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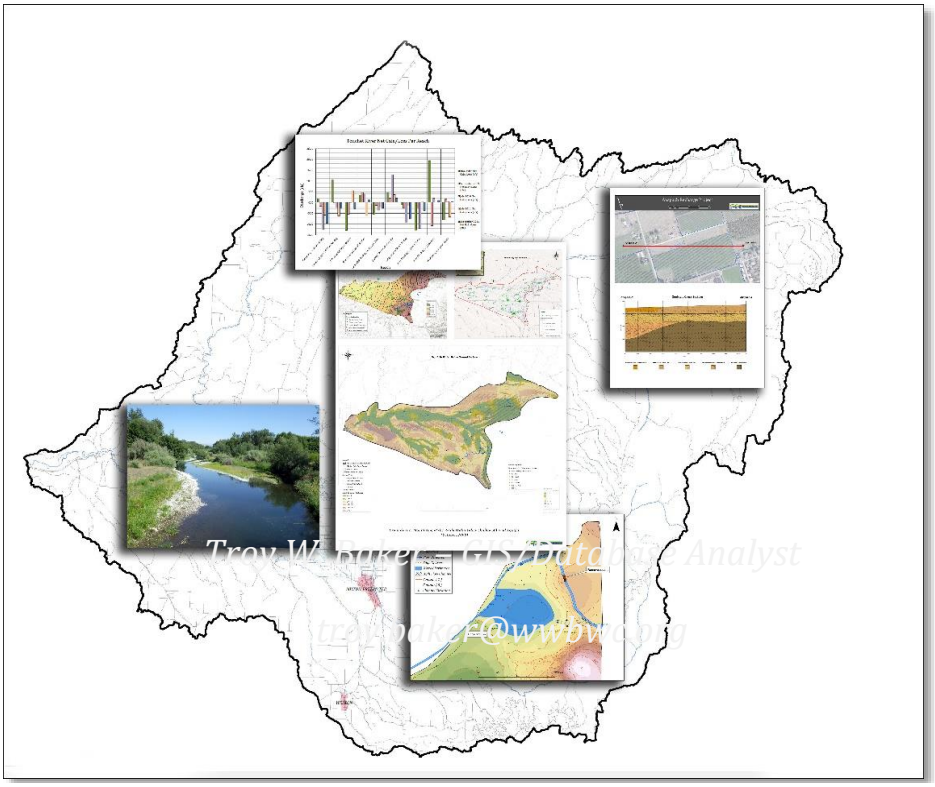
Final Report

ARSR Program Data Analysis and GIS Visualization Project



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In Cooperation with:

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1 Introduction

1.1 Overview

The Walla Walla River basin is a bi-state drainage basin that originates in Oregon and passes through the state of Washington on route to its confluence with the Columbia River. This drainage basin covers approximately 1760 square miles. Two primary drainage areas exist within the Walla Walla Basin: The Walla Walla River and The Touchet River. The Touchet River flows into the Lower Walla Walla River, which drains into the Columbia River. The main tributaries for this study are the North Fork Walla Walla River, South Fork Walla Walla River, Mill Creek, and the East and West Little Walla Walla Rivers. (Figure 1)

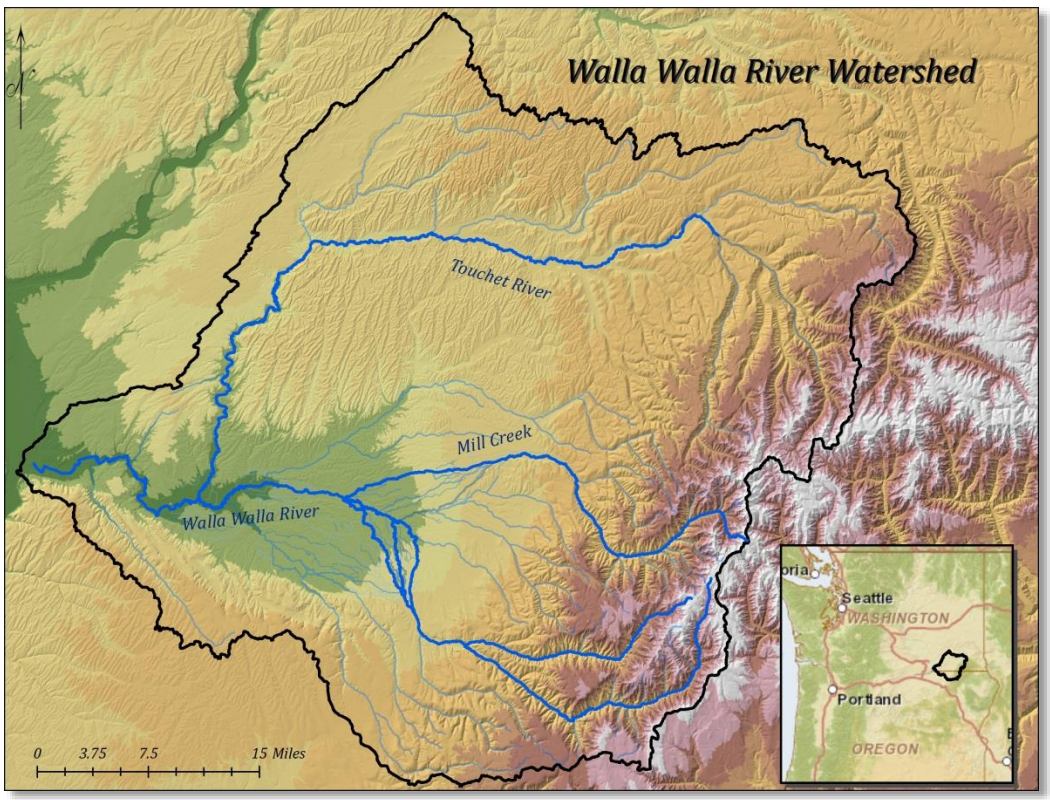


Figure 1. Walla Walla River Watershed

There are numerous agencies within the Walla Walla River Watershed conducting projects focusing on water quality, water quantity, river restoration, and fisheries management. The focus of this project is to pull the available dataset together into a single database and have the data accessible and available to all users.

The database is a collection of hydrologic and fishery based geographic feature datasets with associated features with robust attribute data tables. A GIS database is typically referred to as a geodatabase or a geospatial database. The geodatabase is designed to store, query, and manipulate geographic information and spatial data. Within a geodatabase, spatial data is treated as any other data type. Vector data [1]can be stored as point, polyline, or polygon data types, and may have an associated spatial reference system. A geodatabase record can use a geometry data type to represent the location of an object in the physical world and other standard database data types to store the object's associated attributes. Within a geographic information system (GIS) a geodatabase is one component that can be used to store and manipulate data. The primary advantage of spatial databases, over file-based data storage, is that they let a GIS build on the existing capabilities of relational database management systems (RDBMS).

1.2 Project Objectives

Develop and maintain a database of geographic data for the Walla Walla Basin

ESRI ArcView based geodatabase focusing on the Hydrology, Hydrography, and Fisheries spatial data for the Walla Walla Basin.

Maintain spatial and temporal GIS data models and build a data distribution system

Using collected Walla Walla River Basin data to maintain the structure of the surface flow and temperature data models with spatial reference. Build a data distribution system for the dissemination of hydrologic data.

Surface and Groundwater Model GIS Integration

ESRI ArcView based geodatabase focusing on the structure of the surface and groundwater model components.

2 Methodology

2.1 Walla Walla Basin Geodatabase

The geodatabase is populated with nine unique watershed feature datasets[2]. The feature datasets are as follows: Basin Geology, Boundaries, Fisheries, Groundwater, Points of Diversions, Stream Layers, Surface Water Monitoring, Transportation, and Watershed. The features contained in the geodatabase provide the interface between numeric non-spatial

[1] Geographic features as points, lines, and polygons. "A to Z GIS", ESRI Press 2006

[2] A collection of feature classes stored together that share the same spatial reference. "A to Z GIS", ESRI Press 2006

tabular data and spatial features in a GIS. Tabular data can be referenced to like identifiers such as stream names, monitoring site locations, and geologic layer names. Detailed information about each feature located in the individual feature datasets is located in appendix I.

Feature Datasets

Basin Geology

This feature dataset contains features focused on the geology of the Walla Walla Basin. Boundary and contour layers represent the individual layers that comprise the shallow aquifer of the Walla Walla Valley. The original geologic layers for the Walla Walla Basin were updated in 2015.

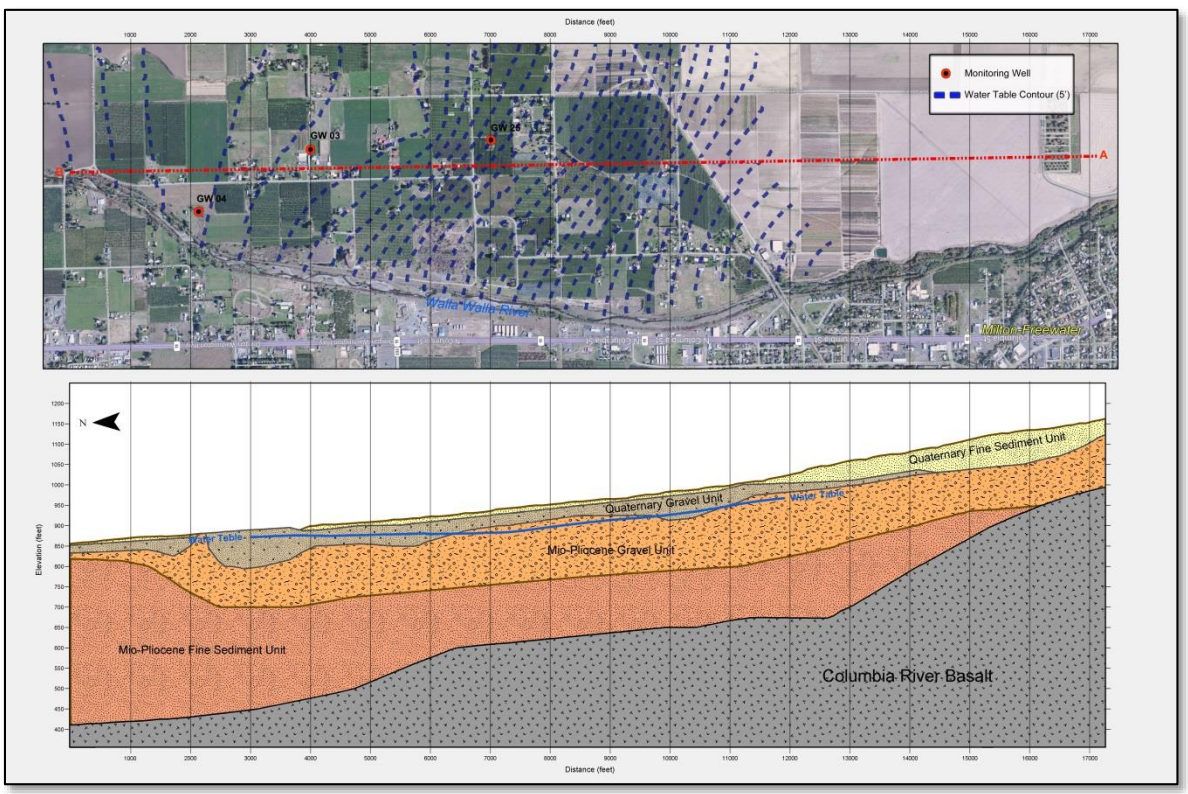


Figure 2 Eastside Milton-Freewater Levee Cross Section through the basin geology datasets.

Boundaries

This feature dataset contains features associated with areas of ownership, sections, townships, towns, and hydrologic unit boundaries within the basin.

Fisheries

This feature dataset contains features associated with past and current fisheries activity throughout the basin.

Groundwater

This feature dataset contains features associated with current and historic groundwater monitoring throughout the basin with a focus on the Walla Walla Valley. The data contained in this dataset populates the surface and groundwater model for the Walla Walla Valley.

Point Of Diversions

Points of Diversions and Place of Use features are located in this feature dataset. The information was compiled from the State of Oregon along with the available data from the state of Washington.[3] Measured diversions from the seepage assessments conducted on the Walla Walla River in 2014 are included in this feature dataset.

Stream Layers

This feature dataset contains layers associated with the Walla Walla Basin Hydrography. A new digitized feature for the entire basin was created to accurately represent the streams, creeks, rivers, ditches, and piped sections within the basin with the focus being the Walla Walla Valley.

Surface Water Monitoring

Throughout the basin there are surface monitoring locations that record continuous, seasonal flow, and water quality data. This dataset contains surface water monitoring locations from various agencies within the basin. Also contained in this dataset are the locations of documented historic spring locations.

Transportation

This feature dataset contains road layers for both the Walla Walla County and the Umatilla County. There is a third feature which combines both county datasets that covers the entire basin.

Watershed

This feature dataset contains a wide range of features which are focused on the watershed.

[3] At the time of this report the Washington Department of Ecology did not have the POD and POU layers available for the inclusion in the geodatabase. When the layers become available they will be integrated.

2.2 Integrated Water Flow Model (IWFM) integration into GIS

Groundwater models require a number of disparate and large data sets that are difficult to manage. GIS can help with the modeling process by coordinating data collection, providing comprehensive database operations, supporting systematic model parameter assignments, conducting spatial analysis functions, and displaying model results in understandable color-map formats.[4]

The IWFM model was developed by the California Department of Water Resources, given its capability for modeling groundwater and its interactions with other hydrologic processes. It is a comprehensive physically-based water resource allocation model that is mathematically complex and computationally efficient by application of the finite element method.[5]

With the completion of the Walla Walla Valley Surface and Groundwater Model it was imperative to have the geodatabase with associated feature datasets built in GIS to insure the integration of the model outputs into the WWBWC's GIS program. The structure in GIS is used to control model inputs, parameters, and to produce visual outputs.

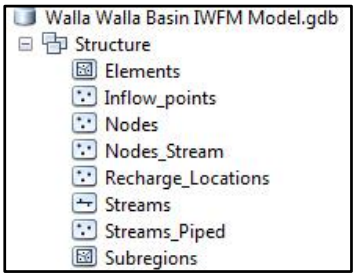


Figure 3 IWFM Feature Data Sets

The IWFM geodatabase is complete and contains seven feature datasets:

Sub Regions

This feature dataset contains a polygon feature which divides the groundwater modeling area into seven unique sub regions.

[4] Lynn E. Johnson, *Geographic Information Systems in Water Resource Engineering* (New York: CRC Press, 2009), 117.

[5] Arístides Crisóstomos Petrides Jiménez, Modeling Surface and Groundwater Interactions near Milton-Freewater, Oregon, (March 17, 2008).

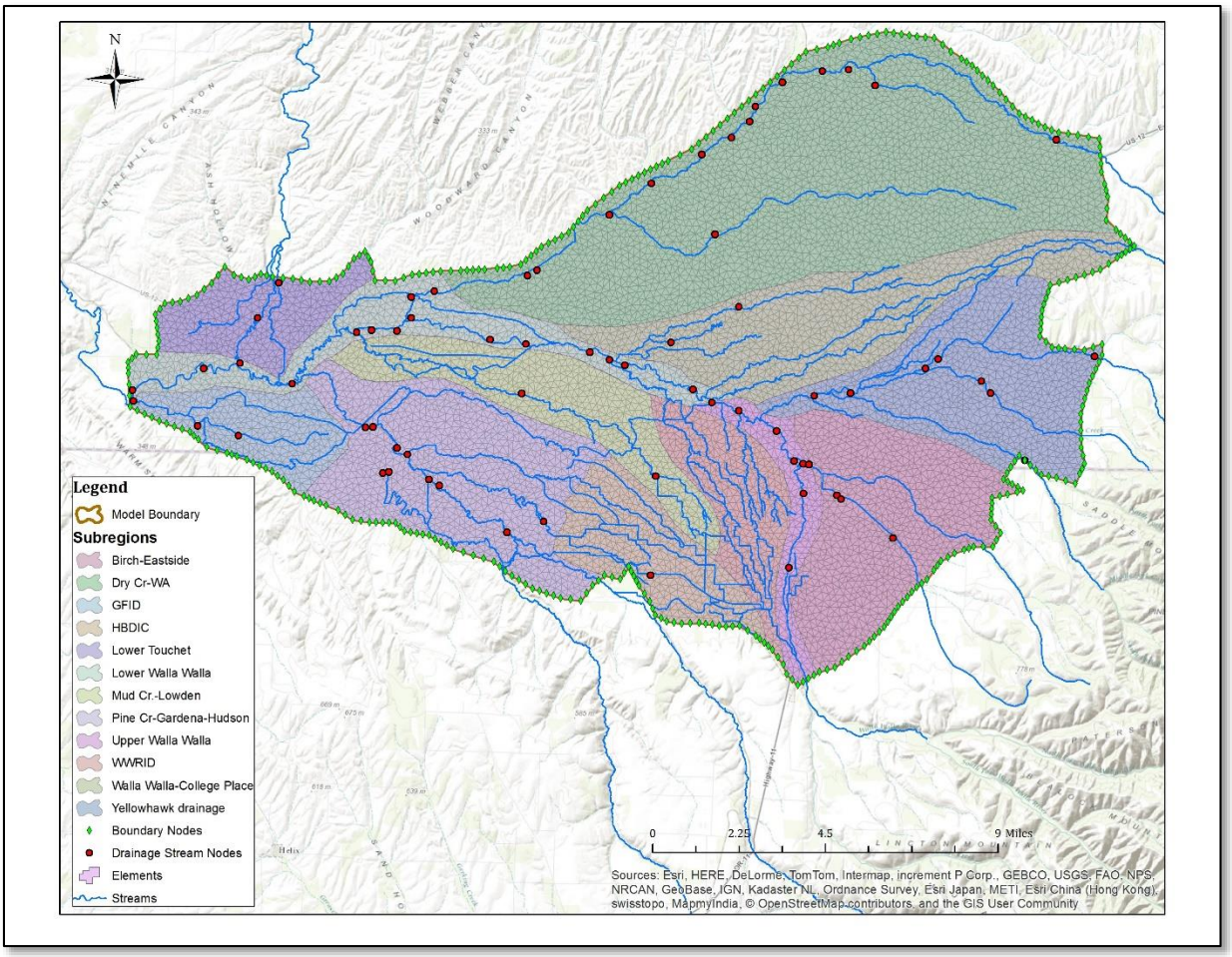


Figure 4. IWFM Surface and Groundwater Model (2015)

Nodes (Model Nodes)

This feature dataset contains point features (model nodes) for the entire modeling area (all nodes), boundary nodes, and stream nodes. The nodes are unique geographic locations within the model which control data inputs.

Streams

The Model Streams feature dataset contains a line feature of the model stream segments.

Elements

The IWFM model used a finite element approach to simulate groundwater flow, surface water flow, and surface water – groundwater interactions. This feature dataset contains a polygon feature of all of the elements used to build the framework of the model.

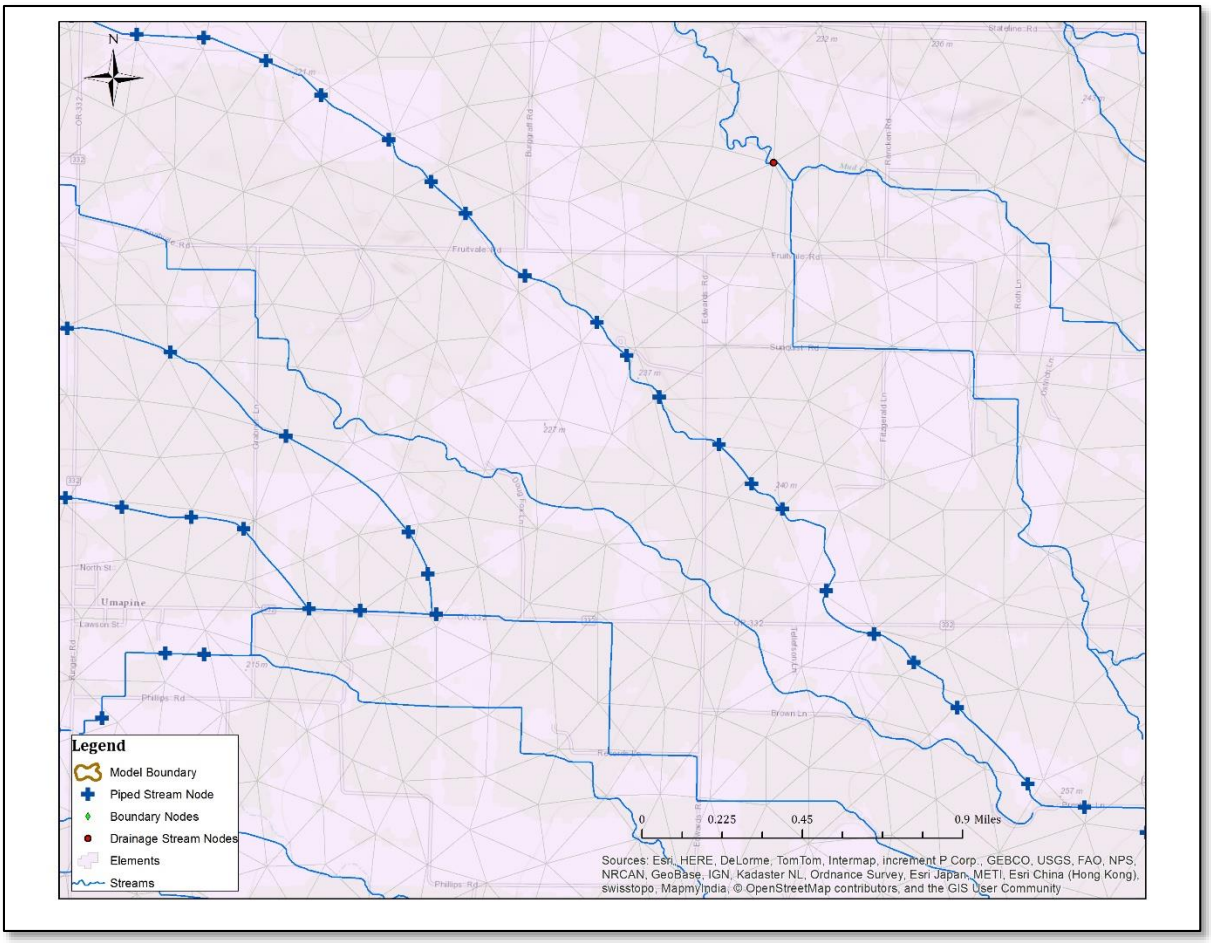


Figure 5 IWFM Model Elements and Nodes.

Recharge Locations

This feature dataset contains a point feature representing the locations of existing and potential recharge sites utilized in the model.

Inflow Points

This is a feature dataset containing locations at which flow enters into the model area at stream nodes.

Boundary

This feature dataset contains a polygon feature representing the geographic location of the extent of the modeling boundary.

2.3 GIS Data Model

The real world can only be depicted in a GIS through the use of models that define phenomena in a manner that computer systems can interpret, as well perform meaningful

analysis.[6] To build the frame for the data models the Walla Walla River feature was converted into a linear route[7].

The Walla Walla River route feature begins at the Highway 12 Bridge at the mouth of the Walla Walla River and extends 111 kilometers upstream. The route was divided into 25 meter segments (Figure 1) with segment 1 starting at the mouth of the river. The attribute table from the feature was then exported into Microsoft Excel. Two were created in Excel to interpret the flow and temperature conditions for the Walla Walla River.

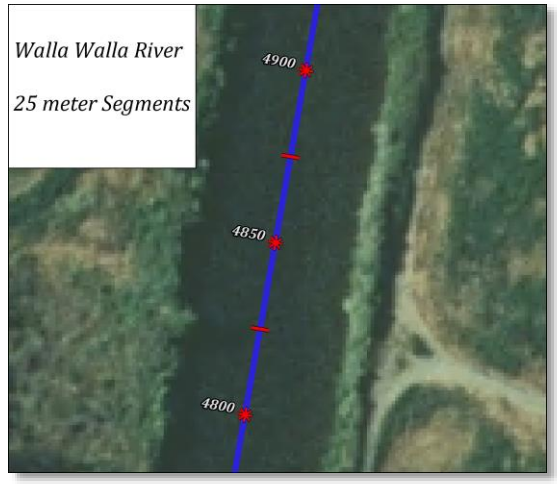


Figure 6. Linear Routing

The linear routing framework is currently used in the channel bed gain and loss calculation documented in the 2014 Seepage Assessment Report[8].

Flow Data Model

After the Walla Walla River was digitized and divided into 25-meter segments a digital spreadsheet was created with each row representing one of those segments. Columns in the spreadsheet were labeled with the dates for the study period (each day in 2007 and 2008). Daily average flow data from all available flow gauges (including WWBWC, OWRD, and WDOE gauge sites) on the Walla Walla River was compiled and put into the spreadsheet along with available diversion and tributary data.

Once all of the compiled flow data was entered into the spreadsheet, flow data for each 25-meter segment of the river was interpolated linearly between the nearest upstream measured flow and the nearest downstream measured flow. Flow changes resulting from diversions and tributaries whose flow data was available occur in the spreadsheet at their respective locations along the river feature. Diversions and tributaries whose daily flows are not recorded or were unknown were ignored and the changes resulting from them are spread out over the whole interpolated reach in which they lie.

[6] University of North Carolina GIS Program

[7] A line feature that has a unique identifier. "A to Z GIS", ESRI Press 2006

[8] Baker, T.W. 2014. 2014 Walla Walla Basin Seasonal Seepage Assessments Report. Walla Walla Basin Watershed Council. www.wwbwc.org.

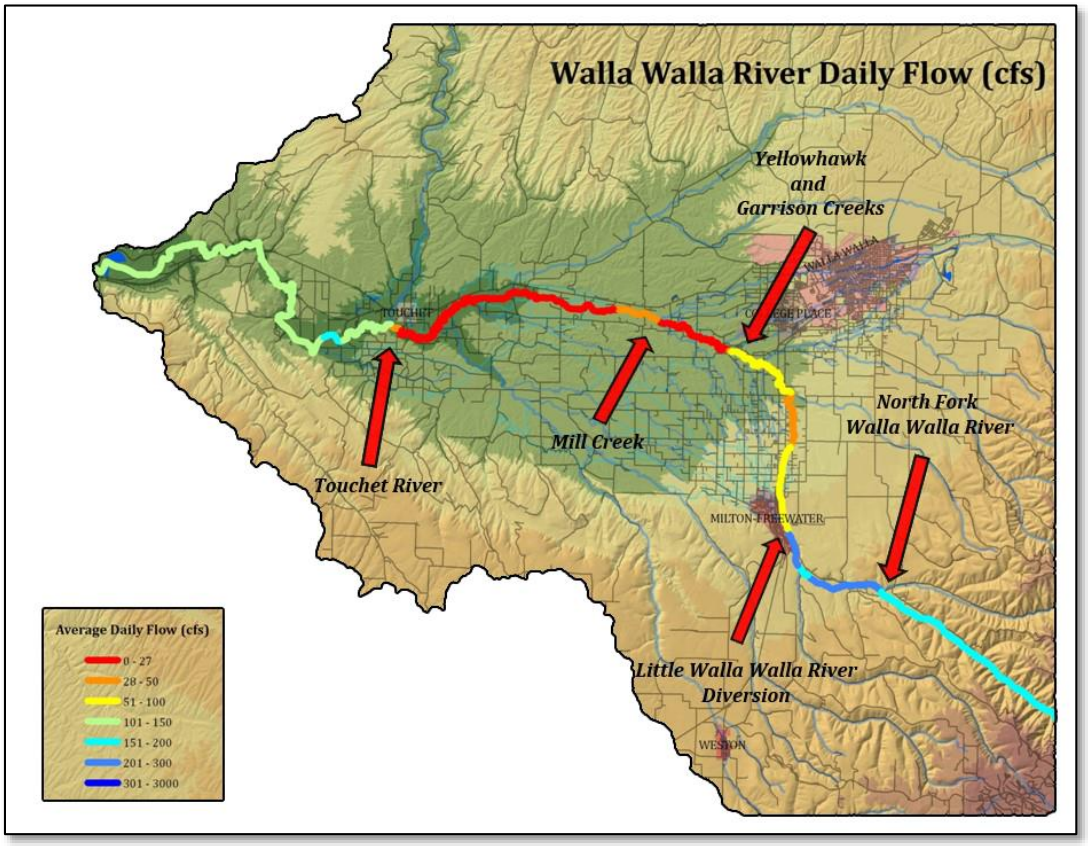


Figure 7 2007 Walla Walla River Daily Flow (cfs)

In this way a cfs flow value was generated for each 25-meter segment of the main stem of the Walla Walla River. This way, when the spreadsheet's data was imported into GIS, the flow for each segment of the river could be represented in varying symbols according to that segment's interpolated flow value.

Stream	SiteID	Site Type	Begin_Meters	End_Meters	Begin_Km	End_Km	Jan0108	Jan0208	Jan0308	Jan0408
Walla Walla River			81425	81450	81.425	81.45	133	16	16	23
Walla Walla River	Day Road WWBWC	R	81450	81475	81.45	81.475	133.00	16.00	16.00	23.00
Walla Walla River	Day Road USFWS	R	81475	81500	81.475	81.5	133.00	16.00	16.00	23.00
Walla Walla River			81500	81525	81.5	81.525	133	16	16	23
Walla Walla River			81525	81550	81.525	81.55	133	16	16	23
Walla Walla River			81550	81575	81.55	81.575	133	16	16	23
Walla Walla River			81575	81600	81.575	81.6	133	16	16	23

Figure 8 Linear Route Attribute Table

The model is designed to allow for the continued addition of known flow data. As diversion, tributary, and mainstem flows from new locations become available, the model can be easily improved by adding that data to the row of the spreadsheet for its corresponding 25-meter segment of river.

Temperature Data Model

After the Walla Walla River was digitized and divided into 25-meter segments three digital spreadsheets (Daily average temperature, daily minimum temperature, and daily maximum temperature) were created with each row representing one of those segments. Columns in the spreadsheets were labeled with the dates for the study period. Daily average, daily minimum and daily maximum temperature from 30 sites (including WWBWC, OWRD, and WDOE sites) on the Walla Walla River were compiled and put into the spreadsheet at the appropriate 25-meter segment.

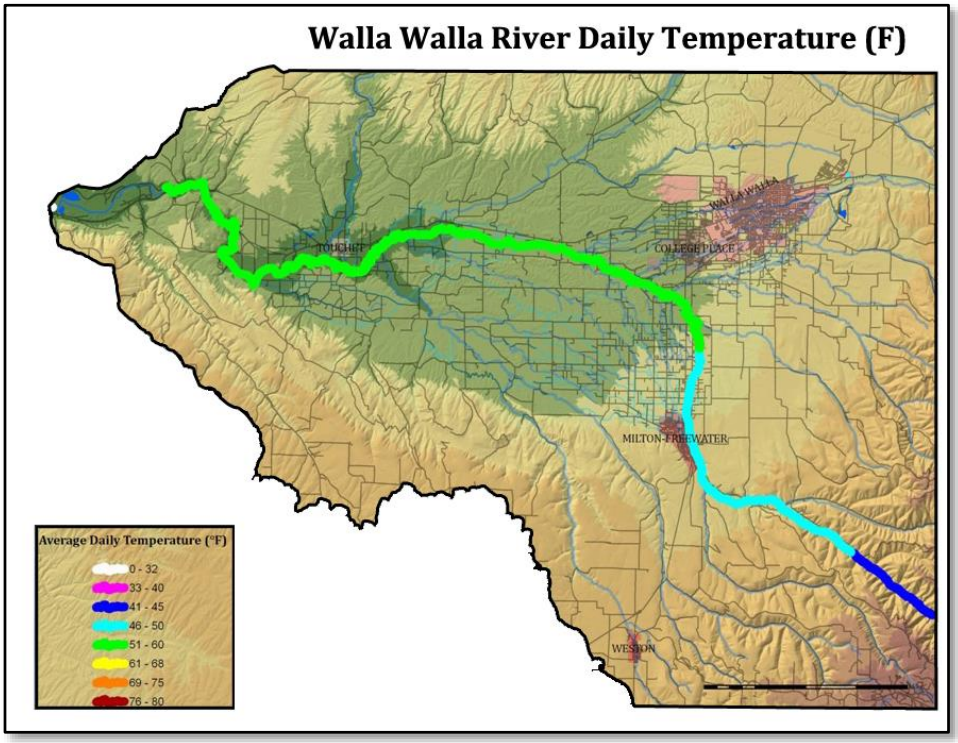


Figure 9 2013 Walla Walla River May 22, Daily Temperature (F)

Once all of the compiled temperature data was entered into the spreadsheets, temperature for each 25-meter segment of the river was interpolated linearly between the nearest upstream measured temperature and the nearest downstream measured temperature. Temperature changes resulting from diversions and tributaries were ignored due to a lack of temperature data for the diversions and tributaries. In this way a temperature value was generated for each 25-meter segment of the main stem of the Walla Walla River. This way,

when the spreadsheet's data was imported into GIS, the temperature for each segment of the river could be represented in varying symbols according to that segment's interpolated temperature value. As temperature monitoring locations increase or decrease over time the collected data can easily be incorporated into the datasets.

2.4 Groundwater in GIS

Methods for collecting data

The WWBWC maintains a bi-state monitoring well network in the Walla Walla Valley (Figure 10). Well monitoring consists of measuring the static water level (SWL), or the depth to water, water temperature and specific conductivity. The well monitoring network is comprised of two types of monitoring wells: continuous monitoring wells, instrumented with pressure transducers that measure static water level once per hour, and non-continuous wells which are measured manually every three months. Temperature and conductivity measurements are taken quarterly at both types of monitoring wells. The collected hourly data from the continuous data loggers was used to create a daily average for each individual continuous monitoring well.[9] The daily average data tables are processed looking for any data inconsistencies or errors. The final data tables (AllWells data table[10]) after the quality check are then used for the creation of the water table grids.

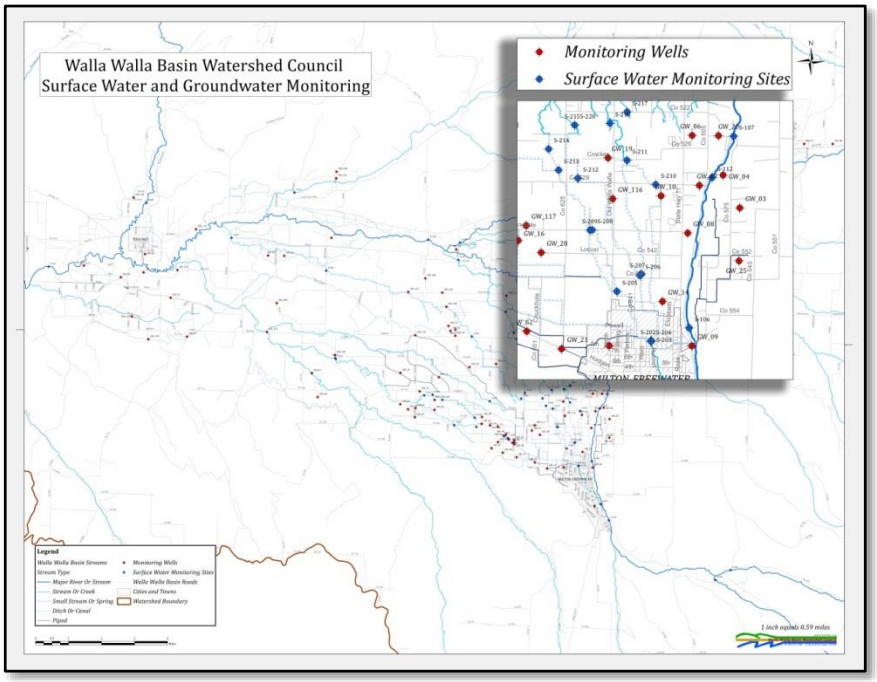


Figure 10 WWBWC Surface Water and Groundwater Monitoring

[9] "Shallow Aquifer Monitoring in the Walla Walla Basin", 2014-2015, wwbwc.org.

[10] Monitoring well network data tables are incorporated into the Walla Walla Basin geodatabase.

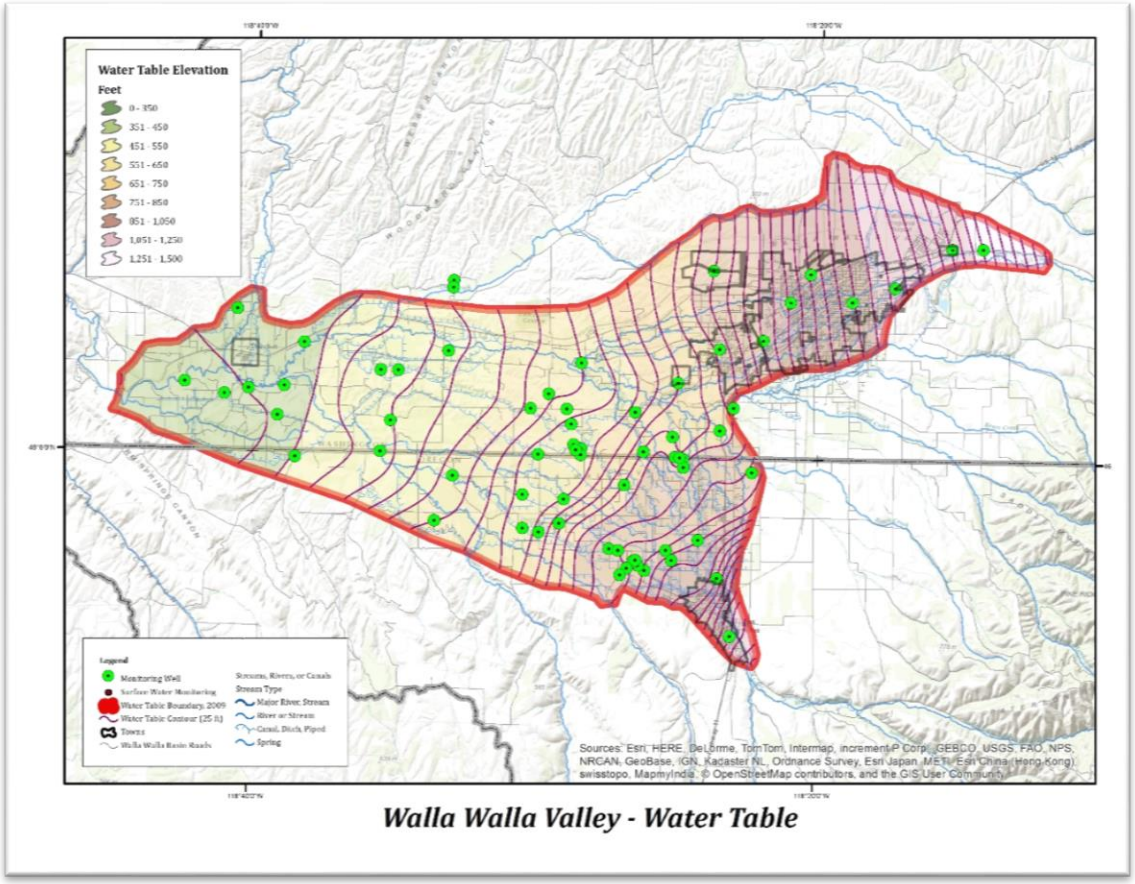


Figure 11 Water Table

Building Water Table Grids

The general procedure to build water tables was to summarize the Water Elevation (feet) field from the AllWells data table for each month, and create an output with the Min, Max, Mean, and Range. This provides information that can be used to create water tables from the average elevation in feet, and also document the range during the month. A model tool (Well Data All) was created for this procedure that started with querying on the dates, to creating the water table using Spline in ArcView Spatial Analyst. (See model and specifics on steps in Figure 12). The tool was incorporated into the WWBasin toolbox[11] in the geodatabase.

[11] Set of tools specific to a given project or database in ArcView

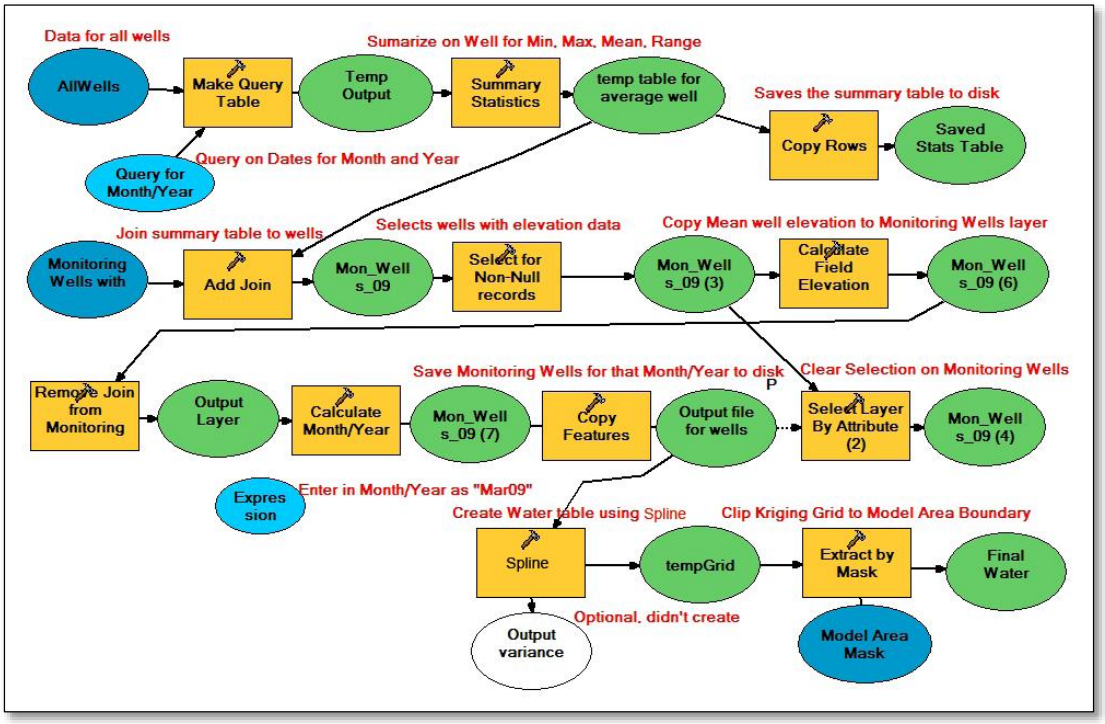


Figure 12 Water Table Grid Tool

Water table grids produced by the ArcView water table model are an approximation of the water table for set interval parameter of the model.

2.5 Fisheries

In the Walla Walla Basin there are numerous monitoring and evaluation sites operated by the WDFW, USFWS, CTUIR, and other state and local agencies. The WWBWC collected fisheries data from the agencies with the initial focus being fisheries data with a geographic and temporal associated attributes. Our goal was to compile geographic and temporal fisheries data[12] to be added to the flow and temperature data models. The initial flow and temperature data models were built for the Walla Walla River and such the focus on the fisheries data was also on, but not limited to, the Walla Walla River. Species Distribution covers the entire Walla Walla Basin. Focus was on the three main species of interest in the basin: Bull Trout, Summer Steelhead, and the Spring Chinook. All of the fisheries

[12] Data collected for the period between 2007 and 2009.

geographic and temporal data was integrated into the geographic database.[13] In the past 10 years, a considerable effort and resources have been and put towards flow restoration in the Walla Walla Basin. The geodatabase provides a tool to begin to examine the added benefits that increased flow and increased water quality and the benefits to fish.

Distribution Maps

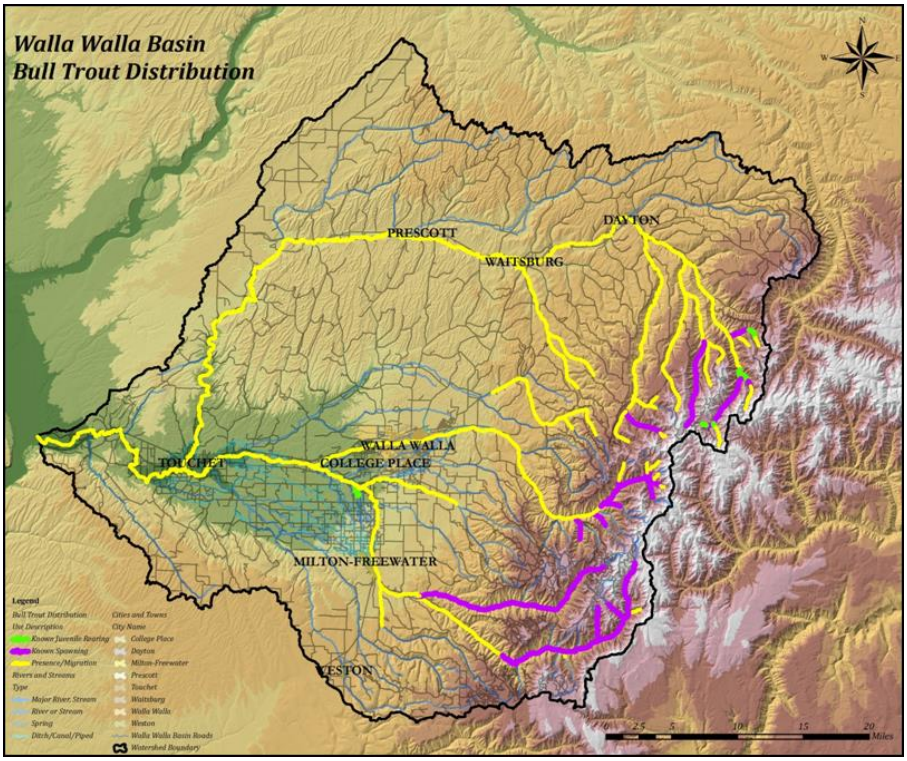


Figure 13 Bull Trout Distribution

[13] WWBASIN geodatabase, WWBWC, 2014

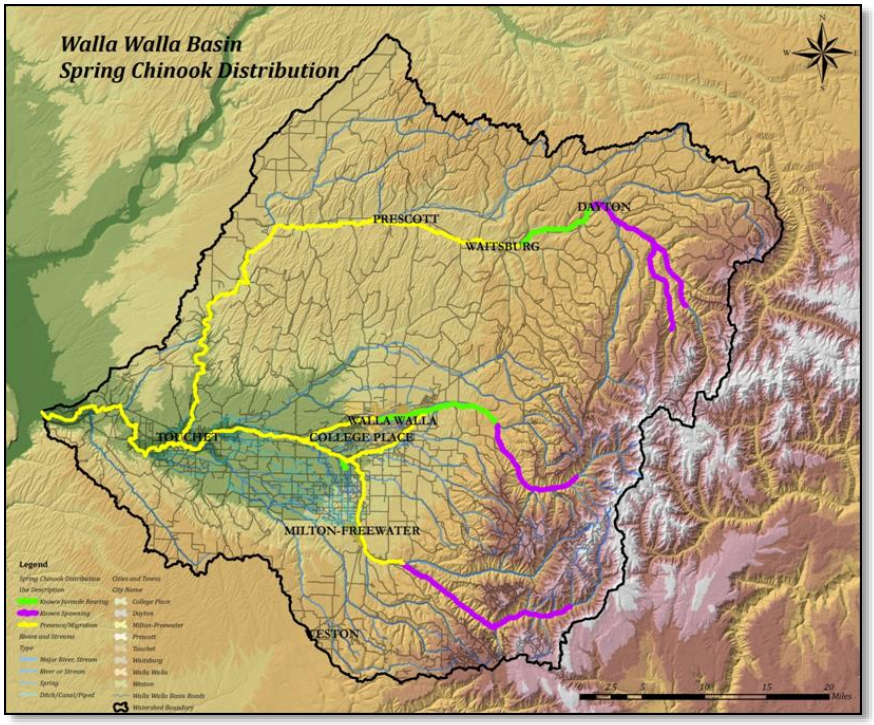


Figure 14 Spring Chinook Distribution

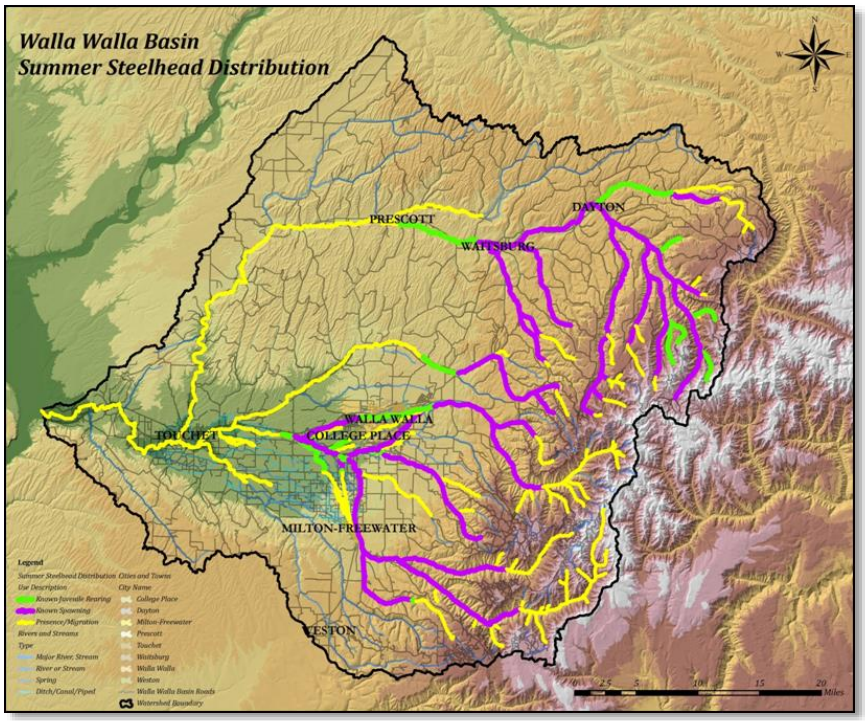


Figure 15 Summer Steelhead Distribution

2.6 Seasonal Movement and Stream Conditions

In 2014 flow gauges were installed at two PIT tag array sites in the lower Walla Walla River. Each site collects water temperature, Discharge (cfs), and air temperature along with interrogation information regarding salmonid upstream and downstream migration. The information gathered at each site in the future will help fisheries managers on the Walla Walla River to fish movements and the conditions in which they're moving. Future analysis on the collected data will help provide an understanding locally of needed conditions for fish migration within the system.

Fish movement can be plotted against flow and temperature conditions in GIS using the data models along with the radio telemetry and PIT tag data that is incorporated in the geodatabase. There are limitations to knowing exactly where fish are in between detection site, but the conditions per reach can be identified. As more data is being collected through various projects in the basin the temperature and flow data models will continue to be refined. Figure 16 shows the flow conditions of the Walla Walla River as a hatchery spring Chinook salmon (150,110,184) migrates up the river.

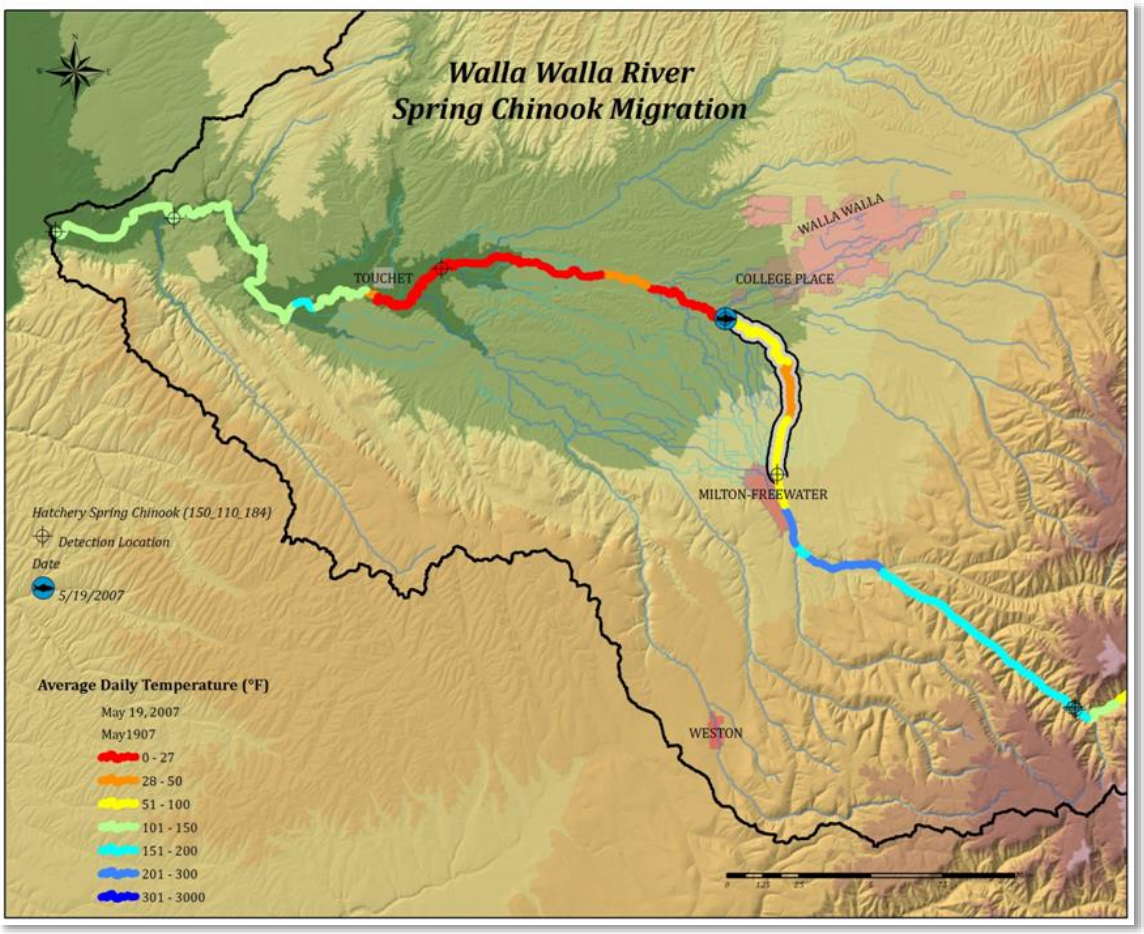
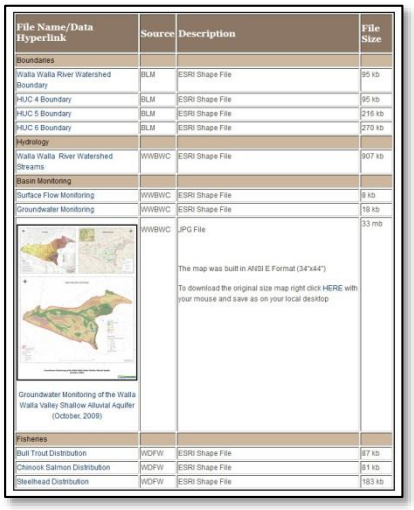


Figure 16 Spring Chinook Migration

3 Results

Basin wide spatial data was collected, created, and incorporated into a single geodatabase. One of the created features is a hydrography layer that was digitized to the 2006 NAIP and was updated to the 2013 NAIP satellite imagery. The created feature locates streams, ditches, and piped sections throughout the basin and is linked to the GIS data models. The GIS data models were created for flow and temperature for the Walla Walla River. A product of this project is a flow and temperature animation for the Walla Walla River. As future datasets are collected from the recent additions to the monitoring network, additional datasets will be used to analyze and create flow and temperature animations.



File Name/Data Hyperlink	Source	Description	File Size
Boundaries			
Walla Walla River Watershed Boundary	BLM	ESRI Shape File	95 kb
HUC 4 Boundary	BLM	ESRI Shape File	95 kb
HUC 5 Boundary	BLM	ESRI Shape File	216 kb
HUC 6 Boundary	BLM	ESRI Shape File	270 kb
Hydrology			
Walla Walla River Watershed Streams	WWBWC	ESRI Shape File	907 kb
Basin Monitoring			
Surface Flow Monitoring	WWBWC	ESRI Shape File	9 kb
Groundwater Monitoring	WWBWC	ESRI Shape File	19 kb
Groundwater Monitoring of the Walla Walla Valley Shallow Alluvial Aquifer (October, 2009)	WWBWC	JPG File The map was built in ANSI E Format (34"x44") To download the original size map right click HERE with your mouse and save as on your local desktop	33 mb
Fisheries			
Bull Trout Distribution	WDFW	ESRI Shape File	87 kb
Chinook Salmon Distribution	WDFW	ESRI Shape File	81 kb
Steelhead Distribution	WDFW	ESRI Shape File	183 kb

Figure 17 GIS Download Section (WWBWC.org)

3.1 Data Availability

The Walla Walla Geodatabase is currently available online for distribution to agency partners. The database provides a base of information for the Walla Walla Watershed and is continually being updated when additional data becomes available. The WWBWC website not only contains downloadable GIS data sets, maps, and videos which are products of the geodatabase, but it also contains robust groundwater and surface water datasets.

The Walla Walla Basin Watershed Council currently monitors over 100 wells in the Walla Walla Valley. On the WWBWC website in the Groundwater Monitoring section a Google map shows the locations of each well. If you click on the map marker, a balloon will appear that shows a hydrograph for that well. Below the hydrograph are links where you can download the hydrograph, the data table for that well (in a .csv format), and a year to year hydrograph comparing each year of data (Jan-Dec) to other years. You can also download a .kml file at the bottom of the page to use on your local computer using Google Earth. Meta data for the dataset is also available for download from the site.

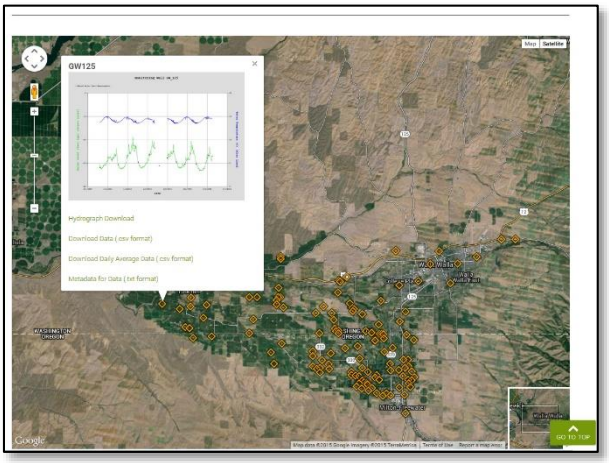


Figure 18 Groundwater Monitoring Network, 2015 (wwbwc.org)

As with the Groundwater Monitoring Network the Walla Walla Basin Watershed Council is actively monitoring the surface water in the springs, streams and rivers in the Walla Walla Basin. The monitoring network's purpose is to provide the community with supplemental water flow data, which can aid management of the valley's water resources. Since 2002, the network has gradually expanded into Washington and evolved to include 50 sites in the Walla Walla Valley, including springs, small order streams, and irrigation ditch sites. On the WWBWC website in the Surface Water Monitoring section a Google map shows the locations of each surface water monitoring location. The map markers when clicked display the current hydrograph for each monitored location. The data associated with the surface and groundwater monitoring networks is updated on a quarterly basis.

In addition to all of the surface and groundwater monitoring locations that are updated on a quarterly basis the WWBWC also provides surface flow real-time data for numerous sites on the Walla Walla River. In 2014 a real-time dedicated monitoring well was added to the information available on the WWBWC.org website.

4 Discussion and Summary

4.1 Management Tool

The GIS geodatabase program is expanding every year and has become a vital tool in the management of the Walla Walla Valley shallow alluvial aquifer. The surface water and groundwater monitoring programs are now integrated into the database. The data once

tied to geographic locations within the basin in GIS is now providing managers valley wide water tables (Figure 11), groundwater conductivity visualizations, seepage assessment gains and losses (Figure 19), and cross sectional shallow aquifer maps (Figure 2).

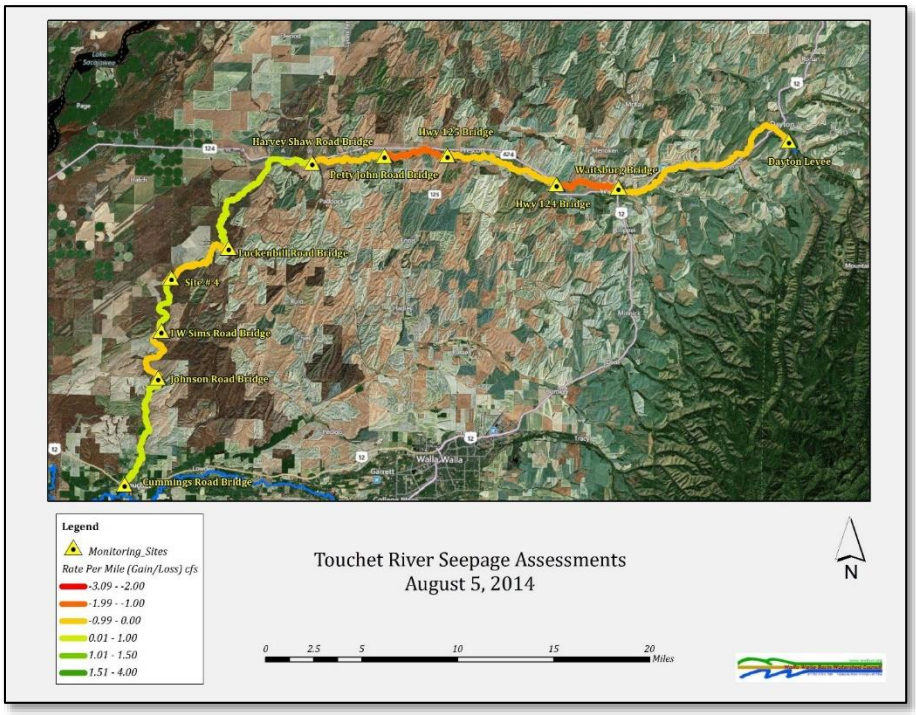


Figure 19 Touchet River Seepage Assessment (August 5th, 2014)

4.2 Modeling

With the completion and subsequent expansion of the IWFM Surface and Groundwater Model the IWFM geodatabase will play a key role in the conceptual and statistical modeling of the Walla Walla Valley. Identifying potential shallow alluvial aquifer artificial recharge sites through the modeling process will lead to localized investigations in GIS for each site. Cross sections through the valley stratigraphy, topographic mapping using survey quality

GPS for accurate elevations and levels, and visualizations of each project for public education and planning will be key roles in site development.

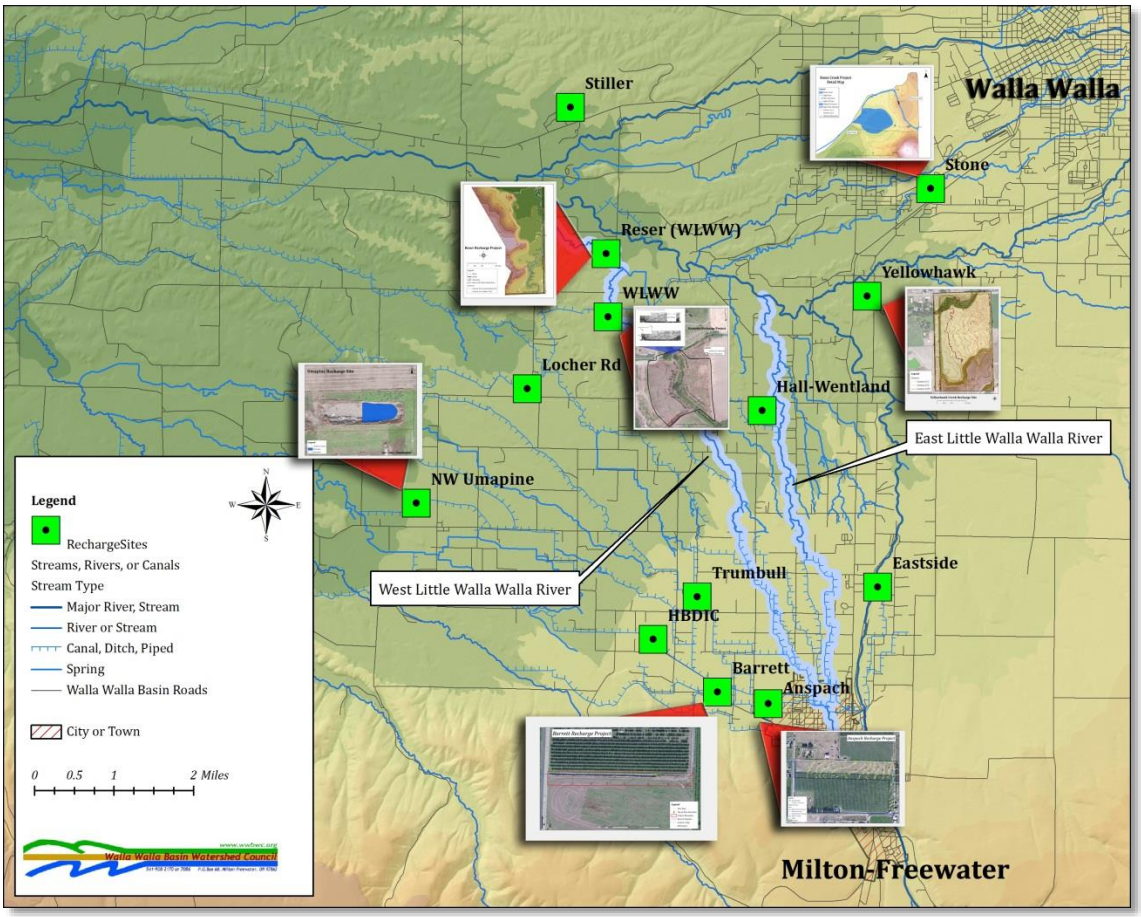


Figure 20 Existing shallow alluvial aquifer recharge sites.

4.3 Moving Forward

In the winter of 2013/2014 the WWBWC completed integrating the surface water monitoring, groundwater monitoring, and evapotranspiration monitoring stations that are fitted with telemetry equipment into the AQUARIUS software created by Aquatic Informatics™. AQUARIUS has enable the WWBWC to better manage the vast amounts of hydrologic time series data, discrete water quality data and river gauging measurements from within the Walla Walla Watershed. The WWBWC now has the ability to leverage a robust notification system for each telemetry site and expand on the current website based publication of data. The WWBWC will continue to expand its' capabilities to produce high quality data and insure the data is available to local, federal, and state agencies along with the general public.

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Appendix

WWBASIN Geodatabase Feature Classes and Features

IWFM Geodatabase Feature Classes and Features

The geodatabases of information can be downloaded on the WWBWC website here:
http://wwbwc.org/images/GIS/2015_GIS_VIS_REPORT_GDBS.zip

Appendix I

Walla Walla Basin Geodatabase

WATERSHED GEOLOGY

MPbc_Bound: Mio Pliocene Basal Coarse Unit

Mpbc_surface_ci50: Mio Pliocene Basal Coarse Unit surface contours at 50' intervals

Mpbc_thick_ci50: Mio Pliocene Basal Coarse Unit thickness contours at 50' intervals

Mpc_Bound: Mio Pliocene Coarse Unit Boundary

Mpc_surface_ci50: Mio Pliocene Coarse Unit surface contours at 50' intervals

Mpc_thick_ci50: Mio Pliocene Coarse Unit thickness contours at 50' intervals

Mpf_Bound: Mio Pliocene Fine Unit Boundary

Mpf_surface_ci50: Mio Pliocene Fine Unit surface contours at 50' intervals

Mpf_thick_ci50: Mio Pliocene Fine Unit thickness contours at 50' intervals

Qc_Bound_1: Quaternary Coarse Unit Boundary 1

Qc_Bound_2: Quaternary Coarse Unit Boundary 2

Qc_surface_ci50: Quaternary Coarse Unit surface contours at 50' intervals

Qc_thick_ci50: Quaternary Coarse Unit thickness contours at 50' intervals

Qf_Bound_1: Quaternary Fine Unit Boundary 1

Qf_Bound_2: Quaternary Fine Unit Boundary 2

Qf_suface_ci50: Quaternary Fine Unit surface contours at 50' intervals

Qf_thick_ci50: Quaternary Fine Unit thickness contours at 50' intervals

TOB_Boundary: Top of Basalt Boundary

Tob_surface_ci50: Top of Basalt surface contours at 50' intervals

GRIDS

Shallow Aquifer GRIDS

G_mpbc_surface: Mio Pliocene Basal Coarse Unit, Surface

G_mpbc_thick : Mio Pliocene Basal Coarse Unit, Thickness

G_mpc_surface: Mio Pliocene Coarse Unit, Surface

G_mpc_thick : Mio Pliocene Coarse Unit, Thickness

G_mpf_surface: Mio Pliocene Fine Unit, Surface

G_mpf_thick: Mio Pliocene Fine Unit, Thickness

G_qc_surface: Quaternary Coarse Unit, Surface

G_qc_thick: Quaternary Coarse Unit, Thickness

G_qf_surface: Quaternary Fine Unit, Surface

G_qf_thick: Quaternary Fine Unit, Thickness

G_tob_surface: Top of Basalt, Suface

WATERSHED SURF MONITORING

SURF_MON_NETWORK: Walla Walla Basin Continuous Gauge Sites (All Agencies)

SURF_CONDUCTIVITY09: Surface Conductivity Monitoring Locations 2009

WDOE_WATERQUAL_SURFMON: Washington Department of Ecology Water Quality Surface Monitoring Site

WWBWC_TEMP: Walla Walla Basin Temperature Monitoring Sites

WATERSHED_W

ADMINISTRATIVE_STREAM_CLOSURES: Administrative Stream Closures Walla Walla County

CROP_TYPE_09_MODEL: Crop types for the 2009 IWFM model.

ETO_STATION_WWBWC: Evapotranspiration Station Locations WWBWC

IMPLEMENTATION_AREAS: Implementation Areas Walla Walla County

NEW_MANAGEMENT_AREAS: New Management Areas Walla Walla County

PRIORITY_RESTORATION_AREAS: Priority Restoration Areas Walla Walla County

RECOMMENDED_SURFACE_WATER_REGULATIONS: Recommended Surface Water Regulations Walla Walla County

WA_STATE_BASEFLOW: Washington State Base Flow Dataset

WATER_QUALITY_AND_HABITAT_IMPROVEMENTS: Water Quality and Habitat Improvement Locations Walla Walla County

WATERBODY_TEMP_RANGES: Water body Temperature Ranges Walla Walla County

WQ_TEMP: Water Quality Temperature Monitoring Locations Multi Agencies

WRIA_PRECIPITATION: Water Resource Inventory Area 32 Precipitation

WSU_PAWS_WEATHER_STATION: Washington State PAWS Weather Station Locations in the Walla Walla Basin

Transportation

UMA_CO_ROADS: Umatilla County Roads

WWB_ROADS: Walla Walla Basin Roads

WWCO_ROADS: Walla Walla County Roads

Groundwater Monitoring

WDOE_OBSWELLS: Washington Department of Ecology Dedicated Monitoring Wells in Basin

WDOE_WELLLOG: Washington Department of Ecology Well Log information for the Walla Walla Basin

WWBASIN_USGS_WELLS: Walla Walla Basin United States Geological Survey Wells

WWBASON_SEDIMENT_DATA: Walla Walla Basin Sediment Data Wells

WWBWC_MON_WELLS: Walla Walla Basin Watershed Council Monitoring Well Network

Stream Layers

CITY_WW_CULVERTS: City of Walla Walla Culverts

LAKES: Walla Walla Valley Lakes or Ponds

LITTLE_WWRIVER_SPRINGS: Little Walla Walla River Springs

STREAM_NET_BASIN_STREAMS: StreamNet Base Routed Hydrology Layer for the Walla Walla Basin 1:100K Scale

WALLAWALLA_STREAMORDERS: Base Walla Walla Stream Order 1:100k Scale

WRIA32_RIVERS: Water Resource Inventory Area 32 Rivers

WRIA32_STREAMS: Water Resource Inventory Area 32 Streams

WWBASIN_STREAM_ROUTES: Walla Walla Basin Routed Streams

NAIP06_STREAMS: Walla Walla Basin Streams Digitized to the National Agriculture Imagery Program Satellite Image

Fisheries

CTUIR_Telemetry: Telemetry Data from the Confederated Tribes of the Umatilla Indian Reservation

BullTrout_Dist: Bull Trout Distribution

CHS_Dist: Spring Chinook Distribution

STS_Dist: Summer Steelhead Distribution

CTUIR_REDD_SUR: Redd Survey data from the Confederated Tribes of the Umatilla Indian Reservation

FISH_PASS_BARRIER_WDFW: Stream Barriers in the Walla Walla Basin

WDFW_Density: Washington Department of Fish and Wildlife Density Survey Data

WDFW_Spawn: Washington Department of Fish and Wildlife Spawning Survey Data

USFWS_PITAG_SITES: USFW Pit Tag interrogation sites.

MillCK_EVAL_SITES_CTUIR: CTUIR evaluation sites located on Mill Creek.

TELEMETRY_CTUIR: Fish telemetry information.

Appendix II

IWFM Geodatabase Feature Datasets and Features

Boundary
Model_Boundary: Polygon feature of the IWFM model boundary area.

BYPASSES
BYPASSES_ALL: Point feature of all surface water bypasses used in the model area

CALIBRATION
GROUNDWATER: Point feature of the groundwater monitoring wells used in the calibration of the model.

ELEMENTS
ELEMENTS: Polygon feature of all of the elements in the model area.

MODEL_STREAMS
STREAMS: Polyline feature of the stream segments that represent the Walla Walla Valley stream network.

NODES
NODES: Point feature of all the nodes within the model area.

NODES_BOUNDARY: Point feature of the nodes which represent the boundary of the model area.

NODES_Stream: Point feature of nodes that represent the stream, spring, and river locations in the model area.

SUBREGIONS

SUBREGIONS: Polygon feature that represents the seven regions in the modeling area.