Spokane County Water Demand Forecast Model

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Executive Summary

This report describes the development and use of the Spokane County Water Demand Forecast Model (demand model). The demand model was developed throughout 2010 by Spokane County Water Resources, technical consultants Tetra Tech and CDM, and an advisory committee comprised of area utility providers, local and state government, academics, and citizens. Funding for the project was provided by the Washington Department of Ecology.

The demand model forecasts total water demand for the period 2008 to 2040 for Spokane County. The demand model is based on water billing and production data, characteristics of self supplied water users, demographic and socioeconomic data, agricultural and industrial data, and weather data. It is organized into the following water use sectors:

- Public-Supply
- Self-Supply Residential
- Self-Supply Industrial
- Agriculture

Each sector is represented by one or more sub models that relate water use to population growth, economic growth, demographic and socioeconomic factors and weather. The sub models vary in complexity from unit use to econometric.

The demand model is a spreadsheet forecasting model that runs in Microsoft Excel 2007. The spreadsheet model provides the framework for calculation of water demand from each sub model based on demographic, water use, agricultural, industrial and climactic data. The demand model is also separated into smaller sub areas of the county and evaluates water demand by month. The model was calibrated and verified with public water supply data and is within 2-5% of actual use based on reported values.

The main source of demographic data used in the demand model was the *Spokane Regional Transportation Council 2030 Growth Forecasts for Employment, Housing, and Transportation* (Intermountain Demographics, 2006). The demand model can be modified to accept various input variables, so as new forecasts are developed they can be incorporated.

The demand model is a tool intended for local water purveyors, planning agencies, and other organizations with an interest in forecasting long term water use in Spokane County. The demand model is designed to accept various inputs (population, housing, employment, weather, etc.) in order to provide users various "what if" options for selected growth scenarios.

The demand model can be used to analyze a wide variety of scenarios. This report provides results for the following analyses:

- Current and projected total water demand by sector for the entire county.
- Current and projected total and monthly water demand for areas served by water from the Spokane Valley Rathdrum Prairie (SVRP) aquifer.
- Current and projected total water demand by sector for each Water Resource Inventory Area within Spokane County.
- Increase in self supplied water use from 2010 to 2040 for each rural sub basin.
- Impact of weather and conservation on current and projected demand.

Significant conclusions that can be drawn for the results of the analyses described above are:

- Total water demand for Spokane County is forecasted to increase 31% by 2040. The public supply sector and self supplied residential sectors are projected to increase by 41% and 47% respectively. During the same time frame population is projected to increase by 55% (based on the Washington State Office of Financial Management medium population projection for Spokane County)

- Demand from the SVRP aquifer from Spokane County (not including Idaho) is forecasted to increase 31% by 2040. The increase is approximately 156 CFS, which is significant given that the most recent USGS study indicates a close relationship between increases in withdrawal and decreases in river flow.

- Evaluation of areas not served by the SVRP aquifer show the Little Spokane watershed has the largest total demand ranging from 7.27 billion gallons annually in 2010 to 9.12 billion gallons annually in 2040. The Hangman watershed has the highest growth rate, a projected increase of 34% between 2010 and 2040.

- Increased demand in the rural areas of the county has the potential to significantly impact summer low flows of nearby streams and creeks. Examples include:
  - Summer withdrawal in the California – Lower Rock Creek subbasin, located in the Latah Creek watershed, is forecasted to increase between 57% and 255% of summer stream flow.
  - Summer withdrawal in the Deep Creek subbasin, located in the Lower Spokane watershed, is forecasted to increase approximately 120% of summer stream flow.
  - Summer withdrawal in the Marshall Creek subbasin, located in the Latah Creek watershed, is forecasted to increase approximately 90% of summer stream flow

  It is important to note, though, the specific hydrogeology that would allow evaluation of impacts of withdrawals on these streams is not fully understood. Therefore an increased withdrawal represents the potential impact to these streams.

- Weather can significantly impact outdoor water use. Water demand forecasted with 2006 weather inputs was 10% greater than demand calculated with 2005 weather inputs.

Month	2005		2006	
	Temp	Precip.	Temp	Precip.
July	83.68	1.1	87.71	0.1
August	83.94	0.46	83.06	0.25
September	69.27	0.84	74.53	0.32

Introduction

The purpose of this report is to describe the Spokane County Water Demand Forecast Model including the methodology and data used for development, components and structure of the model, and future water demand projections for Spokane County.

Assessment of future water demand is integral to effective water resource management. Recognizing the importance, the State of Washington requires public water systems to prepare demand forecasts for their water service area in each system's comprehensive water system plan. Also, in 1998 the Washington State Legislature passed the Watershed Planning Act which provides funding for local communities to develop watershed plans, including a forecast of future water demands. Spokane County has over 65 public water systems that develop water demand forecasts for their systems, and 5 different watersheds for which watershed plans, including a water demand forecast, were developed. These forecasts have a large range of methodology, geographic areas, and time horizons, and, as a result cannot be effectively combined to create a demand forecast for the county as a whole.

Is a county wide forecast needed or do the many forecasts already developed provide the information necessary for effective water management? Each of the existing forecasts addresses a specific utility service area or a specific watershed. The main water source for Spokane County, though, is the Spokane Valley Rathdrum Prairie (SVRP) aquifer which provides water for a majority of water systems and is within the boundaries of 3 of 5 watersheds. To effectively manage this resource and others within the county a comprehensive evaluation of demand is necessary.

Background

This project was conducted as part of Watershed Planning in Water Resource Inventory Areas (WRIAs) 54, 55, 56, and 57. Funding was provided by the Washington Department of Ecology (Ecology) through the Watershed Planning Program. The project was completed in two phases. The first phase included development of a local stakeholder advisory committee, data collection and analysis, and development of a preliminary demand forecast model. Phase II included supplemental data collection, model refinement, model calibration and verification, and analysis of model results.

Phase I was initiated in January 2010. Spokane County was the project manager and the consultant team of Tetra Tech and CDM provided advisory committee meeting facilitation, conducted data collection and analysis, and developed the preliminary water demand model and forecast. The following tasks were included in Phase I.

Spokane County Water Demand Forecast Project Phase I Project scope	
Task 1:	*Develop Goals and Objectives* – Goals and objectives for the water demand forecast model was developed through an advisory committee.
Task 2:	*Data Collection and Assessment* – Available data sources were identified; data was collected and evaluated for use in the model.
Task 3:	*Data Analysis and Preliminary Model Development* – A preliminary water demand forecast model was developed based on project objectives and available data.
Task 4:	*Presentation of Preliminary Model and Findings* - Delivery and training on using preliminary water demand forecast model was provided.
Task 5:	*Advisory Committee Participation* – Monthly advisory committee meetings were conducted to provide regular updates and opportunities for stakeholder participation.

Tetra Tech and CDM completed a technical memorandum that summarizes the work completed in Phase I and it is included as Appendix A.

Phase II was initiated in July 2010. Spokane County completed all aspects of this task including supplemental data collection, model refinement, model calibration and verification, and analysis of model results. This report presents the findings of both project phases.

Project Description

A project advisory committee was developed at the beginning of Phase I and was an important component to the project. The committee was comprised of area utility providers, local and state government, academics, and citizens. The committee developed goals and objectives for the project, provided insight on water use data, and provided technical review during model development. A summary of each meeting is provided in Appendix B.

The goals and objectives developed by the advisory committee were:

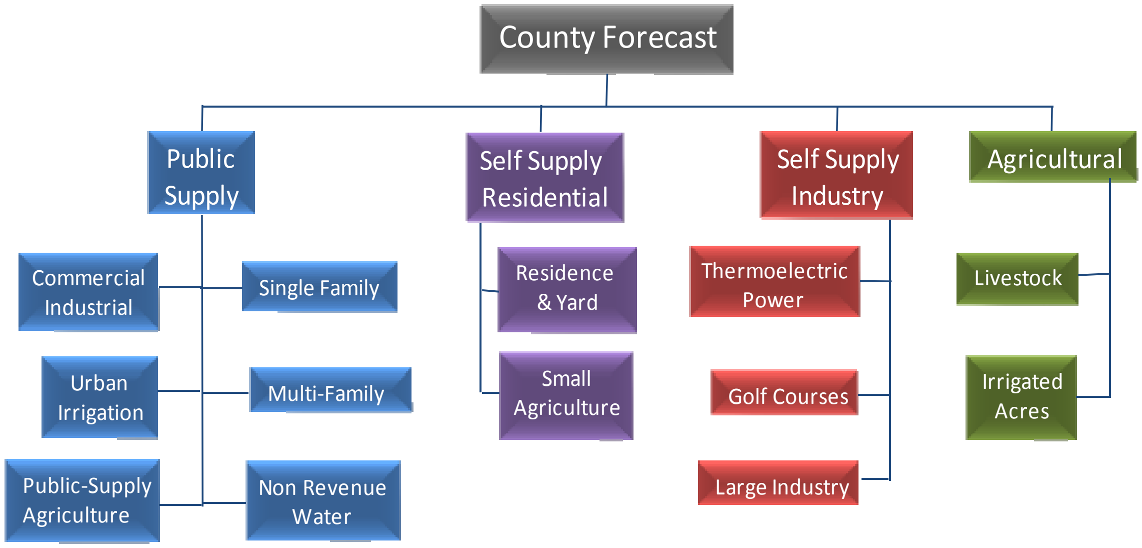
- **Goal 1** — Develop a comprehensive inventory of water demands throughout Spokane County.
  - *Objective 1.1: Inventory addresses similar time horizon.*
  - *Objective 1.2: Inventory uses consistent methodology throughout the County.*
  - *Objective 1.3: Inventory uses uniform data throughout the County.*
- **Goal 2** —Develop the capability to forecast future water demand for consumptive uses in Spokane County.
  - *Objective 2.1: Stakeholders have a high degree of confidence in the data and methodologies.*
  - *Objective 2.2: The model can forecast water demand for municipal/domestic (purveyor-provided and self-supplied), commercial, industrial, and agricultural needs.*
  - *Objective 2.3: Model is based on actual data for Spokane County whenever possible. If data input is used from outside the region, it should be qualified to indicate this.*
  - *Objective 2.4: The model can generate forecasts for specific geographic sub-regions within the County.*
  - *Objective 2.5: The model has the capability to incorporate climate variation, reclaimed water use, seasonal water use variations, and conservation scenarios.*
- **Goal 3** — Create information on water use and factors that influence water use that will benefit local water purveyors.
  - *Objective 3.1: Purveyors have the opportunity to provide specific data so that the unique attributes of their individual systems can be identified.*
  - *Objective 3.2: Purveyors, as well as other stakeholders, have access to the data and underlying assumptions associated with the water demand forecast model.*
- **Goal 4** —Develop a forecasting tool that is available to the local community and can be used to generate user-defined forecast scenarios.
  - *Objective 4.1: Stakeholders have opportunity to participate in model development through an advisory forum.*
  - *Objective 4.2: Demonstration and training will be conducted for the demand forecast model.*
  - *Objective 4.3: Purveyors, as well as other stakeholders have access to the completed model.*
  - *Objective 4.4: Model documentation will enable use by an individual skilled in working with Microsoft Excel spreadsheets.*
  - *Objective 4.5: Output of this model can be used for inputs to the Ground-Water Flow Model for the Spokane Valley-Rathdrum Prairie Aquifer, Spokane County, Washington, and Bonner and Kootenai Counties, Idaho, also known as "the SVRP Aquifer model" (USGS, 2007)*

Model Structure

The Spokane County Water Demand Forecast Model (demand model) disaggregates, or separates, water demand in three primary ways: by water use sector, by geographic location (spatially), and in time (temporally). Disaggregation provides flexibility in analysis. There is interest in water demand for the county as a whole, but there is also interest in water demand for particular areas of the county that may have limited water supplies. A model that is spatially disaggregated allows for analysis of both scenarios.

The demand model has four primary water use sectors: 1. public supply, 2. self supply residential, 3. self supply industry, and 4. agricultural. The primary water use sectors are further broken down into sub sectors, as shown in Figure 1. Each subsector is represented individually

Figure 1: Spokane County Water Demand Forecast – Water Use Sectors



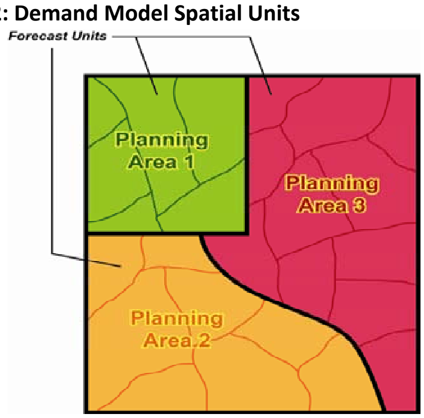
Note: a loss and leakage percentage is also accounted for in the self supply residential, self-supply industrial and agricultural sectors

within the demand model. For example it is possible to evaluate water use from the multi-family sector separate from the county forecast.

The temporal aspect of the model has two facets: (1) it forecasts future water demand in five year increments, and (2) it forecasts demand on a monthly basis. The base year of the model is 2008 and future demand is forecasted for 2010, 2015, 2020, 2025, 2030, 2035, and 2040. This time frame was based on availability of demographic forecasts and input from the advisory committee.

Demand is also forecasted on a monthly basis for each of the forecast years. This is particularly important in Spokane County due to its climate. Spokane County has four distinct seasons including a cold winter and a hot dry summer. The demand for water during the months of July and August are significantly more than other months. Understanding seasonal water demand dynamics is an important attribute of the demand model.

Figure 2: Demand Model Spatial Units



The third aspect of the model is geographic. The demand model is separated into separate spatial units for which demand for each water use sector is forecast. The basic unit is a forecast unit. Forecast units are grouped into planning areas, as shown in Figure 2. The forecast units are also distinguished as urban or rural. Forecast units and planning areas are designated urban if the area is projected to have public water service at some time in the future. Rural forecast units and planning areas are the remaining area. Forecast unit and planning area boundaries are based on data availability and identified analysis needs. A full discussion of the determination of the boundaries is included in the next section.

The demand model structure allows for a wide range of analytical possibilities, ranging from a county wide forecast of all sectors for the year 2040 to more narrowly defined analysis. For example a narrowly defined analysis might include a forecast for July of 2040 for single family residential in a group of forecast units in north Spokane County. Further, the structure allows for an enhanced understanding of what drives water use and what management tools (i.e. conservation measures, new supply development) would be most effective.

Data Collection, Analysis & Use

Data collected and used for this project can be put into three broad categories: (1) water use, (2) water demand drivers, and (3) water demand factors. Water use data is just that, data on how much water is used for a particular purpose for a specified amount of time. Water demand drivers are the major forces that "drive" water demands, such as population, housing, commercial/industrial activity, and irrigation. Water demand factors are variables that are known to influence demand, such as weather, residential lot size, family income, family size, type of commercial/industrial activity, crop type etc.

The basic concept of determining water demand in the demand model is:

Water demand = (rate of use per unit) x (# of units)

Complexity is introduced by adding a number of different types of units, each representing a different water use sector, making the rate of use per unit dependent on water demand factors, and defining the number of units by multiple smaller spatial units.

Water Use Data

Water use data was used to develop the rate of water use per unit for each sector and sub sector. The following are the main categories of water use data that was collected:

- public water system data
- urban irrigation (parks, schools, etc) data
- commercial & industrial water use data
- agricultural water use data
- residential water use patterns
- large industrial uses

Public water system data was collected from 30 systems. The main purpose of this data was to determine a rate of use per unit for a particular sector for a specified time period; for example, 800 gallons per day per residential connection for June 2005, or 200 gallons per day per multi-family unit for May 2003. Table 2 shows the water use data collected from each water system.

Urban irrigation is water used for irrigation of urban and suburban public spaces including parks, schools, and cemeteries. The metric for water use for this subsector within the demand model is gallons per day (GPD) per acre. To determine an appropriate rate of use for Spokane County, average GPD per acre was determined using monthly irrigation use and acreage for a sample of schools, parks, and a cemetery. Data was collected for 2005 through 2009.

Table 1 – Urban Irrigation Estimate

Name	Size (acres)	GPD per acre
Chase Middle School	15.5	5762
Fairmount Cemetery	26.0	5463
Holmberg Park	5.2	7127
Linwood Park	4.9	6801
Dishman Hills Park	2.0	8331
Plantes Ferry Park	63.0	5063
Brentwood Park	2.0	4497
Pine River Park	2.5	5126
Brentwood Elementary School	5.7	5727
Mead High School	26.0	5345
Evergreen Elementary School	8.5	2952
3 park s served by Vera Water	14.0	3480
Average GPD per acre		**5473**

GPD-gallons per day
GPD is an average for June, July, August, and September

The metric for commercial and industrial water use within the demand model is gallons per employee per day (GED). The GED water use estimates were derived from a proprietary set of establishment level water use and employment data compiled by CDM. The data were summarized by SIC code and published in IWR-MAIN 6.0: User's Manual and System Description, Appendix D, Planning and Management Consultants, Ltd. (1994). The data by SIC code was grouped to match the employment data used in the demand model. The following water use rates were used within the demand model:

- Industrial – 155 GED
- Retail – 47 GED
- Medical – 84 GED
- Offices – 61 GED
- Finance, Insurance, and Real Estate – GED
- Education – 105 GED

Table 2 – Public Water System Data

Water System	Reported Years	Frequency	Total		Single Family		Multi Family		Commercial/ Industrial	
			Production	Use[1]	Use	Accounts	Use	Accounts	Use	Accounts
Airway Heights	2001-2007, 2009	monthly			✓	✓	✓	✓	✓	✓
City of Cheney	2006-2008	monthly	✓	✓	✓	✓	✓	✓		
City of Medical Lake	2006	monthly	✓			✓		✓		✓
City of Spokane	2001-2008	bi-monthly			✓	✓	✓	✓	✓	✓
Consolidated Support Services	2008	monthly	✓	✓					✓	✓
East Spokane WD	2003	monthly	✓			✓		✓		✓
Fairchild Air Force Base	1989-2009	monthly	✓	✓						
Four Lakes WD	2006	monthly	✓			✓		✓		✓
Indian Village Estates WA	2001-2009	monthly	✓			✓				
Pasadena Park ID	1999-2008	monthly	✓			✓				
Ridge at Hangman	2006-2008	monthly			✓	✓				
Stevens PUD – Spokane Lake Park	2005-2009	monthly			✓	✓				
Stevens PUD – Riverside	2005-2009	monthly			✓	✓				
Stevens PUD – Halfmoon Ranchos	2005-2009	monthly			✓	✓				
Stevens PUD – Chattaroy Springs	2007-2009	monthly			✓	✓				
Stevens PUD – Denison	2007-2009	monthly			✓	✓				
Stevens PUD – Suncrest[2]	2005-2009	monthly			✓	✓				
Whitworth WD[3]	1990-2009	monthly			✓	✓			✓	✓
Pioneer	2003	monthly			✓	✓				
SCWD#3 – West Spokane Valley	1998-2008	Annually			✓	✓	✓	✓	✓	✓
SCWD#3 – South Spokane Valley	1998-2008	Annually			✓	✓	✓	✓	✓	✓
SCWD#3 – North Spokane	1998-2008	Annually			✓	✓	✓	✓	✓	✓
SCWD#3 – Mead	1998-2008	Annually			✓	✓	✓	✓	✓	✓
SCWD#3 – Pine River Park	1998-2008	Annually			✓	✓			✓	✓
SCWD#3 – Riverview Hills	1998-2008	Annually			✓	✓				
SCWD#3 – Chattaroy Hills	1998-2008	Annually			✓	✓	✓	✓	✓	✓
SCWD#3 – South Spokane	1998-2008	Annually			✓	✓	✓	✓	✓	✓
SCWD#3 – Waterview Terrace	1998-2008	Annually			✓	✓				
Consolidated ID	2007-2009	Semi-Annual			✓	✓				
Strathview	2000 (May-Oct)	monthly			✓	✓				

Note: The definition of what constitutes a single family residence, multifamily residence, or a commercial/industrial account varies between systems. Commercial/Industrial includes multifamily for some systems.
WD – Water District; ID – Irrigation District; WA – Water Association
1 Use indicates billed consumption **2** Suncrest located in Stevens County adjacent to Spokane County **3** Whitworth Water District provided data segregated into 6 zones

One exception to the GED metric was hotels/motels. The data used in the demand model for hotels/motels was by number of rooms, not by employee. An estimate of 36 gallons per day per room was used. This was derived from 60 gallons per day per occupied room and a 60% occupancy rate.

Two metrics are used within the demand model to represent agricultural water use: GPD per acre, and gallons per day per animal (GPAD). Water demand for crops is based on crop irrigation requirements reported in the State of Washington Irrigation Guide (NRCS, 1992). Table 3 shows the crop irrigation requirement in GPD per acre.

Table 3 – Crop Irrigation Requirements in GPDPA

Crop	Apr	May	Jun	Jul	Aug	Sep	Oct
Barley for grain	1285	4257	6146	6946	613	18	61
Corn for grain	1285	4257	6146	6946	613	18	61
Corn for silage or green chop	0	0	1331	5755	7174	4399	79
Forage land used for all hay and haylage, grass silage, and greenchop	0	0	1331	5755	7174	4399	79
Wheat for grain	1285	4257	6146	6946	613	18	61

Water demand for livestock is reported in GPAD. The following watering requirements were used:

- Beef Cows – 12.0 GPAD
- Milk Cows – 40.0 GPAD
- Other Cattle – 12.0 GPAD
- Hogs and Pigs – 4.5 GPAD
- All Poultry – 0.1 GPAD
- Horses – 12.0 GPAD
- Sheeps and Lambs – 2.0 GPAD
- Goats – 2.0 GPAD

Two types of single family residential water use are represented in the demand model; those supplied by a public water system and those supplied by an individual well, or self supplied. Data for publicly supplied single family water use was provided by water systems as described previously, but there is very little data available for self supplied single family residential. To fill this data gap Spokane County conducted a residential water use survey to determine the similarity of self supplied residential water use and publicly supplied residential water use. A full description of the survey and results can be found in: *Spokane County Residential Water Use Survey, June 2010.* The following conclusions were taken from the survey and integrated into the demand model:

- There is not a significant difference in the average amount of irrigated landscape between public supplied and self supplied residences.
- The following variables correlate with the amount of irrigated landscape at self supplied residences:
  - Self supplied residences with well yields below 5 gpm have on average half the average amount of irrigated landscape than those with well yields above 5 gpm. Above 5 gpm the well yield does not impact the amount of irrigated landscape.
  - The setting of self supplied residences does correlate with the amount of irrigated landscape. Residences in forested areas had 25% less irrigated landscape than average.
  - The lot size of a self supplied residence does not correlate with the amount of irrigated landscape.
  - The size of a self supplied residence does correlate with amount of irrigated landscape.
- There are variables that correlate with the amount of irrigated landscape at public supplied residences:
  - Lot size does correlate with the amount of irrigated landscape at public supplied residences.
  - Residence size does correlate with the amount of irrigated landscape at public supplied residences.
  - Homes identified as within a city or city neighborhood have on average less area of irrigated landscape.
- Self supplied and public supplied residences have similar numbers of indoor water use fixtures and appliances.
- Approximately 20% of self supplied residences have at least one livestock.

The last category of water use data that was collected for use in the demand model was large industrial self supplied uses. This data was taken from two sources: 1. *Ground-Water Flow Model for the Spokane Valley-Rathdrum Prairie Aquifer, USGS 2007*, and 2. *WRIA 55* *and WRIA 57 Phase II Level 1 Assessment, Golder 2003*. The following uses were included in the demand model:

- Kaiser Aluminum, Trentwood – 13,416,606 GPD
- Inland Empire Paper – 3,955,185 GPD
- Honeywell-Johnson Matthey Electric – 458,853 GPD
- Mount St. Michaels – 477,708 GPD
- Inland Farmers Peone Plant (Cenex) – 28,233 GPD
- Empire Cold Storage and Frosty Ice – 82,850 GPD
- Avista – 9,300,000 GPD
- Central Pre Mix – 315,000 GPD
- Central Pre Mix Sullivan Rd – 630,000 GPD
- Hutton Settlement – 1,465,955 GPD
- Avista Thermoelectric – 770,000 GPD

Demand Driver Data

Demand drivers are the major forces that "drive" water demand. The demand drivers utilized in the demand model are the following:

- single family residential housing units
- multi family residential housing units
- commercial & industrial employment
- acres of urban irrigation
- acres of crop irrigation
- number of livestock
- large self supplied commercial/industrial use

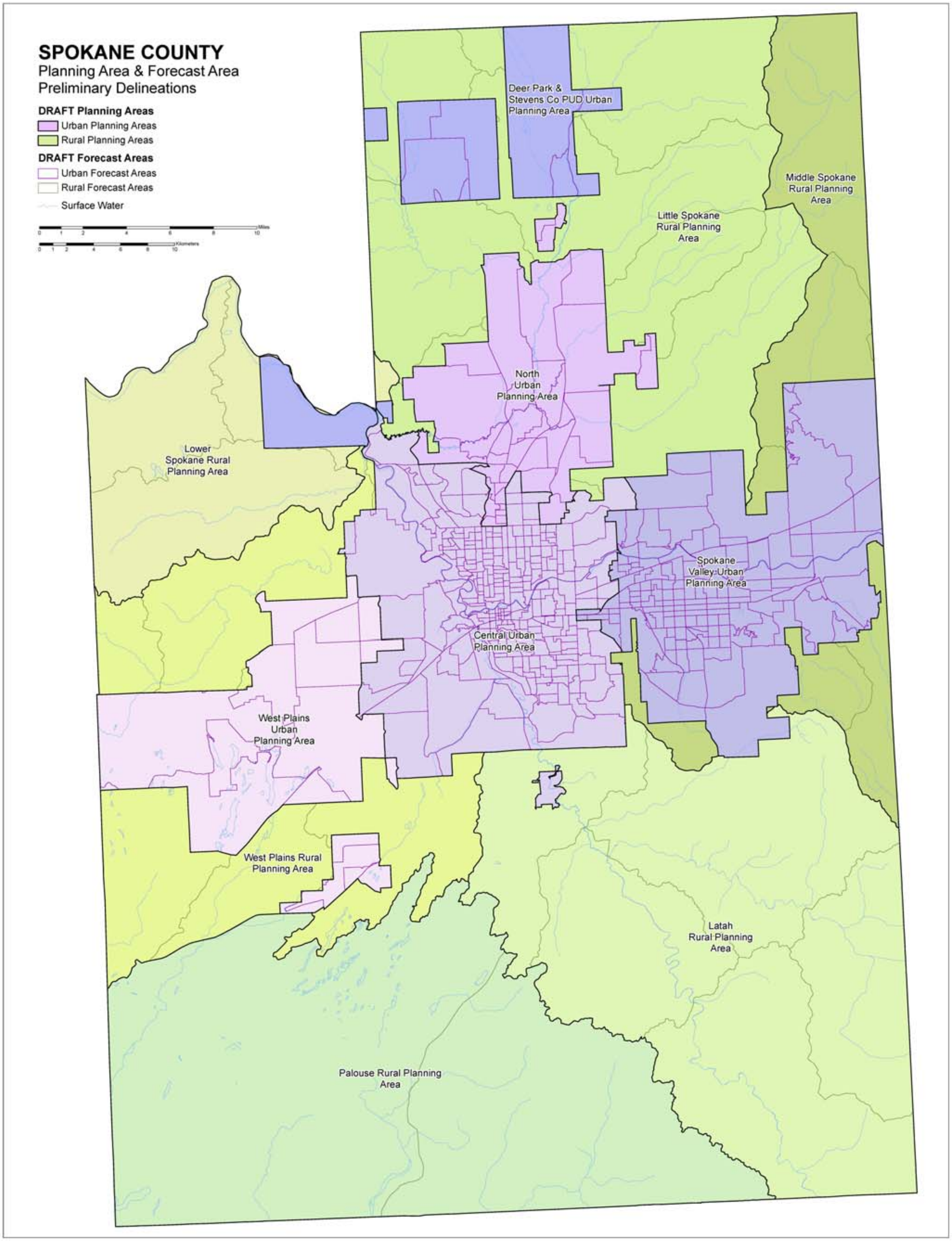
The key information needed for each of these drivers is the quantity (e.g. number of single family residential units) and location, both current and forecasted. To utilize the location information a spatial framework for the model is needed. As described in the Model Structure section two types of spatial units were delineated for the demand model:

- *The forecast unit* is the base model unit. Within each forecast unit, model demand drivers (housing units, employment, etc) and demand factors (weather, house size, etc) are considered homogeneous. For example, home size is averaged within a forecast unit and used as a model input. The forecast unit should be small enough to incorporate variation within the county.
- *Planning areas* are groupings of forecast units into regions that facilitate planning. Model parameters for each forecast unit within a planning area may be set the same or individually.

Additionally the forecast units and planning areas are categorized as urban or rural. The following is a description and rational for the delineations of the forecast units and planning areas for the demand model, as shown in Figure 3:

- **Urban Planning Areas**—The area proposed to be served by public water systems in the Spokane County Coordinated Water System Plan (CWSP) is the urban planning area. Forecast units within the Urban Planning Areas are based on the Transportation Analysis Zone (TAZ) boundaries, delineated and utilized by the Spokane Regional Transportation Council (SRTC), and the CWSP boundaries. The main considerations that support the use of the TAZ boundaries are: (1) TAZ units are small enough to provide the detail to achieve project objectives; (2) TAZ units provide a comprehensive and uniform data set with which to work; (3) TAZ data is the most current data set available; and (4) demographic projections are available by TAZ. TAZ data was generated locally and the raw data and methodology can be researched to resolve any issues or discrepancies encountered during the project. In locations where TAZ and CWSP boundaries do not coincide, a procedure to apportion the TAZ data was utilized. The following Urban Planning Areas have been delineated:
  - Central—primarily the City of Spokane service area
  - Spokane Valley—all service areas east of the City of Spokane service area
  - West Plains—all service areas west of City of Spokane service area
  - North—all service areas north of the City of Spokane service area
  - Deer Park and Stevens PUD—northern county and south of the Spokane River downstream from Spokane

Figure 3 Planning Area & Forecast Units



- **Rural Planning Areas**—Rural Planning Areas are those areas of the County that are outside the CWSP proposed public water service boundaries. For Rural Planning Areas, forecast units are the Washington Department of Natural Resources Watershed Administrative Units (WAUs). WAUs are subwatershed units. Use of a watershed-based forecast unit in rural areas will best facilitate analysis of potential strained water resources since water use in these areas is typically more closely connected to the surface and groundwater within the local watershed. One exception to using the WAU-based forecast unit is in the West Plains region of the county where it is generally recognized that WAUs do not accurately represent groundwater flow. The Rural Planning Area was manually delineated for the West Plains. Demographic projections available by TAZ were aggregated into WAUs for the rural forecasting units. The following Rural Planning Areas have been delineated:
  - Little Spokane
  - Middle Spokane
  - Lower Spokane
  - Latah
  - West Plains
  - Palouse

Demographic data generated by the SRTC for each TAZ was utilized to determine the quantity of drivers within each forecast unit. The SRTC Data Description is provided in Appendix C. For each forecast unit the following data was used in the demand model:

Table 4 – TAZ Data

Driver	Units
Single Family Residential	Dwelling units
Multi Family Residential	Dwelling units
Industrial	Employees
Non CDB[1] Retail	Employees
CDB Retail	Employees
Office	Employees
FIRES	Employees
Medical	Employees
Education K-12	Employees
Education University	Employees
University Students	Students
Hotel/Motel	Rooms

1-Central Business District

Urban irrigation within a forecast unit is quantified in acres. The amount of urban irrigation within a forecast unit was determined from aerial photo interpretation and GIS analysis. All parks, schools, and cemeteries within Spokane County were identified and the area that is irrigated was digitized and a GIS layer was created. This GIS layer was then used to determine the number of acres of urban irrigation that is located within each forecast unit.

Figure 4 – Example of Digitized Urban Irrigation

Data for the quantity and location of irrigated agriculture was from three sources: the 2007 US Census of Agriculture, the WRIA 55/57 Watershed Plan, and aerial photo interpretation. The 2007 US Census of Agriculture provides the number and type of irrigated crops within the county, but does not provide location within the county. The WRIA 55/57 Watershed Plan provided some information on the location of irrigated agriculture which was confirmed and supplemented by aerial photo interpretation. These two sources were used to assign the number of irrigated acres per forecast unit. It was not possible to identify the crop type for each location so a weighted mix of crops based on the Census of Agriculture data was used at each location. One other distinction was made with irrigated agriculture. Moab and Consolidated Irrigation Districts provide water for irrigated agriculture.

Based on information provided in their water system plan the number of acres of irrigated agriculture supplied by public water systems was identified and assigned to the appropriate forecast units.

Livestock was also considered within the agricultural sector. The 2007 US Census of Agriculture provided the number and type of livestock within the county, but did not provide the location. Ecology maintains data for the location and number of livestock for dairies, but other livestock location data was not available. Therefore all livestock with the exception of milk cows were evenly distributed to all forecast units outside of the all Urban Growth Area Boundaries with Spokane County.

The location for each of the large commercial and industrial uses is known and was assigned to the appropriate forecast unit.

Demand Factor Data

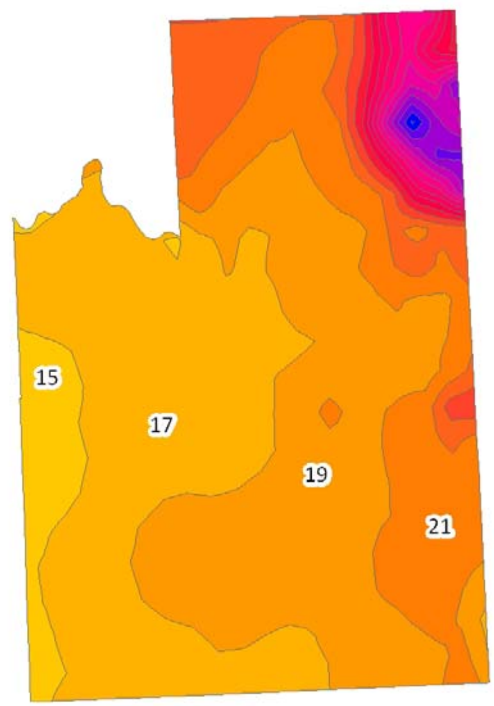
Demand factors impact the rate at which a demand driver uses water. For example, the amount of precipitation influences the amount of water used to irrigate landscape at a single family residence. The number of single family residences drives demand but the amount of precipitation is a factor in the amount each residence uses. Data was collected for the following demand factors:

- temperature
- precipitation
- household size
- family size
- household income
- single family residential assessed value
- lot size
- limited water availability
- rural residential setting.

Weather data was collected from the Western Regional Climate Center website (www.wrcc.dri.edu/index.html). The four weather stations with available climate data in Spokane County were Cheney, Deer Park 2 E, Spokane, and Spokane WSO Airport. Deer Park is located in the northern portion of Spokane County, Spokane and Spokane Airport in the central portion and Cheney in the southern portion. Data chosen for analysis was monthly average of daily maximum temperature and total monthly precipitation. Each station had varying periods of record for this data. The analyzed periods of record are recorded below for each station:

- Cheney: 1938-1954 (data was available starting in 1899, but little data exists between 1899-1938)
- Deer Park: 1912-1976
- Spokane: 1954-1982
- Spokane Airport: 1889-2009

Figure 5: Spokane County Annual Average Precipitation in inches 1960-1990

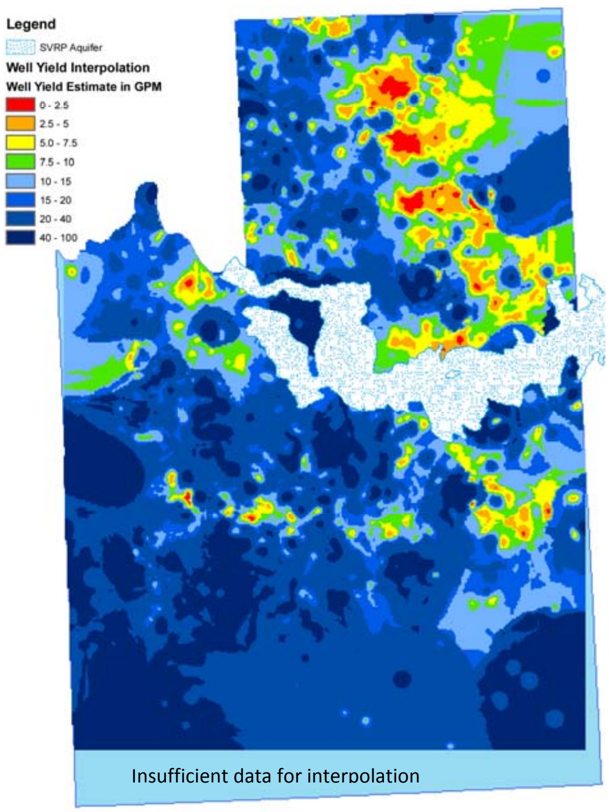


Based on analysis of the available data, it was determined that historical weather patterns at the Spokane Airport weather station are representative of the entire county. While there are variations in weather patterns in Spokane County, these variations are not significant for the level of analysis being completed for this model and occur in the winter months when water use is not affected by weather patterns. As a result, maximum monthly temperatures and total monthly precipitation amounts for the Spokane Airport weather station were used countywide.

Demographic data from the 2000 Census was used to determine the average household size, family size and household income by forecast unit. Data from the Spokane County Assessor was used to determine the average assessed value of single family residences and average lot size in each forecast unit.

The Spokane County Residential Water Use Survey (June, 2010) indicates that limited water availability (i.e., a low yield well) impacts outdoor water use of self supplied residences. To determine if a forecast unit had limited water availability, spatial interpolation of well yield information from Ecology's well log database was used to estimate average well yield for each forecast unit.

Figure 6: Spokane County Well Yield Interpolation



In addition to limited availability the setting of the residence, whether in a pasture/agricultural or forested area, impacted self supplied residential water use. The USGS National Land Cover Database was used to estimate the amount of forested area in each forecast unit.

Water Demand Forecast Model

The demand model was constructed as combination of sector and subsector models as shown in Figure 1. The models vary in complexity from unit use to econometric. This section describes how each sector/subsector model calculates water demand for each forecast unit. The demand model (provided on the accompanying CD) was built and runs in Excel 2007. A series of worksheets interconnect the data and each subsector model.

Single Family Public Supply

The single family public supply model (SFPS) is the most complex of the sector/subsector models. It is an econometric model that correlates single family public supply water use to the following factors: household income, assessed value, temperature, precipitation, and lot size. The relationship between water use and the factors was statistically derived using regression analysis. A full discussion of this approach can be found in section 2.1 of the Tetra Tech/CDM Technical Memorandum in Appendix A.

Log transformations are used in the econometric models within the demand model. When data are transformed into the log form, the distribution of data values has a more normal (i.e., Gaussian, or "bell shaped") distribution (i.e., a log normal distribution). This situation permits the use of standard statistical significance tests that apply to normal distributions, and thus greatly facilitates the analysis. (Tetra Tech/CDM, 2010)

The SFPS model is actually a combination of two models; one for indoor use and one for outdoor use. The indoor use model is used for water use for all 12 months, and the outdoor water use model adds the outdoor portion for May through October. This approach allows the use of temperature and precipitation as factors of outdoor use. If one model was used for the entire year changes in temperature and precipitation in the winter months would impact the calculation of indoor water use when in fact that is not the case.

The SFPS indoor model relates water use to household income. This model uses the average household income within a forecast unit to calculate per household rate of water use in gallons per day for each house. That rate is multiplied by the number of households in the forecast unit to determine the total water use for indoor single family public supply for the forecast unit. Instead of using the absolute value of household income household income relative to the county average was used. This approach was used so overall inflation would not impact use of the model in future updates. The results of the regression analysis for SFPS indoor model are shown in table 5.

Table 5 – SFPS Indoor Demand Model Statistics

Variables	Parameter Estimate	Standard Error	t Value	Pr> |t|
Intercept	5.09	0.12	4.01	<0.001
Log (relative income)	0.47	0.40	128.0	0.001
Number of Observations				15
R-squared				0.55

The following is an explanation of each statistic:

- Observations—The total number of observation in the data set.
- R2, or R-squared—R2 is the coefficient of determination, and is a measure of the variation in (y) explained by the function, or how well the function “fits” the data. An R2 of 1.00 would be optimal.
- Parameter Estimate—The parameter estimate, or coefficient, represents the change in the dependent variable (y) corresponding to a change in the independent variable (x). For example, a coefficient value of 0.30 indicates that a 10 percent increase in (x) results in a 30 percent increase in (y). The coefficient may be positive or negative. A negative coefficient indicates that as the value of the independent variable increases, the value of the dependent variable decreases.
- Standard Error—The Standard Error (SE) of the coefficient is used to test the significance of the individual coefficient. The SE is also called the standard deviation. The smaller the SE, the better. A general level of acceptance is an SE less than 0.05.
- t-Statistic—The t-statistic is calculated as the coefficient divided by the standard error. The larger the t-statistic, the better. Generally, the t-statistic should be at least 2.00.
- P value—The P-value is the probability that the t-statistic is significant, or that the parameter estimate is non-zero. The t-statistic is acceptable with 95 percent confidence when the significance value is 0.05 or less, indicating a statistically significant relationship between the independent and dependent variable.

The SFPS outdoor use model relates water use to the following variables:

- Temperature – The monthly average of daily maximum temperature in degrees Fahrenheit.
- Precipitation – The total monthly precipitation in inches.
- Relative Assessed Value – The assessed value relative to the county average. Similar to household income, relative values are used to normalize the values to account for inflation in future model updates.
- Lot Size – This variable is a binary variable (on or off) that increases water use when lot size exceeds 0.6 acres.
- City of Spokane (COS) Water Service Binary – This variable was added during the calibration process. The value generated from the model for the City of Spokane service area was consistently larger than actual, so a binary variable was added as a correction factor for forecast units within the City of Spokane.

The results of the regression analysis for the SFPS outdoor model are shown in Table 6.

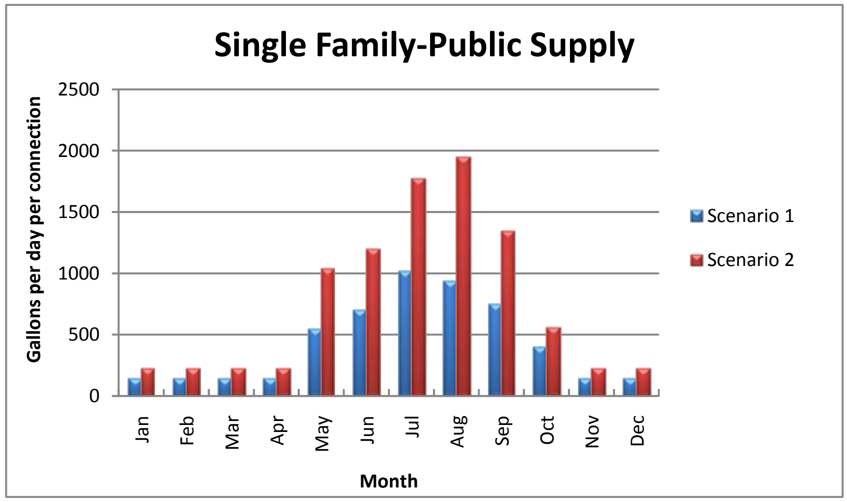
Table 6 – SFPS Outdoor Demand Model Statistics

Variables	Parameter Estimate	Standard Error	z Value	Pr> |z|
Intercept	-8.21	0.570	-14.4	<0.001
Log (precipitation)	-0.018	0.007	-2.44	0.015
Log (Temperature)	3.367	0.131	25.63	<0.001
Log (Relative Assessed Value)	1.258	0.268	4.68	<0.001
Lot size > 0.6 acres binary	0.294	0.180	1.64	0.101
COS binary	-0.240	0.32	-0.75	0.452
Number of Observations				920
R-squared				0.74

The P value for the lot size binary variable and the City of Spokane binary variable are greater than 0.05 which would suggest that the variables do not have a statistically significant relationship with water use. During the calibration process addition of these variables enhanced the performance of the model so they were included. Inclusion of these variables did not impact the R-squared.

Figure 7 – Example of SFPS Model Output

Variables	Scenario 1	Scenario 2
Household Income	$ 30,000	$ 80,000
Assessed Value	$ 144,000	$ 252,179
Average Max Temp		
May	68	68
June	75.13	72
July	85.45	82
August	83.06	85
September	76.67	73
October	60	52.26
Total Precip		
May	0.93	1
June	1.18	2
July	0.48	0.48
August	0.74	1
September	0.51	0.01
October	2.33	2
Averag Lot Size > 0.6 acres	0	0
City of Spokane Water Service	0	0



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scenario 1	143	143	143	143	545	704	1022	936	752	403	143	143
Scenario 2	226	226	226	226	1040	1201	1775	1952	1348	558	226	226

Figure 7 demonstrates the model output. Increased household income increases water use. Increased assessed value increases water use. The temperature differences between July and August determine which month has the highest water use. The accuracy of the model relative to actual reported rates of use from water systems is discussed in the next section.

Single Family Self Supply

The approach to this sector was guided by results from the Spokane County Residential Water Use Survey. The survey suggested that single family self supplied residential water use is similar to public water systems, with a few differences. Therefore the SFPS model was used for this sector with the following modifications:

1. Outdoor water use for self supplied residential within forecast units with limited water availability was reduced by 50%. The reduction was applied in relation to the percent area of the forecast unit that has limited water availability. For example if 25% of a forecast unit is designated with limited water availability the reduction applied to self supplied residential outdoor water use is 0.25 x 0.50 or 12.5%.
2. Outdoor water use for self supplied residential with forested land cover was reduced by 25%. As with limited water availability the reduction was applied in relation to the percent of the forecast unit that was forested.
3. Water use for livestock was added to each forecast unit with self supplied residences. Based on the survey results 11% of self supplied households have livestock, and on average each household with livestock have 3 animals.

Multi Family Public Supply

An econometric model was developed for the multi-family public supply (MFPS) subsector model. A somewhat different approach was taken in comparison to the SFPS model due to the type of data available for this subsector.

The challenge with multi-family water use data is that water systems have differing ways of tracking multi-family accounts. Typically water systems track the number of meters associated with an account, though sometimes the number of units associated with the meter is also tracked. A meter can be associated with just one unit, which is sometimes the case with individually owned condominiums, or many units, as is the case with an apartment complex. This ambiguity makes it difficult to determine the water use per unit.

The technique used for the SFPS model was to associate demand factors with per connection use. There was not sufficient multi-family data that included the number of units associated with the total actual water use per month. Therefore, there was not enough per unit water use data that could be used to develop a statistical relationship between water use per unit and water demand factors.

There were, though, several water systems that tracked total monthly multi-family water use. With that data, the percent increase of water use over winter use (November to April) for each month between May and October was determined. The water use values were then associated with water demand factors and a statistical relationship was developed. In the model the percent increase was added to a base indoor water use to estimate per unit per month water use.

The factors that influence the percent increase over the base amount are temperature and the log of relative assessed value of single family homes in the same forecast unit as the multi family units. Binary variables were added for the months of May, August, and September to account for water use patterns not entirely captured by the temperature variable. The results of the regression analysis for the MFPS model are shown in table 7.

Table 7 – MFPS Demand Model Statistics

Variables	Parameter Estimate	Standard Error	z Value	Pr> |z|
Temperature	0.046	0.001	45.55	<0.001
Log (Relative Assessed Value of SF)	4.43	0.254	17.44	<0.001
May binary	-1.27	0.144	-8.80	<0.001
August binary	1.10	0.153	7.19	<0.001
September binary	1.04	0.147	17.44	<0.001
Number of Observations				234

The following table shows an example of how the per unit use is calculated for a forecast unit with an average single family home with an assessed value of $102,240.

Table 8 – MFPS Model Example Calculation

Month	Base Use	Temp	% increase	Per unit use
January	150	-	0	150
February	150	-	0	150
March	150	-	0	150
April	150	-	0	150
May	150	64.23	16	174
June	150	73.53	186	279
July	150	82.16	225	338
August	150	82.45	336	504
September	150	67.73	263	395
October	150	57.19	110	165
November	150	-	0	150
December	150	-	0	150
Annual Average				229

Base use and per unit use in gpd.

The base use (aka winter use) was developed from water system data from which per unit use could be developed and was adjusted during calibration.

Commercial & Industrial Public Supply

The commercial & industrial public supply (CIPS) model is a unit use model. As the name implies a unit use model uses a water use factor per unit, such as gpd per employee, and the number of units in a geographic area to calculate total water use. In contrast to the single family and multi-family models demand factors are not part of the CIPS model. A seasonality factor is included in the model that adds a percentage increase to each month from May through October. The seasonality factor is based on data provided by Airway Heights, Consolidated Support Services, City of Spokane, and Whitworth Water District. Table 9 demonstrates the CIPS model for one forecast unit.

Urban Irrigation, Self Supplied Industrial & Agriculture

The urban irrigation, self supplied industrial, and agriculture are all unit use models similar to the CIPS model. The unit use is multiplied by the number of units in each forecast unit. A description of the derivation of the unit use values and number of units per forecast unit can be found in the Data Collection, Analysis, and Use section. Similar to the CIPS model, urban irrigation, irrigated crops, and self supplied golf courses include a seasonal factor.

Table 9 – CIPS Model Example Calculation

Month	Seasonal Factor	Industrial		Retail		Medical		Office		FIRES		Education		Hotel/Motel		Total GPD
		Unit Use	# of Units	Unit Use	# of Units	Unit Use	# of Units	Unit Use	# of Units	Unit Use	# of Units	Unit Use	# of Units	Unit Use	# of Units	
January	-	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**47,646**
February	-	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**47,646**
March	-	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**47,646**
April	-	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**47,646**
May	1.22	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**58,128**
June	1.9	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**90,527**
July	2.44	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**116,256**
August	2.59	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**123,403**
September	2.4	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**114,350**
October	1.61	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**76,710**
November	-	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**47,646**
December	-	*155*	16	*47*	25	*84*	5	*61*	35	*168*	52	*105*	300	*60*	20	**47,646**
	TOTAL GPD		***45,037***		***21,338***		***7,627***		***38,772***		***158,646***		***572,040***		***21,792***	**865,251**

Model Calibration & Verification

Calibration and verification is an important component in the process of developing a model. If the model does not represent the real world then it is not a useful analytical tool. Calibration and verification of a model is usually done by comparing output of a model to actual data. Since total water demand for the county is not measured calibration and verification was done by comparing out put of sections of the model that are measured (e.g. public supply) so the modeled values and actual values could be compared.

Calibration of the model was an iterative process. As the model was developed model output was compared to actual values so the accuracy of model components, including water use rates, quantity of demand drivers, and the impact of demand factors could be assessed and improved.

Verification of the model focused on the public supply sector because that is the only sector for which actual use data is collected and available. Verification of the model was done in four ways:

1. **Single Family Residential Usage Rates:** Comparison of actual single family residential average annual per connection water use of a water system to that of the forecast units that comprise the water system;
2. **Annual Public Supply Water Use by Water System:** Comparison of actual reported annual water use for a water system to that of the forecast units that comprise the water system;
3. **Annual Public Supply Water Use for SVRP Aquifer:** Comparison of public supply withdrawals in Spokane County from the SVRP aquifer utilized in the SVRP Ground-Water Flow Model developed by the USGS to annual use for forecast units served by public water systems whose source is the SVRP aquifer; and
4. **Impacts of Weather on Water Use:** Comparison of changes in single family residential annual average per connection use to that predicted by the SFPS model.

There were two main challenges to model verification. Water systems do not always report data for the same subsectors represented in the model, and the boundaries of forecast units do not align with water system service area boundaries. To address those issues subsectors represented in the model but not in water system data were excluded from verification, and forecast units that included two or more water system service areas were apportioned to each system based on the distribution of single family residences within the forecast unit.

Single Family Residential Usage Rates

The average annual per connection water use rates in gpd as reported in each water systems comprehensive plan was compared to the average annual single family water use rates predicted by the SFPS model for the forecast units that comprise the water system. The relative percent difference which is:

$$RPD = \frac{(\text{Modeled} - \text{Actual})}{(\text{Modeled} + \text{Actual})/2} \text{ X } 100$$

was calculated to measure the accuracy of the modeled values. The average RPD of all systems is -6% suggesting that single family residential water use is potentially under represented in the model. If the values from each water system are weighted based on the size of the system the average RPD is 2% suggesting that it is represented accurately.

Factors that impact the agreement between the modeled and reported values include:

- System size
- Whether or not data from the system was used in developing the SFPS model
- Length of time from which the reported annual average was derived

Overall the single family model accurately represents water use. Care should be taken, though, when evaluating smaller spatial subsets of the model.

Table 10–Single Family Water Use Rate: Modeled vs. Reported

Water System	# of Residential Connections	Annual Average GPD per connection		RPD
		Modeled	Reported	
Airway Heights	1,484	364	343	6%
City of Spokane	74,325	464	425	9%
Whitworth WD	9,954	801	785	2%
East Spokane WD	1,700	433	539	-22%
Irvin WD	1,597	421	791	-61%
Model ID	2,513	615	805	-27%
Modern Water Co.	7,424	467	599	-25%
North Spokane ID	703	495	895	-58%
SCWD #3- 1	2,211	551	535	3%
SCWD #3- 2	4,575	707	721	-2%
SCWD #3-3A	1,462	521	516	1%
SCWD #3- 3B	1,475	657	616	6%
Trentwood ID	1,727	553	421	27%
Carnhope ID	495	328	433	-28%
Cheney	4,143	448	554	-21%
City of Deer Park	1,448	488	440	10%
Consolidated ID	4,984	614	500	20%
Four Lakes WD	159	564	450	22%
Hutchinson ID	872	385	685	-56%
Liberty Lake	3,488	964	643	40%
Medical Lake	1,974	505	342	39%
Moab ID	718	855	877	-2%
Orchard Avenue ID	1,255	426	731	-53%
Pasadena Park ID	2,304	825	736	11%
Pioneer Water Co	152	950	820	15%
Vera ID	9,195	731	834	-13%
			Average RPD	**-6%**
			Weighted Average RPD	**2%**

Annual Public Water System Use

The total annual production for public water systems, as reported in each water systems comprehensive plan, was compared with the total modeled public water system demand for the forecast units that comprise the water system service area. If the water system plan reported use for individual subsectors those the modeled values for those subsectors were compared. Table 11 presents the results of the comparison. The RPD for total production as compared to total modeled use was 0.88% and each of the subsector models were within 3% with the exception of total non-residential.

Table 11 – Annual Public Water System Use: Modeled vs. Reported

Water System	Reporting Years	Total Modeled Use vs. Total Reported Production*			Single Family Residential		Multi Family Residential		Total Residential		Commercial Industrial		Urban Irrigation		Total Non-Residential		Non Revenue	
		Modeled	Actual	RPD	Modeled	Actual	Modeled	Actual	Modeled	Actual	Modeled	Actual	Modeled	Actual	Modeled	Actual	Modeled	Actual
Orchard Ave ID	2006	301	474	-45%	178	304	6	14	184	318	78	40	9		87	40	30	22
East Spokane WD	2006	306	377	-21%	190	188	27	85	217	273	55	41	3	22	58	63	31	41
Town of Millwood	2001	221	275	-22%	110	139	11	8	121	147	64	29	15	12	79	41	22	87
Airway Heights	2008	398	456	-14%	118	98	12	53	130	151	228	237			228	237	41	65
Consolidated ID	2001-05	2,743	3,065	-11%														
Moab ID	2006	283	303	-7%	163	209	5		168	209							28	17
City of Cheney	2007-08	603	649	-7%	212	207	123	120	335	327	184	130	23		207	130	65	186
City of Spokane	2001-06	21,275	21,793	-2%	9,327	8,785	2,819	2,991	12,146	1,1776	6,833	7,711	748		7,581	7,711	2,192	2,244
City of Deer Park	2002-06	370	394	-6%	144	167	15		159	167	73	211	100		173	211	37	16
Modern Electric Water Co	2000-05	2,152	2,109	2%	739	1027	391	213	1130	1240	755	517	50		805	517	215	352
Model ID	2003-05	769	765	1%														
SCWD#3 WSA 2	2004-08	1,165	1,124	4%	846	826	123	120	969	946	66	65	34	82	100	147	116	79
Pasadena Park ID	2005-07	697	670	4%														
Trentwood ID	2006				291	224	28	47	319	271	48	84	51		99	84	51	83
Carnhope ID	2004-06	2,001	195	3%														
Whitworth WD	2006	3,416	3,134	9%	2418	2341	239	217	2657	2558	287	312	130	119	417	431	343	70
Vera ID	2002-05	2,945	2,677	10%														
Medical Lake/CSS	2006	388	366	6%	194	156	27	28	221	184	114	108	15	17	129	125	39	57
SCWD#3 WSA 3	2004-08	356	302	16%	176	209	46	17	222	226	83	60	15	10	98	70	36	16
Four Lakes WD	2006	37	28.5	26%	30	24	0	1	30	25	0.5	0.5	0.5	0.5	1	1	6	2.5
SCWD#3 WSA 4	2004-08	469	369	24%	329	216	8	59	337	275	41	40	16	23	57	63	47	31
Liberty Lake	2008	1,455	1,044	33%														
Irvin WD	2006	543	387	34%	153	216	63	57	216	273	265	99	7	14	272	113	54	38
SCWD#3 WSA 1	2004-2008	802	573	33%	302	281	53	72	355	353	353	113	14	21	367	134	80	93
TOTAL		**41,895**	**41,530**		**15,920**	**15,617**	**3,996**	**4,102**	**19,916**	**19,719**	**9,528**	**9,798**			**10,758**	**10,118**	**3,433**	**3,500**
RPD		**0.88%**			**1.92%**		**-2.62%**		**0.99%**		**-2.79%**				**6.13%**		**-1.92%**	

All values reported in millions of gallons per year

*Total production values represent the total amount pumped

Some urban irrigation use is likely modeled as urban irrigation but characterized as non-revenue water in some systems resulting in a higher modeled value than reported. As with the single family residential usage rates the RPD was higher for some water systems so care should be taken when evaluating smaller spatial subsets.

Annual Public Water System Use from SVRP Aquifer

One of the inputs of the *Ground-Water Flow Model for the Spokane Valley-Rathdrum Prairie Aquifer (USGS, 2007)* is actual public water system withdrawals on a monthly basis from the SVRP aquifer for the period 1990-2005. The third aspect of the verification process was to compare withdrawal data from the ground water flow model for the portion of the SVRP aquifer within Spokane County to the public water system demand for forecast units that are served with SVRP aquifer water.

The range of annual withdrawal from the SVRP aquifer reported from the ground water flow model is 36,314 to 42,283 million gallons per year with an average of 39,891 million gallons. Using actual weather data for the period of 1990 to 2005 the demand model results ranged from 38,753 to 46,577 million gallons per year with an average of 42,641 million gallons. The RPD of the averages is 6.67%. The demand model results are based on 2008 demographic data.

Impact of Weather on Water Use

As stated in the model structure section the increase in water use during the summer months is an important aspect of water demand in Spokane County. Annual single family residential water use can vary by 12% depending on weather, and summer time use can vary by 25%. To assess how well the model incorporates weather changes the public supply single family residential model was used to compare the change in annual average per connection water use due to changes in weather inputs with actual changes in annual average per connection use in corresponding years. The modeled values correspond well with actual values. Figures 8 through 13 show the results of the comparison.

Figure 8 – Comparison 1 of modeled vs actual changes in water use due to changes in weather

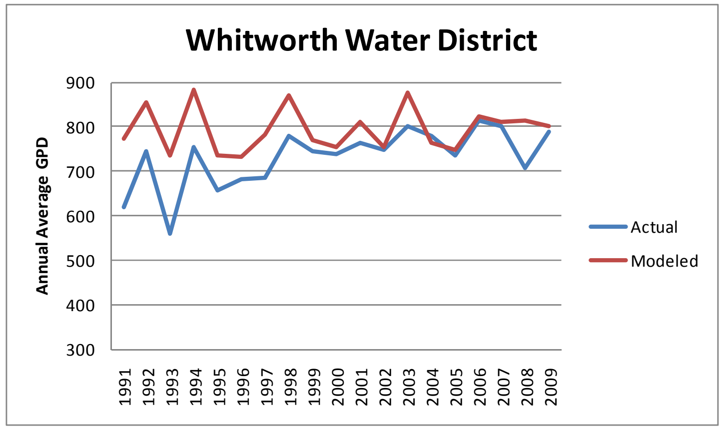


Figure 9 – Comparison 2 of modeled vs actual changes in water use due to changes in weather

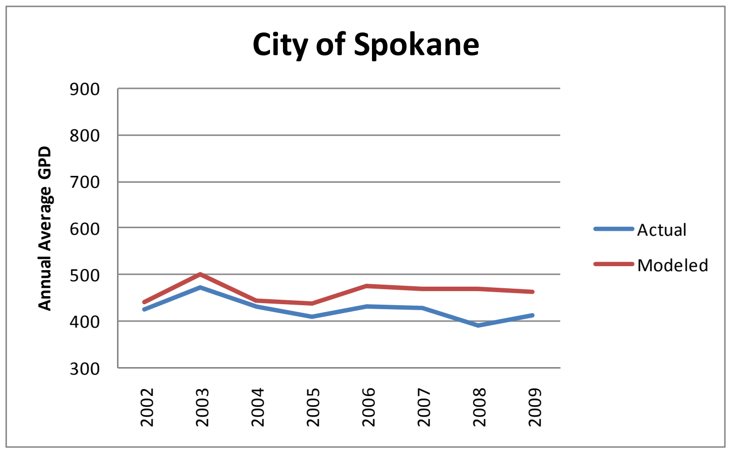


Figure 10 – Comparison 3 of modeled vs actual changes in water use due to changes in weather

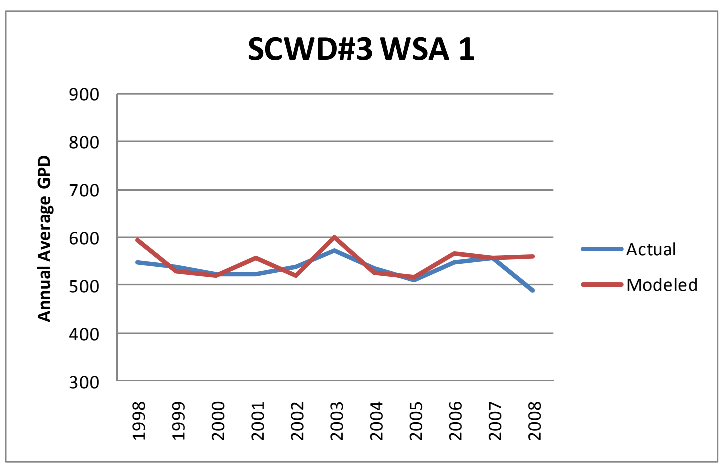


Figure 11 – Comparison 4 of modeled vs actual changes in water use due to changes in weather

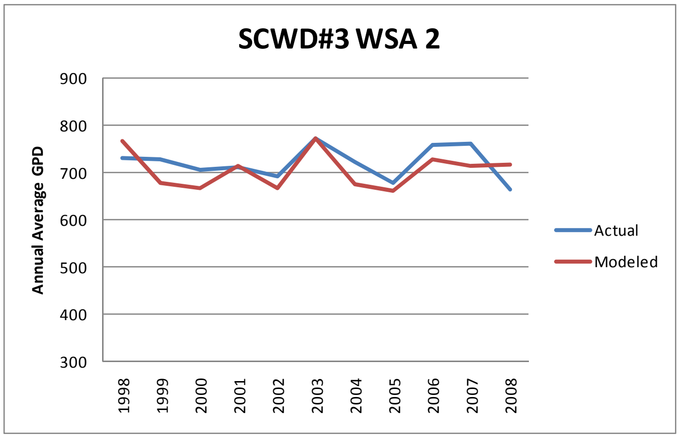


Figure 12 – Comparison 5 of modeled vs actual changes in water use due to changes in weather

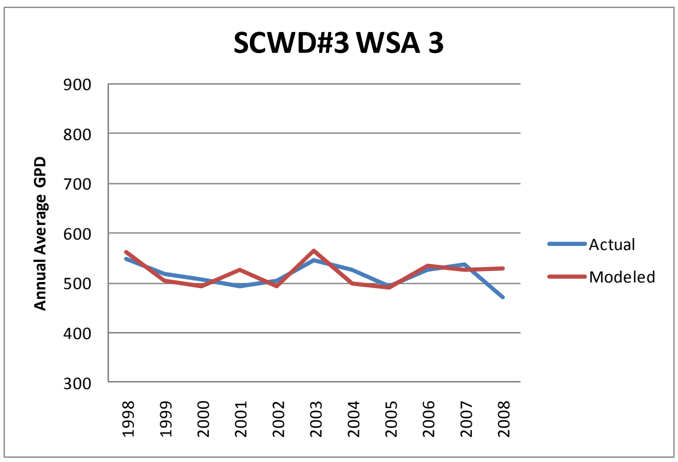
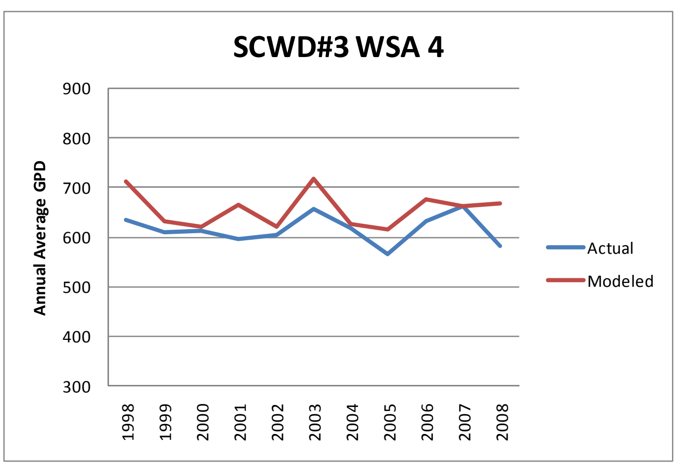


Figure 13 – Comparison 6 of modeled vs actual changes in water use due to changes in weather



The Whitworth Water District comparison shows a discrepancy in the years between 1991 and 1999. The pattern of changes due to weather corresponds but the actual values are lower than modeled. This is likely due to the changing composition of Whitworth Water District. As the system has expanded the average home size, lot size and household income has increased which are all factors that are associated with increased water use per connection.

Results and Analysis

The Spokane County Water Demand Forecast Model was used to conduct the following analyses:

1. Current and projected total water demand by sector for the entire county.
2. Current and projected total and monthly water demand for areas served by water from the SVRP Aquifer.
3. Current and projected total water demand by sector for each WRIA within Spokane County.
4. Increase in self supplied water use from 2010 to 2040 for each rural sub basin.
5. Impact of weather and conservation on current and projected demand.

As described in previous sections of this report, the forecast is based on the *SRTC 2030 Growth Forecasts for Employment, Housing, and Transportation* (Intermountain Demographics, 2006).

The agricultural and self supplied industrial sectors are projected to have no growth in this forecast. In the model these sectors are self supplied and require water rights. Given that approval of new water rights in Spokane County is unlikely, no growth is forecasted. The model, though, can include growth in these sectors.

Spokane County Total Water Demand

Table 12 and Figure 15 present the total projected annual water demand for each water use sector in five year increments.

Table 12 – Spokane County Water Demand Forecast by Sector

Year	Public Supply	Self Supply Residential	Self Supply Industrial	Agricultural	Total
2010	52.27	5.46	7.17	10.53	75.83
2015	55.28	5.75	7.17	10.53	78.73
2020	59.17	6.20	7.17	10.53	83.07
2025	62.62	6.65	7.17	10.53	86.98
2030	66.28	7.10	7.17	10.53	91.08
2035	69.94	7.55	7.17	10.53	95.19
2040	73.59	8.00	7.17	10.53	99.30

All values reported in billions of gallons per year

Growth in the public supply sector over the 30 year forecast is 41% and in the self supply residential sector is 47%. While not growing as quickly as self supplied residential public supply is the largest component of total water demand. Figure 15 shows the public supply forecast segregated by sub sector.

SVRP Aquifer Water Demand

The main source of water for Spokane County is the SVRP aquifer. This resource is utilized both within and outside of the geographic boundaries of the aquifer. Figure 14 shows the aquifer boundary and the approximate area served by water from the aquifer within Spokane County.

Figure 14: Approximate Area Served by SVRP Aquifer

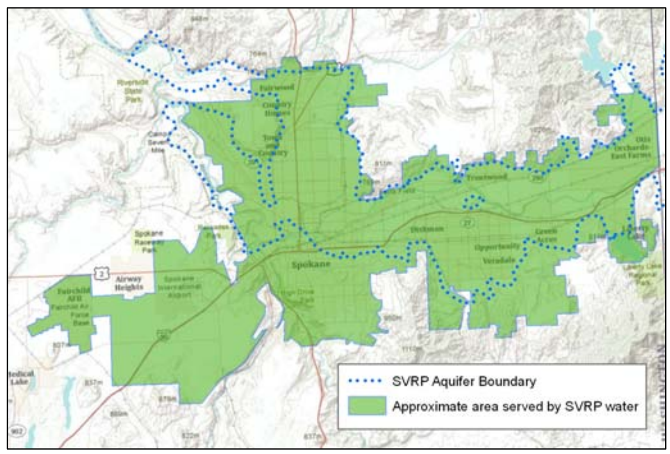


Table 13 and Figure 17 present the total water demand for the SVRP Aquifer in five year increments from 2010 to 2040. Included in this figure are demand projections for the portion of the aquifer within Idaho. The Idaho water demand projections were included because the aquifer is a multi state resource. The demand projections for Idaho were taken from the *Rathdrum Prairie Aquifer Water Demand Projections (SPF Water Engineering, 2010)* report prepared for the Idaho Water Resource Board.

Figure 15 –Total Annual Water Demand 2010-2040

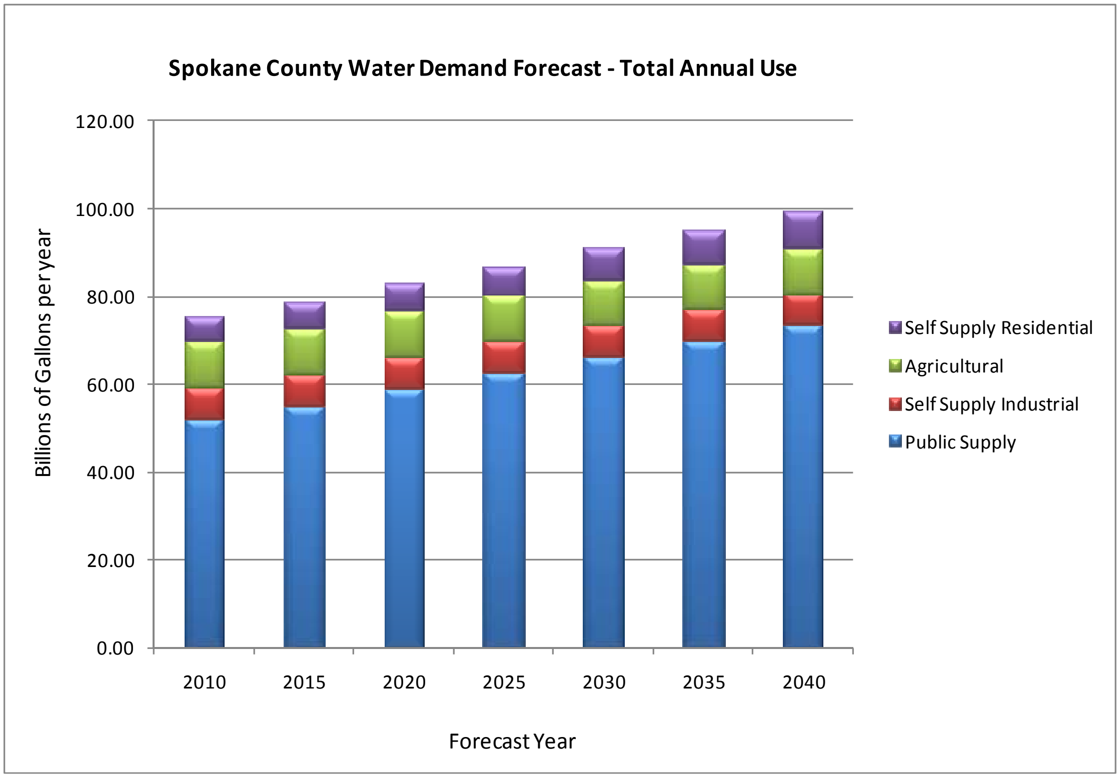


Figure 16 –Public Supply Water Demand 2010-2040

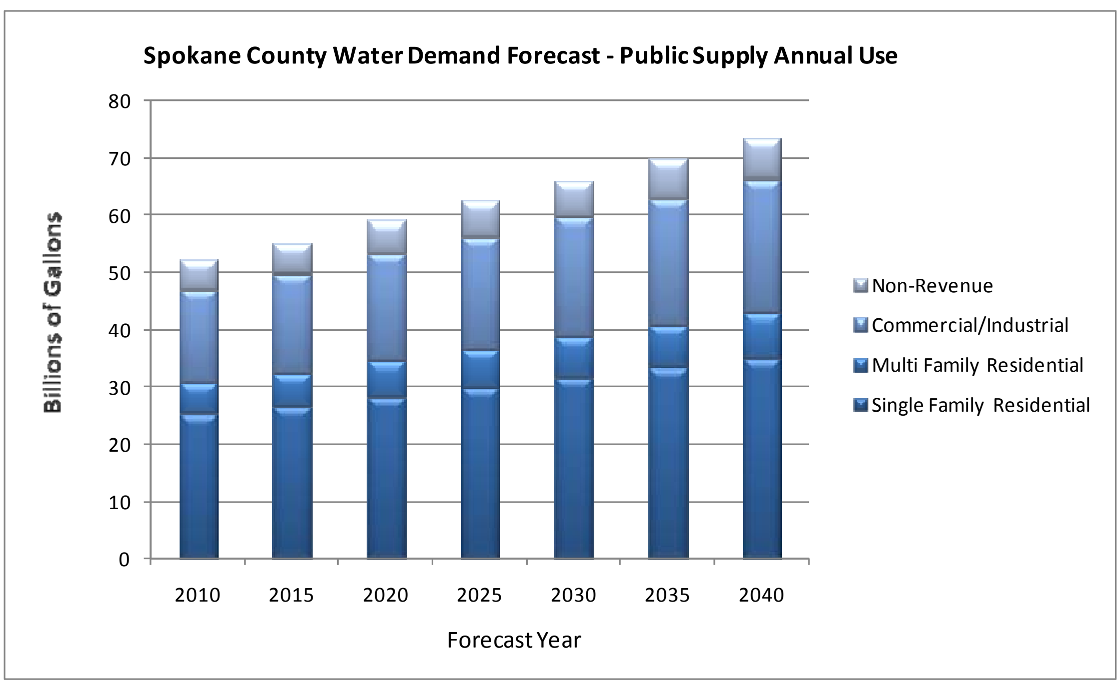


Table 13 – SVRP Aquifer Demand Forecast

Year	Washington	Idaho	Total
2010	53.86	24.24	77.75
2015	56.44	25.71	81.76
2020	59.70	27.66	86.95
2025	62.63	29.85	92.02
2030	65.71	32.23	97.45
2035	68.79	34.90	103.17
2040	71.87	38.16	109.48
Change	18.01	13.92	31.93
% Growth	33%	57%	41%

All values reported in billions of gallons per year

Absolute growth in water demand in Washington is greater while the rate of growth in Idaho is greater which is consistent with recent growth trends.

SVRP Aquifer Water Demand by Month

It is well documented that the SVRP aquifer is connected to the Spokane River, and the *Ground-Water Flow Model for the Spokane Valley-Rathdrum Prairie Aquifer (USGS, 2007)* demonstrated that withdrawals from the aquifer have an impact on river flows within a very short time frame. This is particularly important during the summer months when demand is high and river flow is low. Table 14 and Figure 18 present the monthly water demand from the SVRP aquifer for 2010 and 2040.

Table 14 – SVRP Aquifer Monthly Demand

Year	2010	2040	Change
January	105	137	32
February	105	137	32
March	105	137	32
April	106	138	32
May	249	334	85
June	346	462	116
July	459	613	153
August	454	610	156
September	373	502	130
October	223	305	81
November	105	137	32
December	105	137	32

All values reported in cubic feet per second

The seven day low flow* for the Spokane River as measured at the USGS Spokane River at Spokane, WA gage has ranged from 507 to 1594 CFS in the last 20 years. The increase in demand from the SVRP aquifer in Washington is projected to increase 156 CFS, a range of 10% to 30% of the seven day low flow. During low flow years, which often coincide with high outdoor water use, the increase in demand will make a significant impact on river flow. Also, the demand is reported as a monthly average, not a peak withdrawal. The daily peak withdrawal from the SVRP aquifer will be in excess of 156 CFS.

Water Demand by WRIA

Approximately 29% of Spokane County current water demand is supplied by water not withdrawn from the SVRP aquifer. Table 15 and Figures 20-23 present the water demand for each Water Resource Inventory Area (WRIA) within Spokane County. Figure 19 shows the boundaries of each WRIA.

The current and projected demand presented for each WRIA in Table 15 represents demand that is supplied by water from within the WRIA, and not connected with the SVRP aquifer and is limited to Spokane County.

Table 15 – Water Demand Forecast by WRIA

Year	WRIA			
	34 & 43	54	55	56
2010	2.24	5.00	7.27	3.13
2015	2.31	5.12	7.46	3.29
2020	2.42	5.28	7.82	3.45
2025	2.51	5.42	8.12	3.65
2030	2.61	5.57	8.45	3.83
2035	2.71	5.73	8.79	4.01
2040	2.82	5.88	9.12	4.20
Change	0.58	0.88	1.85	1.07
% Growth	26%	18%	25%	34%

All values reported in billions of gallons per year

*Seven Day Low Flow - A measurement of low stream flow conditions calculated as the lowest average flow over seven consecutive days.

Figure 17 – SVRP Aquifer Water Demand 2010-2040

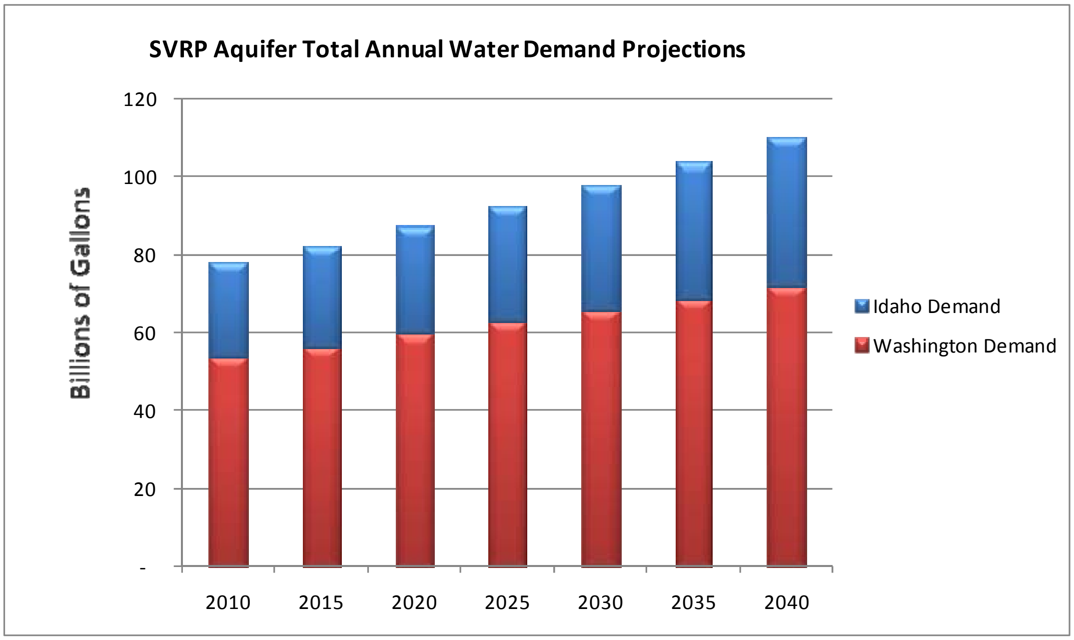


Figure 18 – SVRP Aquifer Monthly Water Demand

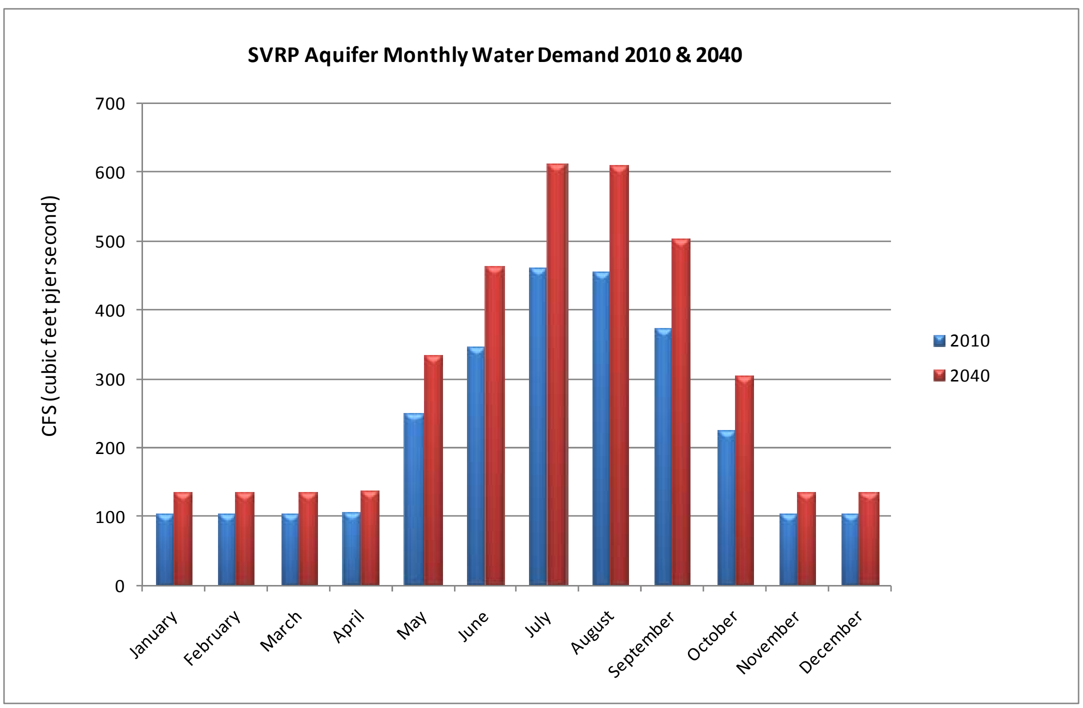


Figure 19 – Spokane County WRIAs

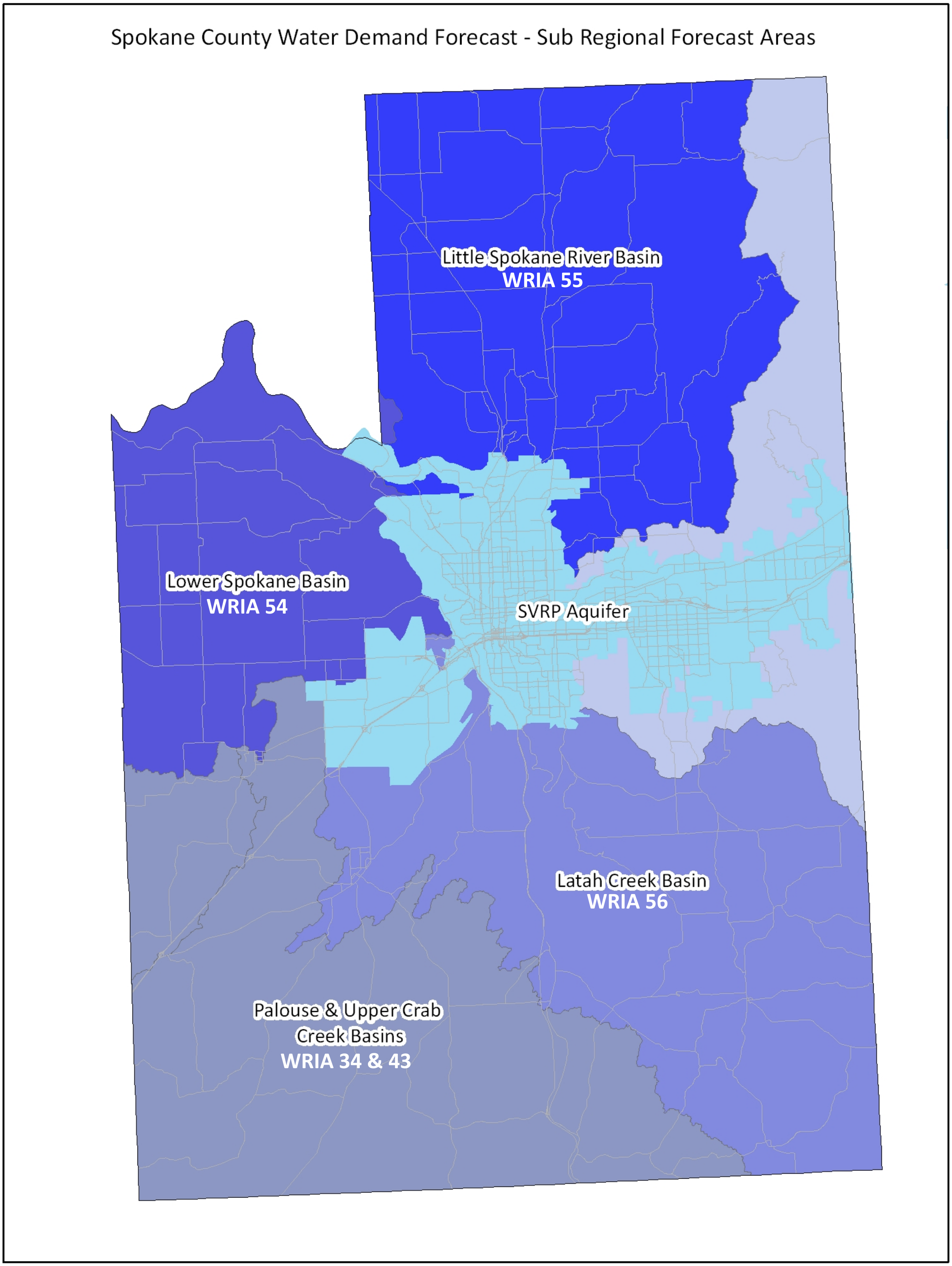


Figure 20 – WRIA 55 (Little Spokane River Basin) Forecast

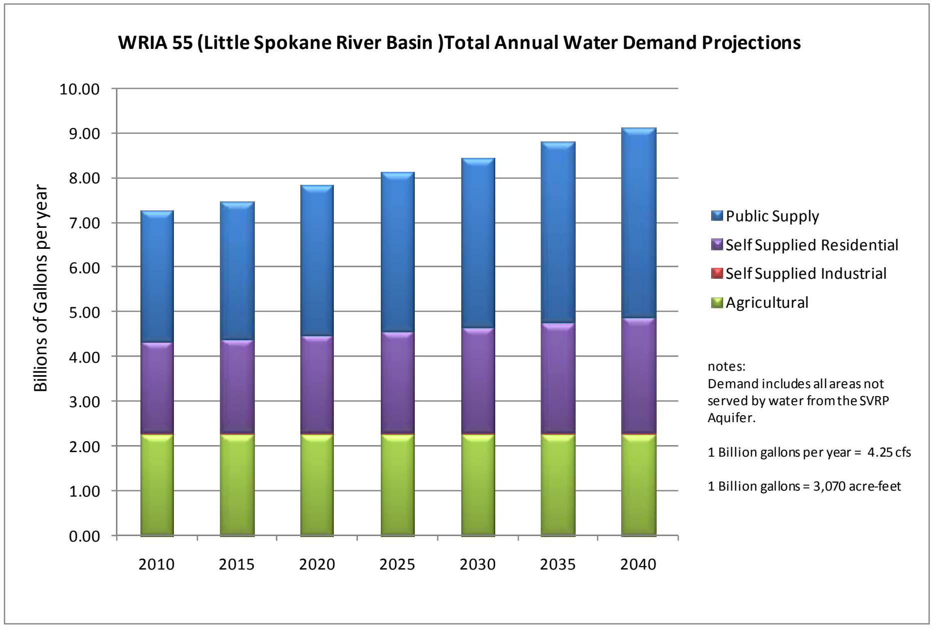


Figure 21 – WRIA 54 (Lower Spokane Basin) Forecast

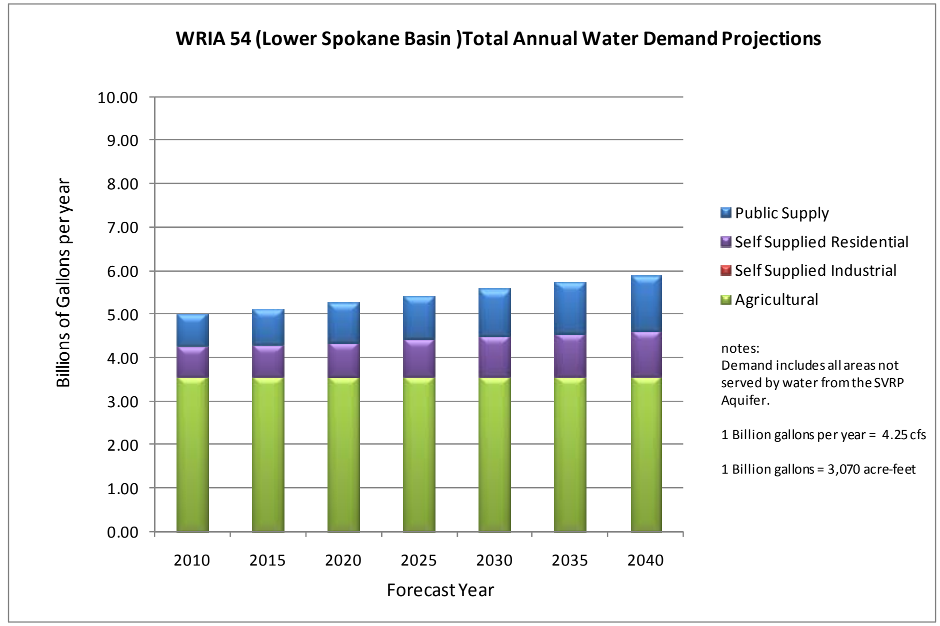


Figure 22 – WRIA 56 (Latah Creek Basin) Forecast

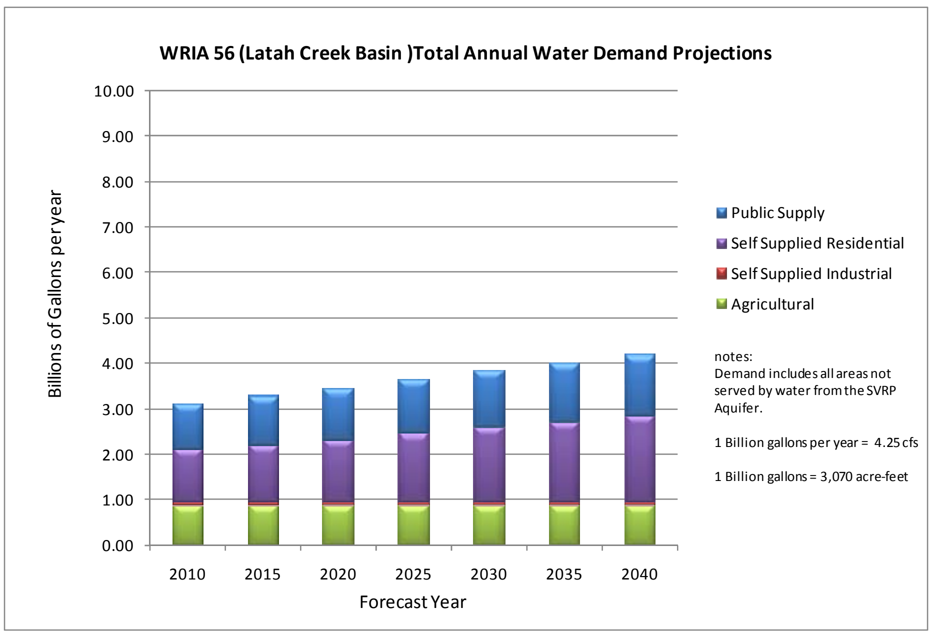
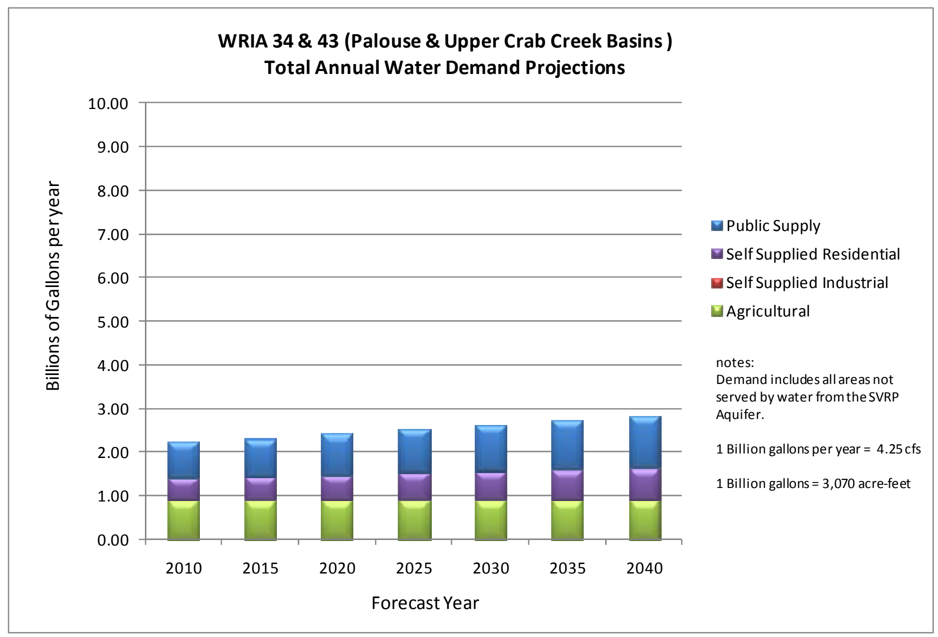


Figure 23 – WRIA 34 & 43 (Palouse & Upper Crab Creek Basins) Forecast



Figures 20-23 show the contribution of each water use sector to total demand. The following observations demonstrate that each WRIA has unique characteristics:

- Self supply within WRIA 56 shows the greatest growth rate of all sectors in the WRIA.
- Agricultural demand within WRIA 54 is the most significant component of total demand.
- Public supply within WRIA 55 shows the greatest growth rate of all sectors in the WRIA.
- Public supply demand is the most significant component of total demand in WRIA 55. Self supply demand is the most significant component of total demand in WRIA 56

Growth in Self Supplied Residential Water Use

The self supplied residential sector represents approximately 7-8% of total water demand in Spokane County. It can be significant, though, at the subbasin level. Several streams within Spokane County have summer low flows near 1 CFS. Increases in water demand that are not significant on a county wide basis can be significant in the context of these low stream flows. In the California – Lower Rock Creek subbasin the forecasted increase in summer withdrawal is between 57% and 255% of stream flow.

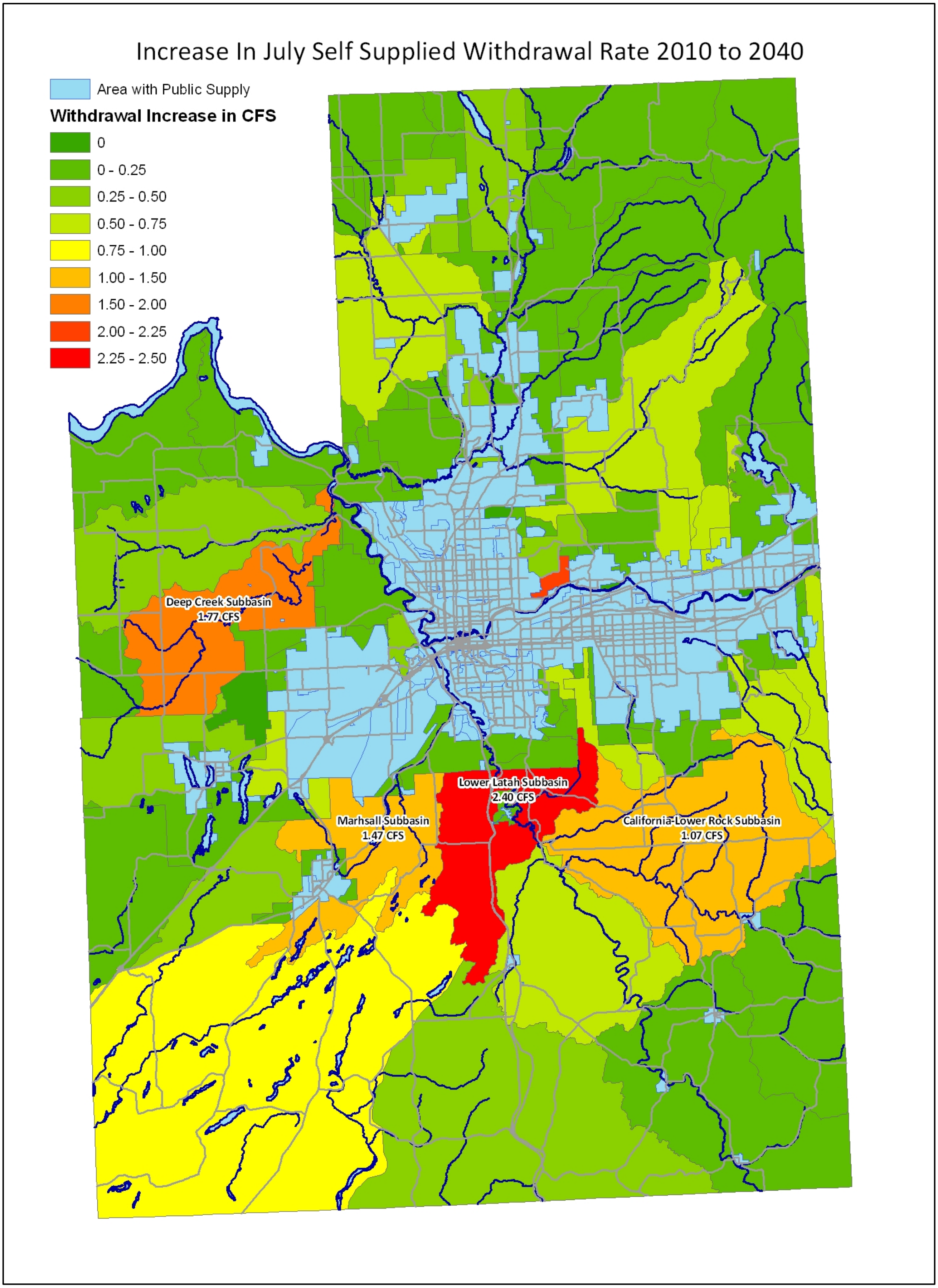
It is important to note, though, the specific hydrogeology that would allow evaluation of impacts of withdrawals on these streams is not fully understood. Therefore an increased withdrawal represents the potential impact to these streams. Table 16 presents the stream flow and projected increases in average and July rates of withdrawal for selected subbasins. Figure 24 shows the increase in the July rate of withdrawal for all subbasins with self supplied residences.

Table 16 – Comparison of Subbasin Stream Flow and Withdrawal Increases

Subbasin	Minimum Summer Low Flow (CFS)	Maximum Summer Low Flow (CFS)	Average Withdrawal (CFS)				July Withdrawal (CFS)			
			2010	2040	Change	% Increase	2010	2040	Change	% Increase
California – Lower Rock Creek	0.42	1.87	0.94	1.40	0.46	49%	2.17	3.25	1.07	49%
Latah Creek	5.10	14.0	1.28	2.29	1.01	79%	3.04	5.44	2.40	79%
Marshall Creek	1.60		0.62	1.28	0.66	106%	1.38	2.85	1.47	106%
Deep Creek	1.5 – 0.6		1.23	2.03	0.79	64%	2.76	4.54	1.78	64%

Notes: California-Lower Rock Creek values are a combination of flow measurements taken at the outlet of each creek. The California-Lower Rock Creek and Latah Creek minimum and maximum values measured by the Spokane County Conservation District (SCCD) between 2001-2010. The Marshall Creek value was measured by SCCD on September 8, 2010. Deep Creek values taken from the *Draft Technical Memorandum Field Data Collection and Phosphorus Loading Summary, Deep Creek Field Data Collection Area, HDR and GeoEngineers, 2010.*

Figure 24 – Increase in July Self Supplied Withdrawal



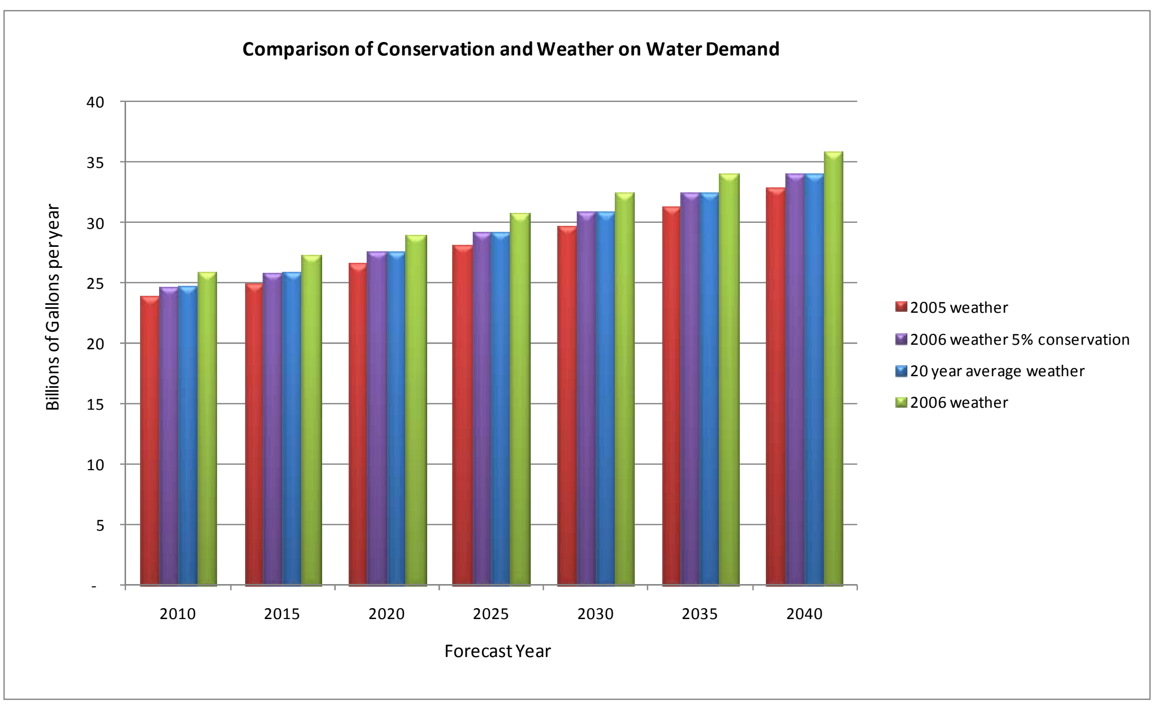
Comparison of Weather and Conservation Impacts on Demand

The Demand Model allows evaluation of alternative weather inputs. The demand projections presented thus far have been based on 20 year average temperature and precipitation. Figure 25 presents a comparison of total water demand projections based on the 20 year average with weather inputs based on 2005 and 2006. The change in weather inputs between 2005 and 2006 increased modeled demand by approximately 10%

Also presented are demand projections from a scenario with 5% conservation and 2006 weather inputs. Demand from this scenario is approximately equal to the demand with the 20 year average weather inputs and no conservation

This demonstrates the impact weather has on water demand and illustrates the difficulty in measuring the success of conservation efforts. The impacts of a successful conservation program can be masked by the impacts of weather on water use.

Figure 25 – Comparison of Conservation and Weather on Water Demand



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Appendix A
Tetra Tech & CDM Memo: Documentation of Water Demand Forecasting Model

Date:	June 28, 2010
To:	Mike Hermanson, Spokane County Division of Utilities—Water Resources
c:	*Bill Davis (CDM), Chris Hansen, Central Files*
From:	Cynthia Carlstad
Project No./Name:	Spokane County Contract #P6582, Consulting Services for Water Use Inventory and Demand Forecast
Subject:	Task 4 Deliverable Memo—Documentation of Water Demand Forecasting Model

This memorandum presents a summary of the methodology, data assumptions, and results of a comprehensive water demand forecast for Spokane County, Washington.

1. BACKGROUND

The objective of this analysis was to forecast the water demand for the forecast period 2008 to 2040 for the combined water users of Spokane County. The water demand forecast is designed to serve as a basis for supply and infrastructure decision making, as well as financial planning.

A water demand forecast model (demand model) was estimated based on water billing and production data, characteristics of self-supplied water users, demographic and socioeconomic data, and weather data. The countywide demand forecast was organized into the following sectors:

- Public-supply
- Self-Supply Residential
- Self-Supply Industrial
- Agriculture

This memo contains:

- Discussion of the spatial units used to delineate the Spokane County demand model
- Methodology employed for the demand model
- Review of the data used to develop the demand model and generate the water demand forecast
- Presentation of the results of the statistical regression analysis, which serves as the basis of the residential single-family portion of the demand model
- Data dictionary for each model component
- Summary of the results of the demand forecast

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2. WATER DEMAND FORECASTING METHOD FOR SPOKANE COUNTY

Given the data available for the Spokane County demand model, there were multiple forecasting methodologies employed in developing the forecast.

The residential single-family portion of the model was developed using the econometric water demand approach. Due to data gaps for multi-family residential, commercial/industrial, and agricultural datasets, a unit use approach was employed for these sectors. In some cases, a modified unit use was utilized in which the unit use factor is adjusted for weather or seasonality.

2.1 Single-family Water Use

An econometric approach statistically correlates sector water demands with factors that influence those demands. The econometric model relies on regression analysis to compute coefficients or elasticities that describe how a water use factor influences water demand. Regression analysis was used to analyze the variation in the dependent variable (y) in relation to the variation in independent variables (x_1, x_2, x_n). We assume there is an underlying relationship between the dependent and independent variables, and that each of the independent variables has an impact on the dependent variable.

Regression analysis determines the equation that provides the 'best fit' to the data. The best-fit equation minimizes the square of the differences between observed values of the dependent variable and estimated values of the dependent variable as estimated by the regression function. A regression analysis calculates elasticity values for each water use factor, or explanatory variable, used to explain the variation in water use.

The following is an example of an econometric equation:

$E(y) = a + b_1x_1 + b_2x_2 + b_nx_n$

Where:

E(y) = the expected value of dependent variable (y) as estimated by the function

a = intercept, or the value of (y) when x = 0

b = coefficient of x, or the change in y given a change in x

x = value of the independent variable

When data are transformed into the log form, the distribution of data values has a more normal (i.e., Gaussian, or "bell shaped") distribution (i.e., a log normal distribution). This situation permits the use of standard statistical significance tests that apply to normal distributions, and thus greatly facilitates the analysis. Also, the variable coefficients are directly interpretable as *elasticities*, which measure the responsiveness of the dependent variable to a change in the particular independent variable. For instance, a price elasticity of -0.10 implies that a ten percent increase in real price will result in a one percent decrease in water demand.

Based on the available data, two statistical models were generated, one for public-supplied single-family residential and one for self-supplied single-family residential. The independent variables are:

- Public-supply Single-Family Residential Water Use
- Self-supply Single-Family Residential Water Use

The explanatory variables with statistically significant relationships to public-supply single-family water use are:

- Monthly Binary Variables (seasonality of the forecast January-December)
- Service Area Binaries for the following water purveyors with unusual usage patterns:
  - Stevens PUD 25
  - Ridge Water Association
- Weather (maximum monthly temperature)
- Lot Size
- Large Lot Size Binary (to account for water use on lots > 3 acres)

The explanatory variables with statistically significant relationships to self-supply single-family water use are:

- Monthly Binary Variables (seasonality of the forecast January-December)
- Weather (maximum monthly temperature)
- Assessed Single-family Home Value relative to the county average
- Percent of forecast unit area with Low Well Yield (< 5 gallons per minute)

The results of these statistical analyses are shown in Tables 1 and 2. A number of statistics are generated to evaluate the acceptability, or "goodness of fit" for each function. A review of these statistics allows one to select the best equation, or model. The regression analysis statistics include the following:

- Observations—The total number of observation in the data set.
- R^2, or R-squared—R^2 is the coefficient of determination, and is a measure of the variation in (y) explained by the function, or how well the function "fits" the data. An R^2 of 1.00 would be optimal.
- Adjusted R^2—The adjusted R-square is used if there are more than one independent variables in the function.

The regression statistics also include statistics for each independent variable included in the function. Statistics are included for the intercept, as well. Note that the "intercept" value would be the estimated value of E(y) if all the independent variables had values of zero. The standard error and t-statistic for the intercept coefficient have little meaning. For each independent variable, the regression analysis estimates the following statistics:

- Parameter Estimate—The parameter estimate, or coefficient, represents the change in the dependent variable (y) corresponding to a change in the independent variable (x). For example, a coefficient value of 0.30 indicates that a 10 percent increase in (x) results in a 30 percent increase in (y). The coefficient may be positive or negative. A negative coefficient indicates that as the value of the independent variable increases, the value of the dependent variable decreases.

- Standard Error—The Standard Error (SE) of the coefficient is used to test the significance of the individual coefficient. The SE is also called the standard deviation. The smaller the SE, the better. A general level of acceptance is an SE less than 0.05.
- t-Statistic—The t-statistic is calculated as the coefficient divided by the standard error. The larger the t-statistic, the better. Generally, the t-statistic should be at least 2.00.
- P value—The P-value is the probability that the t-statistic is significant, or that the parameter estimate is non-zero. The t-statistic is acceptable with 95 percent confidence when the significance value is 0.05 or less, indicating a statistically significant relationship between the independent and dependent variable.

Table 1
Public Supply Residential Demand Model

Number of Observations				2032
Adj. R-Square				0.8231
Explanatory Variables	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > | t |**
Intercept	2.9521	0.26419	11.17	<.0001
Monthly Binaries				
May	0.66225	0.04415	15	<.0001
June	1.18467	0.04842	24.46	<.0001
July	1.50395	0.05459	27.55	<.0001
August	1.63356	0.05385	30.34	<.0001
September	1.49405	0.04806	31.08	<.0001
October	0.84976	0.03848	22.08	<.0001
Service Area Binaries				
Ridge	2.49656	0.07569	32.99	<.0001
Stevens PUD 25	-0.7404	0.07494	-9.88	<.0001
Weather				
Log (Maximum Temperature)	0.41004	0.06081	6.74	<.0001
Other Variables				
Log (Lot Size)	0.15694	0.01251	12.54	<.0001
Log (Average Household Size)	1.25574	0.16501	7.61	<.0001
Large Lot (>3acres)	-0.16306	0.05155	-3.16	0.0016

Table 2 Self Supply Residential Demand Model				
Number of Observations				173
Adj. R-Square				0.7404
Explanatory Variables	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > | t |**
Intercept	2.94289	0.93114	3.16	0.0019
Monthly Binaries				
May	0.39002	0.18097	2.16	0.0326
June	1.0039	0.20034	5.01	<.0001
July	1.41682	0.22531	6.29	<.0001
August	1.44064	0.21945	6.56	<.0001
September	1.20399	0.19665	6.12	<.0001
October	0.325	0.14974	2.17	0.0314
Weather				
Log (Maximum Temperature)	0.38762	0.25182	1.54	0.1257
Other Variables				
Log (% < 5gpm +1)	0.21285	0.04428	4.81	<.0001
Log (Relative Assessed SF Value)	2.28232	0.26284	8.68	<.0001

2.2 Multi-Family Water Use

For the remaining forecast sectors, the unit use approach was employed. For public-supplied multi-family sectors, available historical water use data by purveyor was used to estimate the average gallons per day per unit (gpdu) water use for multi-family housing units. Monthly historical multi-family water use data was available for Airway Heights and the City of Spokane. Average winter water use per unit was calculated for each purveyor and distributed to the respective forecast units. For those forecast units served by both Airway Heights and the City of Spokane, a weighted average unit use was calculated based on areas served. For all other forecast units, the overall average water use per unit of Airway Heights and the City of Spokane was used. The assigned unit use (gpdu) for each forecast unit was multiplied by the number of multifamily housing units in the forecast unit.

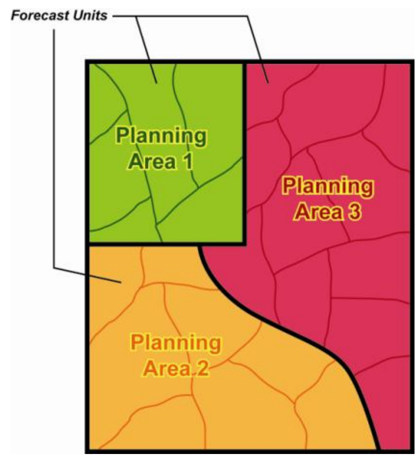
2.3 Non-residential Water Use

Demographic employment data was utilized for commercial and industrial water use. The gallons per employee per day (ged) water use factors were derived from a proprietary data set of establishment level water use and employment data compiled by CDM. The data were summarized by SIC code and published in IWR-MAIN 6.0: User's Manual and System Description, Appendix D. Planning and Management Consultants, Ltd. (1994). CDM recalculated the water use factors by NAICS code after the transition from SIC to NAICS classification of employment and businesses. The database was regrouped and water use factors recalculated to match the employment classifications used by the Spokane Regional Transportation Council. The employment by group for each forecast unit is multiplied by the corresponding ged water use factor.

3. DATA SOURCES AND ASSUMPTIONS

The water demand model requires data to describe water use and factors that influence water use both spatially, and by type of use. This may draw from many different types of data, including demographic, land use, weather, and the nature of water use (i.e. for a single-family residential land use such factors as lot size, home value, and water source may influence the quantity of water use). The types of data collected for the Spokane County water demand model are described below.

3.1 Spatial Data

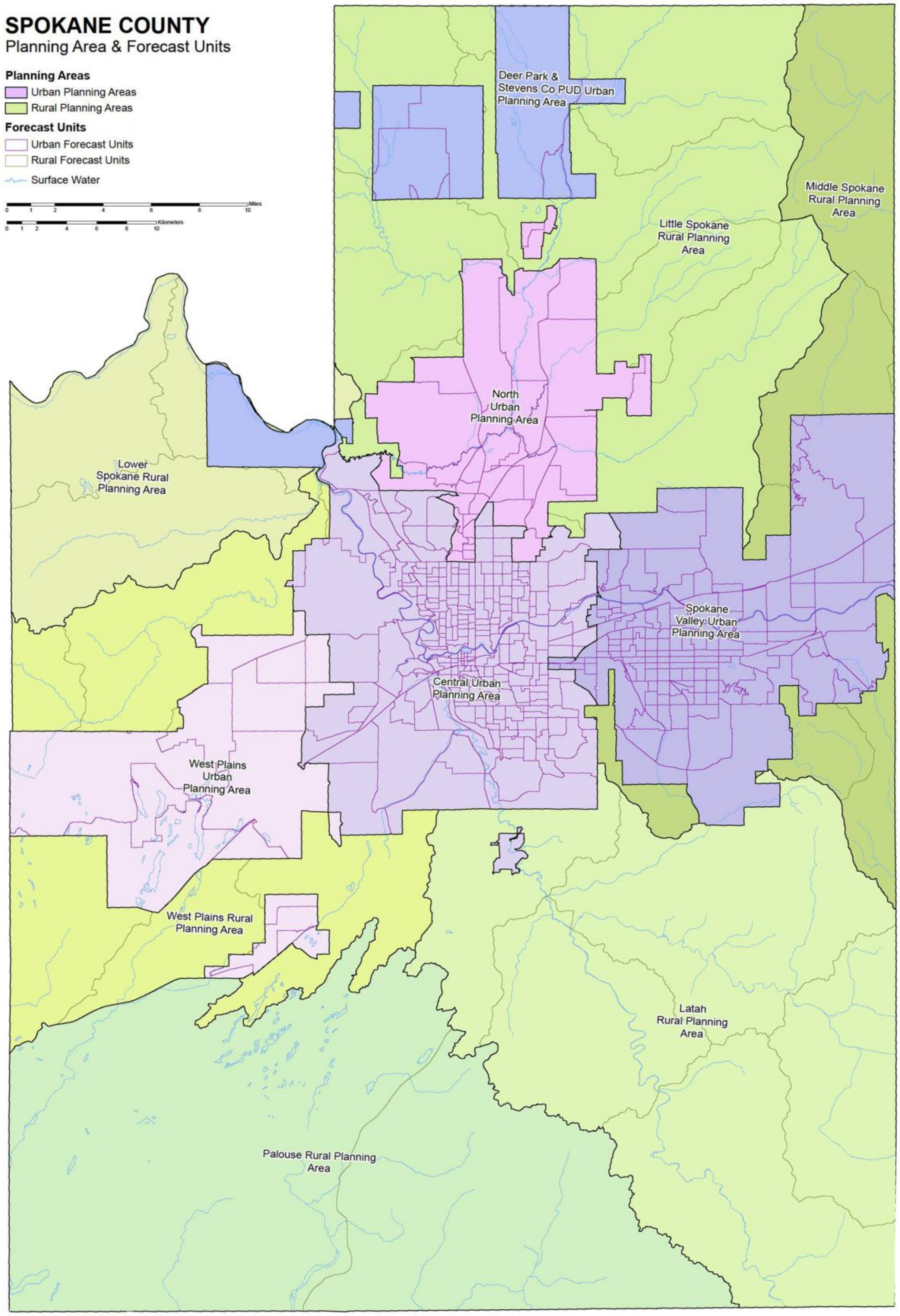


Two types of spatial units were delineated for the Spokane County water demand forecast model. Delineation of these forecast units and planning areas was an important early step in developing the water demand forecast model for Spokane County:

- The *forecast unit* is the base model unit. Within each forecast unit, model demand drivers (housing units, population, etc) and demand factors (weather, house size, etc) are considered homogeneous. For example, home size is averaged within a forecast unit and used as a model input. The forecast unit should be small enough to incorporate variation within the county.
- *Planning areas* are groupings of forecast units into regions that facilitate planning. Model parameters for each forecast unit within a planning area may be set the same or individually.

The following is a description and rational for the delineations of the forecast units and planning areas for the Spokane County water demand forecast model, as illustrated in Map 1:

- **Urban Planning Areas—**The area proposed to be served by public water systems in the Spokane County Coordinated Water System Plan (CWSP) is the urban planning area. Forecast units within the Urban Planning Areas are based on the Transportation Analysis Zone (TAZ) boundaries and the CWSP boundaries. The main considerations support the use of the TAZ boundaries are: (1) TAZ units are small enough to provide the detail to achieve project objectives; (2) TAZ units provide a comprehensive and uniform data set with which to work; (3) TAZ data is the most current data set available; and (4) demographic projections are available by TAZ. TAZ data was generated locally and the raw data and methodology can be researched to resolve any issues or discrepancies encountered during the project. In locations where TAZ and CWSP boundaries do not coincide, a procedure to apportion the TAZ data was utilized. The following Urban Planning Areas have been delineated:
  - Central—primarily the City of Spokane service area
  - Spokane Valley—all service areas east of the City of Spokane service area
  - West Plains—all service areas west of City of Spokane service area
  - North—all service areas north of the City of Spokane service area
  - Deer Park and Stevens PUD—northern county and south of the Spokane River downstream from Spokane



Map 1. Spokane County Planning Areas and Forecast Units

- **Rural Planning Areas—**Rural Planning Areas are those areas of the County that are outside the CWSP proposed public water service boundaries. For Rural Planning Areas, forecast units are the Washington Department of Natural Resources Watershed Administrative Units (WAUs). WAUs are subwatershed units. Use of a watershed-based forecast unit in rural areas will best facilitate analysis of potential strained water resources since water use in these areas is typically more closely connected to the surface and groundwater within the local watershed. One exception to using the WAU-based forecast unit is in the West Plains region of the county where WAUs do not accurately represent groundwater flow. The Rural Planning Area was manually delineated for the West Plains. Demographic projections available by TAZ were aggregated into WAUs for the rural forecasting units. The following Rural Planning Areas have been delineated:
  - Little Spokane
  - Middle Spokane
  - Lower Spokane
  - Latah
  - Palouse
  - West Plains

Table 3 summarizes the data used to delineate the forecast units and planning areas for the Spokane County water demand forecast model.

In order to apportion TAZ data across the forecast units an analysis was performed in GIS. Spokane County Assessor's data was used to determine both current and future land uses within the county at a parcel level. Future land uses were determined by county zoning. These land uses were parsed into five land use categories that could translate into the TAZ demographic projections, and included Single-family Residential, Multi-family Residential, Commercial, Industrial, and Institutional. An overlay of land use data, TAZ boundaries, and Forecast Unit boundaries was used to determine the portion of TAZ data from each land use that resided within the forecast unit. These portions were applied across TAZ data and aggregated to represent demographic projections at the forecast unit level.

3.2 Water Use Data

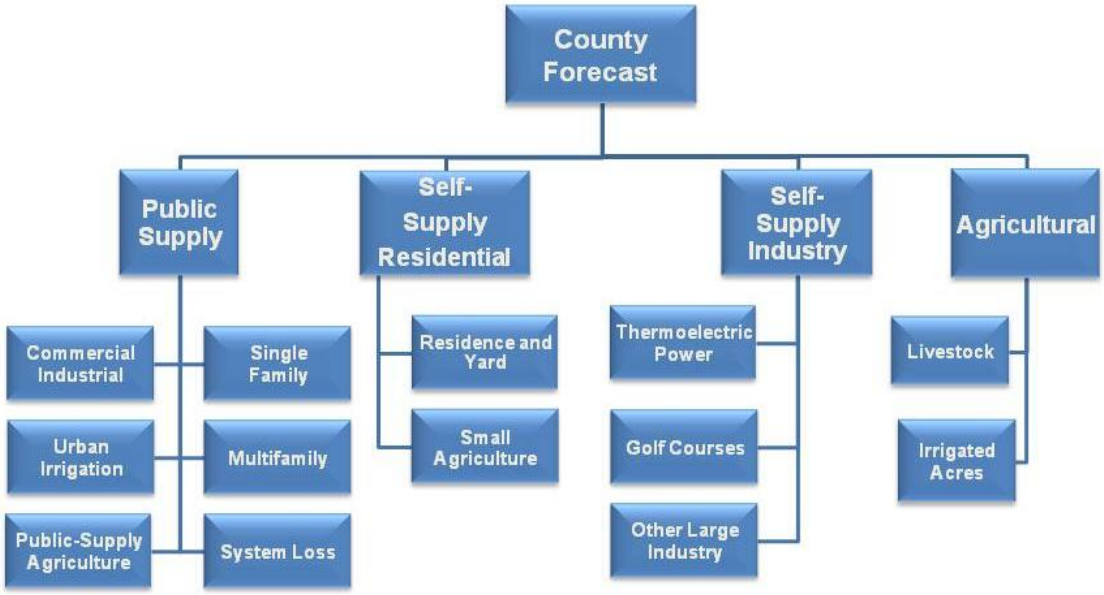
Data used to analyze water use, both historical and predicted future, includes data from metered water use and data describing factors that influence water use for specific water use sectors. The Spokane County water demand forecast model was developed with the sector structure shown in Figure 1.

Data categories can be classified as the following:

- Direct—measured data such as weather data, population data, and metered water use data.
- Supporting—Data such as the landscape irrigation inventory and water use survey were used to support, refine, and confirm analysis based on direct data.

TABLE 3.
AVAILABLE DATA SOURCES FOR DELINEATION OF FORECAST UNITS

Data	Assessment of Quality and Usability
TAZ (Transportation Analysis Zones)	• Source: Spokane Regional Transportation Council (SRTC) • Quality: The spatial accuracy of TAZ boundaries is unknown. The attribute accuracy (dwelling units and employment data for 2008, 2015, and 2030) is the best available. • Usability: Very usable for offering relevant data within the entire county. The TAZ boundaries within the urban planning areas are small enough to model urban areas. The large size of the TAZ boundaries in the rural areas were not adequate for modeling rural water use; however, the data within the TAZ polygons are considered best available for both urban and rural areas.
CWSP (Consolidated Water System Plans)	• Source: Spokane County • Quality: The CWSP polygons include existing service areas for water purveyors as well as planned expansion areas. The boundaries were digitized by Spokane County with input from each purveyor. The accuracy of these boundaries is not documented. • Usability: Very usable within the urban area forecast units to compile existing and projected water use data for each purveyor.
WAU (Watershed Administrative Units)	• Source: Washington Department of Natural Resources • Quality: The WAU boundaries were used as a foundation for developing rural forecast units (as opposed to TAZ boundaries). The spatial accuracy of WAU boundaries is unknown. • Usable: Very usable for creating rural forecast units, as several areas' water use patterns are specific to watersheds.
Parcels	• Source: Spokane County • Quality: Parcels are used as the smallest geographic units. They are easily characterized by current land use and used to create polygons "nested" within TAZ boundaries to assist the disaggregation of TAZ data. The land use codes are fairly accurate, according to County Staff. Spatial accuracy is variable based on local survey control. • Usability: Very usable for disaggregating data otherwise available in only larger units.



**Note that a Loss and Leakage percentage was added to the self-supply residential, self-supply industrial, and agricultural sectors.*

Figure 1. Structure of the Spokane County Water Demand Model

3.2.1 Direct Data

The water demand model was developed from a variety of data sources. The validity of each data source was assumed to be accurate and not thoroughly evaluated. The major data sources used in the development of the water use characterization and forecasting model for each water use sector are summarized below.

Water Use Data included historical monthly water use data as provided by purveyors.

- Single-family water use data: Airway Heights, City of Spokane, IVEWA, Pasadena Park Irrigation District, Ridge at Hangman, multiple Stevens PUD systems, and multiple Whitworth zones
- Multi-family water use data: Airway Heights and City of Spokane
- Non-residential water use data: Airway Heights, City of Spokane, Consolidated Support Services, and Whitworth
- Public supply agricultural data: Consolidated Irrigation District, Moab
- Urban irrigation data: water use records and digitized land area for cemeteries, schools, and parks for Spokane County

3.2.2 Supporting Data

- **Residential water use survey—**Spokane County lead. Approximately 1,300 survey responses, distributed throughout Spokane County, were submitted. These surveys provide information on residential water use characteristics, both purveyor-supplied and self-supplied. Survey results guided unit use quantities used in the model for hobby farm livestock and low well yield water use.

- **Landscape irrigation study**—WRIA 56 lead. Study area is Spokane County portion of WRIA 56. Self-supplied residences only. Digitized “yard” area. Does not include irrigated agriculture. Statistical analysis to show any correlation between parcel characteristics and area of irrigated landscape (independent variables parcel size, improvement value, year built, and residence size) between subbasins. This study was used in combination with the residential water use survey to inform size of landscaping associated with self-supplied residences.
- **USGS MODFLOW Groundwater Model—**Models groundwater flow through the SVRP and impact to Spokane River. Spokane County staff developed data to evaluate full use of inchoate water rights impact to aquifer levels and river flow. (See spreadsheet: Inchoate Rights.xls)
- **Watershed Plan Data—WRIAs 55/57, 56, and 54**—Includes estimates for number of permit exempt wells, livestock. Presents water use data for self-supplied industrial users.

3.3 Historical Weather Data

Weather data was collected from the Western Regional Climate Center website (www.wrcc.dri.edu/index.html). The four weather stations with available climate data in Spokane County were Cheney, Deer Park 2 E, Spokane, and Spokane WSO Airport. Deer Park is located in the northern portion of Spokane County, Spokane and Spokane Airport in the central portion and Cheney in the southern portion. Data chosen for analysis was maximum monthly temperature and total monthly precipitation. Each station had varying periods of record for this data. The analyzed periods of record are recorded below for each station:

- Cheney: 1938-1954 (data was available starting in 1899, but little data exists between 1899-1938)
- Deer Park: 1912-1976
- Spokane: 1954-1982
- Spokane Airport: 1889-2009

Based on analysis of the available data, it was determined that historical weather patterns at the Spokane Airport weather station are representative of the entire county. While there are slight variations in weather patterns in Spokane County, these variations are not significant for the level of analysis being completed for this task and occur in the winter months when water use is not affected by weather patterns. As a result, maximum monthly temperatures and total monthly precipitation amounts for the Spokane Airport weather station will be held constant countywide.

3.4 Agricultural Data

Data from the US Census of Agriculture included countywide animal inventories and irrigated crop acreage for 1997, 2002, and 2007. NRCS State of Washington Irrigation Guide (1992) was used to determine irrigation efficiencies for the region.

Data obtained from Spokane County staff includes an inventory of agriculture and livestock derived from the WRIA 55/57 Watershed Plan. Additionally, data from the Residential Water Use Survey (described above) includes information regarding horses and cattle on small hobby farms in self-supplied rural areas of Spokane County.

4. DEMAND MODEL

The following is a review of the demand model with data sources and assumptions; each bullet corresponds to a worksheet "tab" within the Microsoft Excel spreadsheet forecasting model:

- **Forecast Unit (FCU) Demographics**: The first worksheet of the model is the calculated demographics, county-wide by planning area and forecast unit. The data contains the number of single-family dwelling units (SFDU), multi-family dwelling units (MFDU), hotel employees (HOTELS), industrial employees (INDUST), non-central business district retail employees (NON_CBD_RETAIL), office based employees (OFFICE), financial, insurance, real estate and services employees (FIRES), medical based employees (MED), central business district retail employees (CBD_RETAIL), students (STUDENTS), school faculty (EDUCATION), and university students and faculty (UNIVERSITY). These data sets contain values for 2008, 2010, 2015, 2020, 2025, 2030, 2035, and 2040. The data for 2008, 2015, and 2030 were provided by Spokane Regional Transportation Council and distributed to forecast units by Tetra Tech. Data for 2010, 2020, 2025, 2035, and 2040 were calculated using interpolation and extrapolation equations.

  This worksheet also contains single-family residential lot size (LotSizeSFR) and multi-family residential lot size (LotSizeMFR), both collected from county assessor's office records. The large lot binary is included to distinguish lots greater than 3 acres and is used in the public-supply single-family residential portion of the model. 2000 Census data was used to compute population by forecast area (POP2000), number of households (HOUSEHOLDS), average household size (AVE_HH_SZ), number of families (FAMILIES), average family size (AVE_FAM_SZ), and median household income (MED_HH_INCOME).

  Additionally, the dataset contains assessed value of single-family homes (ASSESS_SF), relative assessed value (REL_ASSESS_SF), and assessed value of multi-family homes (ASSESS_MF). Data provided by the Spokane County Division of Utilities includes the percent of forecast unit area with low yield wells (percentAREA<5gpm) and the percent of the forecast unit that is forested (FOREST). The last columns of the spreadsheet contain the number of acres where urban irrigation is utilized (Urban_Irr), which generally includes parks, schools, and cemeteries; the final column contains the number of acres utilized for urban agriculture (Urban_Ag). Urban irrigation estimates were provided by Spokane County Division of Utilities, Urban agriculture estimates were based on data from Consolidated Irrigation District and Moab Irrigation District.

- **CWSP Areas**: This worksheet contains a breakdown of water service providers by planning area and forecast unit. It also contains the number of acres served by each provider as well as denotation as urban or rural. This data was provided by Spokane County.

- **Weather**: This worksheet was used to determine the seasonality of the forecast, and contains the following tables:

  – *Table 1* illustrates Spokane County Seasonality. This data was computed based on data collected from the Western Regional Climate Center. Data collected included historical maximum monthly temperature and historical monthly precipitation from the Spokane County Airport weather station. Monthly totals are given for 2008, a 20-year average (1988-2008), as well as a future departure from the normal. Percentages may be added to the future departure columns of the worksheet to use in future climate change analysis.

  – *Table 2* gives seasonality values for single-family and multifamily residential and non-residential. May-October monthly percentage increases in water use were computed using historical water use data. An average percentage increase for each sector and month was calculated. This data shows increases in water use during summer months likely due to irrigation.
  – *Table 3* shows the seasonality of urban irrigation in Spokane County. This data was calculated based on summer urban irrigation estimates from June-September provided by Spokane County Division of Utilities.
  – *Table 4* is used to illustrate the seasonality of self-supplied industrial water users. While water use by thermoelectric and industry remain steady based on assumptions of little to no irrigation use by users, golf courses are expected to use the majority of their water during the summer months for irrigation purposes.

- **Single-family (SF) Model**: This worksheet contains the results of regression analysis used to compute the parameters for the single-family residential water use model. The worksheet contains values for variables and binaries used in both the public-supply and self-supply single-family models.
- **Water Use**: This worksheet contains the residential and non-residential water use values.
  – Single-family water use was calculated for public-supply and self-supply using the results of the regression analysis (SF Model Worksheet). These values take into account variables such as seasonality, lot size, and/or assessed value. The results of these calculations give water use as gallons per day per unit (gpdu).
  – Multi-family water use was calculated based on historical multi-family water use provided by Airway Heights and the City of Spokane. Average winter water use was distributed to the forecast areas serviced by these providers and the average winter water use of both providers was distributed to those forecast areas not serviced by either Airway Heights or City of Spokane. For forecast units serviced by both Airway Heights and City of Spokane, a weighted average was calculated based on area serviced. These calculations all resulted in water use as gpdu.
  – Nonresidential water use was derived from a proprietary data set of establishment level water use and employment data compiled by CDM. The database was regrouped and water use factors recalculated to match the employment classifications used by the Spokane Regional Transportation Council. These calculations resulted in water use by gallons per employee per day (ged).
  – Urban irrigation estimates were based on data provided by Spokane County Division of Utilities and the 2005 Estimated Water Use in Washington Report compiled by USGS. Urban agriculture estimates were derived from 2007-2009 data provided by Consolidated Irrigation District and Moab Irrigation District. These water use values are given in gallons per day (gpd)/acre.

- Non-revenue water (NRW) percentages are based on average water loss by water system providers. Based on this data, a non-revenue water loss of 10 percent is assumed throughout the model.

- **Percent Served**: Percent served single-family and multi-family data was compiled by the Spokane County Division of Utilities. This worksheet provides the percent of single-family and multi-family households served by public water suppliers by forecast area. Spokane County staff provided information stating that all multi-family units county-wide are served by public-supply providers. The data in this worksheet reflects that information. It is assumed in this model that all users not served by a public water supplier are self-served water users.

- **Public-supply (PS) Forecast**: The public-supply sector of this forecast was derived by multiplying the water use calculations by their respective unit. For example, residential single-family water use was multiplied by the number of residential single-family units within each forecast unit. This number was then multiplied by the percent served by public-supply water providers. These calculations resulted in the number of gallons per day of water use. Seasonality was computed into the single-family water use based on the results of the regression analysis; however, seasonality is added to the forecast for multi-family and non-residential users by incorporating the seasonality on the weather worksheet. Water use is provided for the years 2008, 2010, 2015, 2020, 2025, 2030, 2035, and 2040. Monthly water use was derived for single-family residential, multi-family residential, commercial and industrial, urban irrigation, and urban agriculture. A system loss of 10 percent is added to the total water use for each year.

- **Self-supplied Residential (SS RES)**: The self-supply residential sector of this forecast was derived similar to that of the public-supply residential sector. The estimated unit use was multiplied by the number of units by forecast area. These values were then multiplied by the difference of the percent served by public-supply (%PS/(1-%PS)), to derive the total residential water use served by self-supply. Total water use is provided monthly for the years 2008, 2010, 2015, 2020, 2025, 2030, 2035, and 2040. The residential forecast includes single-family and multifamily residences and also assumes a system loss of 10 percent.

- **Self-supplied Agricultural (SS AG)**: The self-supplied agricultural sector of this forecast was derived using Residential Water Use Survey data collected by Spokane County staff. Based on the results of a survey of self-supplied water users, it was concluded that an average of 11 percent of self-supplied households have small hobby farms with an average of 3 head of horses or cattle. This information, along with an average U.S. Department of Agriculture (USDA) water requirement of 12 gpd per head of livestock, was used to derive the self-supplied agricultural forecast. Water use in gpd is given monthly for all years of the demand forecast.

- **Self-supplied Industrial Units (SS IND Units)**: This worksheet was used to calculate water use (GPD) for self-supplied thermoelectric, golf course, and large industry users. Locations of these users by forecast unit was provided by Spokane County staff. This data along with derived and estimated water use by user is used to derive the water use on this worksheet.

- **Self-supplied Industrial Total (SS IND TOTAL)**: This worksheet uses the data from SS IND Units worksheet to calculate the total self-supplied industrial water use by forecast unit. The GPD water use is given monthly with seasonality incorporated using Table 4 from the weather worksheet of the demand model. Water use is given for all forecast years and losses are assumed to be 10 percent.

- **Self-supplied Total (SS TOTAL)**: The total self-supplied water use is calculated on the worksheet. These values are the total water use including self-supplied residential, self-supplied agricultural and self-supplied industrial. Data is given monthly for all forecast years.
- **County Agriculture (County Ag)**: This worksheet contains county-wide agriculture data taken from the 2007 Census of Agriculture, the State of Washington Irrigation Guide (1992, NRCS), and Estimated Water use in Washington, 2005 (USGS). Data from this worksheet utilized in the county-wide agriculture forecast includes crop irrigation seasonality, weighted crop irrigation requirements, irrigation efficiency, and livestock water demands. Annual average growth rates in livestock and irrigation are included for 1997-2007; however, based on requests from the Water Demand Forecast Advisory Committee, agricultural growth is kept constant in this version of the demand model. USDA growth rates may be used in later versions of the model if so desired by the County.
- **Livestock Worksheet (Livestock WS)**: This worksheet is used to calculate values used in the agricultural forecast. Non-Urban Growth Area (UGA) Parcel Distribution was used to distribute animal counts taken from the 2007 USDA Census of Agriculture. This parcel distribution was provided by the Spokane County Division of Utilities. Using this information, animal counts were distributed throughout the rural areas of the county by forecast area. Once distribution is complete, these values are multiplied by the water requirement by animal type (taken from USDA estimates) to give the total GPD livestock water requirement by forecast unit.
- **Agriculture Units (AG Units)**: This worksheet is used to calculate total annual agricultural water use by forecast unit. The total number of irrigated acres by forecast unit was provided by the Spokane County Division of Utilities. Based on requests from Water Demand Forecast Advisory Committee, annual projected growth in the number of irrigated acres is kept constant throughout the forecast years (zero percent growth). The irrigation water requirement is derived by multiplying the number of irrigated acres by the weighted crop irrigation requirement. To include losses and efficiency into the irrigation model, the water requirement is then multiplied by the statewide weighted crop irrigation efficiency. Annual growth in livestock was also assumed to have zero percent growth throughout the forecast years. Leaks and losses for livestock were assumed to be 10 percent of the total water requirement.
- **Agriculture Model by Forecast Unit (Ag FCU)**: The agriculture sector of the demand model is derived in this worksheet. Monthly water requirements for irrigation are derived based on seasonality found in the County Ag worksheet. Monthly water requirements for livestock are assumed to have no seasonality. County-wide agricultural water use is given for all forecast years for irrigation, livestock, and total agriculture.
- **Total by Forecast Unit (Total by FCU)**: This worksheet derives the total water use for all sectors of the demand model. This includes monthly totals for public-supply, self-supply residential, self-supply industry, and agriculture, as well as county-wide total water use for all sectors combined. This data is calculated for all forecast years by forecast unit.

- **Total by Planning Area (Total by PA)**: This worksheet contains all the information contained within the Total by FCU worksheet, but is sorted by planning area and provides total water use by planning area.
- **Summary (Summary Output)**: This worksheet contains summary tables and charts shown in the following section of this document.

5. RESULTS

Total county-wide water requirements increase from approximately 236,500,000 gallons per day in 2008 to approximately 312,200,000 gallons per day in 2040. These results by sector are summarized in Table 4.

TABLE 4.
SPOKANE COUNTY WATER USE BY SECTOR

	Total Water Use (gallons/day)							
	2008	2010	2015	2020	2025	2030	2035	2040
Public-supply	158,126,336	161,937,356	171,464,907	182,799,004	194,133,102	205,467,199	216,801,296	228,135,394
Self-supply Residential	12,289,823	12,550,012	13,200,495	14,145,690	15,090,907	16,036,123	16,981,340	17,926,557
Self-supply Industrial	37,248,921	37,248,921	37,248,921	37,248,921	37,248,921	37,248,921	37,248,921	37,248,921
Agricultural	28,841,704	28,841,704	28,841,704	28,841,704	28,841,704	28,841,704	28,841,704	28,841,704
Total	236,508,792	240,580,003	250,758,042	263,037,339	275,316,658	287,595,978	299,875,297	312,154,616

Figure 2 presents the data in Table 4. While agriculture and self-supply industrial water use remain constant throughout the demand forecast, public-supply and self-supply residential water use are projected to increase over time.

Figures 3 and 4 present county-wide water use by planning area for 2008 and 2040, respectively. The data are broken down into sector use by public-supply, self-supply residential, self-supply industrial, and agricultural. These figures represent total sector water use by planning area. As illustrated, rural planning areas tend to have high self-supply and agricultural use, while urban planning areas tend to have high public-supply water use. Figure 3 represents total water use for 2008, Figure 4 represents total water use for 2040.

Figure 5 presents Spokane County total water use by planning area. Based on this figure, Central Urban Planning Area and Spokane Valley Urban Planning Area account for the largest percentages of total water use, county wide.

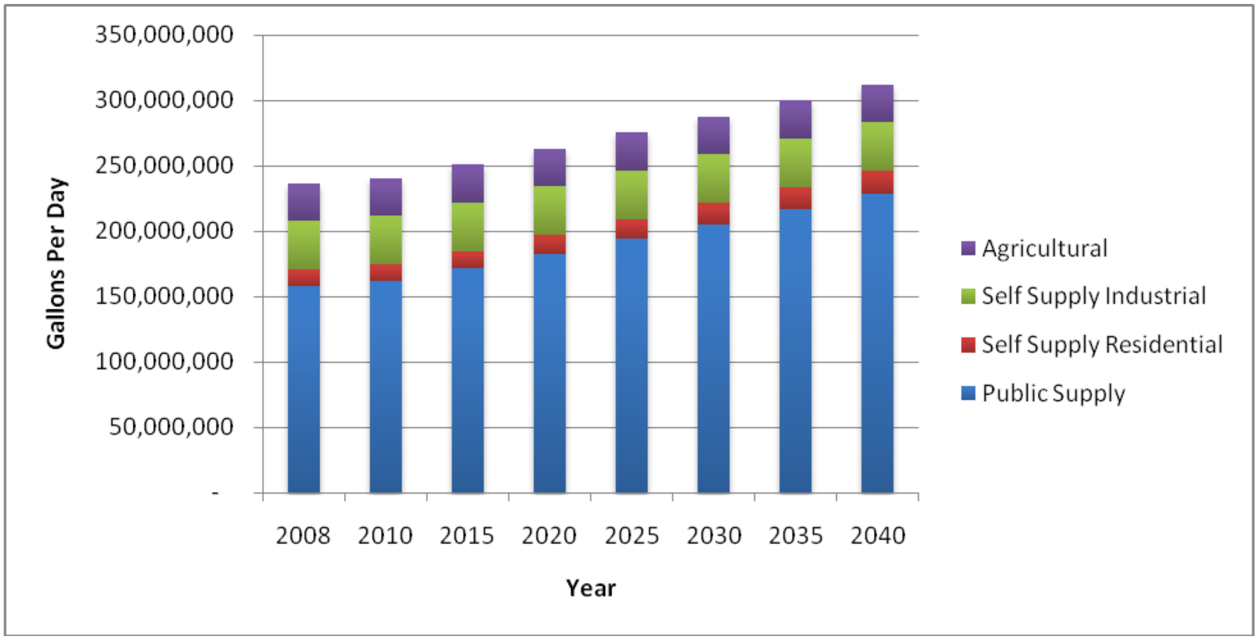


Figure 2. Spokane County Water Use

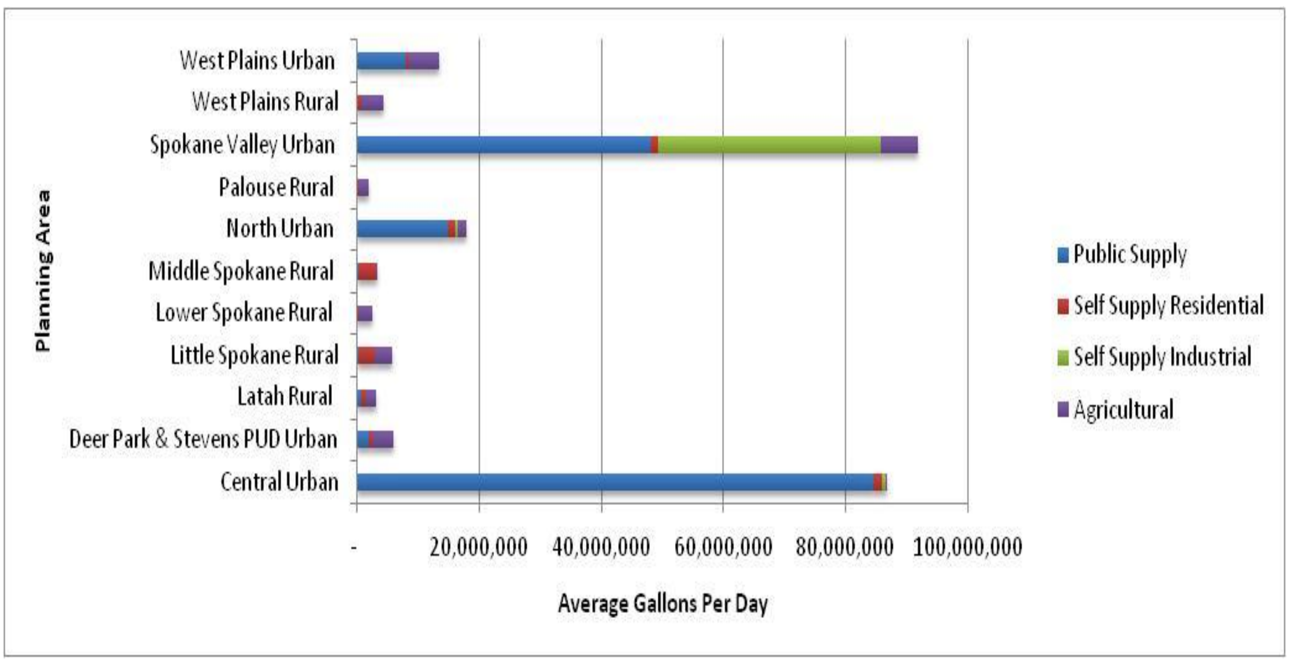


Figure 3. 2008 Spokane County Water Use by Planning Area

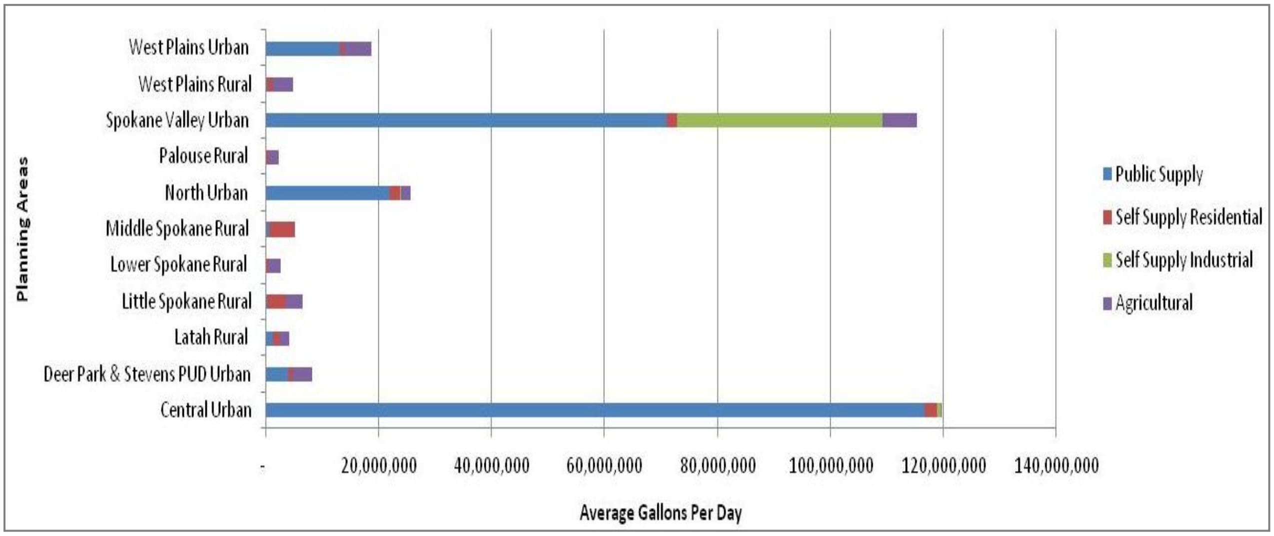


Figure 4. 2040 Spokane County Water Use by Planning Area

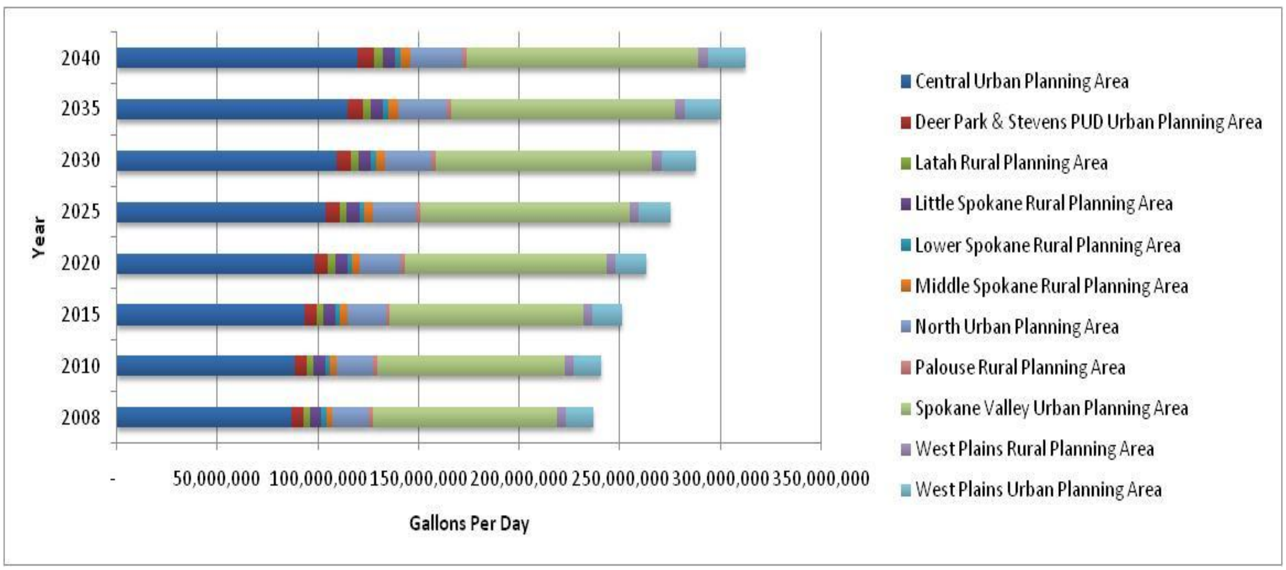


Figure 5. Spokane County Total Water Use by Planning Area

6. CONCLUSIONS AND RECOMMENDATIONS

The Spokane County water demand forecast indicates that water demand is predicted to increase by over 24 percent by the year 2040 without climate change or regional conservation measures.

Also, it is important to understand that these statistical ranges in demand forecasts are based on a set of assumptions regarding data inputs. The range in data inputs may not reflect the entire possibility of outcomes. CDM relied on the best planning information available in setting these ranges, and used professional judgment when planning information was not available. It is strongly recommended that these data inputs be revisited at least every 5 years in order to evaluate the short and long term trends of demographics, home values, and lot sizes. In addition, any future conservation programs beyond those already implemented in the region may alter water use.

The water demand forecasting tool (i.e., spreadsheet model) described in this memorandum is designed to be easily updated as better data become available. With the level of information currently input into the water demand forecast tool, the County can evaluate general water use patterns and trends within the county for general planning purposes. It is highly recommended that the model inputs continue to be validated and refined.

Appendix B
Technical Advisory Committee
Meeting Summaries

MEETING SUMMARY

Spokane County Water Use Inventory and Demand Forecast

Advisory Committee Meeting #1

January 26, 2010, 10:00 a.m. - noon
Spokane County Public Works Building, Conference Room 2B

Meeting Purposes—*Bring together regional water supply stakeholders to: 1) learn about the regional water use inventory and demand forecast model being developed by Spokane County; 2) discuss data needs and available data for the forecasting model; 4) provide input on goals and objectives for the model; and 4) consider continued participation on the advisory committee for this project.*

Welcome and Introductions

Cynthia Carlstad opened the meeting at 10:00. She introduced the water demand forecast project team:

- Mike Hermanson, Spokane County project manager
- Rob Lindsay, Spokane County Water Resources Section manager
- Cynthia Carlstad, Tetra Tech project manager
- Bill Davis, CDM demand forecast model lead
- Chris Hansen, Tetra Tech GIS manager and data specialist.

Project Overview

Cynthia provided a brief slide show introducing the water use inventory and demand forecast project.

> Water demand forecasting done for the three regional watershed plans (WRIAs 55/57, 56, and 54) used simplistic methods that do not truly answer the question "How much water will be needed to support future consumptive water uses" Also, little data exists about the magnitude of actual rural residential water uses, and perceptions vary widely about the water use habits of rural self-supplied water users. Some of these land uses occupy the urban growth fringe, possibly leading to problems with permit-exempt wells. Water system plans done by individual water purveyors address the future water supply needed to support the utility's projections; however these plans may use different methodologies and planning horizons, which do not lend itself to a uniform, comprehensive forecast for the entire Spokane County region.
>
> Some of the benefits of having a model to forecast future water needs include:
>
> - Answers the question "how much water will be needed in the future"
> - Provides a tool for "what-if" scenarios
> - Consistent forecast assumptions/data across the region
> - Provides a means to fine-tune understanding of factors that influence water use
>
> Cynthia showed an example from the City of Miami where the water use among single family residences varied greatly within a small area. This example shows how it is important to understand the underlying factors that influence water use, such as land value, lot size, etc.
>
> The Spokane County Water Use Inventory and Demand Forecast will address all of Spokane County. The deliverable product from this effort will be a spreadsheet-based

model that can be used to forecast future water demand, and a baseline demand forecast. The project must be completed by June 30, 2010; this schedule is driven by grant deadlines for the project funding.

Project elements include the following:

- Develop goals and objectives for the model
- Identify, obtain, and evaluate data sources – water usage, population growth projections, land use, climate, etc.
- Analyze available data and develop preliminary water demand forecast model – spreadsheet-based model
- Use model to develop preliminary water demand forecast
- Training on model
- Advisory Committee participation – six meetings are currently envisioned

The role of the advisory committee will be to provide input on goals and objectives, water use sectors and factors that influence water use in Spokane County. The project team will seek data from purveyors and other stakeholders, and will also want input from the advisory committee on validity of data and use of information. Throughout development of the model, the advisory committee will act as a sounding board for draft model components.

Introduction to Water Demand Forecasting Methodologies

Bill Davis provided an introduction to water demand forecasting methodologies:

The following is an objective for a previous forecast model:

> "Develop a water demand forecasting model that predicts water demand based on known drivers and appropriate water demand factors, with the understanding that this is a "regional" forecast and not a utility forecast"

The following table to contrasts utility forecasting and regional forecasting.

Regional Forecast	**Utility Forecast**
Used to assess demands at a regional and sub-regional levels	Used to size and time facilities, and identify utility-level water supply needs
Represents a consistent forecast approach, rather than adding individual utility forecasts together	Based on specific utility conditions, drivers, and factors
Presents water demands at a 30,000-foot level	Demand forecast is more detailed, both geographically and in terms of precision

Bill introduced the following terminology that will be used throughout this project:

- Sector: Represents typical utility billing categories (e.g., single-family, multifamily, non-residential
- Drivers: Represents the major forces that "drive" water demands, such as population, housing, employment
- Unit Use Demand: The per unit water demand that results from dividing the total demand for a specific sector by that sector's driver
- Factors: Represent variables that are known to influence unit use demand, such as weather, price, income and others
- Elasticity**:** A statistical rate of change that describes how a water use factor influences demand. A price elasticity of -0.10 means that a ten percent increase in real price will result in a one percent decrease in water demand

Many different things influence demand. Population is a major influence, and is commonly used to project water needs. Weather, land use, housing density, and employment are some of the other factors that influence demand. Other factors, specific to an area may also be identified. The general approach to water demand forecasting is to identify observable relationships between factors and water use, then develop a mathematical model to describe the causal relationship.

Water uses can be categorized into potable, raw, and in-stream, then disaggregated into sectors and end-uses within each of the three categories. For this project, in-stream uses will not be evaluated. The forecast will also not evaluate end-uses in detail, however some end-uses may be inform how the sectors are defined. For example, since the Spokane County region may want the ability to plan for reclaimed water use, sectors could be defined to allow planning and forecasting for uses where reclaimed water could be used – such as parks or golf course irrigation.

There are five basic approaches to developing water demand forecasts. The best approach should be determined based on the goals and objectives for the model, available data, and available budget.

- Trend extrapolation – This method assumes that the past trend carries into the future. Although it is simple and the least expensive approach, this is approach is limiting:
    - No ability to "explain" water demands
    - Cannot account for changes in demographics, weather, or other factors
- Per capita – This method assumes a direct correlation between population and water use. While this approach does employ a major driver for water use (population), it does not account for factors such as price, income, types of housing, employment trends, or other influencers of demand.
- Unit use – This approach tailors the predicted water use for each defined sector by applying the appropriate drivers to each sector. However it does not account for other factors that influence water use within each sector.

- Modified unit use – This approach starts with unit use, then applies elasticities to describe additional factors that influence water use. This approach greatly increases the versatility and sophistication of the unit use forecast.

- Econometric – This approach relies on site specific statistically-derived elasticity data to describe influences on water use. While very customized, acquiring and developing the elasticity data is time consuming and costly.

Factors will need to be selected for the Spokane County forecast model based on data availability, appropriateness for the region, and benefit in explaining water demand.

Bill presented case studies from Miami and San Diego. These examples showed how the forecast can include scenarios for climate variation and conservation. The San Diego example also illustrates the impacts of a recession on water use, and how a shift from single family to multifamily residential impacted the San Diego demand forecast. A major point here is that the forecast should be a living tool that is adjusted to reflect changes in the drivers and factors embedded in the model. Bill loaded the spreadsheet-based San Diego model, and walked the meeting participants through the structure and data in that model.

Discussion and questions followed the presentation:

Question: Will the regional forecast break down self-suppled from public-supplied? Answer: Yes

Question: Are the elasticities long-term or short-term. Will they account for short-term changes in behavior that do not persist? Answer: The short-term versus long-term influence must be considered carefully.

Question: Can seasonal demand be modeled? Answer: Yes, primarily by disaggregating winter/summer as indoor/outdoor.

Question: Can soil type be represented as this is a major factor in how much water is needed for irrigation in various parts of the county? Answer: Soils are not typically part of the forecast model, but if soils are a significant factor, they will be incorporated. Need to find a good data source to describe.

Question: How many variables can be used in the model before impacts of individual factors are diluted too much? Answer: Dilution does need to be considered, which is why we need to identify the primary factors.

Comment: An important objective will be the ability to evaluate land use scenarios; land use usually drives water use rather than the opposite.

Comment: Demand needs to be better understood and justified for specific uses.

Role of Data

Chris Hansen showed meeting participants some of the GIS data that the team has acquired so far. Maps were displayed around the room showing water system service area boundaries, municipal boundaries, and Spokane Regional Transit Council traffic analysis zone (TAZ) data. While the TAZ data is developed for transportation system planning, it is also informative about where population growth and development are likely to occur in the future. Several participants commented that building permit activity and other pre-application type planning department activity are also important data sources.

An early focus for the project is deciding on a population base geographic unit for planning. This base unit should be small enough to capture characteristic attributes, and also have the ability to amalgamate into larger planning areas (such as water system service areas or watersheds). The project team is currently considering using the TAZ data or census block data for this purpose. The advantage of the TAZ data is that it is more current (2007) versus census data (2000). Discussion ensued about the TAZ data; several participants have experience with this data and cautioned (1) that it did not prove accurate for wastewater planning in the 1990s, and (2) that population is not always distributed evenly throughout the TAZ zones. Truthing and spot verification of the data will be required if TAZ is used. Whatever is used should be consistent with the designated urban growth area.

There was general discussion about the relative effort that should be spent on characterizing and forecasting for purveyor-provided areas versus self-supplied areas of the county. Several participants questioned the value of spending effort on the purveyor-supplied areas, as they felt water use in those regions is already well understood. Mike Hermanson reported that he personally had gone through the exercise of trying to compile and reconcile purveyor-provided water use through the water system plans and water use data compiled for the watershed plans, but that putting all the pieces together did not make a comprehensive, unified basis from which to plan and forecast.

Goals and Objectives

Cynthia projected the draft goals and objectives for the water demand forecast model (hard copies were also available), and oriented the meeting attendees to its content:

Goal: Develop a comprehensive inventory of water demands throughout Spokane County

> Objective: Inventory addresses similar time horizon
>
> Objective: Inventory uses consistent methodology throughout the County
>
> Objective: Inventory uses uniform data throughout the County

Goal: Develop the capability to forecast future water demand for consumptive uses in Spokane County

> Objective: Stakeholders have a high degree of confidence in the data and methodologies.
>
> Objective: The model can forecast water demand for municipal/domestic (purveyor-provided and self-supplied), commercial, industrial, and agricultural needs.
>
> Objective: Model is based on actual data for Spokane County whenever possible. If data input is used from outside the region, it should be qualified to indicate this.
>
> Objective: The model can generate forecasts for specific geographic sub-regions within the County.
>
> Objective: The model has the capability to incorporate climate variation, reclaimed water use, seasonal water use variations, and conservation scenarios.

Goal: Create information on water use and factors that influence water use that will benefit local water purveyors.

> Objective: Purveyors have the opportunity to provide specific data so that the unique attributes of their individual systems can be identified.
>
> Objective: Purveyors, as well as other stakeholders, have access to the data and underlying assumptions associated with the water demand forecast model

Goal: Develop a forecasting tool that is available to the local community and can be used to generate user-defined forecast scenarios.

> Objective: Stakeholders have opportunity to participate in model development through an advisory forum.
>
> Objective: Demonstration and training will be conducted for the demand forecast model.
>
> Objective: Purveyors, as well as other stakeholders have access to the completed model.
>
> Objective: Model documentation will enable use by an individual skilled in working with Microsoft Excel spreadsheets.

Due to time constraints, Cynthia requested that participants take the draft goals and objectives home, and consider edits/additions/deletions prior to the next advisory committee meeting. The project team will solicit input prior to the next meeting, and the group will also take input live at the next meeting. Through this process, goals and objectives for the model will be solidified at the next meeting.

Next Steps

Meeting dates and times for the next two advisory committee meetings were announced:

- Wednesday February 24, 9:00 am to noon, location tbd
- Wednesday March 24, 9:00 am to noon, location tbd

Meeting Attendees:

Ty Wick, Spokane County Water District #3
Dave Johnson, Spokane County Water District #3
Steve Skipworth, Vera Water and Power
Doug Greenlund, City of Spokane
David Luders, Indian Village Estates Water Association
Gloria Mantz, City of Spokane Valley
Scott Inch, Moab Irrigation District
Susan McGeorge, Whitworth Water District
Rick Noll, Spokane County Conservation District
Kathleen M. Small, Pasadena Park Irrigation District
John Johnson, City of Cheney
Jim Falk, Spokane County Building and Planning Department
Todd Henry, Vera Water and Power
Bryan St. Clair, City of Airway Heights
Bart Haggin, Private Citizen
Tavis Schmidt, City of Spokane Valley
Rob Lindsay, Spokane County
Craig Volosing, Palisades Northwest and Landowner
Rusty Post, Washington Department of Ecology
Greg Sweeney, ELA/WIT
Mike Hermanson, Spokane County
Bruce Rawls, Spokane County

Project contacts:

Mike Hermanson- mhermanson@spokanecounty.org, 477-7260
Cynthia Carlstad – cynthia.carlstad@tetratech.com, (206) 883-9316

TETRA TECH

MEETING SUMMARY

Date of Meeting:	February 24, 2010, 9 a.m. – noon Spokane Regional Health District—Room 310/311 1101 West College Avenue, Spokane Washington 99201
Subject:	Spokane County Water Use Inventory and Demand Forecast Advisory Committee Meeting #2
Project Name:	Spokane County Water Use Inventory and Demand Forecast
In Attendance:	Dave Johnson, Spokane County Water District #3 Steve Skipworth, Vera Water and Power Doug Greenlund, City of Spokane Gloria Mantz, City of Spokane Valley Susan McGeorge, Whitworth Water District Walt Edelen, Spokane County Conservation District Kathleen M. Small, Pasadena Park Irrigation District Jim Falk, Spokane County Building and Planning Department Tavis Schmidt, City of Spokane Valley Rob Lindsay, Spokane County Craig Volosing, Palisades Northwest and Landowner Rusty Post, Washington Department of Ecology Mike Hermanson, Spokane County Bruce Rawls, Spokane County Lee Mellish, Liberty Lake Sewer & Water Bill Rickard, City of Spokane – Water Andy Dunau, Spokane River Forum Jim Lahde, Model Irrigation Frank Tripplett, City of Spokane Cynthia Carlstad, Tetra Tech Bill Davis, CDM Chris Hansen, Tetra Tech
Summary Prepared by:	Cynthia Carlstad (Note: The meeting was audio-recorded)
Project Contacts:	Mike Hermanson- mhermanson@spokanecounty.org, 477-7260 Cynthia Carlstad – cynthia.carlstad@tetratech.com, (206) 883-9316
Project No.:	135-17247-10002

MEETING PURPOSE

Bring together regional water supply stakeholders to:

- Provide input on goals and objectives for the water demand forecast model.
- Assist with defining water use sectors for the model.
- Review proposed planning area units for the model.
- Hear progress update on water use data analysis.

WELCOME/INTRODUCTIONS

Cynthia Carlstad, Tetra Tech project manager and meeting facilitator, opened the meeting shortly after 9:00 and asked all to introduce themselves. She then directed attention to several meeting handouts:

- **Terminology**—Copy of a slide used at the January meeting. Contains definitions for commonly used demand-forecasting terms (see attached)
- **Spokane County Water Demand Forecast Advisory Committee Participation**—Preliminary schedule and topics for advisory committee meetings. There will be five advisory committee meetings.
- **Spokane County Water Demand Forecast Schedule**—Gantt chart project schedule showing anticipated progress on tasks and deliverables, with project completion by June 30, 2010.

GOALS AND OBJECTIVES FOR THE WATER DEMAND FORECAST MODEL

Preliminary goals and objectives were handed out and briefly discussed at the January meeting. Meeting participants were asked to provide feedback on possible edits/additions/deletions at this meeting. The unmodified preliminary goals and objectives were available as handouts at this meeting too.

With the preliminary goals and objectives projected on screen, Cynthia talked through them, asking for input for each goal and its associated objectives. The only input provided by meeting participants was related to the last goal "Develop a forecasting tool that is available to the local community and can be used to generate user-define forecast scenarios." Andy Dunau asked if the demand forecast model would relate to the Spokane Valley-Rathdrum Prairie (SVRP) aquifer model, and requested that an objective be added that demand forecast model output would be useful for input to the SVRP aquifer model. This objective was added, and the model goals and objectives were finalized as follows:

- **Goal 1**—Develop a comprehensive inventory of water demands throughout Spokane County.
  - **Objective 1.1**—Inventory addresses similar time horizon.
  - **Objective 1.2**—Inventory uses consistent methodology throughout the County.
  - **Objective 1.3**—Inventory uses uniform data throughout the County.
- **Goal 2**—Develop the capability to forecast future water demand for consumptive uses in Spokane County.
  - **Objective 2.1**—Stakeholders have a high degree of confidence in the data and methodologies.
  - **Objective 2.2**—The model can forecast water demand for municipal/domestic (purveyor-provided and self-supplied), commercial, industrial, and agricultural needs.
  - **Objective 2.3**—Model is based on actual data for Spokane County whenever possible. If data input is used from outside the region, it should be qualified to indicate this.
  - **Objective 2.4**—The model can generate forecasts for specific geographic sub-regions within the County.
  - **Objective 2.5**—The model has the capability to incorporate climate variation, reclaimed water use, seasonal water use variations, and conservation scenarios.
- **Goal 3**—Create information on water use and factors that influence water use that will benefit local water purveyors.

- **Objective 3.1**—Purveyors have the opportunity to provide specific data so that the unique attributes of their individual systems can be identified.
- **Objective 3.2**—Purveyors, as well as other stakeholders, have access to the data and underlying assumptions associated with the water demand forecast model.

- **Goal 4**—Develop a forecasting tool that is available to the local community and can be used to generate user-defined forecast scenarios.
  - **Objective 4.1**—Stakeholders have opportunity to participate in model development through an advisory forum.
  - **Objective 4.2**—Demonstration and training will be conducted for the demand forecast model.
  - **Objective 4.3**—Purveyors, as well as other stakeholders have access to the completed model.
  - **Objective 4.4**—Model documentation will enable use by an individual skilled in working with Microsoft Excel spreadsheets.
  - **Objective 4.5**—Output of this model can be used for inputs to the SVRP Aquifer model (*Ground-Water Flow Model for the Spokane Valley-Rathdrum Prairie Aquifer, Spokane County, Washington, and Bonner and Kootenai Counties, Idaho*; USGS, 2007)

DRAFT MODEL FRAMEWORK FOR SPOKANE COUNTY

Bill Davis, CDM forecast model lead, presented a schematic diagram showing the draft forecast model structure, organized by sector:

- Public supply
  - Single-family residential
  - Multi-family residential
  - Commercial/Industrial
  - Urban irrigation
- Self supplied residential
- Self supplied industry
  - Thermoelectric power
  - Golf courses
  - Other large industry
- Agricultural
  - Irrigated acres
  - Livestock

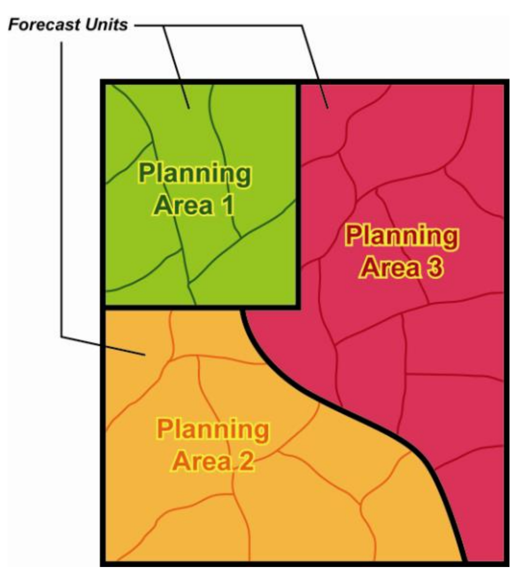
Based on discussion at the meeting, two modifications will be made to the model structure:

- A subsector called "irrigated agriculture" will be added to the public supply sector. A few of the water purveyors provide water to commercial agriculture operations, particularly in "the valley" (generally the region east of the City of Spokane); this is usually a relic of the purveyor's origin as an irrigation district, and may change in the future as these parcels within the urban growth area would be candidates for urban infill land uses. Bruce Rawls commented that he has heard that when these irrigated agricultural lands are converted to urban land uses, the water use may decrease. Steve Skipworth reported that in the 1960s much of this water use was unmetered and untreated (straight from the well to the field), but in the 1970s purveyors began metering and billing the agricultural users based on their use. His impression is that water use decreased dramatically after metering was installed. At this point, it is uncertain whether a land use conversion would result in less water use for those areas. Kathleen Small commented that Moab Irrigation District does supply treated water for agricultural uses, but these are mostly hobby farms.
- The sector "self-supplied residential" will be divided into two subsectors—"residence and yard" and "small agriculture." This modification will address what many believe to be a common situation where landowners in rural areas own livestock or engage in other "hobby farm" type activities. These situations would not be captured by agricultural census data, and likely use more water than "residence and yard" situations. This is potentially significant because there is no limitation on water use for livestock under the state's permit-exempt well laws, so a single residence can provide water to 25 horses or more without a water right and without a Department of Agriculture permit. Craig Volosing indicated his belief that this is common in Spokane County, and that these types of hobby farms also irrigate pastures.

GEOGRAPHIC PLANNING AREAS AND FORECAST UNITS

This portion of the meeting focused on the geographic structure for the model. The project team had presented preliminary work on possible data sources at the January advisory committee meeting. The team has now completed its evaluation and presented a recommended geographic model structure to the advisory committee.

Bill Davis began by orienting the group to the handout entitled *Spokane County Water Use Inventory and Demand Forecast—Forecast Units and Planning Areas,* which describes the basis for the model's geographic structure. Two basic types of geographic units have been established:



- The ***forecast unit*** is the base model unit. In each forecast unit, model parameters such as demand drivers (housing units, population, etc.) and demand factors (weather, house size, etc.) are considered homogeneous. For example, home size within each forecast unit will be averaged and used as a model input. The forecast unit should be small enough to incorporate variation within the county and should be delineated to facilitate informed water resource planning.
- ***Planning areas*** are groupings of forecast units

into regions that facilitate planning. Model parameters for each forecast unit within a planning area may be set the same or individually.

Chris Hansen introduced the group to the “Planning Area & Forecast Unit” map that depicts planning areas and forecast units for the demand forecast model. The Spokane County model will have urban and rural planning areas. Urban planning areas are all areas within the Coordinated Water System Plan (CWSP) boundary; Chris demonstrated with GIS how this area relates to current water service areas, municipal boundaries, and the combined urban growth area. The CWSP boundary was selected because it was established by the water purveyors as their intended “ultimate” service area.

The following urban planning areas have been delineated:

- **Central**—Primarily the City of Spokane service area
- **Spokane Valley**—All service areas east of the City of Spokane service area
- **West Plains**—All service areas west of City of Spokane service area
- **North**—All service areas north of the City of Spokane service area
- **Deer Park and Stevens PUD**—Northern county and south of the Spokane River downstream from Spokane.

Rural planning areas are everywhere outside of the CWSP boundary, and include the following:

- Middle Spokane
- Little Spokane
- Lower Spokane
- West Plains
- Palouse
- Latah.

In rural planning areas, watershed subbasins designated by watershed administrative units will serve as forecast units, to reflect the need to manage water by watershed. In urban planning areas, forecast units will be based on traffic analysis zones (TAZs), which are locally developed designations derived from census data and growth projections.

Mike Hermanson explained the process he used to determine where boundaries would be drawn. Whenever possible, rural planning area boundaries match water resource inventory area (WRIA) boundaries. The one exception is for the West Plains, which was manually delineated to account for a more logical planning boundary. The Deer Park and Stevens PUD urban planning areas are different from the others in that water service within these boundaries is primarily distributed small systems, not a single, expanding system. That is likely to continue in the future. Bill Rickard inquired about the West Plains Urban planning area extending to the Lincoln County line, and Mike confirmed that Medical Lake’s CWSP does extend that far. He also remarked that Medical Lake could reduce its CWSP boundary if it made sense to do so. Steve Skipworth reported that the City of Cheney had recently reduced its CWSP boundary to be more in line with the City’s urban growth area.

Walt Edelen observed that this geographic structure will make it awkward to produce a demand forecast for each WRIA cleanly, since the urban planning areas are not based on subbasin units and they overlap all the WRIAs. Mike Hermanson noted a small adjustment to the Latah/West Plains boundaries that would help with this problem. Even with this drawback, it is a more realistic depiction of where water is coming from, since the water supply is from centralized sources in the urban planning area.

Meeting participants did not identify any other problems with the proposed geographic framework for the demand forecast model. Discussion focused on the complexities of forecasting where growth would occur, the desirability of tying forecasted demand to water supply, and the need for communication/coordination between water purveyors and county planning and development staff prior to approval of comprehensives plan, zoning, and new developments. Susan McGeorge commented that Whitworth Water District could be faced with situations where they are expected to provide water, but are unable to do so because of supply limitations. Rusty Post commented that it will be important to examine the likelihood of development, based on zoning, critical areas, etc.

Additional discussion focused on the forecasting time horizon—30 years, done in five-year increments. Bruce Rawls commented that in his experience a 30-year forecast must be viewed as very tenuous. Gloria Mantz and others emphasized the need to keep the model updated as changes occur.

Some concern was expressed about having more densely spaced forecast units in areas that are not like to change much in the future, and large forecast units in areas where water use is likely to change most. Will this limit us in the future? To address this, Chris Hansen presented a slide showing how the different types of spatial data (TAZ, census block and parcel) relate, and emphasized that we will be using spatial data from all three of these sources to accurately depict population, land use, and water use in each forecast unit. In some cases with the larger forecast units, the most intense land uses occur (or will occur) in a small area within the forecast unit. This can be represented by integrating the parcel and census data with the TAZ data.

WATER USE DATA ANALYSIS —PROGRESS REPORT

General Update on Data Collection and Analysis

Bill Davis presented a schematic slide showing the types of data and how data is being used to construct the model. Data types such as demographic, weather, land use, and water use are analyzed to determine relationships between these factors that inform our knowledge about attributes such as average rate of water use by sector, seasonality of water use, and locational factors. These relationships, along with demographic projections will be built into the forecasting capability of the model.

Bill Davis directed attention to the handout titled *IVEWA Water Well Production Data, 2001-2009*, which breaks down the raw water produced by month for nine years for the Indian Village Estates Water Association. From this data, we can calculate the average usage for each home, average usage per person, and evaluate seasonal variation. This is the sort of analysis the project team is conducting with metered water use data. We can than bring in weather data and other possible factors to determine if there is a relationship with water use.

Discussion occurred regarding the value of production versus usage data. Bill Rickard cautioned that production data can be very misleading, citing historical comparison between water usage in the City of Boise versus the City of Spokane that purported much higher water consumption in Spokane. Bill said that the City of Boise apparently has a network of urban irrigation canals that serve much of the urban irrigation needs. Spokane does not have such a system, so all of this usage is reflected by the City data. Kathleen Small indicated that the production data from Moab Irrigation District may be useful, as they meter that monthly but only meter customer use twice a year. Steve Skipworth reminded the group that at Vera Water District they have had very little increase in production volumes, even with a large increase in customers, so looking at historical production compared to use is important.

Several purveyors have already provided monthly water use data by sector, but the project team is seeking more, particularly in areas where we currently lack detailed data. Having this data will enable the project team to tailor the model to the variability within the County. March 12 was set as the deadline for providing this data to ensure it can be incorporated into the model.

Example of Methodology for Assigning Water Use to Self-Supplied Residential Uses

Chris Hansen demonstrated how the GIS data can be used to evaluate and assign water use for self-supplied, non-metered residential areas. Chris presented an example from the West Plains where we have metered data from a small water system—Indian Village Estates Water Association—that is surrounded by self-supplied homes, assumed to be supplied from permit exempt wells. Using readily available GIS attributes such as parcel size, value of improvements, building permit issuance, and even specific data about the house characteristics such as number of bathrooms and bedrooms (when available), together with visual observations regarding irrigated acreage from ortho-photos, it is possible to distinguish whether the self-supplied areas have characteristics similar to those of the metered systems.

The project team will use this approach, along with other available information about self-supplied residential areas, to assign water use characteristics that are more relevant than the statewide averages.

Preliminary Results from the Residential Water Use Survey

Mike Hermanson presented some of the preliminary results from the residential water use survey that Spokane County is conducting. So far, the county has 194 data points from the surveys. The surveys provide a lot of detailed information about house and landscaping size, as well as irrigation and water use habits. Using address info, Mike has visually cross-checked some responses with county assessor data and ortho-photos; so far most of it checks out pretty close to what is reported on the surveys.

Mike indicated that a few tentative conclusions can be drawn from the data received so far:

- Homes in naturally forested areas tend to have less landscaped area, suggesting less irrigation
- Homes with low-yield wells (less than 5 gallon per minute) have significantly less landscaping
- There is a loose correlation between size of house and size of landscaping
- People served by public water systems are more likely to irrigate seven days a week than those served by private wells.

He cautioned that it appears that lot size does not necessarily mean more landscaping, based on the surveys and other observations he has made. He is also tying in the landscape irrigation study from WRIA 56 for comparison.

Craig Volosing asked if an intensive survey response from one neighborhood would be valuable, and offered to coordinate that in his neighborhood—Palisades—a West Plains neighborhood reliant on permit-exempt wells. Mike indicated that it would, and will get Craig the information needed to facilitate that.

General Discussion Regarding Data

Steve Skipworth suggested that raw pumping data from all the purveyors be used as a quick reality check to the forecast produced by the model.

NEXT STEPS

The next advisory committee meeting will be in late April; Mike will set the date after he confirms room availability. The content of the meeting will include the following:

- Presentation on data assessment
- Presentation on sector model structures, including drivers, rates of use, etc.
- Prototype of forecast model

ADJOURNMENT

Cynthia adjourned the meeting at noon.

MEETING SUMMARY

Spokane County Water Use Inventory and Demand Forecast

Advisory Committee Meeting #3

April 27, 2010, 8:30 a.m. – 12:30 pm
Spokane Regional Health District – First Floor Auditorium
1101 West College Avenue, Spokane Washington 99201

Meeting Purposes—*bring together regional water supply stakeholders to: 1) participate in a presentation on data being used to develop the Spokane County Water Demand Forecast Model; and 2) see preliminary model results for the single family residential sector.*

Cynthia Carlstad, Tetra Tech project manager, opened the meeting at 8:30, welcomed attendees and reviewed the meeting agenda and handouts.

Overview of Progress since February Advisory Committee Meeting

Cynthia provided an overview of progress since the February Advisory Committee meeting. Development of the model base spatial data has been a big focus for the project team since the February meeting. Demographic and land use data has been apportioned into the base model forecast units for current and future time periods. Forecast units are based on Spokane Regional Transit Council Traffic Analysis Zones for the area within the Coordinated Water System Plan (CWSP) boundary, and on Washington Department of Natural Resources Watershed Administrative Units for areas outside the CWSP.

The project team is continuing to pursue water use data; we had originally set March 12 as the deadline but would like to get more. Specifically we need monthly water use data from each purveyor for each sector for ten years if available.

Question: Is water that is transferred from one basin to another considered? Answer: No, this project is modeling pure demand, not related to supply or source.

Assessment of Data for Spokane County Water Demand Forecast Model

Bill Davis, CDM, highlighted areas of the model structure based on input from the February meeting:

- Added public supplied commercial irrigation to the Public-Supplied sector. This addresses water users that receive water from a purveyor for commercial agriculture operations. Input received at the last meeting indicated that there is some of this in the Spokane Valley area. Bill noted that since we've made a place to account for those, we need some input on how those uses are likely to change over time.
- Added "hobby farms" under Self-Supplied Residential. This will account for self-supplied homes that have livestock.

- Commercial – Note that golf courses occur under self-supplied industry and public supplied urban irrigation.
- Agriculture – Based on agriculture census which is county-wide. Need input on appropriate disaggregation into forecast units.

System Losses

Steve Skipworth observed that "system losses" which are a subsector under "Public Supply" occur for all sectors. He emphasized the similarity with irrigated agriculture, where you may measure the quantity of water pumped (production), and apply crop irrigation needs for the demand; there will be a difference caused by pipe leaks, evaporation along the conveyance route, etc. This is analogous to what happens in a public water system. Ty Wick noted that all purveyors are working hard to eliminate system losses and questioned whether we want to forecast a demand for it.

Bill Davis explained that for public water systems this includes all types of unaccounted for water use including planned activities such as pipe flushing. Bill spoke to apparent versus real loss. Apparent loss can include unmetered uses of all types. Real loss subtracts those apparent losses. The value of having it in the demand model is that you can quantify and track reductions.

Bruce Rawls asked how the system loss would be calculated – is it tied to demand, so it will rise proportionately as demand increases? Bill confirmed that it is variable in the model that is tied to demand. The value can be set at any level; currently it is set at 10% of demand.

Bruce also commented that if system losses are leaking pipes infiltrating water to the aquifer or return flow to river, then that water is not really lost. Bill explained that in the base case scenario this distinction between consumptive and nonconsumptive demand is not made, however it could be incorporated into a different scenario. Mike Hermanson indicated that this would be a good connection to the USGS SVRP model that could include evaluating withdrawal from one basin and return flow to another basin. Mike described how this is one limitation of the USGS model that he discovered during the inchoate water right analysis.

Decision: Based on this discussion, participants decided to add a "System Loss" subsector to each model sector.

Livestock Water Uses

The following is a general summary of information and unknowns related to livestock:

- Agricultural census provides a county-wide estimate for number of livestock for each category of animal unit. These animals need to be distributed into forecast units in the model.
- It is not known how many "hobby farms" report their animals through the ag census. Input to the ag census is triggered when an individual claims some level of income from animals. This means that the ag census probably underestimates the total number of animals in Spokane County.

- Results from the Water Use Survey (Spokane County project) indicate that approximately 20% of respondents have horses or cows, and of those 20% the average number of horses/cows is three per household. This data can be used to inform the estimate and geographic placement of cows/horses for the model.
- Dairy locations are pinpointed by the Department of Ecology database
- No confined animal feeding operation permits have been issued in Spokane County.

The group discussed the issues, noting that the number and location of cows and horses can vary a lot from year to year. No other data sources were identified.

Decision: For large cattle operations, it was generally agreed that those should be placed within the Little Spokane and West Plains Rural Planning Areas. The project team will evaluate further to see if they can locate these large cattle operations.

Decision: Lacking better information, it seems reasonable to use the survey data to guide placement of the rest of the cattle and horses, and distribute throughout the county outside of the urban growth area. Zoning restrictions disallow cattle and horses within the urban growth area. Craig Volosing offered to collect a targeted sampling of his neighborhood, the Palisades, to see if the survey data appeared to hold true for a discrete neighborhood.

The group also discussed that while this is a perplexing problem, it does not represent a large water quantity, and therefore is not worth too much effort.

Crop Irrigation Water Use

Data sources for modeled crop irrigation are the ag census, NRCS 1995 irrigated lands survey, WRIA 55/57 data, and a limited aerial verification survey. The ag census provided the types and magnitude of crops, and the irrigated lands survey guided placement of irrigated lands into forecast units. Mike Hermanson used recent orthophotos to verify that the 1995 survey was still fairly accurate. Dave Johnson asked, and Bill Davis confirmed, that we are using Washington State data for crop irrigation requirements.

One outstanding issue related to irrigated lands is separating the self-supplied from the public-supplied irrigation water. In the Spokane Valley region, a few purveyors still provide irrigation water for commercial ag. While the project team received account-level data for some of these, it is still difficult to sort out who is using water for what purposes because of the following:

- Some accounts that are coded as residential accounts use a lot of water in the summer, and it is not clear what the water is being used for.
- Some individual accounts may supply several neighbors
- Individual wells are also present

Susan McGeorge and Kathleen Small suggested working with the district managers to sort out for each parcel. The project team will evaluate this approach.

Prototype Model

Bill Davis displayed a graphic showing the relationships between the data, analysis database, and water demand model, emphasizing that the purpose of all this data is to *identify relationships between demographic information and water use patterns*. The database is both cross sectional to relate these different types of data, and a time series to understand temporal patterns. Statistical software is used to evaluate statistically significant relationships between these data.

Discussion occurred regarding weather data in the model. The Spokane Airport station was determined to be representative for the county. Actual data from weather stations throughout the county indicate that temperature is consistent throughout county. Precipitation is more in the northern part of county; however this occurs in the winter, which would not affect water demand. The weather data uses a 20-year average and includes all data (outliers are not removed).

Bill Davis presented the protype model spreadsheet structure:

- Cover Sheet
- Planning Area and Forecast Units – demographics for each.
- Public Supply Water Use
    - Public supply irrigated ag
    - Urban irrigation – County digitized area for cemetaries, parks, and schools from recent air photos.
    - Non-revenue water – assign % to each forecast unit
    - Single family – multiplier referencing demographics. Planning data has number of households, but need to split between public supply and self supply. Propose using 2000 census wells reported, and overlay with forecast units. This is a significant issue because the difference between the current service areas and the CWSP is large – these areas are mostly self-supplied now.
    - Multifamily– multiplier referencing demographics
- Self-Supplied Residential
    - Need to determine water use factor – different from public supply? Use survey data to inform
    - Small ag – discussed previously about animals
- Self-supplied industry – thermoelectric, golf courses identified. Site specific info used. Most forecast units don't have anything – there are very few of these in the county.
- County agriculture
    - Crop irrigation – 2007 census irrigation by crop type – approximately 13,000 irrigated acres. 2.25 ac-ft per acre per year is average water use rate
    - Livestock – animal inventory from last three ag census'. 40gpd for milk cow. 12 gpd for other livestock. Hold constant for future.
- Synthesis Sheet – draws from each sector sheet and sums for each forecast unit

Bill offered that while the base scenario forecast will not address conservation, he could add a conservation factor to the model. This would be a simple percent variable for each

sector that could be set at a user-specified level to provide a base forecast adjusted for conservation. It would not specify where the conservation was coming from, but could be useful for planning. This would be for the county, not at the utility level.
Decision: A conservation factor will be added to the model.

The group discussed model verification. Bill Davis indicated that the best approach is to compare modeled water demand against year 2000 actual water use, since current population estimates are based on projections from the 2000 census.

The group discussed how the evolution of the areas outside current water service areas from self-supplied to public-supplied would be modeled. Bill Davis indicated this is a tricky part of the forecasting and one that will require updating as improvements to water systems are implemented in the coming years. Currently the division between public supply and self supply in these areas is derived from the 2000 census which collects data about houses on wells.

A question was asked regarding accounting for businesses and industry that may come in the future. Bill Davis explained that employment demographics should account for generalized growth in business and industry. Mike Hermanson noted that most of these will be public-supplied in the future because of difficulty in getting water rights. If new industry wants to site, anyone can manually plug it into a specific forecast unit and evaluate adjusted demand.

The subject of golf courses was raised, and the potential use of the model to evaluate possible reclaimed water uses was discussed. For example it is possible to isolate demand created by existing golf courses and evaluate whether reclaimed water could be a feasible water source.

The future growth of irrigated ag was discussed, and all agreed that it is unlikely to increase. Historical data shows approximately 1% annual increase but this may have been a one-time event associated with expansion of the irrigated ag by the Hutterite community. Local food production (truck farming) may increase if that current national trend continues, but it is uncertain whether this would actually lead to more irrigated land, or just conversion from current water uses.

Desired Model Output Reports

Meeting participants discussed what they would like to see for model output reports; the following were requested:

- Summary for each Planning Area – table plus graphs
- Water use by subsector for whole county
- Seasonality
- Time increments for output – five year to 2040

There was some discussion about a report relating water demand to SVRP aquifer, but this was determined to be premature given that water source has not been integrated into the picture yet.

Meeting Attendees:

Ty Wick, Spokane County Water District #3
Dave Johnson, Spokane County Water District #3
Steve Skipworth, Vera Water and Power
Jim Lahde, Model Irrigation
Doug Greenlund, City of Spokane
Gloria Mantz, City of Spokane Valley
Scott Inch, Moab Irrigation District
Susan McGeorge, Whitworth Water District
Kathleen M. Small, Pasadena Park Irrigation District
Craig Volosing, Palisades Northwest and Landowner
Mike Hermanson, Spokane County
Bruce Rawls, Spokane County
Walt Edelen, Spokane County Conservation District
Genevieve Briand, Eastern Washington University
Mike McBride, Eastern Washington University
Cynthia Carlstad, Tetra Tech
Bill Davis, CDM

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MEETING SUMMARY
Spokane County Water Use Inventory and Demand Forecast
Advisory Committee Meeting #4

May 19, 2010, 1:30 a.m. – 4:30 pm
Spokane Regional Health District – First Floor Auditorium
1101 West College Avenue, Spokane Washington 99201

Meeting Purposes—*bring together regional water supply stakeholders to: 1) receive updates on follow-up items from April meeting; and 2) view/discuss draft water demand forecast model and preliminary baseline forecast; and 3)discuss concepts for additional future model scenarios.*

Cynthia Carlstad, Tetra Tech project manager, opened the meeting at 1:30, welcomed attendees, and reviewed the agenda.

Update on Discussion Items from April 27 meeting

Cynthia directed attention to the posted flip charts with discussion/follow-up items from the April 27 Advisory Committee meeting. The following updates were discussed:

System Loss –added system loss subsector (%) to each model sector. Bill Davis put a 10% placeholder in for now.

Livestock – challenges with how to represent in the model for the self-supplied residential hobby farms. The concern is that these may not be represented in the ag census. The project team used the County water use survey results (approx 1,300 responses distributed throughout the county) that indicate 20% of respondents have horses or cows, with an average of three animals. The total number of animals calculated from this approach corroborated well with analysis from ag census. Livestock are only associated with self-supplied, not public-supplied residential. This is a relatively insignificant water use. Model has built in calculation that forces self supplied/public supplied to equal total number of single family in each forecast unit to avoid double-counting homes.

Self Supplied Residential/Public Supplied Residential - Within CWSP outside of current service areas, the project team developed a methodology to quantify % served by water purveyors versus self-supplied residential. Assessor's data classified as residences outside service area provided actual count. Meeting participants discussed what unit use volumes were applied to self supplied – the model is not using the 5,000 gallons per day permit exempt well limit. The water use survey indicates the following regarding the characteristics of public-supplied residential versus self-supplied residential:

- No statistical difference in landscape size between public supply and self supply – approx 8,000 square feet
- Low yield well areas – residences have less landscaping – approximately 4,000 square feet is average
- Self-supplied homes more likely to have a large garden
- No difference in whether a swimming pool is present.

The growth rate is based on 2008 data, and 2015/2030 projections from Spokane Regional Transit Council. The project team interpolated between these years to obtain five-year increments. 2000 census provided number of households, household size, median income; assessors data provided median value. Low yield wells were located from known hydrogeologic data.

Ty Wick questioned whether there had been any reality check on growth actually occurring in some areas as projected. One area where this is evident is in the Palouse 2 rural planning area which shows a growth projection of 1000 new housing units in the next twenty years. Mike Hermanson said that the county's buildable lands study looked at some of this, especially related to critical areas, but not in the Palouse. Jim Falk indicated a similar exercise called a land quantity assessment had been done in the Mt. Spokane area.

<u>Public Supply Irrigation</u> – Customers within a few Spokane Valley districts receive water for commercial irrigation. Even though the districts track account types, the actual water use for this subsector is still problematic to quantify in the model because other types of customers are receiving more water than would be expected for a single family residence, suggesting that other uses are also being served by these accounts. Given time and budget constraints within this project, the project team is not able to run this totally to ground. For now we have some actual data and are using it, but for those we don't have real data, the irrigated ag is accounted for under commercial irrigated ag (self supplied), and not in the public supplied irrigation.

Draft Model

Bill Davis presented the draft model, which has developed further from the prototype presented in April.

He added a conservation factor for each sector, currently set at 1% per year. Susan McGeorge asked if this percentage would be updated annually as water systems implement water conservation programs. Mike Hermanson answered no, and reminded the group that this conservation factor was a bulk value applied county-wide and there would not be the ability to vary it by water district.

Bill added that while integrating specific conservation scenarios are not included as part of the base forecast, it would be a logical next scenario. This would have to be defined – what types of conservation measures would be modeled. Mike Hermanson noted the need to have weather influences part of that too. Bill also noted that conservation discussions inevitably get down to fixtures – per capita indoor water use has declined, but outdoor has generally increased.

For single family residential, it appears that assessed value is the best variable for predicting water use. There are a few outliers which the project team is still hoping to integrate into an accurate derived value in the model. David Luders noted that one reason for outliers is the 30 foot fire protection buffer needed to protect rural homes from wildfire. Ty Wick offered that his systems show a wide variance in water use. Mike Hermanson reported that SCWD#3 and Whitworth are both systems that have more than one distinct area with very different characteristic water use. The project team has monthly metered data for Whitworth, but not for SCWD#3.

Bill reported that the biggest weather variable is maximum temperature. Precipitation is not significant. David Luders noted that thunderstorms are prevalent around Mt. Spokane in August. Mike Hermanson concurred, but said that this phenomenon is not shown in the precipitation data.

Also, other factors like soil may affect, but water use correlates most strongly with assessed value.

Bill presented the public supply commercial sector model which has gallons per day per employee for each employment group.

For the self supplied industry, the project team still needs to look at specific forecast units that have large individual water users such as Sacred Heart Medical Center and Honeywell. We are using commercial sewer billing records as cross-check on this data. This will not capture irrigation associated with these commercial sites, much of which is associated with stormwater swales. David Luders asked about water supply for gravel pits; Ty Wick knew about several gravel pits and the source varies from public to self supplied. He also noted that part of this water use is nonconsumptive.

David Luders reported that the USDA has a new site specific pan evaporation rate that is updated daily to help guide irrigation application.

Bill described how model verification will be accomplished by comparing water use within service areas for 2008 against that predicted by model. Sewer data will also be used to verify predicted winter water use.

Doug Greenlund inquired about the difference between public-supplied single family residential and self-supplied single family residential. Bill answered that both are strongly influenced by assessed value. The model starts with the same unit use, and then adjusts for known local differences, such as IVEWA, Riverside, and a few others. Finally, factors for supply-limited and forested areas will be added. Animals are included as discussed earlier.

Future Scenario Wish List

Cynthia Carlstad facilitated the group in developing a wish list of how this model could be used in the future. The following list was developed:

1. Land use versus water what-ifs – "If water is not available, so demand is lower, how does that affect demand?"
2. Conversion of irrigated lands to residential
3. Focus on upland areas of UGA
4. Considering other impacts associated with delivering water to new areas
5. Weather variation, including looking into Idaho as it relates to the supply forecast
6. GMA Planning process currently tagged to median OFM projection plus 12%. This is distributed both inside and outside UGA
7. Carrying capacity link
8. What-if data for water balance at subbasin level
9. Water system planning – quantifying difference between need/demand, supply, and water rights. Water system plans are based on current zoning.
10. Link to instream flow rules and regulation
11. Ongoing assessment of model accuracy
12. Evaluating need for storage
13. Emergency response planning related to catastrophic event to water supply (vulnerability assessment)
14. Reclaimed water – how this can be integrated to meet some of the demand
15. Conservation – defined scenarios, including impacts of new technologies and landscaping with native plants
16. Infill in urban areas
17. Refine urban irrigation for commercial sites

18. Update when 2010 census data available
19. High growth/low growth scenarios

Adjournment

The next and final Water Demand Advisory Committee meeting will be held the last week of June. The final model and baseline forecast will be presented. A hands-on training session with the model will be held as a second meeting, either immediately following, or the following day. This will be an opportunity to actually work with the model for those interested. You will need to bring your own laptop.

Cynthia adjourned the meeting at 4:30.

Meeting Attendees:

Ty Wick, Spokane County Water District #3
Steve Skipworth, Vera Water and Power
Jim Lahde, Model Irrigation
Doug Greenlund, City of Spokane
Susan McGeorge, Whitworth Water District
Mike Hermanson, Spokane County
Rick Noll, Spokane County Conservation District
Jim Falk, Spokane County
Rob Lindsay, Spokane County
Todd Henry, Vera Water and Power
David Luders, Indian Village Estates Water Association (IVEWA)
Bill Rickard, City of Spokane
Cynthia Carlstad, Tetra Tech
Bill Davis, CDM

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MEETING SUMMARY

Spokane County Water Use Inventory and Demand Forecast

Advisory Committee Meeting #5

June 29, 2010, 1:30-4:30 p.m.
Spokane Regional Health District – First Floor Auditorium
1101 West College Avenue, Spokane Washington 99201

Meeting Purpose—*bring together regional water supply stakeholders to view and discuss the final water demand forecast model and baseline forecast*

Note: the meeting was audio recorded.

Welcome/Introductions

Cynthia Carlstad, Tetra Tech project manager and meeting facilitator, opened the meeting shortly after 1:30. She noted that this meeting, and the model training session the following morning will be the last scheduled advisory committee meetings for this phase of the water demand forecast project. Today's meeting will be focused on presenting an overview of the completed model and baseline forecast, discussing model verification and next steps. Tomorrow's meeting (June 30, 9-noon at the same location) will be a training session for those interested in actually working with the model. Bill Davis of CDM will lead a guided exploration of the model. Participants with their own laptop can load a copy of the model to explore on their own as well.

Reflections on the Project

Cynthia displayed the goals for this project and commented that a lot had been accomplished in very little time. The project team believes that the model meets the original goals developed by the advisory committee in January and February:

- **Goal 1—**Develop a comprehensive inventory of water demands throughout Spokane County.
- **Goal 2—**Develop the capability to forecast future water demand for consumptive uses in Spokane County.
- **Goal 3—**Create information on water use and factors that influence water use that will benefit local water purveyors.
- **Goal 4—**Develop a forecasting tool that is available to the local community and can be used to generate user-defined forecast scenarios.

This project had originally been scoped to simply develop a workplan for creating a water demand forecast model. When additional project funding came available in February, the project team sought a way to get the model itself developed in the same condensed timeframe. Participation from the advisory committee has been crucial to the overall success of this effort. Input from this group provided much of the foundational data for the model, guided the model structure, and provided a reality check on use of data, model results, and underlying assumptions. The completion of this phase has resulted in a complete model, which is both an endpoint and a starting point. The model can now be refined and alternative scenarios modeled in whatever way the stakeholders wish.

Spokane County Water Demand Forecast Model and Baseline Forecast Results

Cynthia displayed the model structure schematic and reviewed that this represents the water use sectors described and forecasted in the model. Previous advisory committee input on this led to adding an irrigated agriculture subsector under public supply, hobby farm subsector under self supplied residential, and system loss under all sectors (originally there had only been a system loss subsector under public supply).

Bill Davis, CDM forecast model lead, then reviewed the model itself with the advisory committee. He oriented the participants to each of the worksheet tabs that contain the data incorporated into the model:

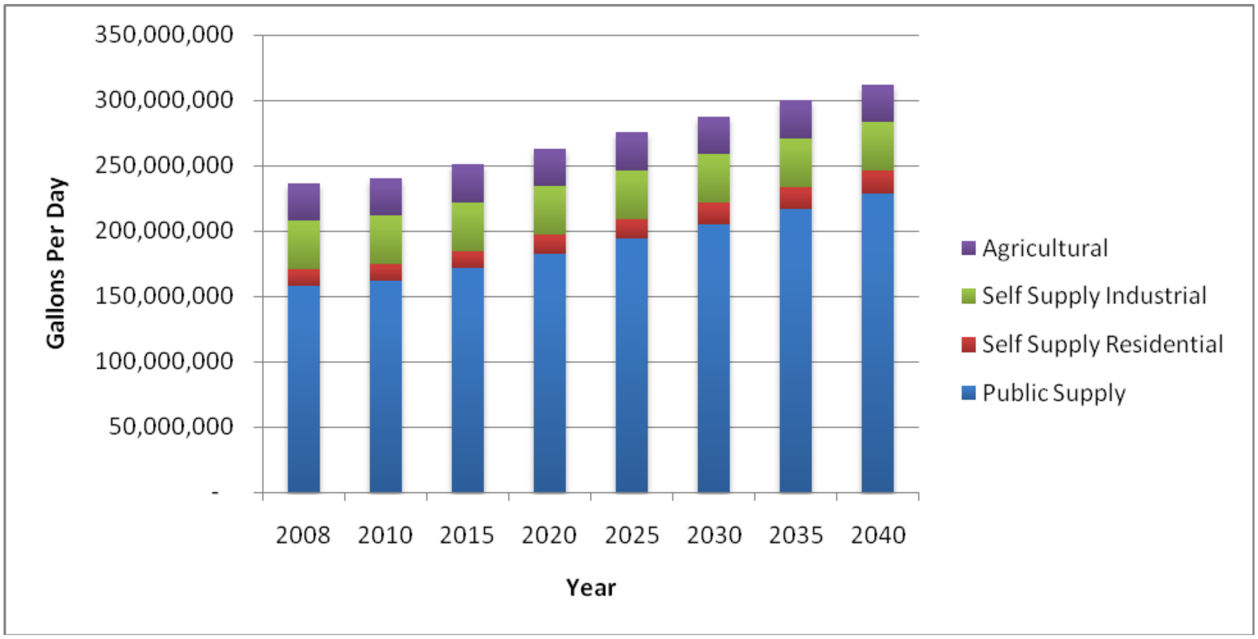
- Demographic data for each forecast unit
- Weather and seasonality
- Single family public supply model
- Single family self supply model
- Multifamily
- Nonresidential
- Housing – percent served by public supply versus self supply for each forecast unit
- Forecasted water needs
- Commercial
- Agricultural
- Totals for all sectors for each forecast unit, summaries by planning area

Bill then presented the results from the baseline forecast through a series of tables and graphs that showed the total forecasted water use for each sector for five year increments out to 2040, the geographic distribution of the forecasted need, and the seasonal variation of the forecasted need.

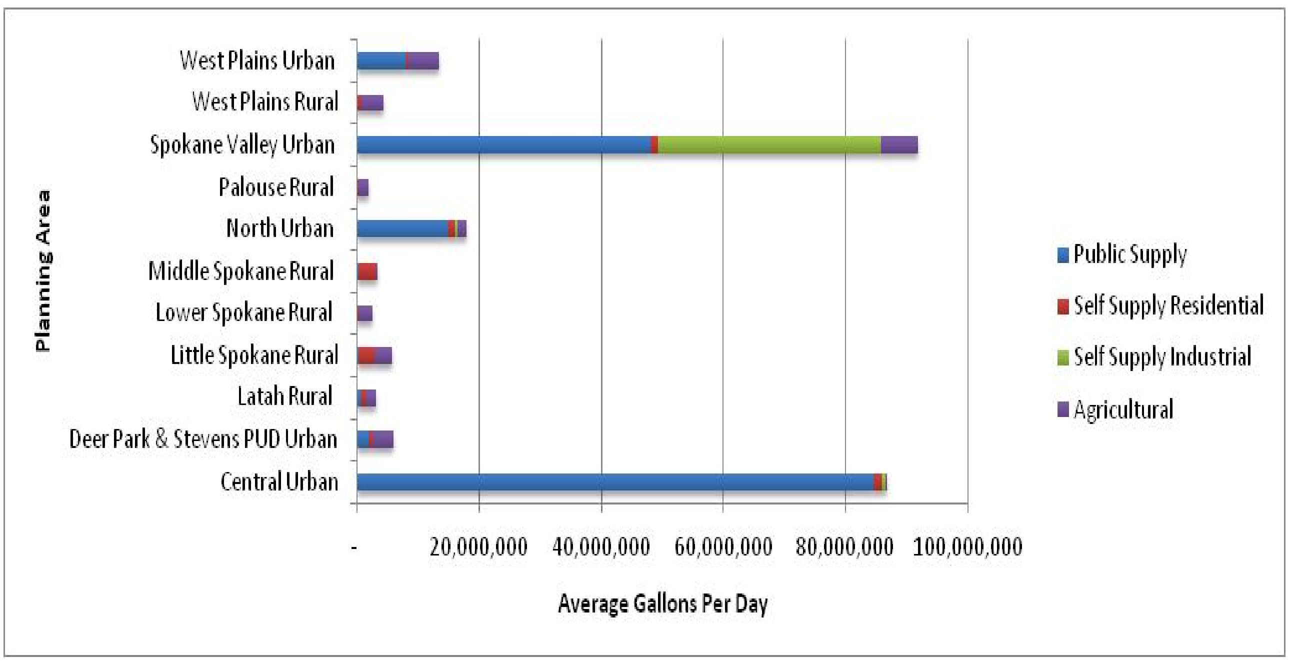
Spokane County Average Daily Water Use by Sector (in million gallons)

	2008	2010	2015	2020	2025	2030	2035	2040
Public-supply	158	162	171	183	194	205	217	228
Self-supply Residential	12	13	13	14	15	16	17	18
Self-supply Industrial	37	37	37	37	37	37	37	37
Agricultural	29	29	29	29	29	29	29	29
Total	237	241	251	263	275	288	300	312

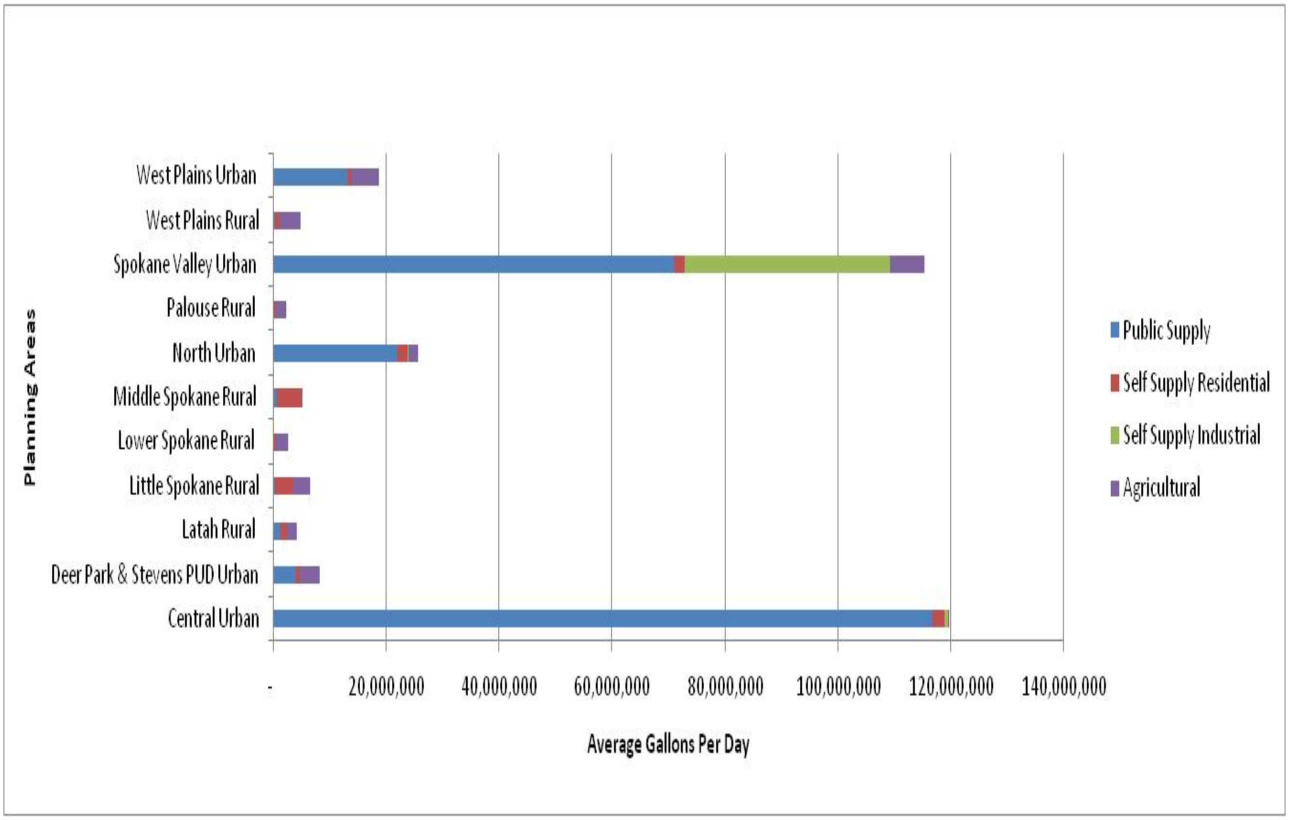
Spokane County Water Use



2008 Spokane County Water Use by Planning Area



2040 Spokane County Water Use by Planning Area



Meeting participants had numerous questions; the following is a summary of the related discussion:

- Regarding population projections, Bart Haggin and Bruce Rawls indicated that the Spokane Regional Transportation Council projections have not been accurate historically. Cynthia reminded the group that at the previous meeting Ty Wick had made a similar specific observation regarding these projections for the Palouse Ag 2 model forecast unit. She also reported that the project team had carefully considered the available data sources for demographic projections during the first two months of the project, and decided that the SRTC data was the only sensible choice given that it is considered the official, locally developed projections for the County. Also, it is used for transportation planning which correlates strongly with developing areas. Now that the group has this baseline forecast using those official demographics, adapting the demographics to fit alternate scenarios that may be more realistic would be a reasonable path to take with the model.

- Susan McGeorge asked if discrete water quantities were attached to self supplied versus public supplied residential such that the model would predict a change in water need if self supplied residential users convert to public supplied. Yes, these unit use values are designated separately. The split between the two categories was set to be adjusted manually as this type of transition is not expected to occur in a uniform growth pattern, but rather episodic as new water infrastructure is built.

- Dick Price asked if there is accounting for wastewater recharge in the model. No, this baseline scenario captures raw demand, with no accounting for how much is actually consumptive.
- David Luders inquired about whether there is an efficiency factor embedded in the model, such as the 1% per year conservation goals that all water systems have. Bill responded that there is not a conservation factor embedded in this forecast. He did include a placeholder in the model for a conservation factor to be added as a user-defined option.
- Genevieve Briand asked about model documentation. Data sources and a model data dictionary are documented in a technical memorandum to accompany the model.
- Steve Skipworth asked how often the County Comprehensive Plan is updated. The County updates the Comp Plan annually, but most are minor changes. They are currently doing a major update of the Urban Growth Area, the first since the initial plan was developed approximately ten years ago (2000). Steve indicated that purveyors use this information to inform system improvement planning.
- David Luders asked about system loss – is this held at 10%? Yes. Mike Hermanson noted that there is no real pattern associated with system loss; it varies a lot by purveyor. Steve Skipworth added that it varies a lot seasonally. Mike added that it is possible to adjust this manually for each forecast unit.
- David Luders asked if this accounts for the impact of lifting the Medical Lake moratorium on new water hookups. No, this is not considered.
- Bruce Rawls asked Mike Hermanson how he envisions the model being used. Mike described his vision that this could be used to provide the demand piece for subbasin water balances. Also it could be used in conjunction with the USGS aquifer model to evaluate where water from the aquifer is going to be dispersed to. A similar analysis could be done for specific subbasins. Mike and Rob Lindsay also indicated that this fills a data gap in analyzing water needs as previously forecasting has been done only on a utility basis, which provides an incomplete and patchwork representation of water needs in Spokane County.

Basis of Public-Supplied and Self-Supplied Residential Model

Bill described the process used to develop the single family residential models. In the analysis database he matched monthly water use data with weather data, then with residential characteristics such as lot size, percent forested, well yield, and assessed value. Using statistical software, significant correlations were identified. Bill noted that the explanatory variables selected explain 80% of the variation seen in water use, which is considered very good.

Bill and Mike discussed the basis for the residential models. Many variables were tested for correlation with water use. Explanatory variables used in the model are weather, seasonality, lot size, average household size, and two water system binaries. The strongest correlation of explanatory variables are assessed value and lot size. These variables also strongly correlate with each other. Lot size was selected for use in the model because of its strong correlation and its seamless connection to land use planning parameters. Bill demonstrated the interaction of these variables through an example that Mike developed by modifying average household size, maximum temperature, and lot size and observing the impact on predicted water demand.

Model Verification

Bill presented the preliminary verification analysis that has been completed. Verifying performance of the model is very important, but it is also not a straightforward effort. Model results for 2008 for each water purveyor were compared against reported water use from the purveyor's water system plan (not necessarily for 2008). The preliminary results look very good in some areas, such as Whitworth and several of the Spokane County Water District #3 systems, but are farther apart for some systems such as the City of Spokane. There is still much to sort out related to this. Some of the discrepencies may be in the way water use is reported by different purveyors. Also, the forecast unit boundaries and water system boundaries do not usually line up precisely.

Bart Haggin noted that there are a lot of irrigation withdrawals from the Little Spokane River that may be affecting reported water use in that area.

David Luders reported that all purveyors are required to report annual water use to the Washington Department of Health, and these reports are posted on the agency's web site. This would have data for the last two years.

Genevieve Briand suggested that if multiple years were evaluated and the difference between modeled and reported stayed the same, it would indicate that the difference is not created by model inaccuracy.

David Luders noted that large meters are only accurate to 3%, and that the ERU (equivalent residential unit) is used as the equalizing parameter for water system planning and this might help create a common denominator for verifying the model too.

Futher Refinements

In looking into the future, the project team has the following list of refinement suggestions:

- Separating indoor and outdoor residential water use – this may help refine accuracy
- Multifamily sector refinement – did not get much data, and did not always get definition of how many unit served per multifamily account
- Updating demographic projections with 2010 census data
- Sensitivity analysis associated with modified growth projections
- Refine commercial/industrial forecast

Meeting Attendees:

Steve Skipworth, Vera Water and Power
Doug Greenlund, City of Spokane
Gloria Mantz, City of Spokane Valley
Susan McGeorge, Whitworth Water District
Walt Edelen, Spokane County Conservation District
Jim Falk, Spokane County Building and Planning Department
Rob Lindsay, Spokane County
Rusty Post, Washington Department of Ecology
Mike Hermanson, Spokane County
Bruce Rawls, Spokane County
Bill Rickard, City of Spokane – Water
Jim Lahde, Model Irrigation

Genevieve Briand, Eastern Washington University
Bart Haggin, The Lands Council
Ty Wick, Spokane County Water District #3
Reanette Boese, Spokane County
Scott Inch, Moab Irrigation District
David Luders, Indian Village Estates Water Association (IVEWA)
Dick Price, Stevens County PUD
Bryan St. Clair, Modern Electric Water and Power
Cynthia Carlstad, Tetra Tech
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Appendix C
Spokane Regional Transportation Council
Transportation Analysis Zone Data Description

Spokane Regional Transportation Council
Land Use Categories

LU1 – Single Family Residential includes those lands occupied by either a single family home, duplex or a manufactured home on a single lot. Measured in dwelling units.

LU2 – Multi-Family Residential uses contain three or more residential units on a parcel of land. Also, this category includes mobile home parks, apartment buildings, and some condominiums. Measured in dwelling units.

LU3 – Hotel/Motel (**SIC 70**) includes motel rooms, hotels and camp areas. Measured in rooms or camp spaces. Note: does not include occupancy.

LU 4 – Agriculture, Forestry, Mining, Industrial, Manufacturing, and Wholesale, uses are included in **SIC** categories: **01-03, 07-14, 15-17, 20-49, (except 43, 45, 472), and 40-51** within a broad range of general or specialty contractors and also generally related to agricultural production, services, timber tracts and products, and mining extraction activities: the production of food, textile, wood, furniture, paper, printing, metal, machinery, electrical and other products; and also includes Transportation, Communication and Public Utilities, such as railroads, trucking and warehouse, air transportation, pipelines, communication towers and electrical, gas and sanitary services. Wholesale Trade facilities include the storage of durable or non-durable goods. Measured in employees.

LU5 – Retail Trade (Non-CBD) includes those uses identified in **SIC** categories: **43,45,52-59, and 72-79.** Retail uses include a broad range of establishments that sell goods directly to the general public, such as restaurants, automotive dealers, home furnishings, food stores or other products. Also included are service establishments that have significant customer traffic, post office and air transportation. Measured in employees.

LU6 – Services and Offices include those uses in **SIC** category **81, 83-97.** Services and offices include business services such as advertising, engineering, legal services and other assorted services. These also include services which are owned, or operated by units of government and provide the administration of public programs.   Measured in employees.

LU7 – Finance, Insurance, and Real Estate Services (FIRES) are those land uses in **SIC** categories **60-67, and 472,** which have more customer traffic than typical offices. These include financial institutions, banks, insurance, real estate offices, and travel agencies. Measured in employees.

LU8 – Medical are those land uses in **SIC** categories **80** which include all health services, doctors' offices, and hospitals. Measured in employees.

LU9 - Retail Trade (CBD) includes those uses identified in **SIC** categories: **43, 45, 52-59, and 72-79.** Retail uses include a broad range of establishments that sell goods directly to the general public, such as restaurants, automotive dealers, home furnishings, food stores or other products. Also included are service establishments that have significant customer traffic, post office and air transportation. Measured in employees.

LU10 – Students University includes full time commuting/non-traditional students who do not reside on campus. Based on percentage of individual institutes total student population and measured in number of students.

LU11 – Education Employees includes K-12 FTE employees and are included in **SIC** categories **821, 823, 824 and 829** which include public and private primary and secondary education (821), libraries (823), vocational schools (824) and schools and educational services not classified elsewhere (829). School districts who report employees by district office must be acquired by contacting the district office for breakdown. Measured in employees.

LU12 – University Employees includes **SIC** category **822** FTE employees in Higher Education (colleges/universities) and technical training schools. Measured in employees.

Land-use data is derived in part, from United States Census Data. Dwelling unit data is adjusted annually from the Census based on permit and plat information supplied by the local jurisdictions in the Spokane area. Forecasts are estimated by the plat information, while the base data is created from permit data for projects that are actually constructed.

Employment data is estimated from Employment Security Department (ESD) information. Local knowledge and ESD control totals are used to fill in any gaps. Forecasts of employment are based on a constant growth factor applied annually.

PURPOSE

The purpose of this analysis is to independently forecast population, housing units, and employment for Spokane County and to allocate changes in those variables to smaller areas known as traffic analysis zones.

MAJOR FINDINGS

Intermountain Demographics forecast Spokane County's population to increase from 441,600 persons in 2005 to more than 563,700 by 2030. Population forecasts prepared by AVISTA Corporation place Spokane County's population at 562,900 by 2029.

The number of housing units in the entire county will reach more than 240,600 units, a gain of more than 53,000 units, over the same time period.

Spokane County employment will increase by about 90,000 employees and reach a total of more than 339,000 employees by 2030.

Areas experiencing major future residential growth are on the eastern, western, and northern edges of the existing urbanized area, particularly the Liberty Lake area, the Airway Heights/West Plains area, and the northern portion of the North South Corridor.

More than 1,000 housing units at Fairchild Air Force Base are removed from the forecasts as the Air Force will no longer provide on-base housing in the future. However, employment at the Air Force Base is forecast to increase by 2,000 employees during the forecast period.

Other areas gaining significant shares of future employment include Airway Heights/West Plains, the northern portion of the North South Corridor, and the traffic zones north of Liberty Lake.

CONCLUSION

Forecasts prepared in this analysis are used for transportation planning and travel forecasting. The forecasts also may be used for other public sector facility planning (water, wastewater, and parks) and public service planning (police, fire, and emergency services). These forecasts also affect economic development as the private sector may use this information in determining future demand for goods and services and for locating or expanding retail and service establishments.

METHODOLOGY

The population forecasts for Spokane County are prepared by using the cohort-survival which factors in births, mortalities, and migration information to produce population projections.

Housing unit forecasts are calculated on population projections and are adjusted for factors such as vacancy rates and family size.

Long range countywide employment forecasts are produced for each employment sector of the economy based on a combination of short term and long term historical trends and on national forecasts for various industries.

The allocation of housing units and employment from the county level of geography to the more than 400 traffic zones in the county is based on a number of factors including interviews with persons familiar with past and current development trends, existing development proposals, SRTC's building permit history file, Spokane County's Land Quantity Analysis, local comprehensive plans and development policies, a "windshield" survey of the county, and Spokane Valley's traffic zone allocation.

INTERVIEWS & DATA SOURCES

The following agencies were contacted in preparing this analysis:

AVISTA Corporation
The City of Spokane Planning Services
The City of Spokane Valley
Spokane County Development Services
SRTC Technical Advisory Committee
Spokane Transit
Washington State Department of Transportation

Data sources for the analysis include the following:

Bureau of Economic Analysis Regional Information System
City of Spokane Draft Comprehensive Plan/Environmental Impact Statement
City of Spokane Valley Comprehensive Plan
City of Spokane Valley Long Plat Subdivision History
City of Spokane Valley Housing Unit and Employment Distribution by Traffic Zone
Center for Business Research and Services, Idaho State University
Office of Financial Management, Washington State County Population Projections
Policy Research Institute, University of Kansas
Population Division, U.S. Census Bureau
Real Estate Research Committee, The Real Estate Report, 2005
Spokane County Development Services Land Quantity Analysis
Spokane County Comprehensive Plan
SRTC Residential Building Permit History, 1990 – 2004
SRTC Housing Unit and Employment Inventory, 2005
Woods and Poole Economics, Spokane County Washington 2005 Data Pamphlet
Zimmerman/Volk Associates, Market Potential Study, Downtown Spokane