduced fish species likely prey upon and compete with native species for habitat space. Interactions between predatory introduced species such as largemouth and smallmouth bass and native juvenile steelhead and Chinook salmon are of most concern. Other warmwater introduced species such as the sunfishes and carp may also compete with native cyprinid, sucker, and minnow species.

Conservation and restoration opportunities for the lower Calapooia River are presented in *Section 6 Restoration and Conservation Opportunity Prioritization.*

4.2 Willamette River

The Willamette River assessment reach covered nearly 8 miles from the mouth of the Little Willamette River at Bowers Rock State Park, downstream to where the Willamette River interfaces with Springhill Road. The river is bordered by the City of Albany, outlying rural residential developments, and agricultural land. Compared to upstream reaches of the Willamette River between Eugene and Corvallis, the river corridor through Albany is more constrained by floodplain development.

4.2.1 Historical River Corridor Analysis

An historical river corridor analysis was completed to evaluate historical channel locations, riparian vegetation conditions, and the influence of land use on the river and adjacent floodplain. River alignments from four air photo series including the 1936, 1950, 1971, 1991, and 2009 series, were digitized and overlaid on to the 2009 air photo (Figure 4-10).

A comparison of the river alignments from the air photo series suggests the contemporary river occupies a location similar to the river captured in the 1936 air photo. Contemporary wetlands and backwater habitats are found within the extents of historical channel locations. The Willamette River has not occupied Thornton Lake or the Albany oxbow lake complex in the recent past, suggesting these features are relicts of more historical channel locations.

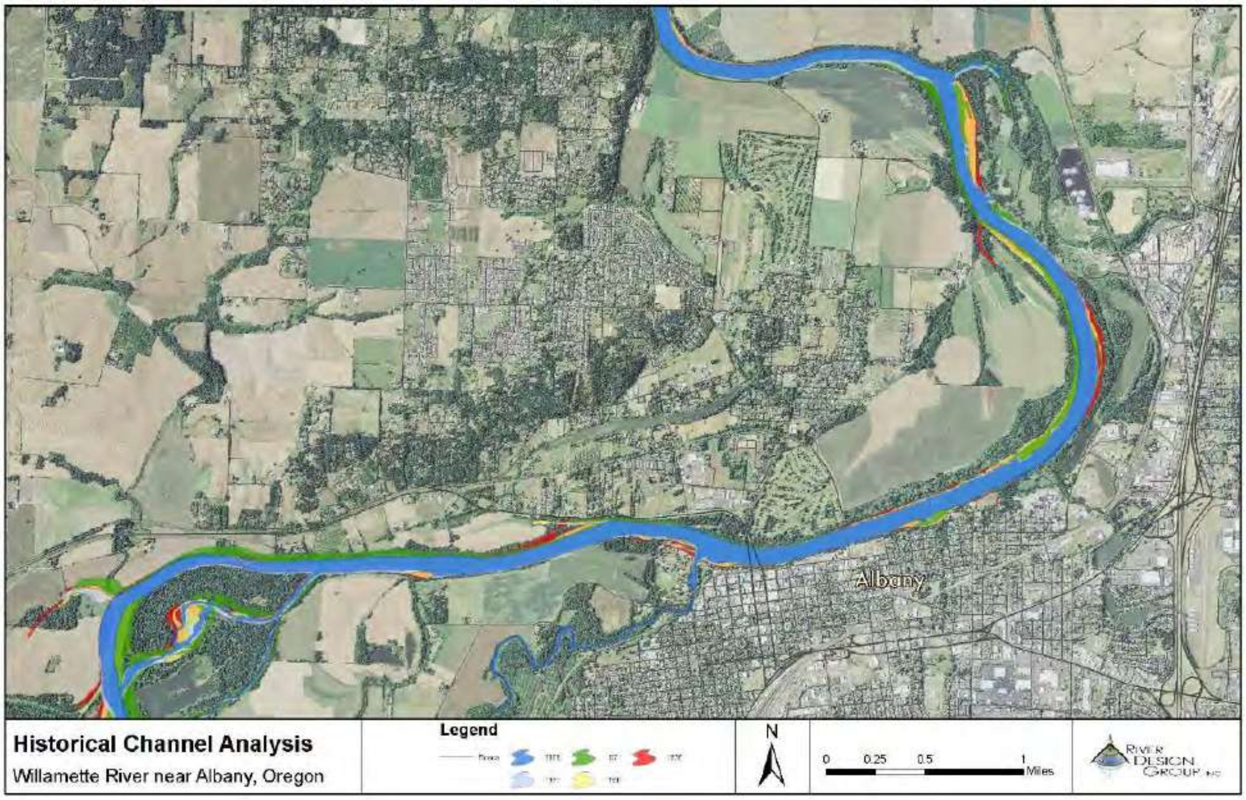


Figure 4-10. The historical channel analysis for the Willamette River. Channel alignments were digitized from 1936 through 2009. The analysis suggests the river location has changed little since the early 1900s.

The 1936 and 2009 air photos were also used to evaluate the riparian corridor bordering the Willamette River to assess how the corridor has changed over time in light of agricultural development and City of Albany growth. Figure 4-11 and 4-12 include representative comparisons of the riparian zone, floodplain habitats, and in-channel complexity in the Willamette River. General observations include:

- Historical riparian forests have been narrowed for agricultural development and rural residential and urban expansion.
- Floodplain depressions and wetlands have been converted for agriculture.
- The Willamette River has narrowed and simplified in response to flood control operations, other watershed changes (e.g. wood removal from tributary rivers), and local river modifications such as bank armoring.

Figure 4-11. A comparison of riparian conditions in the 1936 (left) and 2006 (right) air photos. Primary riparian corridor changes include conversion of the native riparian forest to agricultural land on the western floodplain, and the development of the eastern floodplain north of the City of Albany for industrial uses.

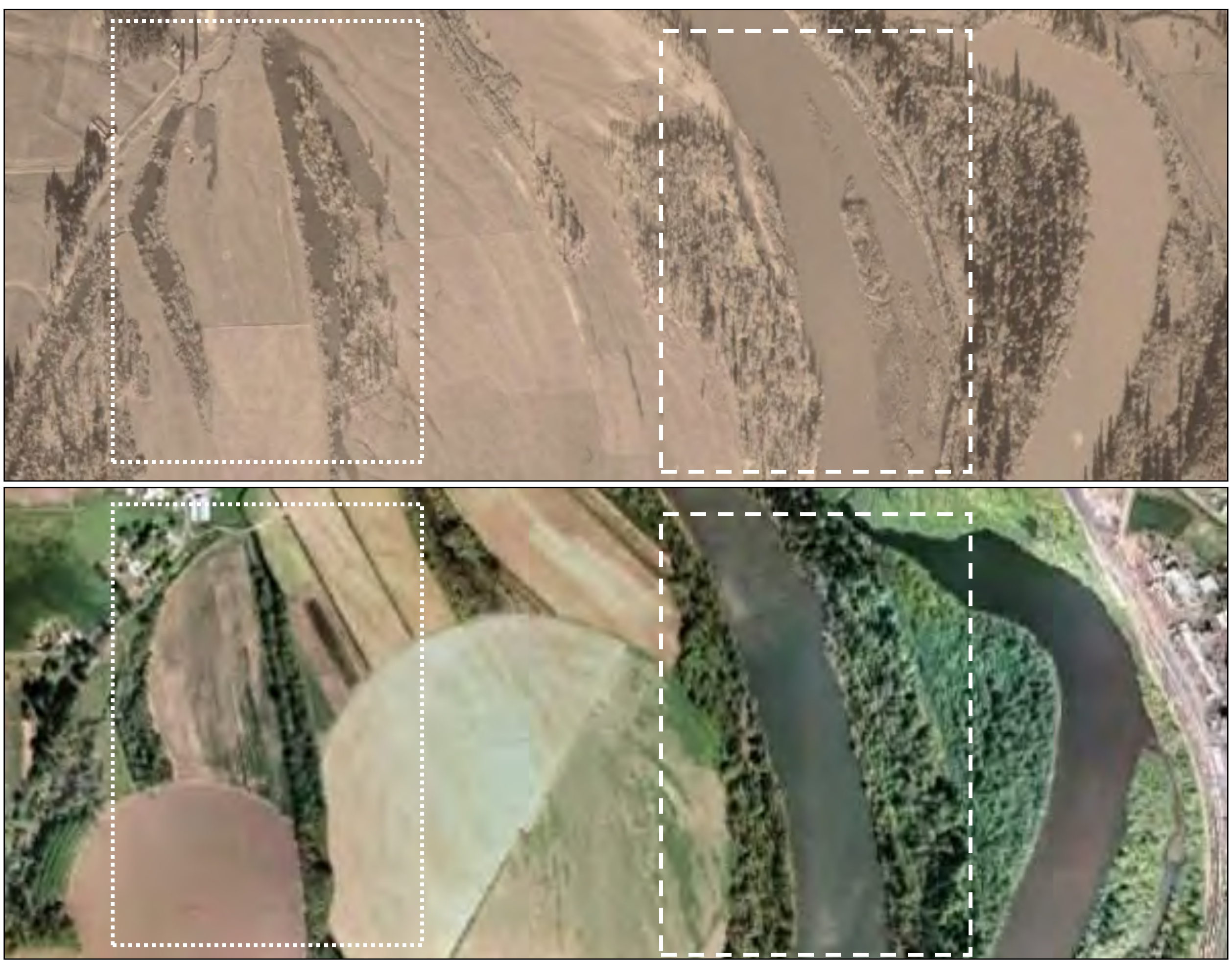


Figure 4-12. A comparison of the 1936 (top) and 2006 (bottom) air photos illustrating floodplain and in-channel habitat simplification that has occurred over time. The Willamette River is currently narrower through the assessment reach than it was historically.

4.2.2 Inundation Mapping

Inundation mapping suggests the high degree of connectivity between the Willamette River and portions of the adjacent floodplain. Figure 4-13 includes the predicted water depths associated with the 2-year event on the Calapooia River. Areas of potential inundation include the southern floodplain between Bowers Rock State Park and the Calapooia River mouth, the western floodplain downstream from the City of Albany, and the Albany oxbow lakes area. Projected floodplain inundation is related to both overbank flows in low elevation floodplain areas, and backwater effects. This process is evident on the western floodplain where backwatering of floodplain swales influences broader floodplain inundation patterns. Figure 4-14 includes a floodplain slough and the associated floodplain inundation during high flows

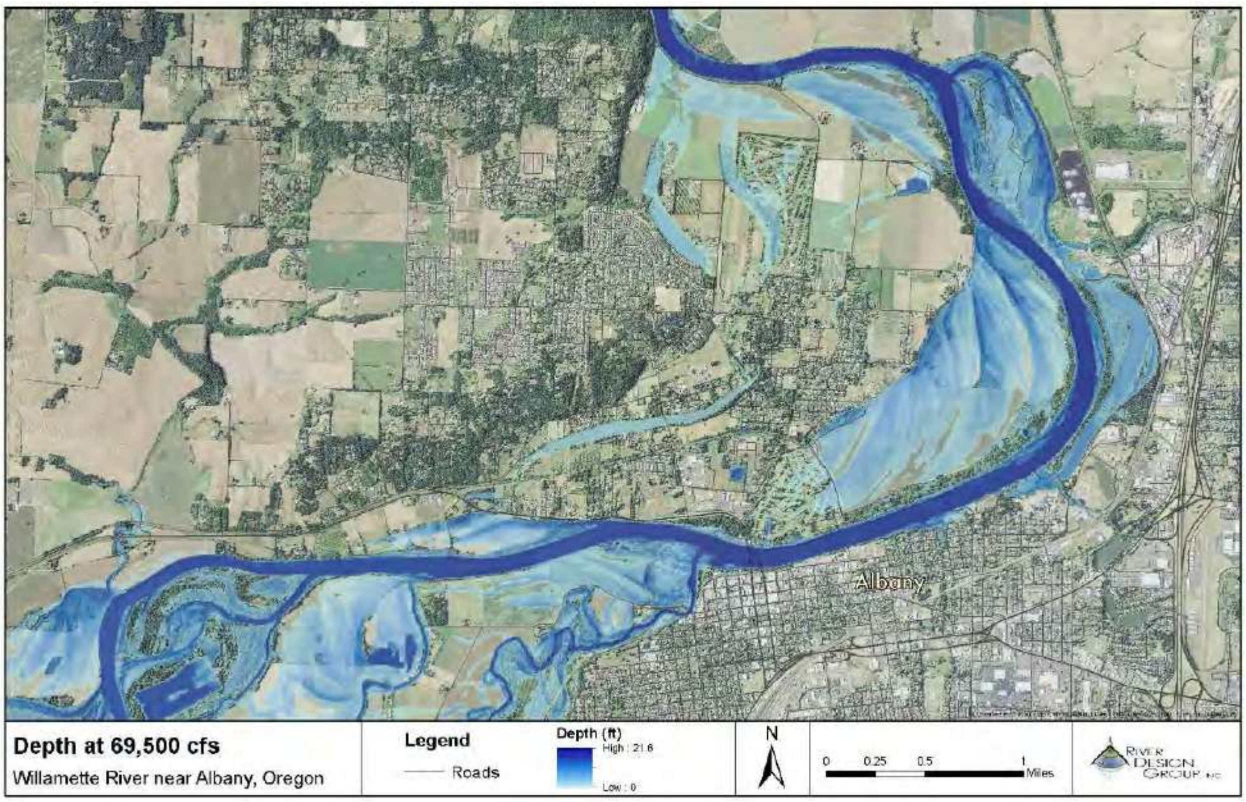


Figure 4-13. The predicted 2-year inundation map for the Willamette River from Bowers Rock State Park downstream to Springhill Road. The predicted 2-year flood potentially inundates floodplain environments through the project reach. Water surface elevations from the Albany gage and previous hydraulic modeling results from studies at Bowers Rock were used to verify the inundation mapping results.

Figure 4-14. An example of a floodplain slough at 16,000 cfs (7.78 ft stage) at the Willamette River Albany gage (left) shows the slough before widespread floodplain inundation on January 7, 2011. At 26,000 cfs (11.2 ft stage) at the Willamette River Albany gage on January 28, 2011, the floodplain is widely inundated due to the backwatering of the floodplain slough (right).

4.2.3 River Corridor Observations

The CWC completed a field data collection effort on the Willamette River assessment reach. CWC highlighted bank erosion and bank stabilization sites, infrastructure, and high quality habitat components. Field data collection was completed during July low flows. RDG completed a reconnaissance of the river from the Calapooia River confluence, downstream to Bowman Park below the Periwinkle Creek confluence in December during typical winter flows. Observing the river at these two stages allowed for assessing streambank conditions and habitat during the base flow period and river-floodplain connectivity during an elevated flow.

Data collection maps and tables are presented in Appendix B. The following is a field data summary.

Habitat

The Willamette River hosts varied in-channel and off-channel habitats. Floodplain features such as the mouths of tributary streams, the Albany oxbow lakes, and channel margin habitats provide diverse habitats in the reach. Large wood and overhanging riparian vegetation also create a range of microhabitats.

Similar to the Calapooia River, the residence time of wood in the Willamette River is dependent on flow levels, wood position in the channel, and structure size. Figure 4-15 includes large wood transported by the Willamette River that has accumulated in the assessment reach. Historically, prior to regulation of the Willamette River and its primary tributaries (e.g. McKenzie River and Santiam River) wood inputs to the Willamette would have been considerably higher. Wood recruitment would have occurred through floodplain contributions related to bank erosion in the Willamette River corridor, as well as wood delivered from tributary streams. River regulation for flood control has decreased the frequency and magnitude of high flows that historically delivered large wood to the Willamette.

Figure 4-15. Large wood accumulations on the Willamette River provide channel margin complexity and habitat (left). Wood and debris transported by the Willamette River often accumulates on bridge abutments, such as this private railroad bridge, located in the assessment reach (right).

Table 4-6 includes the feature number, channel alignment station, location (e.g., river-right, center, or river-left) and dimensions of large wood features identified in the lower Calapooia River assessment reach.

Table 4-6. Wood structures located in the Willamette River assessment reach. Stationing relates to the field data collection maps in Appendix B.

Number	Starting Station	Location	Length (ft)	Height (ft)	Width (ft)	Comment
H3	411	RR	100	6	25	Log snag
H6	410	RR				Large woody debris
H5	410	RR	20	4	20	Log snag
H7	409	RR	50	6	6	Log snag
H9	408	RL	80			Complex of cottonwood & Douglas fir trees fallen from bank
H12	404	RR	25	6	6	Logs
H13	400	RL	100			Large cottonwood tree wedged into bank
H14	393	RL	50			Large cottonwood tree perpendicular to stream flow, collecting smaller debris and trees
H19	345	RL	80			Complex of three large cottonwood trees fallen from bank
H21	284	RL				Series of large cottonwood fallen in river, collecting small trees and debris
H22	263	RL	50			4 large cottonwood trees fallen from bank, collecting

RIVER DESIGN GROUP, INC.

Table 4-6. Wood structures located in the Willamette River assessment reach. Stationing relates to the field data collection maps in Appendix B.

Number	Starting Station	Location	Length (ft)	Height (ft)	Width (ft)	Comment
						small woody debris
H25	182	RL	60	3		Large downed tree in water, key log/10 yrs. Dimensions include rootwad
H27	175	RC				In stream keyed log unit
H32	124	RR	500	100		Large backwater alcove
H40	79	RR				Large wood debris
H41	64	RR				Wood debris over channel
H42	60	RL	700			LWD unit
H44		RR				Lots of large wood not keyed in, near shopping carts, tumbling riprap
H45		RR				Large wood unintentionally cabled in
H43	25	RR				Wood debris in river, accumulating other debris

Side Channels and Alcoves

Side channels include tributaries and floodplain swales that are temporally connected to the Willamette River. Off-channel habitats are located throughout the reach including the following features.

- Little Willamette River,
- Bowers Rock State Park sloughs,
- Backwater system on river-left between the Willamette River and Thornton Lake,
- Calapooia River confluence area,
- Periwinkle Creek confluence area,
- Albany oxbow lakes,
- Channel margin habitats bordering river-right through the Albany oxbow lakes reach, and
- The western floodplain between the confluence of Fourth Lake and the end of the assessment reach.

These features vary in size and degree of connectivity with the Willamette River. In general, side channel, channel margin, and alcove habitat areas increase in size with increasing river stage. Figure 4-16 includes a comparison of the Periwinkle Creek confluence in July and December. Juvenile Chinook salmon and steelhead were sampled from the confluence area during the ODFW and City of Albany sampling in 2001 and 2002. Juvenile and adult fish likely use these lower velocity areas during winter and spring high flows.

Figure 4-16. The mouth of Periwinkle Creek during summer base flows (left) and typical winter flows (right). The Periwinkle Creek confluence provides shallow, low velocity habitat year round.

Table 4-7 includes the feature number, channel alignment station, location (e.g., river-right, center, or river-left) and dimensions of side channels, alcoves, and channel margin habitats identified in the Willamette River assessment reach.

Table 4-7. Side channels, channel margin, and alcove habitats located in the Willamette River assessment reach. Stationing relates to the field data collection maps in Appendix B.

Number	Starting Station	Location	Length (ft)	Height (ft)	Width (ft)	Comment
H1	n/a	RL	15	2	5	Beaver dam, small logs
H10	408	RR				Bowers slough, fish
H15	384	RR				Off-channel habitat
H16	384	RR				Off-channel habitat
H17	375	RR				Off-channel habitat
H18	367	RL	375	20	0.5	rush patch, deep water juvenile fish rearing habitat
H20	329	RL	150	75		Backwater oxbow at confluence, small tributary backflow channel
H23	241	RR				Periwinkle Creek
H24	241	RR				Periwinkle Creek
H26	180	RR				Small backwater and alcove, wapato patch
H28	162	RR				Backwater reed marsh, highwater refugia
H29	148	RR	300	10	50	Willow thicket, high water refugia
H30	137	RR	400			Rush marsh, high water refugia
H31	126	RL				Off-channel, north of Kenagy Slough
H34	108	RR	100			Small alcove
H36	90	RR	75			MP 89, large backwater channel, creek confluence,

River Design Group, Inc.

Table 4-7. Side channels, channel margin, and alcove habitats located in the Willamette River assessment reach. Stationing relates to the field data collection maps in Appendix B.

Number	Starting Station	Location	Length (ft)	Height (ft)	Width (ft)	Comment
						beaver activity
H37	83	RR				Small side pocket in bedrock
H38	81	RR				Channel margin, deep water next to riffle
H39	79	RR				Side channel

Infrastructure

Infrastructure in the Willamette River included a broader range of features than found in the lower Calapooia River. Typical infrastructure included crossings, pump intakes and pipe outfalls, docs, and bank stabilization treatments. Larger scale structures such as bridge abutments and bank stabilization structures are more influential on river processes. Table 4-8 includes the infrastructure that was identified during the field data collection.

Table 4-8. Infrastructure located in the Willamette River assessment reach. Stationing relates to the field data collection maps in Appendix B.

Number	Starting Station	Location	Length (ft)	Height (ft)	Comment
I1	409	RL	1	0.5	Dock, house area
I2	409	RL			6" pipe, house area
I3	405	all			Major power lines
I4	404	all			Power lines
I5	400	RL	10	8	Wood stairs in disrepair
I6	400	RR			2nd set of powerlines
I7	395	RR			Power line area
I8	389	RL			4" pipe drawing water
I9	374	RL			Concrete blocks
I10	374	RL			4" pipe in water
I11	353	RR			6x6 cable box/protector for old pipe
I12	353	RR			Pump
I13	345	RR			Property line, no buffer downstream
I14	341	RL	5	2	Wood frame
I15	341	RL	30		8" pipe, approx 5' from shoreline, underwater running parallel with flow
I16	332	RR			Pipe, power pole
I17	331	RR			Phone pole, pipe, RR tie
I18	303	RR			Powerline (2), Bryant Park

Table 4-8. Infrastructure located in the Willamette River assessment reach. Stationing relates to the field data collection maps in Appendix B.

Number	Starting Station	Location	Length (ft)	Height (ft)	Comment
I19	301	RL	20	15	Asphalt slabs
I20	301	RL	40	8	power pole
I21	297	RR			City docks/pilings
I22	295	RR			Pilings
I23	289	RL	30	70	Bridge
I24	289	RL	40	2	Dock at Takena Landing park
I25	282	RR			Old pilings
I26	280	RR	20	15	Pipe/rock
I27	275	RR			Large building
I28	272	RR	750		Some rock stabilizing, piling, lining bank
I29	265	RL	10	2	8 pilings
I30	265	RR			Asphalt downstream, large outflow
I31	265	RR	3		Rocky outfall, gated large culvert
I32	263	RR			Before shopping cart and bridge, Concrete pillars
I33	262	RL			Train bridge
I34	262	RR			RR bridge, rock by trestle
I35	262	RR			1.5' pipe under RR bridge, sleeping area, Concrete blocks downstream
I36	256	RL	10	2	Concrete blocks
I37	255	RR			Small grey unconnected pipe and asphalt areas
I38	239	RL	6	2	Concrete blocks
I39	207	RR			Major riprap with erosion downstream
I40	155	RR			Riprap stabilized banks downstream from industrial outflow
I41	149	RL	20	10	Kenagy family farm Pump site #1. 2-screened 6" pipes.
I42	149	RR			Industrial outflow and pumps
I43	145	RL			Powerline
I44	123	RL			Kenagy family farm Pump site #2. Screened 6" pipe.
I45	76	RL			Pump site (upper Clem Pump). Screened 8" pipe.

Table 4-8. Infrastructure located in the Willamette River assessment reach. Stationing relates to the field data collection maps in Appendix B.

Number	Starting Station	Location	Length (ft)	Height (ft)	Comment
I46	65	RR			Irrigation pump
I47	62	RL			Unused Pump site
I48	55	RL			Clem's lower Pump site. Screen 6" pipe.
I49	40	RL			Springhill Country Club's Pump site. Screened 5" pipe.
I50	24	RR			Irrigation pump
I51		RR			Power line after slough, mostly willows and dogwood
I52		RR			Old pilings

Figure 4-17 includes example infrastructure in the Willamette River assessment reach. Pump stations deliver irrigation water and water for industrial uses.

Figure 4-17. The pump station on the Willamette River supplies water to the ATI-Wah Chang facility (left). Pilings protect the City of Albany pier on the Willamette River downstream from the Calapooia River confluence.

Bank Erosion

Bank erosion sites were also noted during the field data collection. Sites typically exceeded 100 ft in length and were generally over 10 ft high from the top of the bank to the toe of the slope. Eroding banks were generally defined by fine bank materials, steep bank slopes, and poor vegetation conditions. Invasive plant species were common throughout the survey. Ivy, blackberry, and reed canary grass were the dominant invasive species. Streambank height and slope appeared to be the variables most associated with eroding bank locations.

Table 4-9 includes bank erosion sites on the Willamette River. Figure 4-18 includes examples of an eroding bank and a stable bank for comparison.

Table 4-9. Bank erosion sites located in the lower Calapooia River assessment reach. Stationing relates to the field data collection maps in Appendix A.

Number	Starting Station	Location	Length (ft)	Height (ft)	Comment
E1	n/a	RL			Steel cable & eroded tree
E2	n/a	RR	50	10	Erosion
E3	370	RR	750	10	Erosion
E4	370	RR			Erosion and ivy
E5	343	RR	1000	11	
E6	343	RR			Erosion site, rusted metal box
E7	328	RR	250	10	Erosion
E8	328	RR	250		Eroding bank
E9	314	RR			Erosion patch area
E10	290	RR			Erosion by bridge/house/dock
E11	289	RR			Pipe and erosion, invasive species
E12	247	RR			Lower area RR, slight bank Erosion, house
E13	235	RR	500	10	Erosion/pavement
E14	208	RR	750	10	Erosion, outside bend of river
E15	195	RR			Minor erosion
E16	136	RL	700		Erosion along bank

Figure 4-18. Example streambank conditions in the Willamette River reach. Stable banks were typified by lower gradient bank slopes, lower bank heights, and dense riparian vegetation (left). Unstable banks had steeper bank slopes, were higher, and often had comparatively poor riparian vegetation conditions

(right). Overhanging vegetation and channel margin habitat were common attributes associated with stable banks.

4.2.4 Ecological Considerations

The Willamette River has experienced over 150 years of European American habitation. Over the last one hundred years, the system has been altered by flood control dams, revetments, and mechanical river modifications, conversion of the native riparian corridor for agriculture and urban development, and the introduction of invasive fish and plant species. Between 1880 and 1950, federally funded “clearing and snagging” projects removed more than 65,000 snags from the river to improve navigation and reduce flooding (OWEB 2010). Thirteen large flood control dams were constructed from 1941 to 1968 to control discharge of tributary streams and flooding on the Willamette River. To protect specific properties from erosion, USACE has constructed 42 miles of revetments, eliminating more than 90 miles of river channel (OWEB 2010). These actions have impacted the ecology of the Willamette River, resulting in the listing of aquatic species under the federal Endangered Species Act.

Flood control revetments paralleling the Willamette River have enabled broad conversion of the indigenous riparian corridor for agriculture and town site expansion. Loss of native riparian corridors has depressed wildlife habitat and simplified off-channel habitats that were historically used by the native fish assemblage. These activities have led to a simpler river corridor with fewer habitat niches.

The introduction of invasive plant and fish species has likewise affected the Willamette River corridor. Invasive plants outcompete native species, typically forming monocultures that displace natives. Himalaya blackberry and English ivy are two notable invasive plants that outcompete native species, resulting in ecosystem simplification. Introduced fish species have varied impacts on the native assemblage. In the near term, species diversity increases as native and introduced species co-exist. However, over time, introduced species which tend to be more tolerant of degraded stream conditions and potentially lack the predators and disease that control their populations where they originate, may displace native species resulting in diminished diversity. Introduced fish of concern in the Willamette River include largemouth and smallmouth bass which are voracious predators that prey on juvenile spring Chinook salmon and winter steelhead. Carp have the capacity to degrade water quality resulting in the dislocation of native species that require higher quality conditions to persist.

Despite the challenges facing the Willamette River fish community, there remains opportunities for preserving and enhancing river and off-channel habitats. Although these opportunities may be more limited in the assessment reach than in upstream sections of the river that have a broader floodplain corridor, large wood, intact riparian vegetation, and connected off-channel areas provide the beneficial conditions conducive to recovering threatened species and expanding other native species’ populations.

4.2.5 Summary

Nearly 8 miles of the Willamette River were reviewed during the field data collection. Bank erosion, infrastructure, and habitat locations were mapped and summarized. Large wood and side channel habitats are frequent features in the reach, providing diverse habitat for the river's fish and wildlife. Infrastructure, ranging from docks to bridge crossings, influences river hydraulics and riparian habitats. Bank stabilization and revetments affect river migration and riparian vegetation conditions. Naturally stable banks were characterized by shallow bank slopes, moderate bank heights and dense riparian vegetation. Eroding banks in the reach contribute gravel and large wood to the river and are not necessarily problematic except where narrow riparian fringe provides minimal buffer between the river and inland land uses.

Conservation and restoration opportunities for the Willamette River are presented in *Section 6 Restoration and Conservation Opportunity Prioritization.*

4.3 Periwinkle Creek

The field assessment covered Periwinkle Creek from the Santiam Highway SE crossing, downstream to the confluence with the Willamette River. Air photo evaluations were made of the entire watershed with emphasis on the urban corridor west of Interstate 5.

4.3.1 Historical Stream Corridor Analysis

The historical air photo series and GLO map were reviewed to assess the historical stream corridor. The 1852 GLO map followed the earliest development of the City of Albany and included Periwinkle Creek past the eastern extent of the New Albany town site. Based on the channel pattern in the 1936 air photo, it appears the GLO surveyors did not provide sufficient detail for the Periwinkle Creek planform. A portion of the GLO map is included in Figure 4-19.

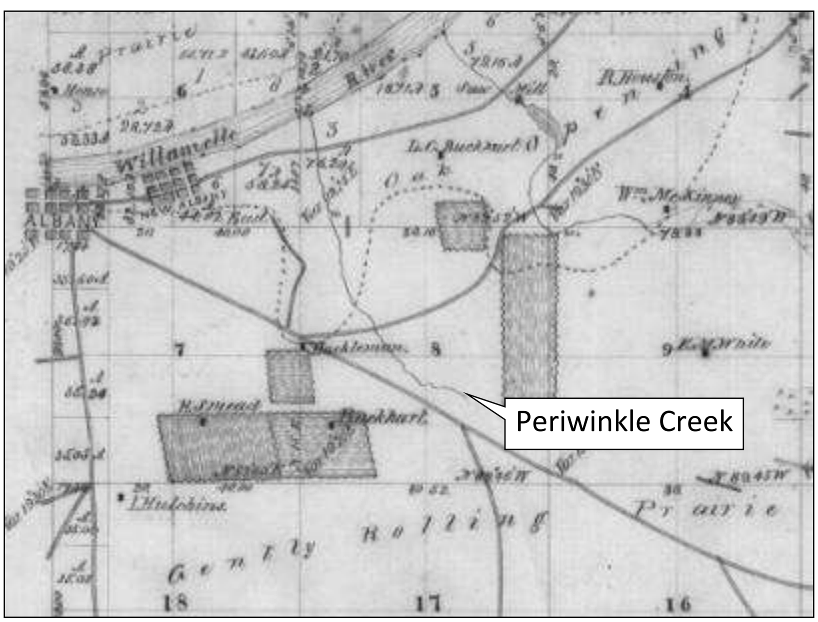


Figure 4-19. A portion of the 1852 GLO map showing the Albany and New Albany town sites, the Willamette River, Periwinkle Creek, and Cox Creek.

The Willamette River in the vicinity of the Periwinkle Creek confluence changed considerably from 1936 to 2006. Figure 4-20 includes an air photo from the two periods. The 1936 river was wider with a mid-channel bar that created a narrow channel between the island and river-right bank. The mouth of Periwinkle Creek had a narrow riparian zone and the creek's delta appeared to be due north of the main creek alignment.

The contemporary Willamette River lacks the mid-channel island seen in the 1936 photo. The river appears to have narrowed through the reach primarily by filling at the mouth of Periwinkle Creek. The deltaic deposit is now vegetated by a cottonwood overstory and willow understory. The encroachment of the Periwinkle Creek delta may be the result of the Willamette River's reduced sediment transport capacity related to flood control operations. The rapid urbanization of the Periwinkle Creek watershed may have also caused channel incision and subsequent sediment deposition at the creek's mouth. A combination of these processes may account for the expanded floodplain at the Periwinkle Creek confluence.

Figure 4-20. A comparison of the 1936 (left) and 2006 (right) air photos of lower Periwinkle Creek. The photos are approximately the same scale and perspective. The red box surrounds the creek in both photos. An island was formerly located mid-channel in the Willamette River across from the Periwinkle Creek confluence. An area that was formerly inundated by the Willamette River, is now floodplain marking the mouth of Periwinkle Creek and the western extent of Bowman Park. The white hatched line shows the 1936 shoreline overlaid on both photos. The red dot represents the Periwinkle Creek confluence.

Periwinkle Creek historical headwaters were south of present day SE 9th Avenue. With the growth of Albany, stormwater discharge conveyance became a priority. An artificial channel was excavated from the historical upstream extent of Periwinkle Creek to at least Interstate-5. It is unknown when the channel was excavated although a portion of the artificial channel is visible in the 1971 air photo. East of Interstate-5, the channel receives agricultural return flow and runoff.

The rapid population growth of the City of Albany since the 1990s typifies urbanization in the Willamette Valley, with displacement of agricultural land for housing developments. Figure 4-21 presents a comparison of the middle Periwinkle Creek watershed in 1994 and 2006. Former agricultural land north of Grand Prairie Road SE was converted to housing developments over an approximate 10 year period. The developments and road network convey stormwater to the artificial section of Periwinkle Creek.

Figure 4-21. A comparison of more recent air photos shows the increasing density of development in the middle Periwinkle Creek watershed. The two air photos from 1994 (left) and 2006 (right) highlight the stream corridor modifications that have occurred on Periwinkle Creek. Infill development that occurred over the 12 years covered by the air photos increased impervious surface area and stormwater discharge.

4.3.2 Inundation Mapping

Inundation mapping for Periwinkle Creek was completed as part of the Willamette River inundation mapping. The 2-year regulated discharge on the Willamette River backwaters Periwinkle Creek to approximately Water Avenue (Figure 4-22). Water depths are greatest in the channel while inset floodplain surfaces in the stream corridor would experience shallow flooding. The incised condition of Periwinkle Creek likely precludes flooding of adjacent developed properties except when exceptional flows on Periwinkle Creek are synchronized with a high stage on the Willamette River. Debris jams that impede flow in Periwinkle Creek could also affect stream stage.

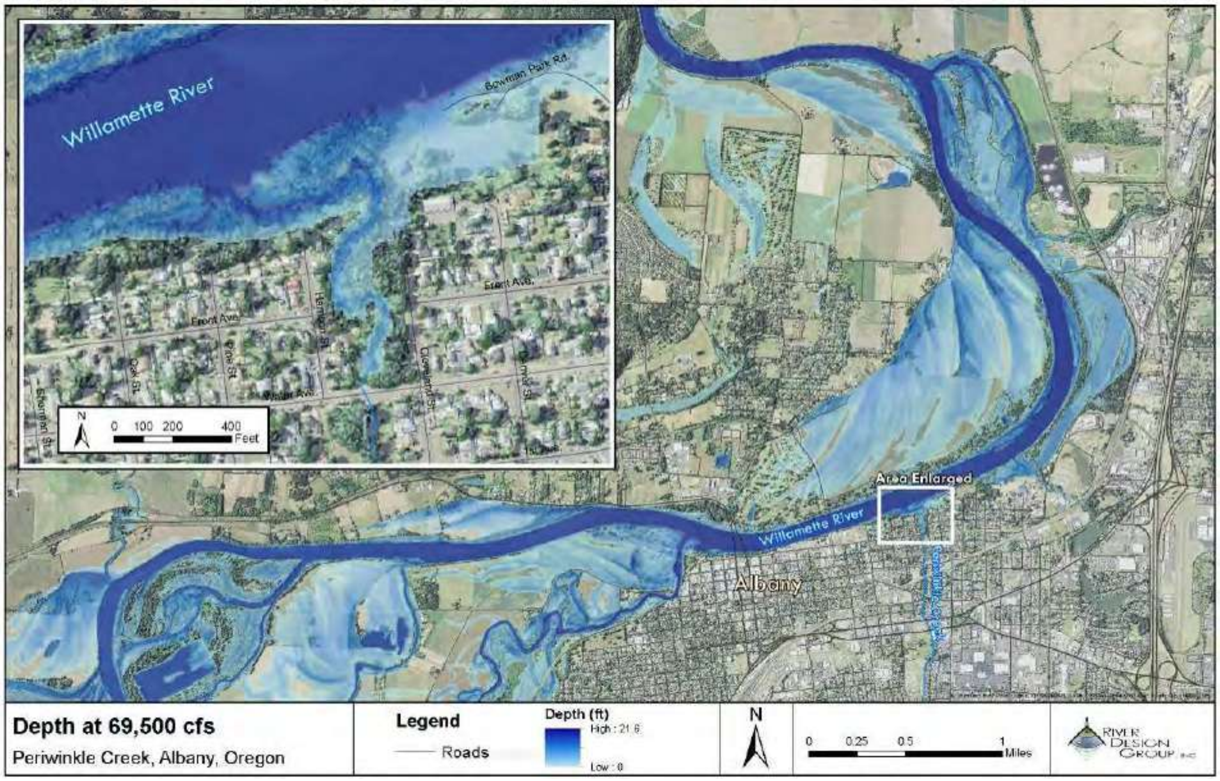


Figure 4-22. The predicted 2-year inundation map for the Willamette River from Bowers Rock State Park downstream to Springhill Road with an inset for lower Periwinkle Creek. The 2-year regulated flow on the Willamette River backwaters the downstream reach of Periwinkle Creek.

4.3.3 River Corridor Observations

The CWC completed a field data collection effort on Periwinkle Creek from Santiam Highway SE downstream to the confluence with the Willamette River. CWC highlighted bank erosion and bank stabilization sites, infrastructure, and habitat components. Field data collection was completed during August low flows. RDG limited site visits to the assessment reach in January 2011.

Data collection maps and tables are presented in Appendix C. The following is a field data summary.

Habitat

Periwinkle Creek exhibits a range of habitat conditions. The delta forming the downstream extent of the reach hosts a lush riparian zone with a pool-riffle gravel bed channel. Wood debris and overhanging vegetation provide habitat diversity and stream shading. With distance from the mouth, the stream increasingly exhibits the effects of urbanization. Although concrete, asphalt, and rock become more frequent, scour pools and depositional bars characterize the channel morphology. A maple and cottonwood canopy shades the stream while blackberry and native riparian shrubs border the channel. Inset floodplain surfaces are homogenous but provide a surface for flood water storage and sediment and debris deposition. Figure 4-23 includes example higher quality habitats in lower Periwinkle Creek.

Figure 4-23. A maple and cottonwood dominated canopy shades lower Periwinkle Creek. Riffle-pool channel morphology, wood debris, and riparian shrubs characterize stream corridor habitats.

Table 4-10 includes the feature number, channel alignment station, location (e.g., river-right, center, or river-left) and dimensions of habitat features identified in the lower Periwinkle Creek assessment reach.

Table 4-10. Habitat features in lower Periwinkle Creek. Stationing relates to the field data collection maps in Appendix C.

Number	Starting Station	Location	Length (ft)	Comment
H1	29	RC		Riffle
H2	26.6	RL		Deep pool, small debris, small log across creek
H3	26.6	RL	30	Deep pool upstream
H4	18.5			Rootwads on each side at downstream end of pool
H5	15			Small willows , Downstream of Water St. bridge, slight erosion
H6	12.8	RC		Downstream of ladder, deep pool, no structure
H7	8	All		Large trees, multiple aggregates 3-12"
H8	8	All		Before stream makes right turn, pool at turn
H9	5	RL		Habitat in riparian area
H10		RC		Deep pool, few structures, only one keyed in

Table 4-10. Habitat features in lower Periwinkle Creek. Stationing relates to the field data collection maps in Appendix C.

Number	Starting Station	Location	Length (ft)	Comment
				piece/rooted in

Infrastructure

Infrastructure in lower Periwinkle Creek included an assortment of debris from refuse and old bank stabilization treatments for fish passage structures designed to improve stream connectivity. Table 4-11 includes infrastructure sites identified on Periwinkle Creek. Bank stabilization treatments typically included rock, broken concrete, and broken asphalt. Car bodies and other urban debris were also used at several locations to stabilize formerly eroding banks.

Table 4-11. Infrastructure located in the Periwinkle Creek assessment reach. Stationing relates to the field data collection maps in Appendix B.

Number	Starting Station	Location	Length (ft)	Comment
I1	33.5	All	12	Culvert, large bank stabilization project w/ large wood recently completed by City of Albany near Linn Benton Housing units. Ducks, fish, ivy, blackberry.
I2	33			Asphalt chunks, 12" and 15" pipes,
I3	32	RR		Wood fence, incised, pool, concrete and bricks 2' and smaller
I4	31.7	All		Kitchen sink, 15' blackberry, car bumper/frame, metal
I5	31			Small branches, shopping carts, tire
I6	28.5	RC		RR trestle, small 3' deep pool before small debris jam at trestle
I7	28			Downstream of trestle, culvert, blackberry, construction on RR before culvert
I8	14			Above bridge, undersized culvert 16' dia., eroding past concrete sides, large ivy
I9	13	RC		Fish ladder, 7 steps, 4 weirs in culvert not working well/can feel concrete bottom
I10	12.5	All		Stream barrier with passage "mini dam", cobble stream, bed with 2'x2'x4" concrete slabs
I11	11.5	RL	100	Rocks in river up to stream edge, house above river with blackberry to bank
I12	9.5	All		Bowman park bridge, avg boulder 3' diam.
I13	9			Concrete blocks
I14	8			Downstream end of bridge, is a newer bridge

Figure 4-24 includes example infrastructure in the Periwinkle Creek assessment reach. Infrastructure includes a variety of bank stabilization treatments. The SE 2nd Avenue crossing is a fish friendly oversized concrete arch.

Figure 4-24. Debris such as old car bodies was used in the past for bank stabilization treatments (left). A concrete arch at SE 2nd Avenue provides fish passage (right).

Bank Erosion

Bank erosion sites were also noted during the field data collection. Sites were typically limited in extent as much of the stream has been stabilized. Eroding banks were generally limited to the bank toe. Table 4-12 includes bank erosion sites identified on Periwinkle Creek. Figure 4-25 includes examples of eroding banks within the assessment reach.

Table 4-12. Bank erosion sites located in the lower Periwinkle Creek assessment reach. Stationing relates to the field data collection maps in Appendix C.

Number	Starting Station	Location	Length (ft)	Comment
E1	26	RR	75	Eroded bend, partial river rock, fill
E2	19		20	Yard clippings
E3	12.5	RL	300	
E4	12		150	Erosion
E5	9		50	
E6	8	RL	200	Erosion
E7	8	All	75	
E8	4	RR	200	

Figure 4-25. Example streambank erosion sites on lower Periwinkle Creek. The left photo is site E6, a river-left eroding site at STA 8+00. The right photo is from the E4 site located at STA 12+00. The river-left toe of the bank has been scoured.

4.3.4 Ecological Considerations

Periwinkle Creek has experienced a long period of urbanization. The channel has been extended and modified to facilitate development of the area, resulting in altered habitat characteristics. The stream corridor is most intact in the lower portion of the watershed with decreasing habitat quality in an upstream direction. Poor water and habitat quality, elevated water temperatures, and suspended sediment loading are largely attributed to the artificial reaches of Periwinkle Creek that start in the agricultural headwaters and proceed west to the SE 9th Avenue area where the historical channel began.

The City of Albany has completed two fish passage projects in lower Periwinkle Creek to improve stream connectivity. The rock ramp through Bowman Park and the fish ladder at the Water Avenue (constructed 2003) crossing provide fish access to the upper watershed. The oversized concrete bridge at SE Second Avenue also has a natural channel bed that provides stream-like conditions through the crossing.

ODFW and City of Albany fish surveys in 2001 and 2002 found a diverse species assemblage inhabiting lower Periwinkle Creek. The greatest species diversity and number of native species were found in the confluence area of Periwinkle Creek. Sampling results for sites further upstream yielded fewer total species and a larger percentage of the assemblages were comprised of introduced species. The sampling effort predated the fish passage structures that were installed in lower Periwinkle Creek. This speciation pattern suggests the warmer water and more degraded conditions of upper Periwinkle Creek relative to the confluence area that is typified by more diverse habitats and stream shading as well as proximity to Willamette River source populations.

Lower Periwinkle Creek from the confluence to the Highway 99E crossing has an overhead riparian canopy that shades the stream and provides a riparian corridor for birds and wildlife.

Although the riparian corridor width is constricted upstream of Water Avenue, the corridor broadens downstream of Water Avenue. Revegetating upstream reaches of Periwinkle Creek could potentially lower water temperatures and improve the ecological condition of the urban stream.

4.3.5 Summary

Periwinkle Creek has been affected by urban development since the late 1800s. Although the City of Albany road network crossing Periwinkle Creek was completed by the 1936 air photo series, few buildings had been constructed adjacent to the stream. Changes in lower Periwinkle Creek and the Willamette River across from the Periwinkle Creek confluence, are likely linked to the Willamette River flood control operations and sediment generated by channel incision and the construction of the upper Periwinkle Creek stormwater channel.

Ecological attributes in the lower watershed include an intact riparian canopy, riffle-pool channel morphology, and stream connectivity. The fish assemblage in this area supports native species; steelhead, Chinook salmon, and cutthroat trout were sampled from the confluence area in the 2001/2002 ODFW and City of Albany fish surveys.

Conservation and restoration opportunities for Periwinkle Creek are presented in *Section 6 Restoration and Conservation Opportunity Prioritization.*

4.4 Thornton Lake

Thornton Lake occupies a former location of the Willamette River and is typically referred to as West Thornton Lake and East Thornton Lake with the two waterbodies bifurcated by the North Albany Road bridge. West Thornton Lake is the more developed of the two waterbodies with rural residential housing on the north shore and the eastern portion of the south shore. East Thornton Lake has less development and retains more intact aquatic habitat and emergent wetlands. A wastewater pipeline located on the lake bed at the North Albany Road crossing, influences the connection between the two waterbodies. As lake water levels decline, the pipeline becomes a barrier between the two systems.

RDG completed a site visit with the Friends of East Thornton Lake (FETL) in January 2011, and also acquired information on the lake from FETL. The City of Albany with technical support from FETL purchased a 27 acre property on East Thornton Lake in 2010. The East Thornton Lake Natural Area (ETLNA) and Kalapuya Interpretive Center is slated for the parcel that was previously planned for development. FETL and the City of Albany are currently securing funds to repay a promissory note on the property.

4.4.1 Historical Oxbow Lake Analysis

The 1852 GLO map and surveyor notes and the 1936 air photo were reviewed to assess historical conditions of Thornton Lake. Figure 4-26 includes the portion of the GLO map covering the Thornton Lake area. The GLO map provided minimal detail on Thornton Lake but the surveyor notes included interesting insights regarding ground water springs and the lake's dimensions.

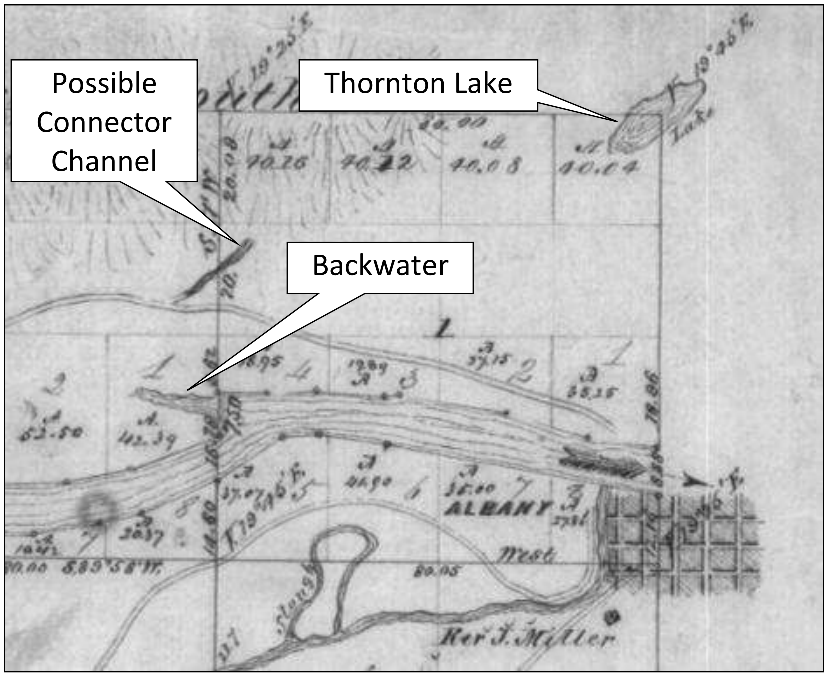


Figure 4-26. A portion of the 1852 GLO map showing a stylized rendition of Thornton Lake, the Willamette River, Albany town site, and the confluence of the Calapooia River (bottom of map). The Willamette River backwater and the possible downstream extent of the connector channel are also called out on the figure.

North Albany Road is present in the 1936 air photo and provided access to farmland north of Albany (Figure 4-27). East Thornton Lake had approximately five home sites on the north side of the lake, and one home site on the south side of the lake. The riparian zone on the north side of the lake appeared sparse except along the western extent of East Thornton Lake where riparian shrubs colonized the lake margins. A riparian fringe that included mature conifers buffered the south side of the lake from agricultural land uses on the southern upland landform. Crops appeared to include orchards and perhaps grains on the higher elevation terraces.

Although few home sites were located on West Thornton Lake in 1936, several properties adjacent to the lake appeared to have cultivated orchards. Riparian vegetation formed a fringe along the shoreline and followed the connector channel to the Willamette River backwater.

Later air photos track the development of the Thornton Lake area. Orchards expanded on the southern uplands adjacent to West Thornton Lake and along the connector channel by the 1950 air photo. Agricultural lands south of East Thornton Lake were delineated into multiple fields supporting varied crops. Residential development also increased on the north side of East Thornton Lake with an expanding number of home sites.

By the 1971 air photo, subdivisions in North Albany and the Spring Hill Country Club were prominent improvements. West Thornton Lake was increasingly developed with former agricultural properties replaced by residential housing. Residential properties were also established on the eastern portion of the southern uplands of East Thornton Lake, again replacing former agricultural land.

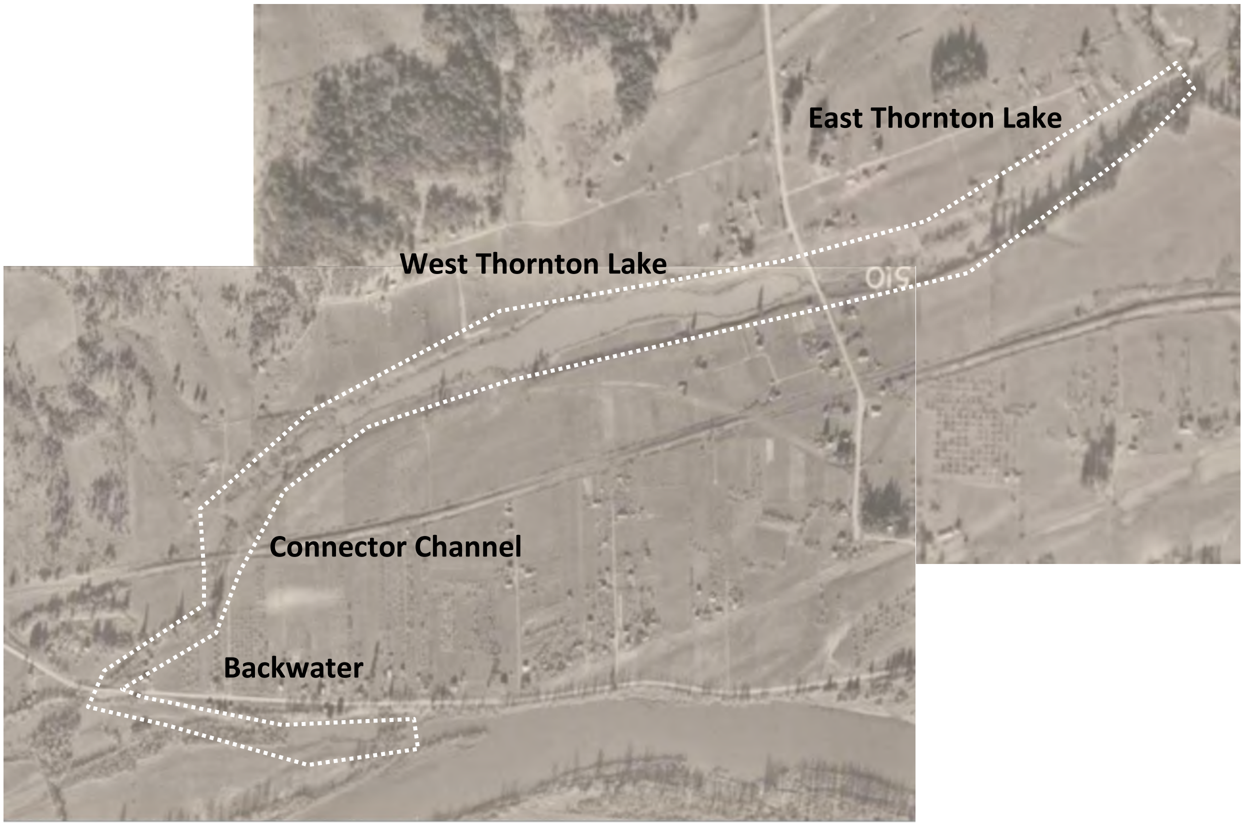


Figure 4-27. Thornton Lake including East Thornton Lake, West Thornton Lake, the connector channel and the backwater that connects with the Willamette River. The image is the 1936 air photo.

4.4.2 Inundation Mapping

Inundation mapping for Thornton Lake was completed as part of the Willamette River inundation mapping (Figure 4-28). The 2-year regulated discharge on the Willamette River backwaters Thornton Lake via the Willamette River backwater and connector channel. The Horseshoe Lake complex to the north of Thornton Lake is similarly backwatered by an outlet channel (Horseshoe Creek) that connects the lake with the Willamette River. The land surface between the northern extent of Thornton Lake and the southern extent of Horseshoe Lake was inundated during the 1996 flood event when the Willamette River flooded the area.

The Thornton Lake connector channel conveys water either into or out of West Thornton Lake depending on the stage of the Willamette River. When the Willamette River stage is elevated, the river will backwater into West Thornton Lake. When river levels recede, West Thornton Lake will drain via the connector channel to the Willamette River backwater. When the lake stage is elevated, the lake drains over a potentially modified outlet (Pacific Water Resources 2010). When the lake level drops below that outlet elevation, the lake can drain an additional 1-2 ft by way of a buried culvert. In the past, landowners have inserted boards in the culvert inlet to block outflows and maintain a higher lake elevation primarily for recreation and aesthetics. The culvert therefore allows management of the lake elevation during summer and fall when inputs to the lake subside.

Other inputs to the lake include natural surface water sources (e.g. face drainages surrounding the lake) and stormwater sources. With expanding development around the lake, stormwater has become an increasingly large source of water to the lake. Addressing stormwater concerns and potential impacts on water quality is of interest for the City of Albany, landowners, and FETL. Several landowners on West Thornton Lake operate aerators to maintain dissolved oxygen levels in the lake.

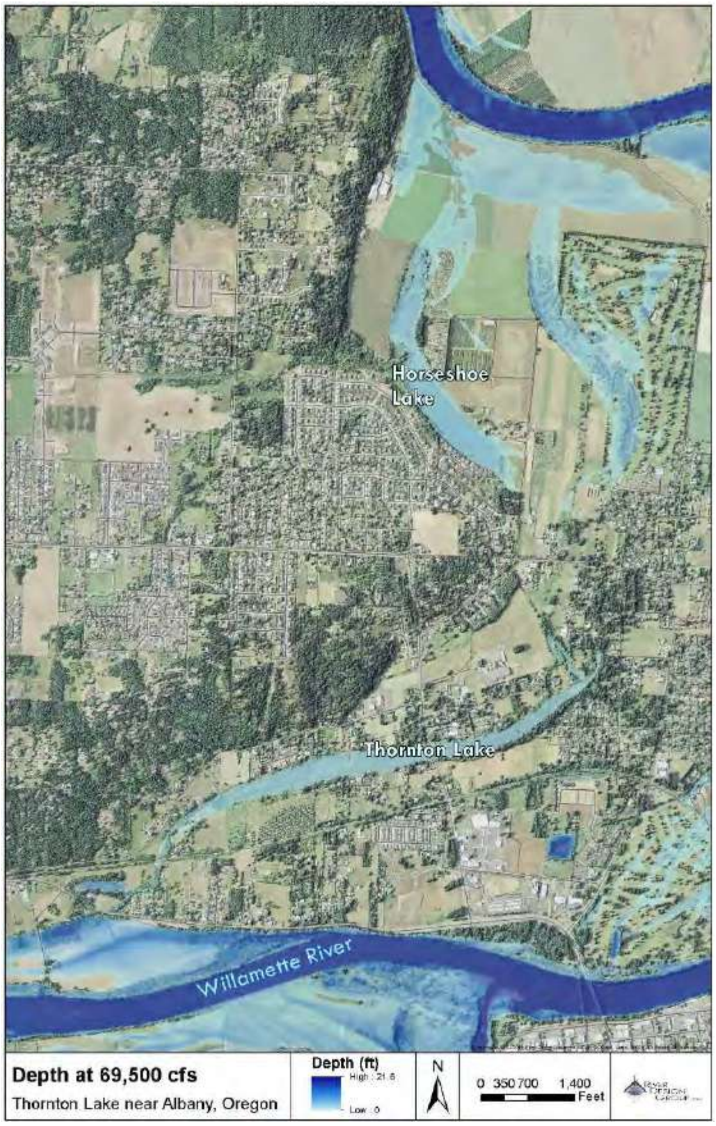


Figure 4-28. The predicted 2-year inundation map for the Willamette River including Thornton Lake and Horseshoe Lake. The Willamette River backwaters into Thornton Lake during the 2-year event, and likely more frequently.

Figure 4-29. The outlet at West Thornton Lake at moderate flows in January 2011 when the natural outlet was overtopped (left) and during summer conditions when the lake level is below the outlet elevation (right). A board is placed in the culvert inlet to block outflow from the lake. The culvert allows for drawing down the lake an additional 1-2 ft below the outlet.

4.4.3 River Corridor Observations

RDG accompanied FETL on a float of Thornton Lake in January 2011. The float started near the north end of East Thornton Lake and proceeded south to the outlet of West Thornton Lake. Observations were recorded and photos were taken of lake and riparian conditions. The following is a summary of the field assessment and other data provided to RDG by FETL.

Habitat

Aquatic and riparian habitat conditions vary between East and West Thornton lakes. East Thornton Lake maintains higher quality lake margin habitat and the riparian fringe surrounding the lake is more contiguous relative to the western lake. Emergent willows, large wood, and overhanging vegetation provide habitat for the two pond turtles that inhabit the lake. The following information was prepared by the City of Albany and FETL (City of Albany 2011).

> There are two species of native turtles in Oregon, the Western Painted (*Chrysemys picta bellii*) and the Western Pond (*Actinemys marmorata*). Both species are listed as “Sensitive-Critical” on the Oregon Department of Fish and Wildlife’s Sensitive Species list. The “Sensitive-Critical” designation is a category for species whose numbers are in such severe decline that without some recovery, they will become endangered. In Washington State, the Western Pond turtle is currently listed as endangered. Pond and Painted turtles are thought to be in decline due to the reduction of suitable habitat, introduction of non-native turtles (sliders) into the wild etc**.** Good habitat for turtles includes quiet backwater ponds and lakes with logs and other debris in the water for basking, adequate aquatic vegetation along the water edge to provide food as well as cover from predators and a sunny open area away from the water for nesting. Fortunately, East Thornton Lake has all these amenities. It is home to both Western Pond and Western Painted turtles and is thought to be only one of a handful of places left in Oregon where breeding populations of both species exist.

Fish sampling in Thornton Lake has been limited with available information related to the 2001sampling completed by ODFW and the City of Albany. The survey crew sampled the lake on May 8, 2001, using minnow traps baited with white bread and set for approximately four hours. While the traps were set, the crew conducted an angling survey for larger fish species. The crew accessed the lake through private land on Thornton Lake Place, and the bulk of the sampling took place in West Thornton Lake (10T-0490500, UTM- 4943800). Fish species observed were carp, largemouth bass, western mosquitofish, yellow bullhead, and yellow perch. The one time sampling may have yielded a skewed assessment of the fish community. Recent discussions with ODFW suggest the likely use of Thornton Lake, the connector channel, and the Willamette River backwater by native species during high water periods in the Willamette. Fish would move into these habitats to avoid the higher velocities in the mainstem river channel.

Birds and wildlife are also common at Thornton Lake. The 2010 Christmas Day Audubon count at Thornton Lake documented 23 species (City of Albany 2011). Wildlife known to occur at Thornton Lake include raccoons, foxes, coyotes, otters, beavers, and deer. Example habitats from the Thornton Lake shoreline are included in Figure 4-30.

Figure 4-30. Example habitat conditions from the East Thornton Lake Natural Area (left) and the north shore of West Thornton Lake (right). Much of the riparian zone around East Thornton Lake remains intact. West Thornton Lake has experienced more residential development and riparian conditions are more variable. Photos courtesy of FETL.

Infrastructure

Home sites, docks, and the North Albany Road bridge are the primary infrastructure on Thornton Lake. Table 4-13 includes lake front infrastructure statistics including the number of lake front residences, and developed lake frontage. Properties with intact riparian areas as delineated from air photos were included as undeveloped frontage. Properties were considered to have developed frontage if the riparian corridor between the residence and the lake was noncontiguous even if a narrow riparian shrub buffer was maintained. Figure 4-31 includes the 2009 air photo of Thornton Lake that was used for the infrastructure interpretation.

Table 4-13. Development statistics for Thornton Lake from the 2009 air photo interpretation.

	Water Front Residences	Docks	Developed Frontage (mi)	Undeveloped Frontage (mi)	Total Frontage (mi)
West Thornton Lake			0.84 (64%)	0.48 (36%)	1.32
North Shore	18	9			
South Shore	11	7			
East Thornton Lake			0.4 (34%)	0.76 (66%)	1.16
North Shore	9	1			
South Shore	6[1]	1			

[1]: Water front properties located on the north end of East Thornton Lake maintained riparian buffer so were considered to have undeveloped frontage.

Figure 4-31. The 2009 air photo covering Thornton Lake. The stormwater GIS layer is included to show the location and extent of stormwater infrastructure (data courtesy of City of Albany GIS).

Bank Erosion and Lake Frontage Vegetation

Bank erosion was minimal on Thornton Lake due to the low energy environment. Rather than focus on bank erosion, we noted lake frontage vegetation conditions. Maintaining a riparian buffer between upland land uses and the lake is important for sequestering sediment, nutrient, and pollutant runoff, and for providing aquatic and riparian habitat. Table 4-14 included a summary of lake front habitat conditions. Example photos are included in Figure 4-32. Typical beneficial conditions included a riparian shrub buffer comprised of willows, dogwood, and spirea thickets. Conversely, managed landscapes included manicured lawns extending to the lake edge. An intermediate condition was defined by reed canarygrass (often including spirea) which provides a buffer between upland runoff and the lake, but lacks the habitat characteristics attributed to plant communities dominated by native shrubs. Working with landowners to maintain appropriate riparian buffers would potentially improve water quality and enhance shoreline habitat.

Figure 4-32. A comparison of three lake front vegetation conditions on Thornton Lake. The left photo includes a side by side comparison of a lawn extending to the lake edge next to a property that has a reed canarygrass and spirea buffer. The right photo shows the diverse habitat conditions along the ETLNA. While most of the vegetation along the natural area is native, invasive blackberry and ivy have encroached on the riparian zone. The tree in the middle of the photo has been colonized by ivy which will eventually kill the tree if not treated. FETL is currently preparing a vegetation management plan for ETLNA.

4.4.4 Ecological Considerations

Thornton Lake is a unique waterbody in the project reach. While the meandering lake retains much of its historical character, it has also been affected by residential and agricultural development, stormwater runoff, and conversion of the native riparian community. Limited fish sampling results suggest at least the seasonal presence of introduced fish species. Despite these conditions, Thornton Lake also provides habitat for two species of native turtles, wildlife, and a diverse bird community. For local landowners and other visitors, Thornton Lake provides valuable recreational opportunities and rural aesthetics in close proximity to an urbanized area.

There are opportunities to work with the City of Albany to improve stormwater discharge to the lake and to collaborate with local residents on enhancing lake frontage with native plant species. Other areas of ecological interest include determining appropriate management of the lake outlet. Further assessing the outlet structure and devising a plan that does not require outlet management is recommended. Maintaining a relatively high outlet elevation would hold the lake at a higher water surface elevation, but would reduce the frequency of high water exchange between Thornton Lake and the Willamette River.

4.4.5 Summary

Thornton Lake is a valuable ecological resource on the outskirts of Albany. Recent activities pursued by the City of Albany and Friends of East Thornton Lake aim to preserve the remaining contiguous undeveloped properties surrounding the lake. Protecting these remaining properties and working collaboratively with landowners around the lake are opportunities to improve water quality, lake aesthetics, and habitat.

Conservation and restoration opportunities for Thornton Lake are presented in *Section 6 Restoration and Conservation Opportunity Prioritization.*

4.5 Albany Oxbow Lakes

The Albany oxbow lakes are located north of the City of Albany on the east side of the Willamette River. The oxbow lakes include First Lake through Fourth Lake in addition to four tributary streams including Cox, Burkhart, Truax, and Murder creeks. This area is a juxtaposition of industrial development and historical floodplain corridor. The eastern half of the reach has been developed for wood products processing and industrial materials production. The western half along the river front has retained a largely intact riparian corridor replete with oxbow lakes, tributary channels, and multi-story riparian vegetation.

4.5.1 Historical Oxbow Lake Analysis

The 1852 GLO map and the historical air photo series were reviewed to evaluate past land uses that have occurred in the area. The 1852 GLO map does not include the oxbow lakes but given their presence in the 1936 air photo, the oxbows were undoubtedly part of the landscape at the time of the survey but were not included in the survey. Cox Creek and Murder Creek were both included on the GLO map (Figure 4-33). A timber mill was in operation on Cox Creek by 1852. Given the proximity of the Cox Creek mill to First Lake, and the later use of First Lake for storing saw logs, it is probable that First Lake and potentially Second Lake were being used by the late 1800s for storing timber prior to milling.

Review of later air photos from 1950 and 1971 capture the increasing development of the area. First Lake and Second Lake were used for log storage by the local mill in the 1950 air photo. The northern floodplain surrounding Third Lake and Fourth Lake appeared to support limited agriculture. The terrace east of Third Lake was also under cultivation east to the railroad alignment. Truax Creek and Murder Creek appeared to be in their natural condition although a portion of Cox Creek was developed for a timber mill by the 1850s.

The floodplain continued to industrialize through the 1960s. The 1971 air photo shows an expanded complex of mills and log ponds. First Lake was expanded and what appeared to be a meander scroll in the 1936 air photo, was excavated by the 1950 air photo and further expanded by the 1971 air photo to provide another log pond to store logs for the mills south of Second Lake. The area northeast of Second Lake was developed between the 1950 and 1971 air photos. By 1971, the triangle of land between Second Lake, Murder Creek, and the intestate hosted numerous facilities. The industrial wastewater treatment ponds east of Third Lake were also in place by 1971.

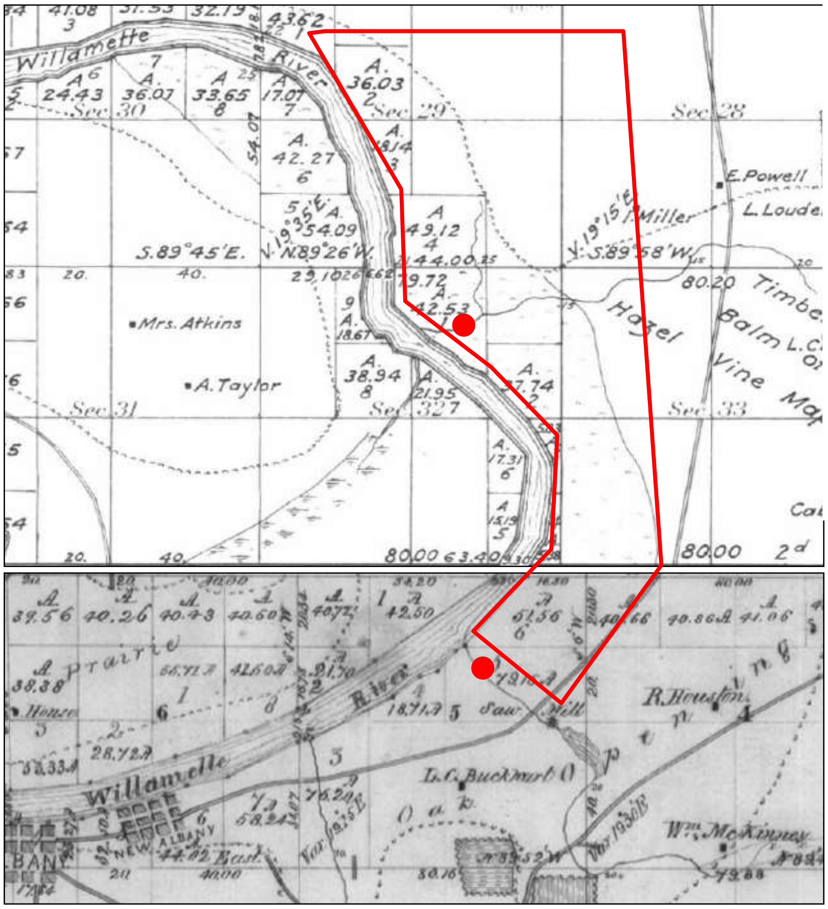


Figure 4-33. A portion of the 1852 GLO map capturing the Willamette River north of the City of Albany. The lakes were not detailed as part of the survey (area outlined in red polygon). However, Murder Creek and Cox Creek were included in the survey, as noted by the red dots. The map suggests that Murder Creek may have historically connected with the Willamette River.

Figure 4-34. The 1936 (left) and 2006 (right) air photos of the Albany oxbow lakes area. The oxbow lakes area has been used for economic development since the 1800s when First Lake and Second Lake were used to store logs for the timber mills that have occupied the eastern floodplain of the Willamette River. The industrial wastewater treatment ponds that were most recently used by the International Paper facility were constructed between the 1950 and 1971 air photos.

4.5.2 Inundation Mapping

The prepared inundation map (Figure 4-35) spanned the Willamette River from the Periwinkle Creek mouth downstream to the Fourth Lake confluence. The mapped 2-year event suggests the Willamette River either backwaters or overtops the floodplain in the oxbow lake area. Project water depths over the floodplain are shallow except where defined channels are located. The modeling under predicts the lake depths due to an artifact of the modeling. The industrial wastewater treatment ponds appear to be located on a low terrace which the regulated 2-year flood event does not appear to access.

Figure 4-35. The predicted 2-year inundation map for the Willamette River including the Albany oxbow lakes and the North Albany floodplain. The Willamette River backwaters and overtops floodplain areas in the assessment reach.

4.5.3 River Corridor Observations

Completed field reconnaissance included review of Fourth Lake by CWC and a site visit by RDG of the floodplain area by First and Second lakes, lower Cox Creek, and lower Truax Creek. RDG did not access the lower floodplain area due to public access limitations associated with private landownership (International Paper).

Habitat

The Albany oxbow lakes area includes river, stream, lake, and backwater habitats. Four tributary streams flow through the area and connect with the Willamette River or waterbodies in the in the oxbow area. Although the tributary streams have experienced varying degrees of modification, they continue to provide habitat in the lower reaches downstream of the industrialized areas. A brief review of Cox Creek, Truax Creek, and Murder Creek, and discussions with ODFW concerning Burkhart Creek suggest fish passage is affected by crossings including a small concrete dam on Cox Creek and the railroad crossing on Burkhart Creek (in the process of being replaced). A more detailed inventory of possible fish passage constraints is recommended to determine possible fish passage issues on these tributaries.

The downstream extent of Cox Creek from the ATI-Wah Chang facility to the Willamette River was reviewed. Cox Creek is characterized by a confined meandering, gravel bed, riffle-pool morphology channel transitioning to an unconfined deltaic flat before joining the Willamette River. The confluence area provides off-channel habitat for fish residing in the Willamette River. Lower tributaries provide spawning habitat, floodwater refugia, and alternative habitat types that may not be available in the Willamette River. Figure 4-36 includes ground photos of lower Cox Creek and Truax Creek.


Figure 4-36. The concrete dam on lower Cox Creek is a fish passage barrier to upstream migration (left). Truax Creek was formerly used to dispose of industrial wastes. Contaminants were removed from the stream corridor and the creek was stabilized (right). Treated wastewater from the ATI-Wah Chang facility is discharged to Truax Creek, providing flow in lower Truax Creek after the upstream seasonal stream dewaters in the summer.

Burkhart Creek joins Second Lake in the upper half of the oxbow lake while Truax Creek meets Second Lake at the downstream terminus of the waterbody. Murder Creek is constrained between settling ponds before joining the connector channel that links Second Lake with Third Lake.

First Lake and Second Lake were historically used as log ponds by the local mills. Pilings remaining in First Lake suggest the past use of the oxbow lake for storing logs that were then milled nearby. First Lake is shallower and smaller than the downstream Second Lake. A broad connector channel links First Lake and Second Lake. Riparian vegetation surrounding the lakes is characterized by native species with a surprising infrequency of invasive species that are common elsewhere on the Willamette River floodplain. A road located to the west of the oxbow lakes separates the lakes from the Willamette River. The road has been converted to a walking path but still functions as a levee disconnecting Willamette River high water from the oxbow lakes. Figure 4-37 includes photos of First Lake and the lower Cox Creek floodplain.

Figure 4-37. Timber piers in First Lake reflect the historical use of the oxbow as a log storage pond (left). The confluence area of Cox Creek and the Willamette River is characterized by a broad wet meadow that provides aquatic and riparian habitat (right).

The Willamette River bordering the oxbow lakes reach is characterized by a diverse river-right bank edge supporting multistory riparian vegetation (Figure 4-38). Although portions of the bank were stabilized at some point in the past, much of the bank remains native. Previous analysis included in the Willamette River discussion noted how the river has narrowed and simplified over time in response to changes in the watershed hydrology due to Willamette Project operations. Over time, the river-right bank has encroached into the river as riparian vegetation has stabilized sediments and expanded the floodplain. Channel margin vegetation, backwater areas and shallow wetland features that broaden microhabitat availability.

Figure 4-38. A view of the river-right bank of the Willamette River adjacent to the Albany oxbow lakes (left). The foreground of the photo shows remnant riprap that was placed for bank stabilization. The riparian corridor is characterized by a multistory plant community dominated by native species. A view across Second Lake illustrates the size of the oxbow lake and the complex riparian community (right).

The Talking Water Gardens project is currently being completed under the cooperative efforts of the City of Albany, City of Millersburg and ATI-Wah Chang. Talking Water Gardens is located immediately northeast of Cox Creek and is the site of the former Simpson and Edwards Lumber mills. A summary of the effort form the City of Albany website (www.cityofalbany.net) is included below:

> The Albany-Millersburg Talking Water Gardens are the first public/private engineering project of its kind in the United States: an integrated wetlands system designed to provide an additional level of natural treatment for a combined municipal and industrial treated wastewater flow. It will be the final step in returning this treated water safely to the Willamette River – a treatment option its designers say has more than twice the natural resource value of conventional alternatives.

The Talking Water Gardens will not only serve as a wastewater treatment wetland, but will provide the local community with a gathering place to interact with the environment. A trail network and viewing areas will provide opportunities for walking, bird watching, and environmental education. Figure 4-39 includes recent ground photos of the site as it is readied to receive treated wastewater flow. The complex will be open to the public in Summer 2012.

Figure 4-39. A view to the northeast across the Talking Water Gardens wetlands (left) and a view of one of the five aeration waterfalls planned for the site (right). The treatment wetlands will provide recreational and educational opportunities for the local community as well as cool and remove nutrients from treated wastewater.

Infrastructure

Infrastructure on the terrace adjacent to the Albany oxbow lakes area includes the City of Albany wastewater treatment facility, ATI-Wah Chang, Duraflake, the now closed International Paper containerboard mill, and transportation corridors including the railroad and road systems. These facilities are located on the eastern perimeter of the oxbow lake complex, but influence the tributary streams that drain to the Willamette River and oxbow lakes area. The facilities directly affect channel morphology, aquatic and riparian habitats, and water quality. However, relative to past interactions between these properties and the adjacent waterbodies, contemporary impacts are undoubtedly a fraction of the historical disturbance that included toxic waste disposal, channel dewatering, and direct channel manipulation.

West of the industrial facilities, industrial wastewater treatment ponds and storage areas formerly operated by International Paper are located on the western extent of the terrace. This land surface borders the oxbow lake complex. A road network provides access among farmed areas within the riparian corridor.

4.5.4 Ecological Considerations

The oxbow lake system offers unique opportunities for preserving high quality floodplain habitats and enhancing stream and lake environments in close proximity to the Willamette River. Slow water habitats provide off-channel areas for fish to move out of the river during high flows. High gradient tributary streams exhibit riffle-pool morphologies and maintain gravel beds, preferred spawning habitat for many of the native fish found in the Willamette River system. Waterfowl, raptors, and wildlife are common in the area belying its close proximity to industrial and urban development.

There would be a benefit to public ownership of this expansive riparian area. Addressing land use disturbance in these areas and restoring the riparian corridor are suggested for enhancing the ecology of the reach.

A closer investigation of the tributary streams and the oxbow lakes would be beneficial for assessing aquatic habitat conditions. Additionally, gaining a better understanding of the oxbow lakes' fish community and how it changes through the year in response to river flows, spawning migrations, and water quality would also be of interest. The varied assortment of streams, lakes, and wetlands suggest this area of Willamette River was highly dynamic historically and still maintains much of its diverse character.

4.6 Summary

The Albany oxbow lakes comprise the final assessment area of the Calapooia-Albany project. An aerial view of the reach illustrates the landscape level contrasts that define the reach. Using the railroad as the demarcation line, the eastern terrace is dominated by industrial uses. The western floodplain maintains an assemblage of waterbodies and habitats, many of which appear to remain intact relative to the likely historical condition.

The Talking Water Gardens is a progressive effort being undertaken by Albany-Millersburg, and ATI-Wah Chang to improve the quality of discharged wastewater. When completed, the Gardens will provide final stage wastewater filtration that will cool the water and remove nutrients prior to the treated water being eventually discharged to the Willamette River. The Talking Water Gardens are expected to be a valuable community gathering area that will offer recreational and educational opportunities.

5 Guiding Planning Documents

Two planning documents were reviewed to understand on-going natural resource protection initiatives that affect the assessment area. The documents include the Willamette River TMDL and the Statewide Planning Goal 5 program. A description of these two programs is provided in the following section. The programs are also referenced in *Section 6 Conservation and Restoration Opportunities Plan*.

5.1 Willamette River TMDL

The following information is taken from the Willamette Basin TMDL (ODEQ 2006).

> The Oregon Department of Environmental Quality has identified the Willamette River as water quality limited because of elevated stream temperatures. This designation extends from the confluence of the Coast Fork Willamette and Middle Fork Willamette Rivers, which join to form the mainstem Willamette, downstream to the Columbia River. In addition, many stream segments tributary to the Willamette River have also been identified as impaired because of elevated temperatures. Approximately 1,200 miles of stream in the Willamette Basin are included on the 303(d) list of impaired waters because of temperature concerns.

> Water quality standards include designation of beneficial uses of water, numeric and narrative criteria for individual parameters to protect those uses, and antidegradation policies to protect overall water quality. Beneficial uses and the associated water quality criteria are generally applicable throughout the basin. Some uses such as salmonid spawning require further delineation to ensure the appropriate application of numeric and narrative criteria. These criteria are intended to protect the beneficial uses within the Willamette Basin as designated by Oregon Administrative Rule (OAR 340-41-962, Table 19), Table 4.3.
>
> The purpose of Oregon's temperature standard is to protect designated beneficial uses that are sensitive to temperature. Salmon, trout and other cold water species that inhabit most streams in the Willamette Basin are considered to be the beneficial uses most sensitive to stream temperature. Furthermore, each stage of the salmon or trout life cycle has separate water temperature preferences and tolerances. Biologically-based numeric criteria are specific to salmonid life stages such as spawning and rearing. There are also numeric criteria for critical habitat areas that serve as the core for salmonid protection and restoration efforts.

Beneficial uses listed for the Upper Willamette River which incorporates the assessment reach are included in Table 5-1.

Table 5-1. Beneficial uses occurring in the Upper Willamette River which includes the assessment reach.

• Public Domestic Water Supply • Private Domestic Water Supply • Industrial Water Supply • Irrigation • Livestock Watering • Fish & Aquatic Life	• Wildlife & Hunting • Fishing • Boating • Water Contact Recreation • Aesthetic Quality

The Willamette River at Albany is currently listed as a temperature-limited system due to the exceedance of the seven day moving average for maximum water temperatures relative to cold water salmonid rearing criteria (17.8 °C target temperature). The mouth of the Calapooia River is similarly listed as a temperature-limited waterbody for cold water salmonid rearing criteria.

The Willamette River and Calapooia River are also listed as water quality limited due to elevated fecal bacterial concentrations. The following information is taken from the Willamette River TMDL: Bacteria (ODEQ 2006).

> Water quality impairments due to bacteria vary in scale throughout the Willamette Basin. Violations are common in creeks that drain urban and agricultural land and discharge to the Willamette River. These sources of bacteria are addressed in the individual subbasin TMDL documents following this chapter. The 2002 303(d) list identified river miles (RM) 0 to about 149 of the Willamette River as not attaining the applicable bacteria criteria to support water contact recreation during fall-winter-spring months. The river is not listed as water quality limited in summer and assessment of the available data confirms its compliance. Observed fall-winter-spring water quality violations in the Willamette River above Willamette Falls are very subtle, and are limited to rare violations of the single sample maximum concentration at a few sites.

> The City of Albany reported pump station failures with discharges into the Willamette River and the Calapooia River. These discharges are rare and unpredictable, but may be expected to occur during wet weather events.

The Willamette River is also water quality limited due to elevated mercury concentrations. The bioaccumulation of mercury in fish is a well-recognized environmental problem throughout much of the United States. These fish consumption advisories represent an impairment of the beneficial use of fishing in the Willamette Basin and demonstrate that mercury is bioaccumulating in fish tissue to levels that adversely affect public health. The TMDL for mercury is designed to restore the beneficial use of fish consumption to the Willamette River and its tributaries.

Total maximum daily load targets have been established to address water quality impairment to restore beneficial uses. Proposed high priority projects should in part implement strategies to correct processes that have led to water quality impairment.

5.2 City of Albany Goal 5 Plan

Oregon's land use planning program addresses nineteen statewide planning goals. The mandate of Goal 5: Natural Resources, Scenic and Historic Areas, and Open Spaces, is to protect these resources from development. As stated in the Oregon Administrative Record OAR 660-015-0000(5):

> Local governments shall adopt programs that will protect natural resources and conserve scenic, historic, and open space resources for present and future generations. These resources promote a healthy environment and natural landscape that contributes to Oregon's livability.

Guidance provided by Goal 5 encourages municipalities to direct development to conserve open space, fish and wildlife areas and habitats, stream flow and water levels, and significant natural areas that are historical, ecologically, or scientifically unique. To accomplish these objectives, state and federal agencies are to develop statewide plans and provide technical assistance to local and regional agencies. State and federal plans should coordinate with local and regional plans.

The City of Albany website provides an overview of the Goal 5 plan and the City's implementation approach (City of Albany 2011).

> Oregon's land use planning program addresses nineteen statewide planning goals. Periodically the City is required to review and amend its comprehensive plan and development code so they are consistent with the statewide planning goals. The City's work program to address Statewide Planning Goal 5 required us to inventory **wetlands, riparian corridors, and wildlife habitat** inside the City's urban growth boundary (UGB), identify which resources have the highest value and function ("significant"), and adopt measures to protect the significant resources.
>
> The City is beginning the process to adopt amendments to the Albany Comprehensive Plan and Development Code to protect significant natural resources under Statewide Planning Goal 5.

The *City of Albany Goal 5 Significant Natural Resources Technical Report & Recommendations* (Pacific Habitat Services, Inc. 2009) report, included an inventory of Goal 5 resources (i.e. riparian corridors, including water and riparian areas and fish habitat; significant wetlands; and significant wildlife habitat) and recommendations for protecting the inventoried resources. Resource protection includes defining appropriate conservation options to protect significant resources. The City is beginning the process to adopt amendments to the Albany Comprehensive Plan and Development Code to protect significant natural resources under Statewide Planning Goal 5.

6 Conservation and Restoration Opportunities Plan

6.1 Introduction

The following section provides an approach and prioritization plan for conserving and restoring aquatic and riparian habitats, water quality, and promoting recreational and educational opportunities in the project area. We pursued a multi-tiered method for assessing potential opportunities on each of the reviewed waterbodies. The proposed actions presented in this section are preliminary and would require further vetting by CWC, the City of Albany, landowners, and other stakeholders including funding entities and permitting agencies.

To coordinate with other planning efforts that have been completed in this area of the Willamette River basin, the opportunities plan includes a limiting factors analysis as outlined in the Willamette Basin Biological Opinion (NMFS 2008) and summarized by the Oregon Watershed Enhancement Board's (OWEB) document, *Willamette River Habitat Protection and Restoration Program 2010-2015* (OWEB 2010). Information presented in Section 5, including water quality limiting factors presented in the Willamette River TMDL, and conservation priorities put forth in the Goal 5 plan, were also considered during the limiting factors analysis. Using this holistic approach to identify limiting factors therefore enables an analysis that reviews conditions that affect fisheries, water quality, riparian corridor integrity, and recreation.

6.2 Limiting Factors Analysis

Limiting factors are conditions which limit the full expression or recovery of a species or process. Limiting factors that affect ecological communities in the assessment area operate at multiple scales ranging from local site-specific effects, to larger Willamette River watershed level effects. Although this analysis could be expanded further to out-of-basin limiting factors, large scale effects are only extended to the Willamette River basin.

6.2.1 Local Scale Limiting Factors

Limiting factors operating at the local scale include stream corridor alterations such as streambank stabilization and channel manipulation, riparian vegetation conversion for agriculture and development, displacement of native plant communities by invasive species, and water quality degradation due to altered landscapes, land uses, and wastewater discharge.

These factors not only affect native anadromous fish populations, but also deteriorate other environmental qualities favored by the human population such as cool, clean water for recreation and water use. Compared to larger scale Willamette River basin-level limiting factors, the local scale limiting factors identified in this section are more likely to be resolved by stakeholders involved with this assessment.

6.2.2 Willamette River Basin Limiting Factors

The *Willamette River Basin Flood Control Project Biological Opinion* (NMFS 2008), states "Habitat in the Willamette River mainstem and lower reaches of all the tributaries to the Willamette River is moderately to severely degraded." (summarized in OWEB 2010). Further, the draft Recovery Plan identifies numerous threats and limiting factors for spring Chinook salmon and winter steelhead, many of which are common to both species and all populations. Limiting factors caused by the Willamette River Basin Flood Control Project (Willamette Project) include:

- Lack of gravel recruitment,
- Impaired sediment recruitment,
- Altered water temperatures,
- Reduced peak flows/channel complexity and habitat diversity, and
- Altered flows caused by the flood control/hydro-system that affect habitat in the tributaries below the dams and in the mainstem Willamette River.

The limiting factor of impaired physical habitat refers to the straightening and hardening of riverbanks as well as the loss of riparian vegetation (conifer forests and other native plants in the floodplain). These limiting factors are largely applicable to the Calapooia-Albany Assessment project reach. However, several of these conditions as they pertain to the waterbodies in the assessment reach are not necessarily caused by the Willamette Project. For example, altered water temperatures in Periwinkle Creek are caused by land use changes rather than by the operation of the Willamette Project.

Specific actions identified in the draft Recovery Plan to address limiting factors in the mainstem and lower reaches of the tributaries include the following:

- Restore substrate recruitment using a combination of peak flows and substrate supplementation.
- Identify sites in the mainstem Willamette River where habitat restoration is desirable and coupled to peak flows, design restoration projects, implement work, and monitor.
- Protect the highest quality rearing and migration habitats through conservation measures, acquisition, and/or regulation.
- Using the framework in the "Willamette Planning Atlas," protect and restore aquatic habitat function at the mouths of tributaries; increase non-structural capacity of

floodwater, restore natural riparian communities and their function; increase channel complexity; and increase native floodplain forest.

These actions are applicable to the Calapooia-Albany Assessment project reach. For example, the historical air photo analyses detected a general simplification of mainstem Willamette River habitat due to the loss of mid-channel bars and complex channel margin habitats created by channel bed features. Bedload sequestration in tributary reservoirs has reduced sediment loading to the mainstem Willamette. Coupled with decreased sediment loading, flood control operations have dampened flood peaks thereby reducing channel migration rates and the accompanying bank erosion and sediment recruitment to the river.

6.2.3 Willamette River TMDL

As presented in Section 5, the Willamette River and the lower Calapooia River are water quality limited due to elevated water temperatures and fecal bacterial concentrations. The Willamette River is also affected by mercury concentration. These impairments affect beneficial uses as presented in Table 5-1. The water quality impairments serve as water quality limiting factors that the State will address through the total maximum daily load (TMDL) process. A TMDL defines the amount of a pollutant that can be present in a waterbody without causing water quality criteria to be exceeded. A Water Quality Management Plan was developed to describe the overall framework for implementing the Willamette Basin TMDL. The Willamette River TMDL was approved by the U.S. Environmental Protection Agency in 2006. Example load reduction methods for temperature, fecal bacteria, and mercury are included in Chapter 14 of the TMDL (ODEQ 2006).

Water quality improvement requires a comprehensive watershed approach to solving pollution problems (DEQ 2006). A holistic approach takes into account the cumulative effects all activities in a watershed have on overall water quality. To solve water quality problems in a stream, river, lake or estuary, the cumulative impact from all upstream sources including groundwater need to be considered. Eight management strategies have been identified by the Center for Watershed Protection in Maryland for watershed protection and restoration. ODEQ believes that the strategies are equally applicable for watershed protection and restoration in Oregon. The eight strategies are:

- Land Use Planning
- Land Conservation
- Aquatic Buffers
- Better Site Design
- Erosion Prevention and Sediment Control
- Stormwater Best Management Practices
- Non-Stormwater Discharges
- Watershed Stewardship Programs

Using these tools, it is possible to develop and implement a comprehensive watershed management program and plan that identifies all necessary programmatic and structural management strategies. Many of these strategies also overlap with the natural resource conservation goals outlined in the Goal 5 Plan.

6.3 Opportunities Prioritization by Project Reach

The following section presents the limiting factors for each assessment waterbody (e.g. lower Calapooia River). The limiting factors include those provided by NMFS (2008) and ODEQ (2006) as they relate to the Willamette River and the Calapooia River. The analysis also incorporates limiting factors that were determined during the Calapooia-Albany Assessment and may not be necessarily linked to Willamette Project operations or TMDL-related water quality impairment declarations.

RDG used information from multiple sources to prioritize potential projects. Sources included NMFS (2008), ODEQ (2006), the Goal 5 Plan, discussions with projects stakeholders, and professional judgment. Projects were prioritized on a waterbody-specific basis rather than across all five waterbodies or areas that were reviewed for the assessment. We believe this was a more effective approach in highlighting potential opportunities that stakeholders can pursue.

The following prioritization section first presents the limiting factors for each waterbody. This information is followed by actions that could be implemented to address the limiting factors. We then present the limiting factor, restoration goal, general restoration actions, and importance of action in tabular format to better associate the step-wise process of impairment identification, goal establishment, and action prioritization. The importance of the restoration actions are ranked on a qualitative scale from “Low” to “High” based on our understanding of the individual waterbodies, the limiting factors, restoration goals, and stakeholder interests. An explanation is then provided for the prioritization of the general restoration actions. The final table for each waterbody includes specific projects that could be implemented to achieve the restoration goals.

We chose to rank the general restoration actions rather than individual projects to maintain a broader view of restoration activities. Ranking the individual projects would also be cumbersome and likely of limited use to the assessment stakeholders. Similar general restoration actions across the waterbodies may not be ranked the same, depending on the limiting factors and restoration goals of a particular waterbody. Ranking general restoration actions was also challenging since the prioritization requires comparing a spectrum of actions that typically range from low cost, delayed benefit to high cost, immediate benefit. Table 6-1 includes example comparisons.

Table 6-1. Potential restoration goals and a comparison of typical low cost, delayed benefit and high cost, immediate actions that could be taken to achieve the restoration goal.

Restoration Goal	Low Cost, Delayed Benefit	High Cost, Immediate Benefit
Habitat enhancement	Riparian planting	Large wood placement
Stream protection	Public education	Remove illegally dumped household waste
Water quality improvement	Riparian planting	Structural stormwater improvements
Riparian expansion	Change land use	Riparian planting

Additionally, ranking the general restoration actions also implies ranking the importance of the limiting factors and their overall effect on the target waterbody. This task is challenging in that for some waterbodies, multiple limiting factors suppress ecological recovery. For example, on Periwinkle Creek, is lowering water temperatures by disconnecting the stormwater system more important than removing hazardous household waste from the stream especially when the cost of the two actions is considered? In short, prioritizing general restoration actions and the underlying projects is a more complicated endeavor than simply attaching a qualitative ranking to each action.

This the above qualifiers now presented, the following sections include a review of the waterbodies and the proposed general restoration actions to achieve restoration goals.

6.3.1 Calapooia River

Limiting factors are related to the ecology of the lower Calapooia River and do not focus on an individual species, although spring Chinook salmon and winter steelhead are of particular interest in the Calapooia River watershed. Improving the ecological potential of the lower Calapooia River is expected to benefit ecological communities inhabiting the Calapooia River and the Willamette River. Limiting factors affecting river corridor ecology and beneficial uses include:

- Degraded water quality including altered temperatures and elevated fecal bacteria concentrations,
- Reduced habitat diversity,
- Riparian vegetation loss, invasive plant species expansion, and river bank armoring, and
- Floodplain fish passage.

Actions to address the limiting factors include:

- Mitigate non-point source water quality degradation through BMP implementation, maintaining riparian buffers, and improving stream shading.
- Protect the highest quality river corridor aquatic and riparian habitats through conservation measures, acquisition, and/or regulation. Better manage existing riparian areas including removal of invasive plant species.
- Using the framework in the "Willamette Planning Atlas," protect and restore aquatic habitat function at the mouths of tributaries; increase non-structural capacity of floodwater, restore natural riparian communities and their function; increase channel complexity; and increase native floodplain forest.

Table 6-2 reiterates the limiting factors, presents the restoration goals and general restoration actions, and categorizes the importance of the general restoration actions in addressing the limiting factor.

Table 6-2. Limiting factors, restoration goals, general restoration actions, and importance of general restoration actions for the lower Calapooia River. Limiting factors include Willamette Project Recovery Plan limiting factors, beneficial use limitations as outlined in the Willamette River TMDL, and impairments determined during the Calapooia-Albany Assessment. Ratings of high (H), moderate (M), and low (L) indicate the importance of the general restoration actions.

Limiting Factor	Restoration Goal	General Restoration Action	Importance of Action
Riparian conversion and simplification	Expand the riparian corridor	• Preserve remaining riparian corridor through landowner education • Conservation easements for willing landowners • Treat invasive plant species where feasible to minimize expansion • Plant armored banks and promote bioengineering in-place of riprap where stabilization is necessary • Expand riparian buffers through riparian planting	H M H L H
Degraded water quality	Decrease water temperature and turbidity in lower Calapooia River	• Improve long-term stream shading through riparian planting • Institute riparian buffers • Implement BMPs to buffer runoff from agricultural fields and developed areas.	H H M
Reduced habitat diversity	Improve habitat diversity through in-channel and off-channel enhancement	• Reconnect floodplain off-channel habitats • Install stable log jams for in-stream habitat • Wetland enhancement	H L L
Floodplain fish passage	Provide passage to fish-bearing tributaries	• Replace fish barrier culverts	L
Exposed historical landfill	Assess and stabilize former City of Albany landfill	• Remove and properly dispose of landfill contents	H

The general restoration actions that will achieve the restoration goal of expanding the riparian corridor was ranked the highest action for the lower Calapooia River. Expanding the riparian corridor will eventually decrease water temperatures, enhance instream habitat through debris recruitment, improve riparian habitat for wildlife, and improve water quality by filtering overland runoff, and reducing bank erosion through improved streambank stability. Riparian corridor expansion would address multiple limiting factors identified for the lower Calapooia

River. The individual actions are generally lower cost, delayed benefit type actions. The actions also have lower failure risk.

Specific projects designed to execute the general restoration actions in Table 6-2, are included in Table 6-3.

Table 6-3. Restoration goals, specific projects, and project locations for the lower Calapooia River.

Restoration Goal	Specific Project	Location (STA)	Floodplain/Channel Location
Expand the riparian corridor	Riparian Enhancement	160+00 - 170+00	RR FP
	Riparian Enhancement	78+00 - 135+00	RL FP
	Riparian Enhancement	135+00 - 159+00	RR FP
	Riparian Enhancement	70+00 - 75+00	RR FP
	Riparian Enhancement	73+00 - 120+00	RR FP
	Riparian Enhancement	32+00 - 50+00	RL FP
	Riparian Enhancement	2+00 - 27+00	RL FP
	Riparian Enhancement	60+00 - 62+00	RL FP
Improve habitat diversity through in-channel and off-channel enhancement	Engineered Log Jam	108+50	RR
	Engineered Log Jam	107+00	RR
	Engineered Log Jam	106+50	RR
	Engineered Log Jam	106+00	RR
	Engineered Log Jam	105+00	RR
	Engineered Log Jam	75+00	RR
	Engineered Log Jam	75+50	RR
	Engineered Log Jam	73+50	RR
	Engineered Log Jam	70+00	RR
	Engineered Log Jam	68+75	RR
	Engineered Log Jam	68+00	RR
	Engineered Log Jam	72+50	RR
	Engineered Log Jam	144+00	RR
	Engineered Log Jam	143+00	RR
	Engineered Log Jam	143+50	RR
	Engineered Log Jam	144+40	RR
	Engineered Log Jam	144+50	RR
	Wetland Enhancement	148+00	RL FP
	Wetland Enhancement	155+00	RL FP
	Wetland Enhancement	120+00	RL FP
	Off Channel Enhancement	144+00	RL
	Off Channel Enhancement	75+00	RR
	Off Channel Enhancement	112+00	RL
	Off Channel Enhancement	70+00	RR
	Bank Stabilization	162+00 - 165+00	RR
	Bank Stabilization	146+00 - 151+00	RR
	Bank Stabilization	82+00 - 96+00	RL
	Bank Stabilization	57+00 - 61+50	RL
Provide passage to	Culvert(s) replacement in	146+00	RL FP

Table 6-3. Restoration goals, specific projects, and project locations for the lower Calapooia River.

Restoration Goal	Specific Project	Location (STA)	Floodplain/Channel Location
fish-bearing tributaries	floodplain tributary joining Calapooia		
Assess and stabilize former City of Albany landfill	Landfill debris removal	109+00 - 114+00	RR FP

6.3.2 Willamette River

Limiting factors for the Willamette River are from NMFS (2008) and water quality impairments are provided in ODEQ (2006). Limiting factors include:

- Degraded water quality including altered temperatures, and elevated fecal bacteria and mercury concentrations,
- Reduced peak flows/channel complexity and habitat diversity,
- Altered flows caused by the flood control/hydro-system that affect habitat in the tributaries below the dams and in the mainstem Willamette River, and
- Riparian vegetation loss due to riparian conversion and bank armoring.

Specific actions to address limiting factors on the Willamette River include the following:

- Identify sites in the mainstem Willamette River where habitat restoration is desirable and coupled to peak flows, design restoration projects, implement work, and monitor.
- Protect the highest quality rearing and migration habitats through conservation measures, acquisition, and/or regulation. Better manage existing riparian areas including removal of invasive plant species.
- Using the framework in the "Willamette Planning Atlas," protect and restore aquatic habitat function at the mouths of tributaries; increase non-structural capacity of floodwater, restore natural riparian communities and their function; increase channel complexity; and increase native floodplain forest.
- Implement watershed protection strategies to address water quality degradation.

Table 6-4 reiterates the limiting factors, presents the restoration goals and general restoration actions, and categorizes the importance of the general restoration actions in addressing the limiting factor.

Table 6-4. Limiting factors, restoration goals, general restoration actions, and importance of general restoration actions for the Willamette River. Limiting factors include Willamette Project Recovery Plan limiting factors, beneficial use limitations as outlined in the Willamette River TMDL, and impairments determined during the Calapooia-Albany Assessment. Ratings of high (H), moderate (M), and low (L) indicate the importance of the general restoration actions.

Limiting Factor	Restoration Goal	General Restoration Action	Importance of Action
Riparian vegetation loss and bank armoring	Expand the riparian corridor	• Preserve remaining riparian corridor through landowner education	H
		• Conservation easements for willing landowners	M
		• Convert portions of properties bordering the river back to riparian corridor	H
		• Treat invasive plant species where feasible	H
		• Plant armored banks and promote bioengineering in-place of riprap where stabilization is necessary	L
Degraded water quality	Decrease water temperature, and fecal bacteria and mercury concentrations in the Willamette River	• Improve long-term stream shading through riparian planting	H
		• Watershed protection strategies	H
Channel and floodplain simplification	Improve habitat diversity through in-channel and off-channel enhancement	• Add large wood to off-channel habitats	L

The general restoration actions that will achieve the restoration goal of expanding the riparian corridor were ranked the highest for the Willamette River. Expanding the riparian corridor will eventually decrease water temperatures, enhance instream habitat through debris recruitment, improve riparian habitat for wildlife, and improve water quality by filtering overland runoff and reducing bank erosion through improved streambank stability. Riparian corridor expansion would address multiple limiting factors identified for the Willamette River in NMFS (2008) and ODEQ (2006). The individual actions are generally lower cost, delayed benefit type actions. The actions also have lower failure risk.

Specific projects designed to execute the general restoration actions in Table 6-4, are included in Table 6-5.

Table 6-5. Restoration goals, specific projects, and project locations for the Willamette River.

Restoration Goal	Specific Project	Location (STA)	Floodplain/Channel Location
Expand the riparian corridor	Riparian Enhancement	383+00 - 405+00	RR
	Riparian Enhancement	332+00 - 375+00	RR
	Riparian Enhancement	302+00 312+00	RR
	Riparian Enhancement	9+00 - 92+00	RL
	Riparian Enhancement	6+00 - 86+00	RR
	Riparian Enhancement	131+00 - 285+00	RL
	Riparian Enhancement	220+00 - 229+00	RR
	Riparian Enhancement	205+00 - 215+00	RR
	Education	304+00	RR
	Education	241+00	RR
	Education	234+00	RR
Improve habitat diversity through in-channel and off-channel enhancement	Off Channel Enhancement	375+00	RR
	Off Channel Enhancement	88+00	RR
	Off Channel Enhancement	146+00	RR
	Off Channel Enhancement	127+00	RL
	Off Channel Enhancement	327+00	RL

6.3.3 Periwinkle Creek

Limiting factors for the Willamette River are from NMFS (2008) and water quality impairments were identified during the assessment. Limiting factors include:

- Degraded water quality due to stormwater runoff and agricultural inputs,
- Reduced habitat diversity,
- Riparian vegetation loss due to riparian conversion and bank armoring, and
- Illegal dumping and trash.

Specific actions identified in the draft Recovery Plan to address limiting factors in the mouths of tributaries to the Willamette River and other approaches to address problems in Periwinkle Creek include the following:

- Using the framework in the "Willamette Planning Atlas," protect and restore aquatic habitat function at the mouths of tributaries; increase non-structural capacity of floodwater, restore natural riparian communities and their function; increase channel complexity; and increase native floodplain forest.
- Remove debris from the stream corridor that degrades habitat and habitat-forming processes. Promote education and volunteer stream clean-up efforts concerning household hazardous waste (HHW). Increase education regarding proper refuse disposal and recycling.
- Investigate structural and non-structural approaches to reduce agricultural runoff and runoff from impervious surfaces to the Periwinkle Creek stormwater channel.

Table 6-6 reiterates the limiting factors, presents the restoration goals and general restoration actions, and categorizes the importance of the action in addressing the limiting factor.

Table 6-6. Limiting factors, restoration goals, general restoration actions, and importance of general restoration actions for Periwinkle Creek. Limiting factors include Willamette Project Recovery Plan limiting factors and impairments determined during the Calapooia-Albany Assessment. Ratings of high (H), moderate (M), and low (L) indicate the importance of the general restoration actions.

Limiting Factor	Restoration Goal	General Restoration Action	Importance of Action
Degraded water quality	Improve water quality related to upper stormwater system inputs to lower Periwinkle Creek	• Riparian plantings in exposed areas	H
		• Institute BMPs in agricultural region	M
		• Install bioswales to filter stormwater before it reaches stream	M
		• Disconnect stormwater network from natural stream at low flows	H
		• Public education concerning pet waste disposal and feeding ducks and geese in City parks	H
		• Remove HHW from stream corridor and improve education	M
		• Flow augmentation using Santiam Canal water	L
Reduced habitat diversity	Improve habitat diversity through conservation measures, invasive species treatment, and debris removal	• Preserve remaining riparian corridor through landowner education	M
		• Remove urban debris from lower Periwinkle Creek	H
		• Remove concrete and asphalt from stream channel in park areas	M
		• Do not remove large wood that recruits to lower creek if not a flood risk	M
		• Remove invasive plant species and replant treated areas with native species	M

The general restoration actions that will achieve the restoration goal of improving water quality in lower Periwinkle Creek were given the highest ranking. Priority actions include planting exposed areas, disconnecting the stormwater network during summer time periods, and improving public education concerning pet waste, feeding waterfowl, and illegal trash disposal. These actions would improve water quality in lower Periwinkle Creek and reduce water temperatures.

Specific projects designed to execute the general restoration actions in Table 6-6, are included in Table 6-7.

Table 6-7. Restoration goals, specific projects, and project locations for Periwinkle Creek.

Restoration Goal	Specific Project	Location (STA)	Floodplain/Channel Location
Improve water quality related to upper stormwater system inputs to lower Periwinkle Creek	Construct detention pond(s) to disconnect summer time stormwater system discharge to lower Periwinkle Creek	Stormwater channel upstream from SE 9th Ave	All
	Agricultural land BMPs	Agricultural headwaters	All
	Bioswales and BMPs for areas draining large impervious areas	Stormwater channel upstream from SE 9th Ave	All
	Riparian plantings in stormwater channel reach	Stormwater channel upstream from SE 9th Ave	All
Improve habitat diversity through conservation measures and debris removal	Education	11+00	RR
	Education	8+00	RR
	Debris Removal	12+75	All
	Debris Removal	14+00	All
	Debris Removal	16+00	All
	Debris Removal	18+50	All
	Debris Removal	24+25	All
	Increase opportunities for HHW disposal		Parks and Illegal Dumping Sites
	Invasive Species Management	3+00 - 15+00	RL
	Invasive Species Management	4+00 - 16+00	RR
	Riparian plantings in stormwater channel reach		

6.3.4 Thornton Lake

Limiting factors for Thornton Lake are taken from NMFS (2008) and include observations from the assessment. Limiting factors include the following:

- Altered water temperatures,
- Degraded water quality due to stormwater runoff and agricultural inputs,
- Riparian vegetation loss due to riparian conversion for agriculture and residential development, and

- Habitat simplification due to shoreline development.

Specific actions identified in the draft Recovery Plan to address limiting factors in the mouths of tributaries to the Willamette River and other approaches to address problems in Thornton Lake include the following:

- Using the framework in the "Willamette Planning Atlas," protect and restore aquatic habitat function at the mouths of tributaries; increase non-structural capacity of floodwater, restore natural riparian communities and their function; increase channel complexity; and increase native floodplain forest.
- Manage invasive species and expand riparian buffers around lake by restoring native riparian plant communities.
- Address stormwater inputs to lake.

Table 6-8 reiterates the limiting factors, presents the restoration goals and general restoration actions, and categorizes the importance of the action in addressing the limiting factor.

Table 6-8. Limiting factors, restoration goals, general restoration actions, and importance of general restoration actions for Thornton Lake. Limiting factors include Willamette Project Recovery Plan limiting factors and impairments determined during the Calapooia-Albany Assessment. Ratings of high (H), moderate (M), and low (L) indicate the importance of the general restoration actions.

Limiting Factor	Restoration Goal	General Restoration Action	Importance of Action
Riparian vegetation loss	Expand the riparian corridor	• Preserve remaining riparian corridor through landowner education • Treat invasive plant species where feasible • Expand riparian buffers promoting native plant species	H H H
Degraded water quality	Manage stormwater discharge and runoff from residential properties	• Landowner education • Institute BMPs for stormwater • Route stormwater to Willamette River • Expand riparian buffers to mitigate for residential runoff to lake • Manage future development	H H L H H
Habitat simplification	Augment lakeshore and riparian habitat where appropriate	• Install basking logs for turtle habitat • Maintain emergent vegetation community	L H

Table 6-8. Limiting factors, restoration goals, general restoration actions, and importance of general restoration actions for Thornton Lake. Limiting factors include Willamette Project Recovery Plan limiting factors and impairments determined during the Calapooia-Albany Assessment. Ratings of high (H), moderate (M), and low (L) indicate the importance of the general restoration actions.

Limiting Factor	Restoration Goal	General Restoration Action	Importance of Action
Connectivity	Ensure fish passage through connector channel to Thornton Lake	• Assess fish passage conditions at crossings in connector channel and address as necessary	M
		• Replace outlet culvert with natural outlet set at preferred elevation	M

The general restoration actions that will achieve the restoration goal of expanding the riparian corridor were given the highest ranking for Thornton Lake. Priority actions include protecting remaining native vegetation, managing invasive species, expanding riparian buffers, and educating landowners. These actions would improve water quality and riparian habitat around Thornton Lake.

Specific projects designed to execute the general restoration actions in Table 6-8, are included in Table 6-9.

Table 6-9. Restoration goals, specific projects, and project locations for Thornton Lake.

Restoration Goal	Specific Project	Location (STA)	Floodplain/Channel Location
Expand the riparian corridor	Riparian Enhancement	61+00 - 88+00	South Shoreline
	Riparian Enhancement	106+50 - 124+00	South Shoreline
	Invasive Species Mngmnt	107+00 - 131+00	South Shoreline
	Vegetation Management / Conservation	110+00 - 130+00	North Shoreline
	Vegetation Management / Conservation	73+00 - 105+00	North Shoreline
	Vegetation Management / Conservation	85+00 - 105+00	South Shoreline
Manage stormwater discharge and runoff from residential properties	Stormwater Management	105+50	Lake Shoreline
	Stormwater Management	106+50	Lake Shoreline
	Stormwater Management	80+00	Lake Shoreline
	Stormwater Management	131+50	Lake Shoreline
	Stormwater Management	73+00	Lake Shoreline
	Stormwater Management	68+50	Lake Shoreline
	Stormwater Management	89+00	Lake Shoreline
Augment lakeshore and riparian habitat where	Turtle Basking Logs	132+00	North Shoreline
	Turtle Basking Logs	127+00	North Shoreline
	Turtle Basking Logs	128+00	North Shoreline

Table 6-9. Restoration goals, specific projects, and project locations for Thornton Lake.

Restoration Goal	Specific Project	Location (STA)	Floodplain/Channel Location
appropriate	Turtle Basking Logs Turtle Basking Logs	129+50 128+00	South Shoreline South Shoreline
Ensure fish passage through connector channel to Thornton Lake	Fish Passage Fish Passage	71+75 60+00	Connector Channel Connector Channel

6.3.5 Albany Oxbow Lakes

Limiting factors for the Albany oxbow lakes are taken from NMFS (2008) and include observations from the assessment. Limiting factors include the following:

- Altered water temperatures,
- Degraded water quality due to stormwater runoff and discharge from industrial facilities,
- Riparian vegetation loss due to riparian conversion for agriculture and industrial development,
- Habitat simplification due to historical and contemporary industrial use of oxbow lakes and the adjacent floodplain, and
- Fish passage barriers on tributary streams.

Specific actions identified in the draft Recovery Plan to address limiting factors in the mouths of tributaries to the Willamette River and other approaches to address problems in the Albany oxbow lakes area include the following:

- Using the framework in the "Willamette Planning Atlas," protect and restore aquatic habitat function at the mouths of tributaries; increase non-structural capacity of floodwater, restore natural riparian communities and their function; increase channel complexity; and increase native floodplain forest.
- Assess and address fish passage barriers particularly on Cox Creek.
- Address stormwater inputs to tributaries and oxbow lakes.
- Enhance habitat in oxbow lakes and lower tributary reaches.
- Manage invasive plant species and expand native riparian areas.

Table 6-10 reiterates the limiting factors, presents the restoration goals and general restoration actions, and categorizes the importance of the action in addressing the limiting factor.

Table 6-10. Limiting factors, restoration goals, general restoration actions, and importance of general restoration actions for the Albany oxbow lakes. Limiting factors include Willamette Project Recovery Plan limiting factors, beneficial use impairments, and impairments determined during the Calapooia-Albany Assessment. Ratings of high (H), moderate (M), and low (L) indicate the importance of the general restoration actions.

Limiting Factor	Restoration Goal	General Restoration Action	Importance of Action
Riparian vegetation loss	Expand the riparian corridor	• Preserve remaining riparian corridor • Treat invasive plant species where feasible • Re-establish historical riparian areas	H H H
Degraded water quality	Manage stormwater discharge and runoff from agricultural and industrial development	• Institute BMPs for stormwater • Install bioswales to filter stormwater	H H
Habitat simplification	Augment habitat in oxbow lakes and lower reaches of tributary streams	• Install large wood in oxbow lakes, connector channels, and lower tributaries for fish habitat • Improve connection between oxbow lakes • Remove bank armoring from streams where unnecessary	M M L
Fish passage	Provide fish passage on tributary streams including Cox, Truax, and Murder creeks	• Provide fish passage on lower tributaries to expand fish use of streams	H

The general restoration actions that will achieve the restoration goal of expanding the riparian corridor were given the highest ranking for the Albany oxbow lakes. Priority actions include preserving the remaining riparian corridor, managing invasive species, and re-establishing historical riparian areas. The small number of large landowners in the Albany oxbow lakes area makes achieving these actions very feasible. These actions would improve riparian and off-channel habitat, expand recreational opportunities, and potentially lower water temperatures.

Specific projects designed to execute the general restoration actions in Table 6-10, are included in Table 6-11.

Table 6-11. Restoration goals, specific projects, and project locations for the Albany oxbow lakes.

Restoration Goal	Specific Project	Location (STA)	Floodplain/Channel Location
Expand the riparian corridor	Riparian Enhancement Riparian Enhancement Wetland Enhancement Wetland Enhancement	15+00 - 62+00 16+00 - 75+00 42+00 - 66+00 148+00 - 158+00	Third Lake Third Lake Mouth of Cox Cr. East of Third Lake
Manage stormwater discharge and runoff from agricultural and industrial development	Stormwater Management	Cox Creek	All
Augment habitat in oxbow lakes and lower reaches of tributary streams	Turtle Basking Logs	120+00	Second Lake
	Turtle Basking Logs	119+00	Second Lake
	Turtle Basking Logs	117+00	Second Lake
	Turtle Basking Logs	102+00	Second Lake
	Turtle Basking Logs	90+00	Second Lake
	Turtle Basking Logs	88+50	Second Lake
	Channel Enhancement	50+00 - 80+00	Second Lake
	Engineered Log Jam	85+00	Connector Channel
	Engineered Log Jam	80+50	Connector Channel
	Engineered Log Jam	76+25	Connector Channel
	Engineered Log Jam	71+50	Connector Channel
	Engineered Log Jam	73+75	Connector Channel
	Engineered Log Jam	68+00	Connector Channel
	Engineered Log Jam	65+00	Connector Channel
	Engineered Log Jam	61+00	Connector Channel
	Engineered Log Jam	57+25	Connector Channel
	Engineered Log Jam	53+00	Connector Channel
	Engineered Log Jam	52+00	Connector Channel
	Engineered Log Jam	40+50	Connector Channel
	Engineered Log Jam	35+00	Connector Channel
	Engineered Log Jam	34+00	Connector Channel
	Engineered Log Jam	27+25	Third Lake
	Engineered Log Jam	23+50	Third Lake
	Engineered Log Jam	25+50	Third Lake
	Engineered Log Jam	15+00	Fourth Lake
	Engineered Log Jam	9+25	Fourth Lake
	Engineered Log Jam	106+00	Second Lake
	Engineered Log Jam	110+00	Second Lake
Provide fish passage on tributary streams including Cox,	Fish Passage	75+00	Murder Creek
	Fish Passage	90+00	Truax Creek
	Fish Passage	150+00	Cox Creek

Table 6-11. Restoration goals, specific projects, and project locations for the Albany oxbow lakes.

Restoration Goal	Specific Project	Location (STA)	Floodplain/Channel Location
Truax, and Murder creeks			

6.3.6 Restoration Prioritization Summary

A step-wise approach for project prioritization was presented whereby limiting factors, restoration goals, general restoration actions, and specific projects were presented by waterbody. General restoration actions were prioritized based on the importance of limiting factors in suppressing the full expression of ecological systems and beneficial uses. Actions that are expected to have the best potential for achieving restoration goals received the highest rankings. Conversely, actions that are higher risk, higher cost, and less likely to achieve restoration goals received lower rankings. Individual projects associated with highly ranked general restoration actions should be investigated for earliest implementation.

7 Summary

The Calapooia-Albany Assessment included evaluating five primary waterbodies in the vicinity of the City of Albany. Field reconnaissance was completed on the lower Calapooia River, the Willamette River, Periwinkle Creek, Thornton Lake, and the Albany oxbow lakes. Collected field data and remote sensing information were used to characterize historical and existing waterbody conditions.

Waterbodies in the assessment reach have been influenced by agriculture and development since the mid-1800s. Conversion of the historical landscape has had measureable effects on the assessment reach. Direct alterations have included channel straightening and relocation, large wood removal, and riparian vegetation conversion. Indirect changes to the Willamette River have included channel narrowing and habitat simplification. These alterations are related with the Willamette Project and flood control management. Despite the human-induced changes that have occurred in the assessment reach, the focus waterbodies continue to maintain ecological conditions that with enhancement, would benefit native biological communities.

The assessment information and limiting factors described in the *Willamette River Basin Flood Control Project Biological Opinion* (NMFS 2008), and beneficial uses and water quality impairments outlined for the Willamette River and lower Calapooia River outlined in the *Willamette River TMDL* (ODEQ 2006), were used to classify limiting factors that impair the ecological function and beneficial uses of the target water bodies. Limiting factors relate to riparian corridor conversion, instream and oxbow lake habitat simplification, and water quality degradation. General restoration actions were developed to address the limiting factors, and were prioritized for each waterbody. Individual projects associated with each general restoration action were highlighted. Projects associated with highly ranked general restoration actions are recommended for early implementation. Additional design and implementation funding would be pursued for the selected projects. Second tier projects would be pursued following completion of the highest priority projects. The proposed opportunity prioritization process would be a collaborative approach to restoring river and stream corridor habitats and beneficial uses through the Albany reach of the Willamette River and its associated waterbodies.

8 References

Calapooia Watershed Council. 2004. Calapooia River Watershed Assessment. Prepared by Biosystems, Water Work Consulting, and Alsea Geospatial for the Calapooia Watershed Council. Brownsville Oregon.

Colvin, R.W. 2005. Fish and amphibian use of intermittent streams within the Upper Willamette Basin, Oregon. M.Sc. Thesis. Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR.

Environmental Systems Research Institute. 2009a. ArcGIS Version 9.3.

Environmental Systems Research Institute. 2009b. Spatial Analyst extension.

Environmental Systems Research Institute. 2009c. 3D Analyst extension.

Hulse, D., Gregory S., and Baker, J. (editors). 2002. Willamette Basin Planning Atlas, Trajectories of Environmental and Ecological Change. Oregon State University Press, Corvallis, OR.

NOAA-National Marine Fisheries Service (NMFS). 2008. Willamette River Biological Opinion. 4 chapters.

Oregon Department of Environmental Quality. 2006. Willamette Basin TMDL. Chapter 4: Temperature-Mainstem TMDL and Subbasin Summary. 208 pp.

Pacific Habitat Services, Inc. 2009. City of Albany Goal 5 Significant Natural Resources Technical Report & Recommendations. Prepared for the City of Albany. http://www.cityofalbany.net/comdev/projects/goal5/index.php. 35 pp. with appendices.

River Design Group, Inc. (RDG). 2008. Middle Calapooia River Assessment and Project Implementation Plan. Completed for the Calapooia Watershed Council. 101 pp.

APPENDIX A
GIS Maps Key

The accompanying data collection maps in Appendix B through D contain symbols related to four categories. Definitions for the four data categories follow.

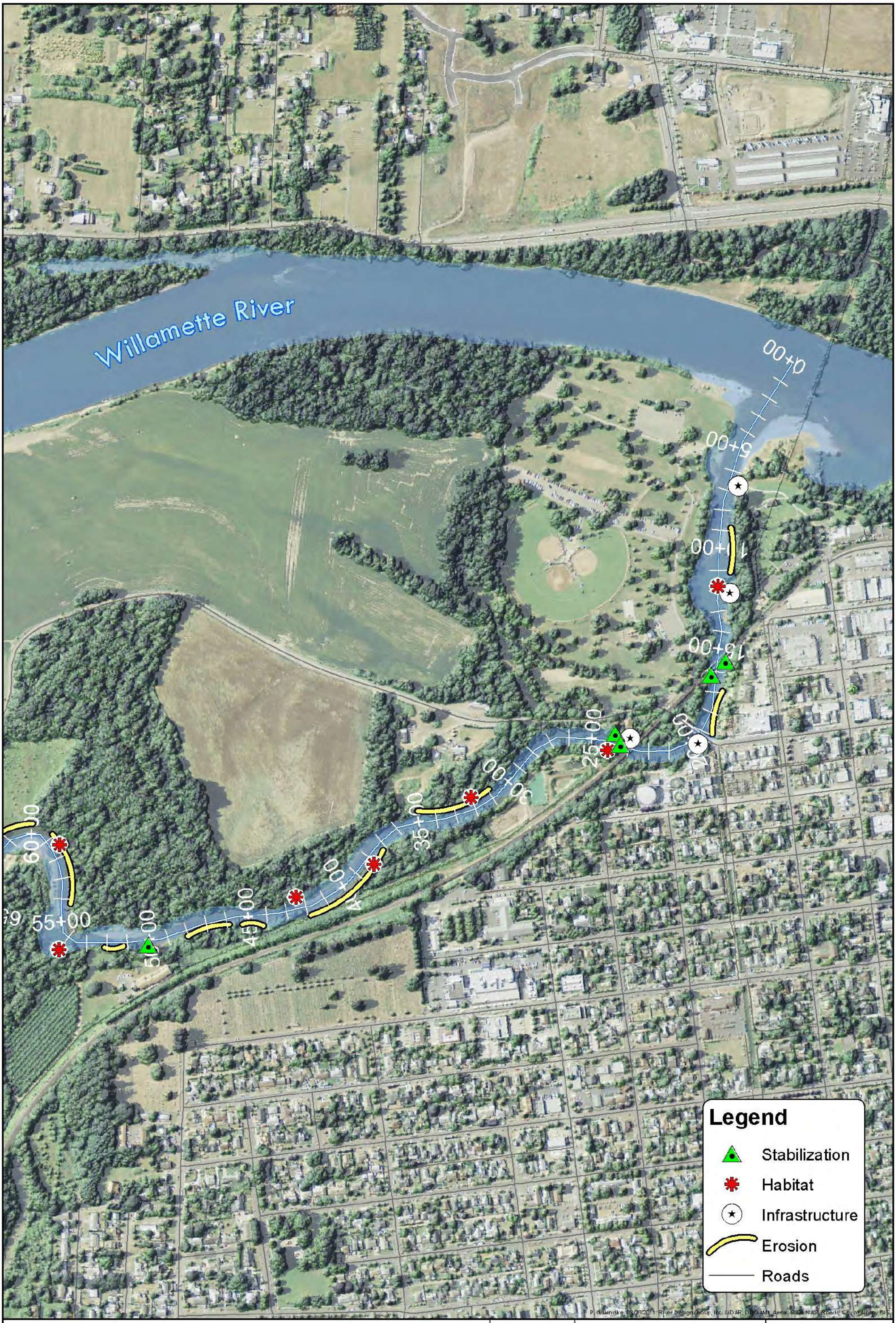
- **Stabilization:** Existing human-made bank stabilization features comprised of various treatments including riprap, large wood, car bodies, among other materials
- **Habitat:** Existing quality habitat likely used by the target fish species. High quality example habitat components include log jams, deep pools, off-channel habitats, and overhanging vegetation.
- **Infrastructure:** Location of existing infrastructure such as utility poles, bridge abutments, pipelines, and pumps among other items.
- **Erosion:** Significant bank failure or eroding bank.

The accompanying opportunity maps presented in Appendix B through F contain symbols that are defined as follows.

- **ELJ:** Engineered log jam used to create aquatic habitat and/or stabilize eroding banks.
- **Bank Treatment:** Bank stabilization projects used to slow eroding banks, re-establish native vegetation and protect valuable infrastructure. Treatments could include; engineered log jams, bank re-shaping, vegetated soil lifts, and native plantings.
- **Wetland:** Enhancement of existing wetland habitats. Treatments include floodplain excavation and planting of native emergent and submergent vegetation.
- **Riparian:** Enhance existing riparian conditions. Treatments include removing present invasive species and planting appropriate native vegetation.
- **Off-channel:** Enhance current or historical off-channel habitats such as side channels, backwater, and alcoves. Treatments include floodplain lowering to increase connectivity, addition of large woody debris, and riparian plantings.
- **Connection**: Treatment aimed to increase connectivity between two waterbodies or a waterbody and floodplain by re-grading channels or removing levees or berms.
- **Basking Log:** Logs placed in slow or slackwater habitats to increase basking habitat for native turtles.
- **Fish Passage**: Projects aimed at improving fish passage at crossings. Treatments include replacing failed or undersized culverts, repairing existing fish ladders or building new fishways.
- **Education**: Includes educational opportunities such as signage, project viewing areas, or interaction with the public.
- **Debris Removal**: Treatments pertain to removing human-made debris located in the river corridor that affects the river environment, water quality, or other beneficial uses.
- **Invasive Species Management**: Remove or control present invasive species.

- **Vegetation Management**: Educate landowners to maintain riparian vegetative buffers along waterbodies.
- **Stormwater Management**: Evaluate and mitigate stormwater runoff entering waterbodies.

APPENDIX B
Lower Calapooia River Maps and Data



Field Data Collection Map 1

Calapooia River, near Albany, Oregon

N

0 150 300 600 Feet

RIVER DESIGN GROUP, INC.

Field Data Collection Map 2

Calapooia River, near Albany, Oregon

N

0 150 300 600 Feet

River Design Group, Inc.

Proposed Treatments Map 1

Calapooia River, near Albany, Oregon

N

0 150 300 600 Feet

RIVER DESIGN GROUP, INC.

Proposed Treatments Map 2

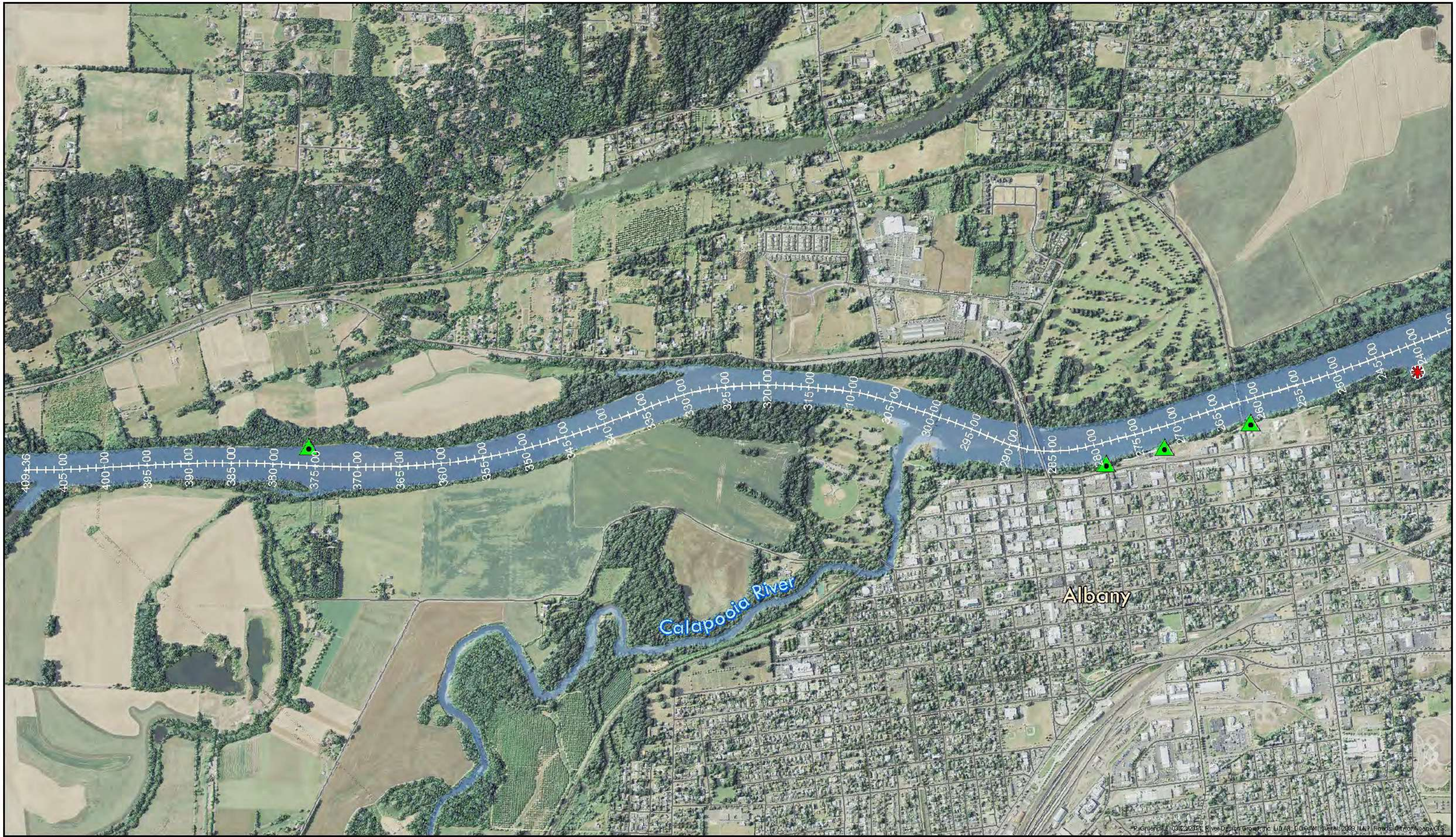
Calapooia River, near Albany, Oregon

N

0 150 300 600 Feet

River Design Group, Inc.

APPENDIX C
Willamette River Maps and Data



Field Data Collection Map 1

Willamette River, near Albany, Oregon

Legend

- Stabilization
- Infrastructure
- Habitat
- Invasive Species
- Erosion
- Roads

N

0 625 1,250 2,500 Feet

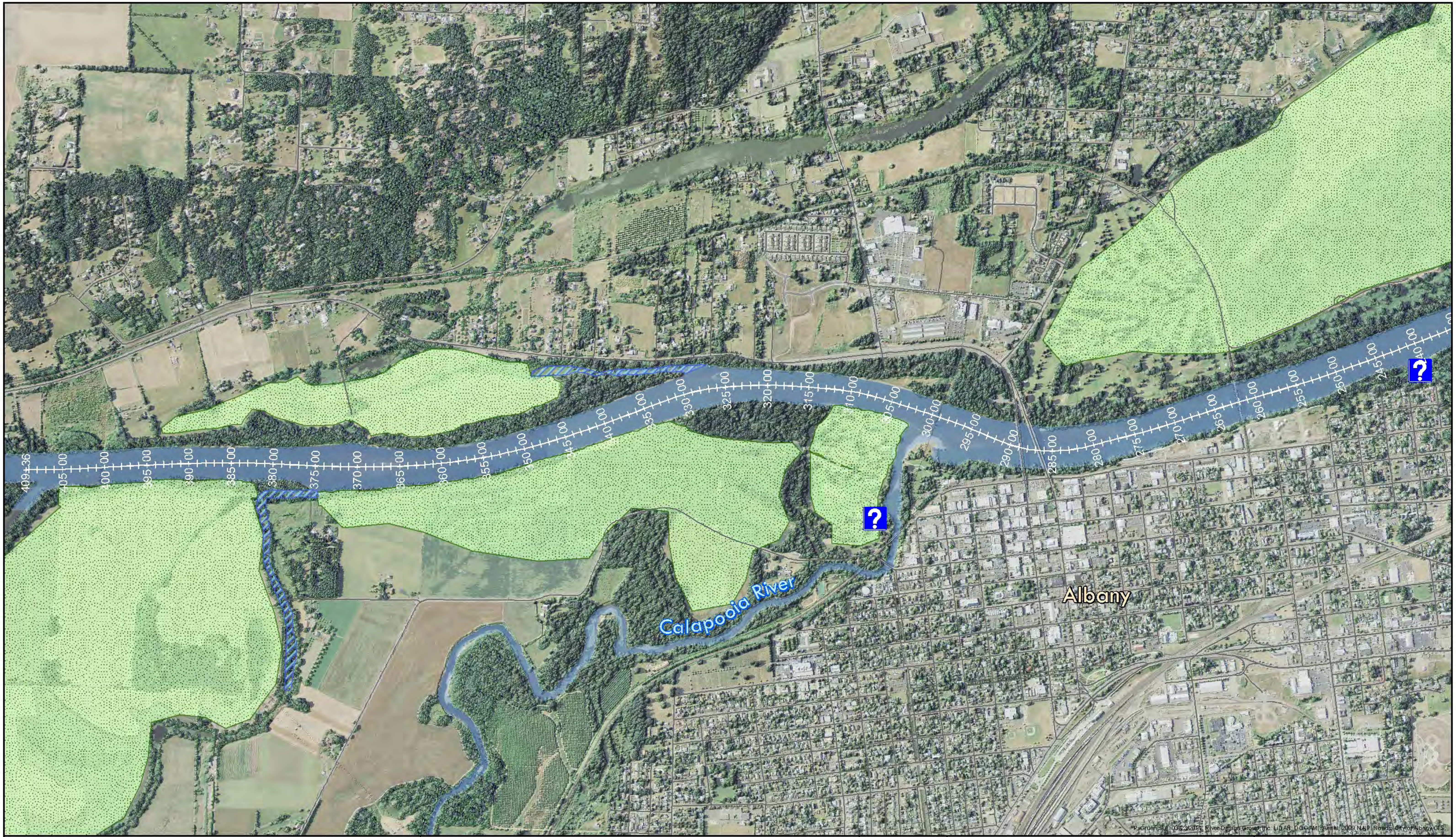
River Design Group, Inc.

Field Data Collection Map 2

Willamette River, near Albany, Oregon

0 375 750 1,500 Feet

River Design Group, Inc.



Proposed Treatments Map 1

Willamette River, near Albany, Oregon

Legend

Off Channel

Riparian

Education

Roads

N

0 625 1,250 2,500 Feet

RIVER DESIGN GROUP, INC.

Treatment Map 2

Willamette River

Legend

Off Channel

Riparian

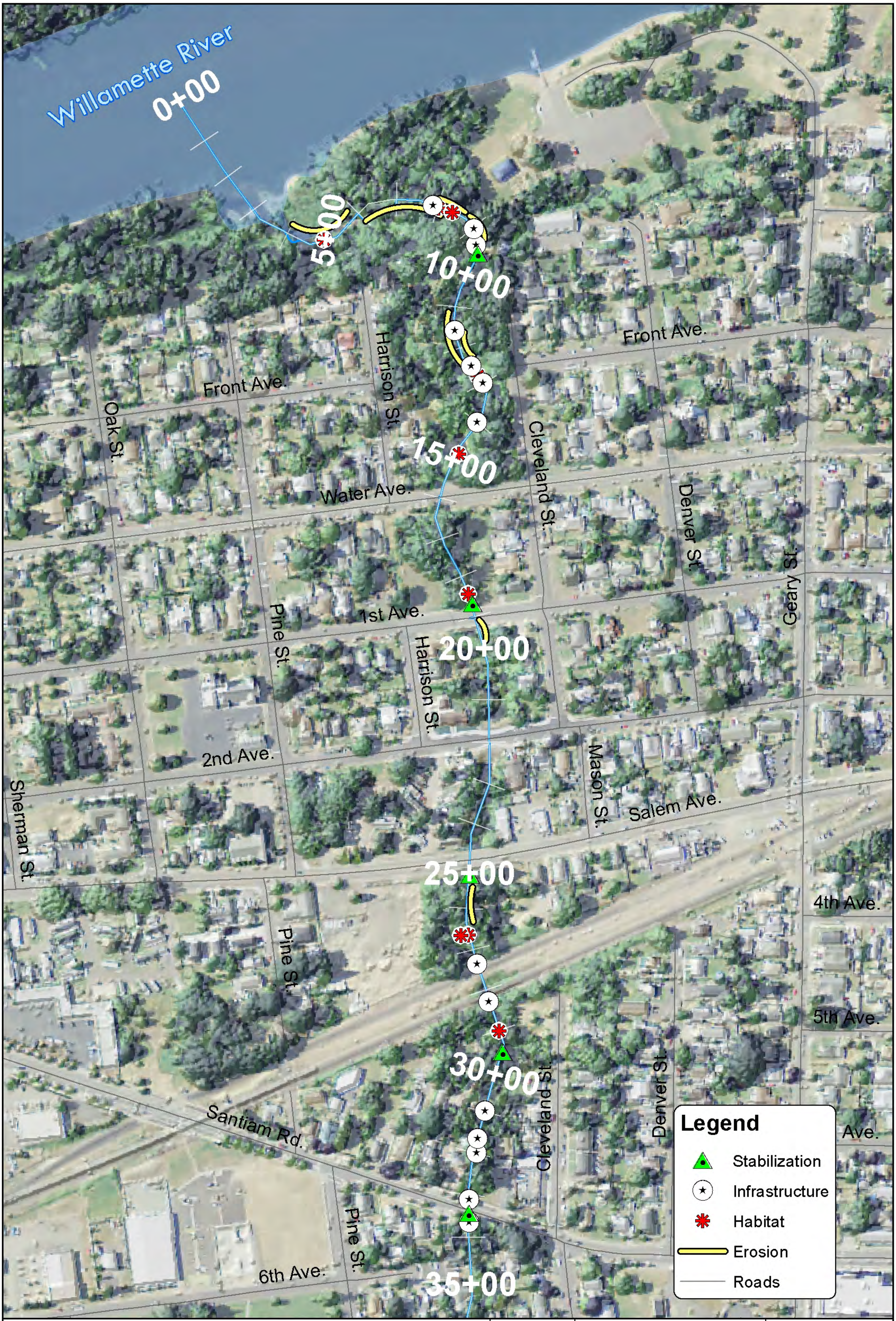
Education

Roads

0 375 750 1,500 Feet

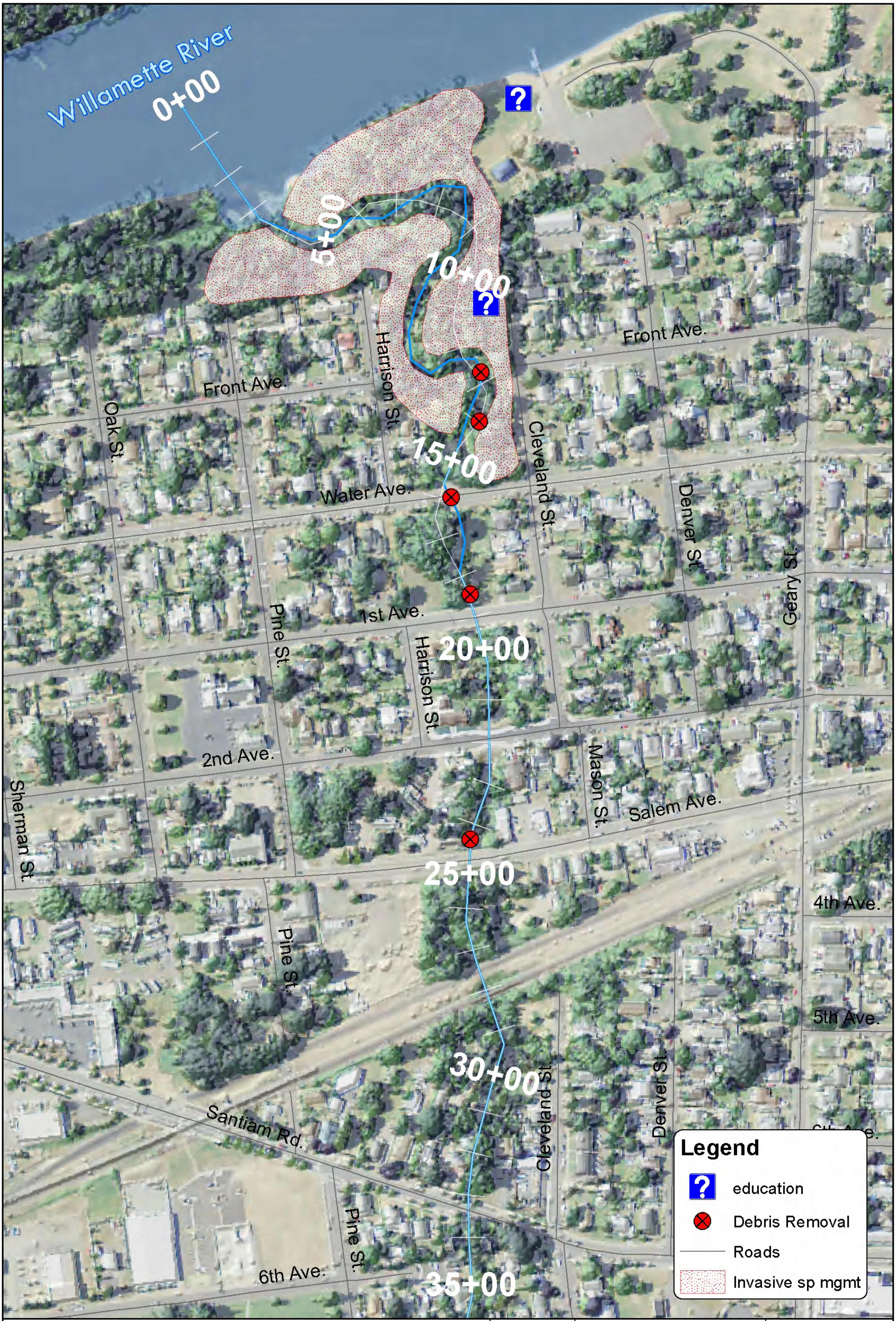
River Design Group, Inc.

APPENDIX D
Periwinkle Creek Maps and Data



Field Data Collection Map

Periwinkle Creek, Albany, Oregon



Proposed Treatment Map

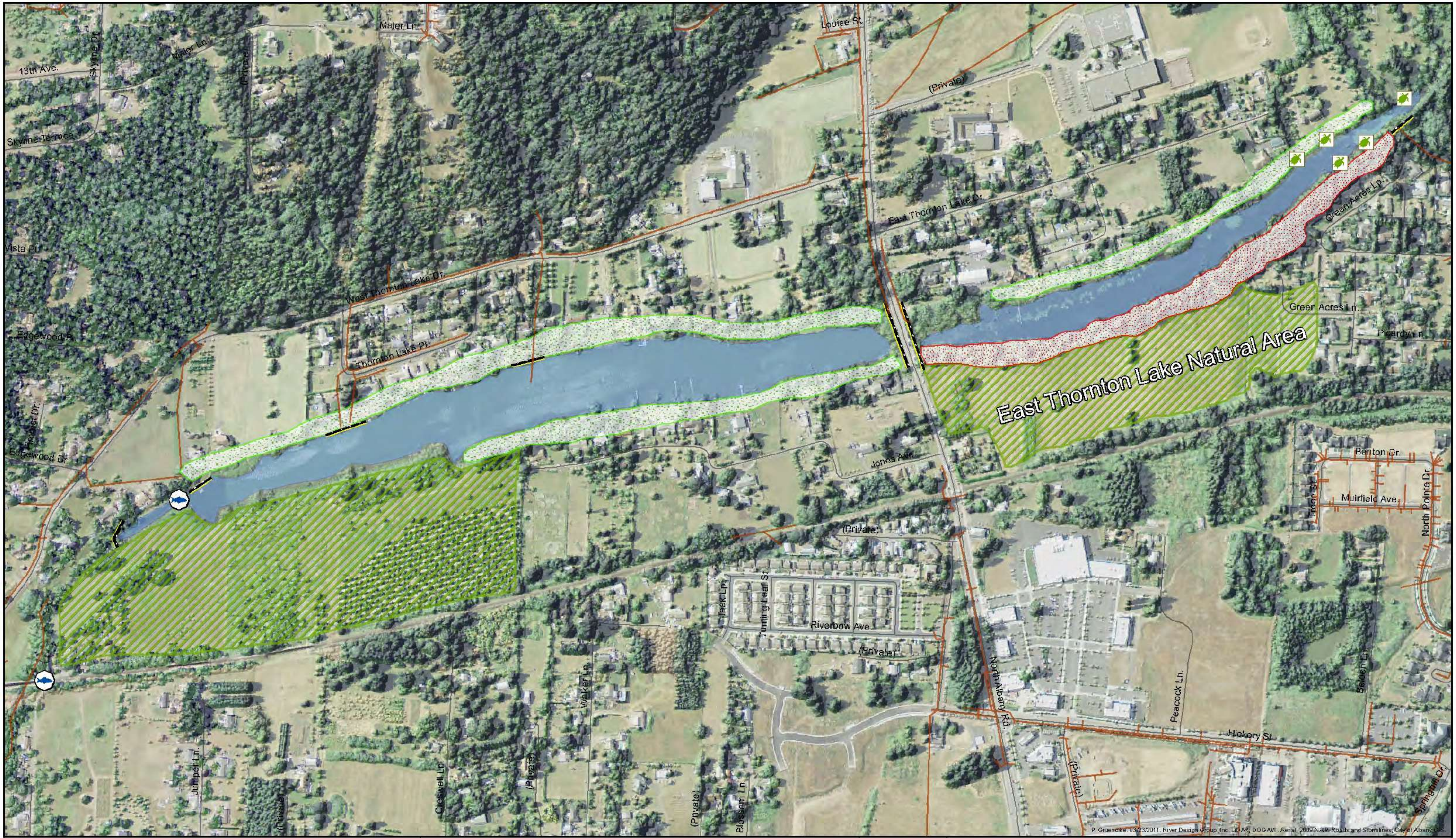
Periwinkle Creek, Albany, Oregon

N

0 75 150 300 Feet

River Design Group, Inc.

APPENDIX E
Thornton Lake Maps and Data



Treatment Map

Thornton Lake, near Albany, Oregon

Legend

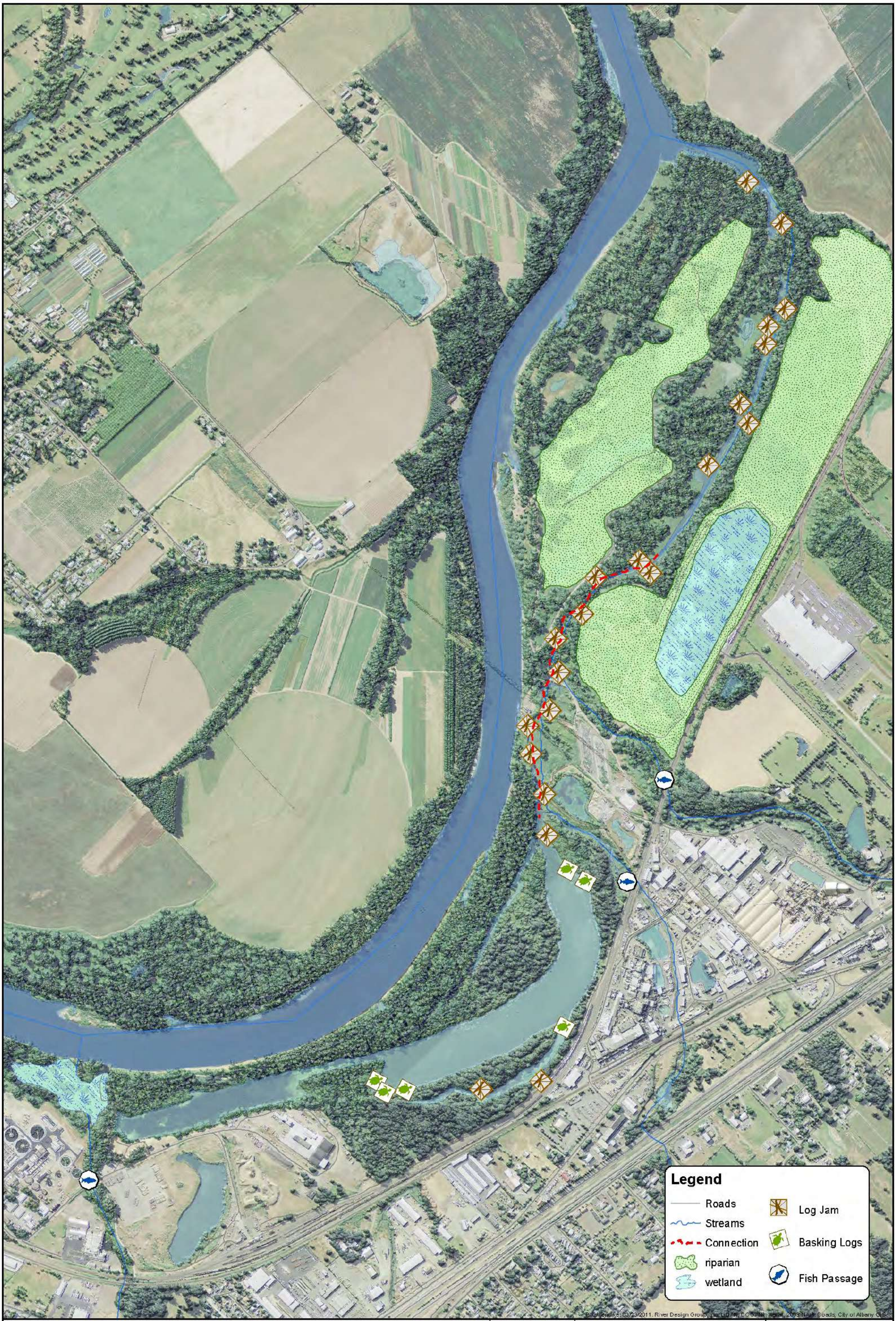
- Basking Logs
- Fish Passage
- Storm Lines
- Roads
- Stormwater Mgmt
- Vegetation Mgmt
- Invasive Mgmt
- Riparian Planting

N

0 250 500 1,000 Feet

River Design Group, Inc.

APPENDIX F
Albany Oxbow Lakes Maps and Data



Proposed Treatments Map

Albany Oxbows, Albany, Oregon

N

0 300 600 1,200 Feet

RIVER DESIGN GROUP, INC.