LITTLE SPOKANE RIVER WATER BANK MODELING AND DECISION SUPPORT TOOLS

GRANT APPLICATION
BUREAU OF RECLAMATION
WaterSMART: DROUGHT RESILIENCY PROJECT GRANTS

Spokane County Utilities
1004 North Freya Street
Spokane, Washington 99202

Mike Hermanson – Project Manager
mhermanson@spokanecounty.org
(509) 477-7578

TABLE OF CONTENTS

Executive Summary 1
Background Data 1
Source of Water Supply 2
Water rights, Water Supply, and Water Demand 4
Curtailment Analysis 8
Water Supply, Demand, and Climate Change 9
Technical Project Description 9
Evaluation Criteria 11
Evaluation Criterion A-Project Benefits 11
Evaluation Criterion B-Drought Planning and Preparedness 15
Evaluation Criterion C-Severity of Actual or Potential Drought Impacts to be addressed by the Project 17
Evaluation Criterion D-Project Implementation 19
Evaluation Criterion E-Nexus to Reclamation 19
Performance Measures 20
References 21
Environmental and Cultural Resources Compliance 22
Existing Drought Contingency Plan 22
Required Permits or Approvals 22
Letters of Support 22
Official Resolution 22
Project Budget 22
Funding Plan and Letters of Commitment 22
Budget Proposal 23

Appendix A – Washington State Comprehensive Emergency Management Plan – Drought Contingency Plan
Appendix B – Washington State Drought Contingency Plan Update Work Plan
Appendix C – Letter of Support
Appendix D – Spokane County Resolution approving and supporting the grant application
Appendix E – Cost share funding – Ecology grant award and agreement

EXECUTIVE SUMMARY

Date: April 11, 2016
Applicant Name: Spokane County Division of Utilities
City/County/State: Spokane, Spokane County, Washington

The goal of this project is to develop the necessary components to establish a water bank in the Little Spokane River Basin, an essential tool to address water availability issues in the basin. Water availability issues in the basin are significant, and include stream flow that has fallen below regulatory minimum flows in 25 of the last 37 years, water rights permits that have not been acted on for over 15 years, municipal water rights and 7,900 domestic wells that are junior to the regulatory flow and at risk of curtailment during drought conditions, and significant uncertainty about the ability of landowners to drill new wells.

To address the water availability issues Spokane County Utilities is developing a water bank that will acquire and reallocate existing water rights and support development of new water supplies in the basin. In June 2015 the Little Spokane Water Bank Feasibility Study was completed. This $190,000 effort led by Spokane County Utilities in conjunction with Pend Oreille and Stevens Counties, public water purveyors, and the State of Washington concluded that a water bank was a feasible and appropriate approach to existing water supply restrictions and lack of available water for new uses. Spokane County Utilities recently received a $275,000 grant from the Washington State Department of Ecology (Ecology Grant) for Phase II of the development of the Little Spokane Water Bank. The 2015 feasibility study acknowledged that a sophisticated understanding of the hydrology and hydrogeology was necessary to develop new water supplies, and to match both acquired water rights and potential new supply to areas of water demand. The Ecology Grant does not include sufficient funding to completely develop the sophisticated technical tools necessary for bank management.

Spokane County Utilities seeks federal funding assistance to develop those tools, specifically a coupled ground and surface water model for the entire Little Spokane River Basin. This model will be the technical foundation for the water bank and essentially unlock the potential market forces on water supply development and reallocation by allowing calculation of the mitigation value of a new water supply project or reallocation of an existing supply. Without a model it will be difficult to assign value to new and innovative water supply projects such as shallow aquifer recharge, interbasin transfers, and wetland development and restoration; tools that will be essential in the Little Spokane River Basin during drought conditions.

BACKGROUND DATA

The Little Spokane River Basin (Figure 1) encompasses just under 700 square miles along the eastern border of Washington including areas in Spokane, Pend Oreille and Stevens Counties. Elevations in the watershed range from more than 5,300 feet above mean sea level (amsl) in the north and east sides of the basin to approximately 1,540 feet amsl at the junction of the Little Spokane River and Spokane River. The Little Spokane River basin can be broadly split into two regions; the Columbia Plateau region, and the Northern Rocky Mountains region. Broad and relatively flat topographic features with deeply incised river drainages characterize the Columbia Plateau region of the southern portion of the basin. Steep-sided canyons and relatively straight river courses, characterize the Rocky Mountains region to the north. Evergreen forests are the primary land cover in the mountainous areas to the north and east. Agricultural lands are interspersed throughout the watershed but the majority are found on the south and east sides of the watershed. The remaining portions of the watershed are composed of urban areas, rangeland, wetlands and barren land (Golder, 2003).

The climate of the Little Spokane River Basin is generally warm and dry in the summer and cool and moist in the winter. Large variations in climate occur across the watershed from a sub humid mountain climate in the north to semiarid in the south. Annual precipitation also varies spatially within the basin and temporally throughout the year. There is significantly more precipitation in the upper elevation areas in the north eastern portion of the basin, and during the winter and spring months. On average precipitation during July, August, and September is less than 2 inches.

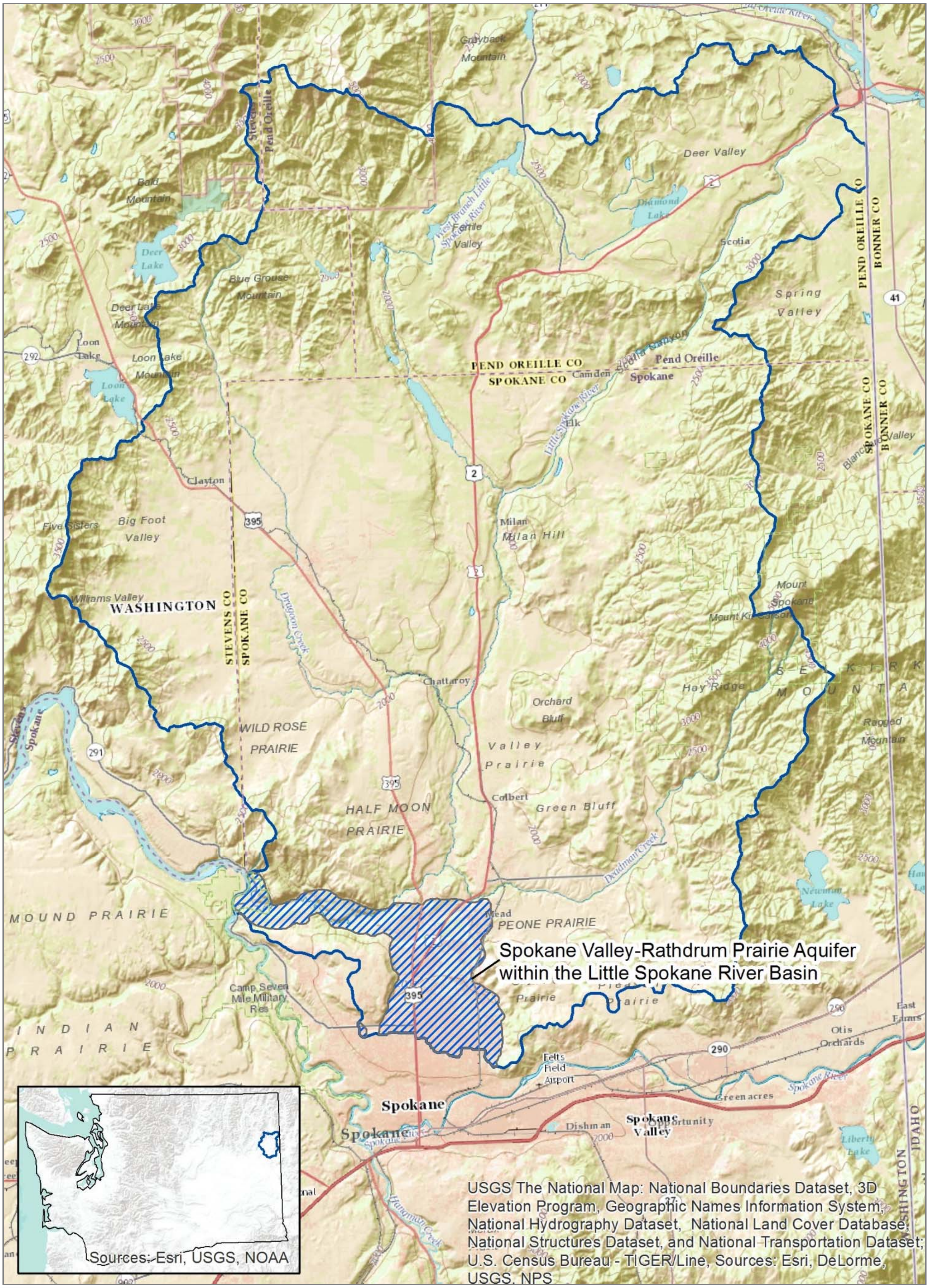
SOURCE OF WATER SUPPLY

Water supply within the Little Spokane River Basin can be divided into two important components: water supply from the Spokane Valley-Rathdrum Prairie (SVRP) aquifer and supplies that are connected to local sources within the basin, both surface and groundwater. The SVRP aquifer is a prolific aquifer that is interconnected with the Spokane River. It covers approximately 4% of the southern portion of the basin, as shown in Figure 1. Some urban areas in the southern portion of the basin, including portions of the City of Spokane, derive their water from the SVRP aquifer. This project addresses water supply issues within the remaining 96% of the basin that derives water from local sources. It should be noted that significant suburban areas in the southern portion of the basin and other developed areas within the basin are supplied from localized Little Spokane River Basin aquifers. There are approximately 19,300 single family residences and a population of 45,000 within this portion of the basin (Spokane County, 2013).

The Little Spokane River Basin is largely a snowmelt driven system. Significant snow pack accumulates mostly in the eastern and northern portions of the basin at relatively high elevations. Up to 60% of the total precipitation falls as snow during the winter months over the higher elevations in the watershed. Snowmelt along with spring precipitation produces a large spring runoff. Tributary streams with steep slopes in the headwaters rapidly convey the surface runoff and then experience low summer flows, causing seasonal distribution problems. The main stem of the Little Spokane River also conveys the significant runoff, but during summer months has a sustained base flow derived from groundwater.

Groundwater plays a significant role in water supply for the Little Spokane River Basin. The hydrogeology of the basin is varied and complex. Groundwater in the basin is principally found in four hydrogeologic units:

1. Upper Sand and Gravel Unit – This unit is composed mostly of sand and gravel and occurs on about 32 percent of the surface area of the watershed. This unit receives recharge from precipitation and snow melt during the winter and spring, and provides base flow to surface water during the summer and fall. This unit is capable of producing significant quantities of water.
2. Columbia River Basalt Unit – This unit is comprised of the basalt formations and sedimentary interbeds. Groundwater occurs in the joints, vesicles, fractures and sedimentary interbeds.


Spokane Valley-Rathdrum Prairie Aquifer within the Little Spokane River Basin
USGS The National Map: National Boundaries Dataset, 3D Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; U.S. Census Bureau - TIGER/Line, Sources: Esri, DeLorme, USGS, NPS
Sources: Esri, USGS, NOAA
PEND OREILLE CO
SPOKANE CO
STEVENS CO
SPOKANE CO
PEND OREILLE CO
BONNER CO
SPOKANE CO
BONNER CO
WASHINGTON
IDAHO
Deer Valley
Spring Valley
Big Foot Valley
Williams Valley
Deer Lake
Loon Lake
Diamond Lake
Newman Lake
WILD ROSE PRAIRIE
HALF MOON PRAIRIE
MOUND PRAIRIE
PEONE PRAIRIE
INDIAN PRAIRIE
Valley Prairie
Green Bluff
Orchard Bluff
Hay Ridge
Mount Spokane
Milan Hill
Chattaroy
Colbert
Clayton
Mead
Camden
Scotia
Spokane
Spokane Valley
Felts Field Airport
Greenacres
Otis Orchards
Dishman
Little Spokane River
Dragoon Creek
Deadman Creek
Spokane River

The largest occurrence of this unit is found in the southeastern portion of the watershed in the Deer Park area, where much of the agriculture in the watershed is located.

3. Bedrock Unit – This unit underlies the entire basin and occurs at land surface on approximately 44 percent of the basin's surface area. It is comprised of granite, quartzite, schist and gneiss. This unit produces quantities of water suitable for domestic use where fractures can be found.
4. Lower Sand and Gravel Unit – This unit is comprised of localized sand and gravel aquifers found beneath low permeability confining layers. This unit can produce significant quantities of water, and hosts some large municipal production wells in the southern portion of the watershed.

These hydrogeologic units are commonly heterogeneous and locally discontinuous. Wells completed in the sand and gravel units follow a typical annual cycle of diminishing water levels through the summer and fall months with recharge during the spring. The main impact of ground water withdrawal is the degree to which withdrawals reduce groundwater inflows to surface water during the summer months. During drought years recharge peaks earlier and water levels do not rebound as usual, thus creating greater reductions in groundwater inflow and lower river flows. Also during drought years domestic wells completed in the bedrock unit often go dry. Whitworth Water District received a Washington State Drought relief grant in 2015 to improve their water hauling station, which experienced unprecedented demand from homeowners hauling water for domestic use.

WATER RIGHTS, WATER SUPPLY, AND WATER DEMAND

The core issue in the Little Spokane Basin is the balance between out of stream and instream uses of water. Water supply issues in the basin came to a head in the early 1970s, and on September 21, 1973, the Washington Department of Ecology adopted Washington Administrative Code (WAC) 173-108 for the purpose of withdrawing the waters of the Little Spokane River Basin from further appropriation pending development and adoption of a water management program for the basin (Ecology, 1975). In 1976 the water management program for the Little Spokane River Basin was adopted allowing for some limited additional appropriation of water, though now minimum flows were established and would be protected like any other water right.

WATER RIGHTS

In Washington State minimum flow levels can be established for surface water in WAC, as was done in the Little Spokane River Basin. Once established the minimum flows are a water right with a priority date, and are subject to the prior appropriation doctrine in the same manner as any other water right (Ecology, 2014). Minimum flows can be impaired by senior water rights and water rights with a priority date after the establishment of a minimum flow can be curtailed if the surface water is below the minimum flow.

The Little Spokane River Basin is subject to WAC 173-555: Water Resource Program in the Little Spokane River Basin, WRIA 55 (LSR Rule) which has a priority date of January 6, 1976. The LSR Rule established base flows at locations along the mainstem of the river and closed all tributaries to further withdrawal. The LSR Rule specifies that "All rights hereafter established shall be expressly subject to the base flows established in section WAC 173-555-030 (1) through (3)." The base flows specified in the rule are presented in Table 1.

Table 1 – Base Flows in the Little Spokane River, WAC 173-555

	Location	Elk	Chattaroy	Dartford	Confluence
	River Mile	37.6	23.1	11.4	0
Month	Day	Flow (cfs)			
Jan.	1	40	86	150	400
	15	40	86	150	400
Feb.	1	40	86	150	400
	15	43	104	170	420
Mar.	1	46	122	190	435
	15	50	143	218	460
Apr.	1	54	165	250	490
	15	52	143	218	460
May	1	49	124	192	440
	15	47	104	170	420
Jun.	1	45	83	148	395
	15	43	69	130	385
Jul.	1	41.5	57	115	375
	15	39.5	57	115	375
Aug.	1	38	57	115	375
	15	38	57	115	375
Sept.	1	38	57	115	375
	15	38	63	123	380
Oct.	1	38	70	130	385
	15	39	77	140	390
Nov.	1	40	86	150	400
	15	40	86	150	400
Dec.	1	40	86	150	400
	15	40	86	150	400

Water rights with a priority date after the adoption of the LSR Rule are at risk of curtailment when river flows fall below the levels specified in Table 1. There are 788 acre-feet/year of surface water rights and 26,051 acre-feet/year of groundwater rights that are junior to the LSR Rule (Aspect, 2015).

In addition to certificated water rights and minimum flow water rights, there is also a substantial amount of water use that has been established under the exemption to the water rights permitting process contained in the Washington State Water Code. The exemption is available for groundwater, but not surface water. Under the exemption water use falling below the following thresholds does not require a water user to go through the water rights permitting process:

- Single or group domestic uses in an amount not exceeding 5,000 gallons a day.
- Watering of a lawn or of a noncommercial garden not exceeding one-half acre in area.
- Stock-watering purposes.
- Industrial purpose in an amount not exceeding 5,000 gallons a day.

Water use established under the permit exemption is a water right with a priority date, usually the date the water was first put to beneficial use. The vast majority of permit exempt use in the Little Spokane River Basin are associated with rural residential development which includes domestic use, lawn and garden watering, and stock watering. There are an estimated 7,900 wells in the Little

Spokane River Basin totaling 7,240 acre-feet/year that have been established under the permit exemption since January 6, 1976 and are junior to the LSR Rule. Most permit exempt water use does not utilize the full amount allowed under law.

WATER SUPPLY

The average annual flow in the LSR at the Dartford gage is 215,820 AF/yr. More important than the annual average is the temporal distribution of supply. As is the case in much of the Western United States, the issue is the largest water demand occurs during times of limited supplies.

Figure 2 – Little Spokane at Dartford Gage-Monthly Supply

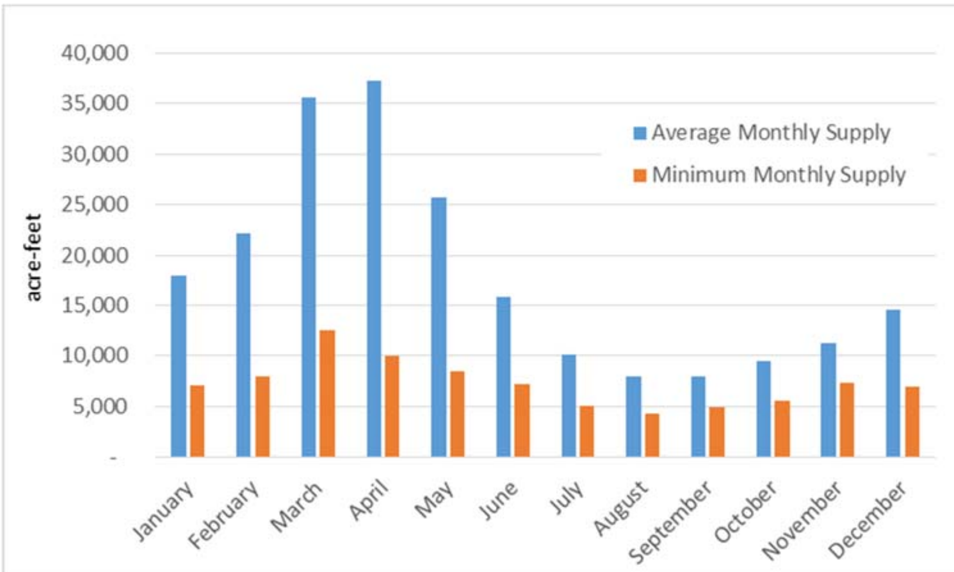
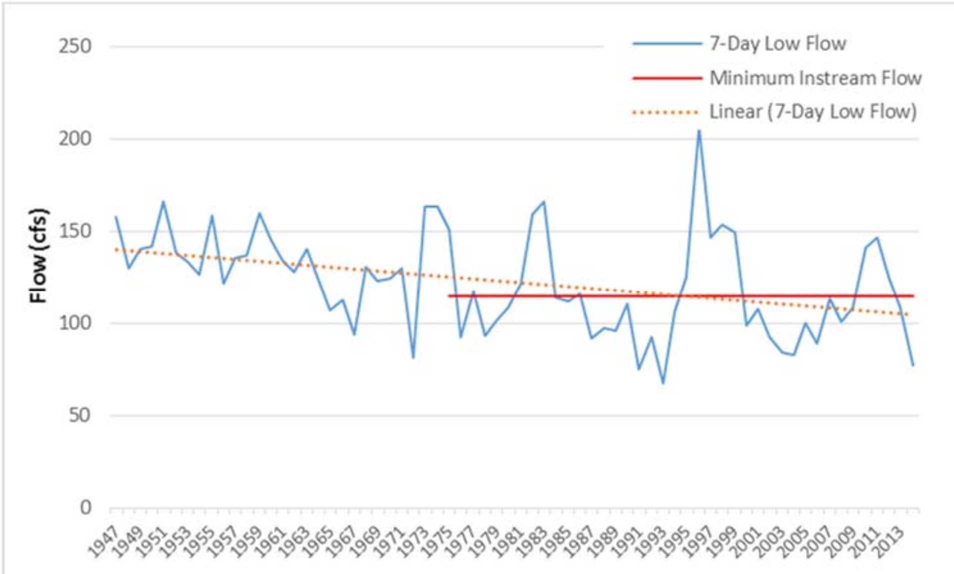


Figure 2 demonstrates that under average conditions summer flows are significantly less than spring runoff flows. In the summer and fall tributary streams are often reduced to flows under 1 cfs, or dry for some reaches. Under drought conditions (minimum monthly supply in Figure 2) the summer supply is less than half the average, and the winter and spring supply is less than one third of average. Reduced winter and spring supply often indicate conditions in which groundwater recharge is diminished.

A key water management challenge in the basin is the frequency at which the Little Spokane River falls below the minimum flow levels established in the LSR rule. When the flow drops below the minimum level water rights that have a priority date or exempt uses established after January 6, 1976 are at risk of curtailment. Surface water users are regularly curtailed during the summer months. Figure 3 presents the 7-day low flow, the metric by which junior water rights are curtailed, for the period 1947-2015. Flows below the red line indicate years in which junior surface water rights have been curtailed. The orange dotted line indicates a downward trend in the 7-day low flow.

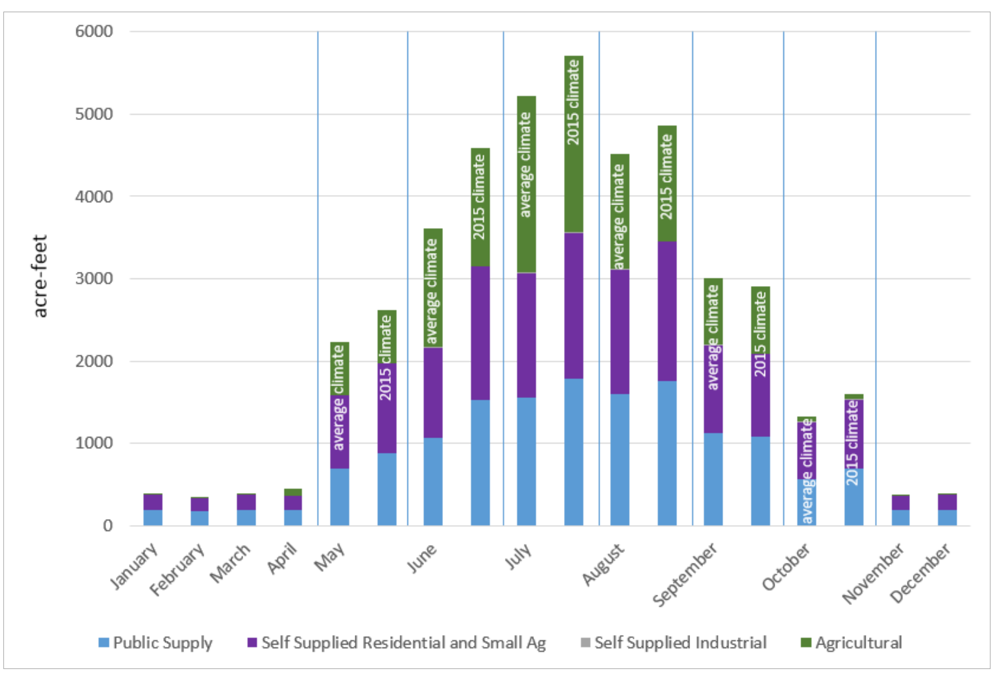
Figure 3 – LSR 7-Day Low Flow at Dartford



CURRENT WATER DEMAND

Current water demand within the Little Spokane River Basin was determined from the Spokane County Water Demand Forecast Model (Forecast Model). Water demand was calculated under average climactic conditions and under drought conditions. The Forecast Model is based on an econometric analysis of water use that, among other variables, utilizes average maximum daily temperature and precipitation to model water use. Under average climate conditions the 2015 annual demand from all water use sectors is 22,240 acre-feet/year, and under 2015 climate conditions annual demand from all water use sectors is 24,607 acre-feet/year. Figure 4 shows the monthly distribution of annual demand.

Figure 4 Monthly Water Demand – Average and 2015 Climate Conditions

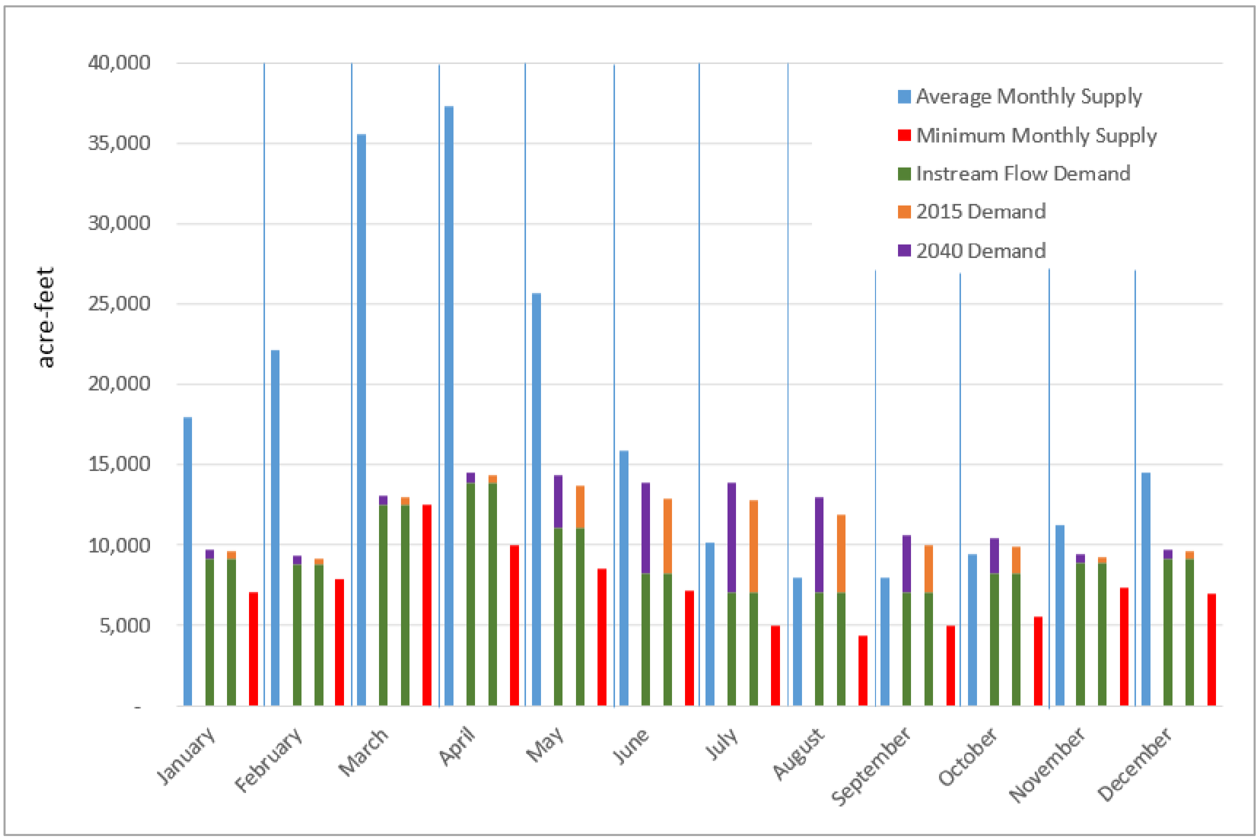


FUTURE WATER DEMAND

The Forecast Model was used to estimate demand in 2040. Under average climate conditions the 2040 annual demand from all water use sectors is 27,380 acre-feet/year, and under 2015 climate conditions 2040 annual demand from all water use sectors is 30,486 acre-feet/year; a 23% and 24% increase over the next 25 years.

Currently out of stream uses and instream demand, as specified in the LSR rule, are greater than average monthly supply in July, August, September, and October. Combined demand is greater than minimum supply in every month of the year. Figure 5 shows the average monthly supply, minimum monthly supply, instream demand, out of stream demand in 2015 and out of stream demand in 2040. During July and August out of stream demand or instream demand considered alone are both greater than the minimum supply. Groundwater storage is the buffer that allows demand to exceed supply but as drought years, such as 2015, increase in frequency groundwater reservoirs will be diminished.

Figure 5 Comparison of Water Supply and Water Demand



CURTAILMENT ANALYSIS

The 2011 Columbia River Basin Long-Term Water Supply and Demand Forecast provided the following curtailment analysis for the Little Spokane River Basin:

> Modeling of curtailment of interruptible irrigation water rights indicated that it occurred in every year between 1977 and 2005. The resulting unmet demand ranged from 1,130 to 3,541 ac-ft per year depending on yearly flow conditions, with an average of 2,503 ac-ft per year. Simulation of future curtailment occurred in all the years for the middle

> climate scenario. The resulting unmet demand per year ranged from 1,512 to 3,870 with an average of 1,512 ac-ft per year. Due to data and resource constraints, the modeling of unmet demand did not consider curtailment of one water user in favor of another more senior water right holder, water shortages in localized areas (subbasin scale), or over time periods within months. Modeling also indicated that at the WRIA level there was insufficient water to meet the instream flow targets in every year between 1977 and 2006. The resulting unmet instream flow ranged from 59,463 to 225,247 with an average of 122,093 ac-ft per year. Simulation of future insufficient water occurred in all the years for the middle climate scenario. The resulting unmet flow per year ranged from 41,469 to 183,923 with an average of 102,607 ac-ft per year. (WSU, 2012)

WATER SUPPLY, DEMAND, AND CLIMATE CHANGE

Climate change is forecasted to both decrease supply during the summer months and increase demand. The 2011 Columbia River Basin Long-Term Water Supply and Demand Forecast, which includes the Little Spokane River Basin, provides the following description of the impact of climate change on water supply and demand.

> Although annual precipitation is not expected to change much in the mid-term, temperature changes will likely change water availability throughout the Columbia River basin. Specifically, higher temperatures will cause earlier snowmelt. The trend towards earlier peak spring runoff has already occurred and is projected to continue, with runoff shifting 15 to over 35 days earlier within this century (Stewart et al. 2004). April 1 snowpack is projected to decline as much as 40% by the 2040s (Payne et al. 2004). This will reduce the amount of water available during the summer and autumn, when flows are already normally low (Payne et al. 2004; Stewart et al. 2004). The summer dry period will be longer (Stewart et al. 2004) and flows will be lower in the late summer, both due to earlier snowmelt and because higher summer temperatures will lead to increased evaporation and higher water loss from vegetation. (WSU, 2012)

TECHNICAL PROJECT DESCRIPTION

A coupled groundwater and surface-water flow model will be constructed and calibrated to use as a tool to simulate changes in surface water flows and groundwater reservoirs resulting from reallocation of existing water rights or development of new water supplies. Outputs from the model will be utilized to assign mitigation value within the Little Spokane Water Bank to proposed reallocation of existing water rights or development of new supplies. The model will also be capable of simulating climate changes and the impacts to surface water flows and groundwater reservoirs. This will allow for consideration of climate changes and simulation of drought management approaches.

The project proposes to use GSFLOW, a coupled groundwater and surface water flow model that integrates the USGS Precipitation-Runoff Modeling System (PRMS) and the USGS Modular Groundwater Flow Model (MODFLOW). The project includes data compilation, construction and calibration of the model, model simulations, and project reporting and documentation. The project will also include a stakeholder technical advisory committee to guide model development and use, an important project component to facilitate acceptance of model results in bank management and drought response efforts.

Task 1 Technical Advisory Group – Convene a group of stakeholders and technical experts to guide model development. This group will provide guidance on input data, model construction and calibration, and selection of simulation criteria. This group will provide peer review of final products.

Task 2 Data Compilation – Compile and evaluate required data sets; prepare for inclusion in model. Data may include, but is not limited to:

- Climate and meteorological data
- Land use
- Soil types
- Topography
- Surface water hydrology
- Water use
    - Surface water withdrawals
    - Groundwater withdrawals
    - Return flows
- Geologic and hydrostratigraphic units
    - Occurrence
    - Lateral extent and thickness
    - Hydraulic properties
    - Horizontal and vertical continuity
- Three dimensional hydrogeologic framework
- Groundwater flow system
    - Groundwater gradients and flow directions
    - Recharge and discharge
    - Boundary conditions
    - Surface water and groundwater interaction
    - Lateral and vertical continuity of groundwater flow
- Groundwater levels
    - Long-term
    - Interannual
    - Seasonal

Task 3 Construct and Calibrate a Coupled Groundwater and Surface-Water Flow Model – An integrated groundwater and surface-water flow model (GSFLOW; Markstrom and others, 2008) will be constructed to represent hydrologic processes in the Little Spokane River Basin and simulate potential anthropogenic and climatic impacts on groundwater and surface-water resources. GSFLOW integrates the USGS Precipitation-Runoff Modeling System (PRMS) and the USGS Modular Groundwater Flow Model (MODFLOW). Preliminary modeling using existing data will begin early in the project in order to begin to understand the hydrologic system. Model calibration and sensitivity analysis will be conducted using parameter estimation methods. Time-averaged and synoptic groundwater-level and streamflow data will be used in the transient model calibration. Transient conditions will be simulated with a daily time step. A combination of commercial and USGS graphical user interfaces will be used to construct the model, manage the data, and conduct post-processing of modeling results. Model boundary locations and conditions will be selected that match natural hydrologic boundary features as closely as possible. If it can be determined through the analysis of groundwater levels and other information that groundwater movement in the deeper parts of the aquifer system is governed by regional boundary conditions located beyond the watershed boundary, then those more distant and representative features may be used to bound the model.

Task 4 Construct Water Budgets – Water budgets provide a means for evaluating availability and sustainability of a water supply and a basis for assessing how a change in one part of the hydrologic cycle may affect other aspects of the cycle (Healy and others, 2007). Water budget components that will be simulated by the flow model include precipitation, streamflow, evapotranspiration, groundwater storage, and recharge.

Task 5 Model Simulations – The calibrated model will be used to simulate the effects of different potential future scenarios with different groundwater withdrawal conditions. Simulations could demonstrate modeled responses (changes in streamflow and groundwater levels) to variations in groundwater withdrawal rates, depths, and locations, changes in precipitation and temperature, and changes in land use such as the addition of pavement and stormwater drains. Pumping strategies may be mathematically designed to minimize changes in water levels and/or streamflow discharge, while maximizing groundwater withdrawal.

Task 6 Report Preparation and Publication – Model Construction and Results - A report summarizing the coupled groundwater and surface-water flow model construction, calibration, limitations, and results from simulations of different groundwater withdrawal conditions will be prepared and published.

Task 7 Integration into Little Spokane Water Bank – Throughout the project the model will be integrated into the operation of the Little Spokane Water Bank.

A report that documents the model inputs, development, calibration, simulation results, and guidance on use of the model for water market decision making will be prepared. A draft report will be provided for public review and comment, a comment response summary will be completed. A public meeting will be held near the initiation of the project and at project completion. A public project website will be established and maintained for the duration of the study. All files associated with the development of the model and necessary to run the model will be publicly available on the project website.

Our intention is to use GSFLOW, but if during the first phase of the project another modeling platform is deemed appropriate we will modify the approach to accommodate the alternate platform. A change will be done in coordination with Reclamation and the Technical Advisory Group.

EVALUATION CRITERIA

The proposed project meets the objectives of two project categories eligible for funding under Funding Opportunity R16-FOA-DO-006:

- Task B – Projects to Improve Water Management through Decision Support Tools, Modeling, and Measurement
- Task C – Projects that Facilitate the Sale, Transfer or Exchange of Water.

EVALUATION CRITERION A-PROJECT BENEFITS

Will the project make additional water supplies available?

There has been significant work completed in the last 15 years to identify water storage opportunities in the Little Spokane River Basin. For any of these supplies to be utilized in a water bank an understanding of the temporal distribution, spatial distribution, and quantity of surface flow benefits is necessary. Without that information mitigation value cannot be assigned to projects and investments in water storage will not be made. Opportunities identified in previous work include:

- Surface Water Storage – Surface water storage opportunities in Buck Creek, Beaver Creek, and Eloika Lake totaling between 7,925 and 10,680 AF. (Golder, 2004 and PBS&J, 2009)
- Wetland Restoration – A total of 115 potential wetland restoration or creation sites covering approximately 3,900 acres have been identified. (PBS&J, 2009)
- Interbasin Transfer – A unique opportunity exists to potentially withdraw groundwater or divert surface water from the Pend Oreille watershed into the upper headwaters of the Little Spokane River. An appraisal level study of the opportunity was conducted at a flow of 10 cfs, totaling 7,900 AF/year. (Aspect, 2015)
- Shallow aquifer recharge – Hydrogeologic investigations have identified the potential for shallow aquifer recharge in tributary basins. An estimate of the quantity has not been determined. (Aspect, 2015)

How will the project build long-term resilience to drought? How many years will the project continue to provide benefits?

The project will provide information that will form the technical basis for water management into the foreseeable future in the Little Spokane River Basin. Water supply or reallocation projects will not be undertaken unless mitigation value (i.e. increases in surface water flow) can be assigned to a specific project. The proposed model is an essential tool to assign mitigation value.

Many of the projects would include enhancements to groundwater recharge, which provides much of the domestic water supply in the watershed, and base flow to surface water during the late summer. Groundwater allows the watershed to sustain itself through drought years.

How will the project improve the management of water supplies? For example, will the project increase efficiency or increase operational flexibility (e.g., improve the ability to deliver water during drought or access other sources of supply)? If so, how will the project increase efficiency or operational flexibility?

A fundamental goal of the Little Spokane Water Bank is to increase efficiency and operation flexibility of water management in the basin. The bank will be designed to facilitate transfer of water, both temporarily, through leases and permanently through acquisition. Currently transfers of water are required to go through the Department of Ecology administrative process before it can be used in a different location or from a different point of withdrawal. This process is often long and can be technically challenging when looking at one individual transfer. The water bank will provide an institutional mechanism that will facilitate transfers of water in an appropriate time frame to respond to drought conditions. The modeling tools that would be developed under the proposed project will allow technical evaluations to be completed in a timely and consistent manner.

Will the project make new information available to water managers? If so, what is that information and how will it improve water management?

The proposed model will provide water managers with the following information that is not currently available:

- ***Impacts to surface water from withdrawals of groundwater.*** It will determine impacts depending on the hydrogeologic unit, the timing and magnitude of the withdrawal and the location of the withdrawal.

- ***Impacts of decreased snow pack on river flows and groundwater recharge.*** The model will allow simulation of different climactic scenarios, which will have a significant impact on the hydrologic processes within the basin.
- ***Changes in surface water flows and groundwater from a proposed water supply project or reallocation of an existing senior water right.*** This important information is essential to the proper functioning of the water bank, and will facilitate investment in new water supplies. In essence the amount of instream flow benefit from a particular project determines the value of the project, and without knowing the value it is impossible to determine if a project is cost effective.
- ***Changes in river flow over an extended time frame as the result of increased withdrawals or climate changes*.** Changes in precipitation seasonality and snow pack are anticipated. April 1 snowpack is projected to decline as much as 40% by the 2040s and runoff is predicted to shift from 15 to 35 days earlier within this century. Also higher summer temperatures will lead to increased evaporation and higher water loss from vegetation (WSU, 2012)

An understanding of the short and long term changes in the hydrologic processes of the basin due to changes both within and outside of our control will be invaluable to the management of water resources in the basin.

Will the project have benefits to fish, wildlife, or the environment? If so, please describe those benefits.

The goal of the Little Spokane Water Bank is to allow for new uses without impairing existing rights, principally the right established by the LSR Rule. The LSR Rule was established with the following policy for water use established after the effective date, January 6, 1976.

> Maintain base flows for the preservation of wildlife, fish, scenic, aesthetic, and other environmental values. Consistent with the fundamental policy of this state and public desires expressed through public meetings and surveys, appropriation of future water rights shall not impair maintenance of base flows in the stream (Ecology, 1975).

To confirm the flows established in the LSR Rule, an instream flow needs assessment was conducted in 2003 to re-evaluate the existing minimum instream flows in the context of habitat needs for selected fish species (redband/rainbow trout and mountain whitefish). The assessment found that while the flow established in the LSR Rule provide adequate habitat, additional flow would be beneficial (Golder, 2003). The Little Spokane Water Bank will provide a mechanism in the basin to preserve current flows and promote projects that enhance flows. The proposed project will provide the necessary information to quantify the instream benefits and facilitate market activity. Without quantification of instream benefits market activity will be minimal.

What is the estimated quantity of water that will be better managed as a result of this project?

The Little Spokane Water Bank seeks to address the quantity of water that is junior to the LSR Rule and allow for new uses to meet projected demand. Existing water use junior to the LSR Rule include 788 acre-feet/year of surface water rights, 26,051 acre-feet/year of groundwater rights, and 7,240 acre-feet/year of permit exempt water use. There is an estimated 5,140 acre-feet/year of new demand projected by 2040. The model will support overall management of water rights in the basin, including potential simulation of improved irrigation efficiencies, conversions to new uses, and effects of bank seeding and associated water transfers.

Provide a brief qualitative description of the degree/significance of anticipated water management benefits.

The purpose of the Little Spokane Water Bank is to utilize market forces to improve water management. As described by Smith in a comprehensive graduate research and analysis project that evaluated 38 water banks within the United States, there are three critical elements to a bank's structure and success (Smith, 2010):

1. Regulation
    a. Closed Basin
    b. Instream flow as a beneficial use
    c. Laws and rules that allow for water banking
2. Hydrological Model
3. Enforcement of regulation

The Little Spokane Basin has all but one of the parameters above. The Little Spokane River Basin is closed, regulated on a regular basis, and has established instream flow as a protected beneficial use. The State of Washington has enacted laws to facilitate water banking, and regulation enforcement is conducted. The missing element to the success of the Little Spokane Water Bank is a hydrological model. The proposed project will provide the missing element and provide the framework for significant investment in water management solutions.

New Water Marketing Tool or Program.*—How does the new tool or program increase the flexibility of acquiring water on the open market? What is the scope of water users and uses that will benefit? Are there any legal issues pertaining to water marketing that could hinder project implementation (e.g., restrictions under Reclamation or State law or contracts, or individual project authorities).*

The proposed project will create a modeling tool and technical framework by which water acquired or newly developed can be associated with a new use. Without this modeling tool the application of an acquired water right or newly developed supply will be spatially and temporally limited. The quantification of instream benefits associated with reallocation of water or development of a new supply will provide the currency by which willing buyers, willing sellers, and proponents of new supply projects will be able to enter into agreements within a water market framework with certainty.

Water markets are the most successful tool in addressing limited water supplies in Washington State. They have been accepted by parties on all sides of the issue including environmental and conservation groups, private developers, and local and state governments. They work within the fundamental prior appropriation scheme and as a result have not been subject to significant litigation. The Washington State Legislature has enacted statutes to facilitate water banking throughout the state. An essential component of a successful water bank is the ability to quantify impacts and benefits from market activity. The proposed project will provide this essential component.

The scope of water users that will benefit from the project include:

1. Holders of surface water rights with low flow provisions that are regularly curtailed,
2. Exempt users and those with groundwater rights junior to the LSR Rule that are not currently curtailed but are at risk of curtailment. The risk alone can significantly impact financial transactions associated with the property (property sales, refinancing).

3. New water users, both permitted and exempt. Water right applications dating back to the late 1980s have not been acted on, and new building permits within the basin may be conditioned on a showing of mitigation water.

EVALUATION CRITERION B-DROUGHT PLANNING AND PREPAREDNESS

Explain how the applicable plan addresses drought.

The purpose of the Washington State Drought Contingency Plan (Drought Plan) is described in the Plan as follows:

> To provide a process for: monitoring water supply conditions around the state; anticipating potential drought problems; mobilizing local, state and federal resources should drought conditions occur; coordinating local, state and federal responses to such conditions; gathering and disseminating pertinent water supply and water use information; managing the state's natural resources effectively during times of water shortage; and providing relief and assistance to those seriously affected by drought so as to minimize the overall impacts of drought upon the citizens of the state (Ecology, 1992).

Explain whether the drought plan was developed with input from multiple stakeholders. Was the drought plan developed through a collaborative process?

The drought plan was developed by the Executive Water Emergency Committee which includes the following local, state, and federal agencies:

State Agencies

- Governor's Office (Chair)
- Agriculture
- Community Development
- Ecology
- Energy Office
- Employment Security
- Fish and Wildlife
- Health
- Natural Resources
- Office of Financial Management
- Trade and Economic Development

Federal Agencies

- Bureau of Reclamation
- Army Corps of Engineers
- Bonneville Power Administration

Local Agencies

- Cooperative Extension

Does the drought plan include consideration of climate change impacts to water resources or drought?

The current drought contingency plan was developed in 1992, and does not address climate change. The Washington State Department of Ecology received a WaterSMART Drought Contingency Planning Grant and is currently developing a new drought plan. This plan will address climate change.

Describe how your proposed drought resiliency project is supported by an existing drought plan.

The Little Spokane Water Bank, and the proposed project in particular, will facilitate key aspects of both drought preparedness planning and drought response identified in the Drought Plan. Identified drought preparedness activities include:

- Conduct water resources planning activities, including basin planning, setting minimum instream flows, and other activities, which permit the logical and orderly management and use of the resource.
- Accept and investigate applications for new water rights, permitting such uses if sufficient water is available for the new use and no conflict with existing rights will result. Such new rights will be subject to regulation based upon any provisions contained in the permit, including minimum streamflow levels. This may include emergency water withdrawal authorizations during droughts.
- Process water right transfers. Current state law allows for the transfer of water rights to others when the transfer can be accomplished without detriment to any existing water rights. Applicants for such transfers must file an application with Ecology and the transfer application is processed as a water right application.
- Conduct surface and ground water investigations.
- Conduct research on hydrologic processes and the effects of climate change.

Identified drought response activities include:

- Regulate existing water rights. The department can regulate existing junior water right holders on a stream or within a groundwater basin to ensure that senior right holders receive the full measure of their right. Similarly, the department can regulate those rights on streams which have minimum flows set if they were issued after the setting of the flow levels.
- Effect temporary and permanent water right transfers. Current state law allows for the transfer of water rights to others when the transfer can be accomplished without detriment to any existing water rights. Normally these applications are processed as ordinary water right applications, but processing during drought periods can be expedited under the rules adopted to implement the 1988 drought legislation.
- Issue temporary water rights. The Department can issue temporary water right permits for development of supplemental water supplies to be used for limited periods of time to offset anticipated shortages from normal sources. These can include the drilling of wells; the installation of alternative diversion, conveyance or storage facilities; and other development activities, which normally require the securing of a permit through the normal application and review process. Applications for temporary water rights will be subject to review by WDW and WDF and subject to established instream flows.
- Respond to complaints of well interference and take action as necessary.
- Adopt guidelines for: (1) Temporary transfers of water between willing parties who are not within irrigation districts, and (2) Water spreading to allow the same amount of water to be consumptively used on a greater number of acres.
- Monitor and enforce adopted instream flow provisions.

The proposed project will provide the technical information necessary to effectively implement all of the above identified drought preparedness and response activities within the Little Spokane River Basin.

EVALUATION CRITERION C-SEVERITY OF ACTUAL OR POTENTIAL DROUGHT IMPACTS TO BE ADDRESSED BY THE PROJECT

What are the ongoing or potential drought impacts to specific sectors in the project area if no action is taken?

Water users are currently curtailed during drought conditions and the water bank will provide a mechanism by which those users who need water can purchase from those who do not. The most significant potential impact, which is becoming increasing likely as drought conditions occur more frequently, is the impact of water availability on new development and existing water users at risk of curtailment.

Providing water for residential development that relies on individual wells in basins with established instream flow rights has become a significant issue in Washington State. As a result of numerous Washington State Supreme Court Decisions dating back to the mid 1990s instream flow rights in some basins in Washington (Skagit River Basin) now prohibit the use of new individual wells that are not mitigated, which has essentially created a development moratorium in areas without public water supply, or a source of mitigation such as a water bank. Also in some basins owners of residences utilizing wells that are junior to an instream flow right are finding that lending institutions will not provide loans on their property, effectively prohibiting property sales and refinancing. Similar situations are occurring in the Upper Yakima River Basin, and the Dungeness River Basin. A Washington Supreme Court decision (Hirst v. Whatcom County) that will have significant ramifications is expected this spring or summer. This court decision could compel Counties to stop issuing building permits in river basins with instream flow rights, that are not met, such as the Little Spokane River Basin, and call into question the reliability of water supplies to existing residences that are junior to the instream flow right.

There are significant economic consequences if new development is restricted and if junior water supplies are called into question in the Little Spokane River Basin, including:

- According to Spokane County Assessor data there was $21,564,450 of new construction in 2015 that relied on new individual wells. A restriction on the use of new individual wells could put that economic activity in jeopardy.
- Existing developed property with water use established after January 6, 1976, and junior to the LSR Rule, has an assessed value of 1.39 billion dollars. Economic activity such as property sales and financing related to that property could be significantly restricted.
- The value of undeveloped land is determined by the highest potential use, which is most often residential development that requires a water supply. Undeveloped land that would require a new individual well to be developed has a value of 800 million dollars, and would immediately go down in value significantly if new individual wells were restricted.

Describe existing or potential drought conditions in the project area.

Drought conditions are most notably apparent as reduced stream flow. As described in the preceding background section the Little Spokane River routinely falls below the established minimum flow. Table 2 shows the percentage of times during the period 1993 to 2013 that instream flows fell below minimum flows during each month at the Dartford Gage, the gage that is principally used to manage the basin.

Table 2 Days below minimum flow

Month	Number of Days	Percentage of Days
January	25	4%
February	30	5%
March	20	3%
April	6	1%
May	33	5%
June	33	6%
July	112	18%
August	322	52%
September	329	55%
October	222	36%
November	118	20%
December	47	8%

Is the project in an area that is currently suffering from drought or which has recently suffered from drought?

The Little Spokane Basin suffered from extreme drought in 2015, and routinely has moderate to severe drought during the summer months, as shown in Figure 6 and Figure 7.

Figure 7 – Drought in the Little Spokane River Basin 2000-2016

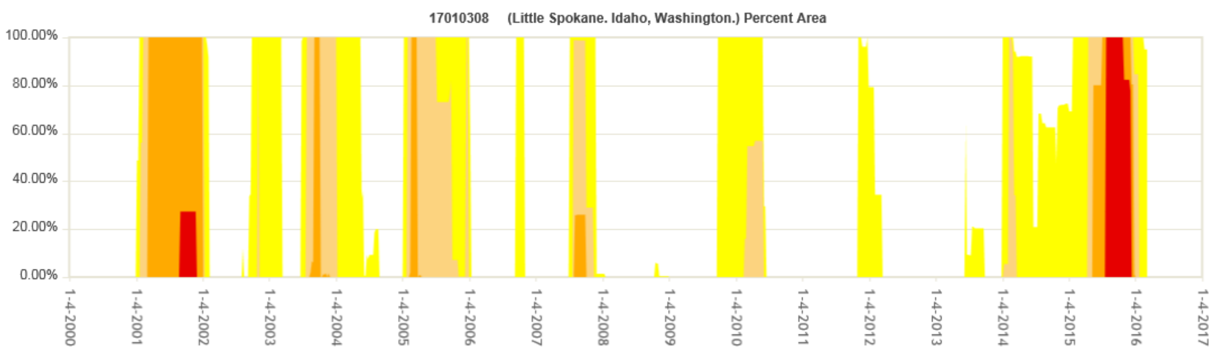
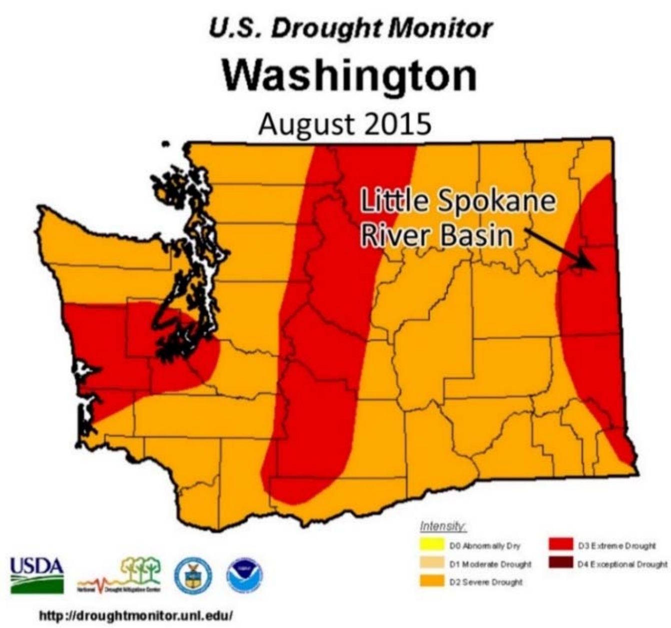


Figure 8 – August 2015 Drought



Describe any projected increases to the severity or duration of drought in the project area resulting from climate change.

As described in the preceding background section the Little Spokane River Basin hydrology is driven by storage of water in the form of snow during the winter months and release of that water during the spring and early summer. Higher temperatures from climate change will cause earlier snowmelt. April 1 snowpack is projected to decline as much as 40% by the 2040s (Payne et al, 2004). This will reduce the amount of water for late summer and early fall stream flow. The development of additional storage, enhanced aquifer recharge, and restoration of wetlands that would be facilitated by the Little Spokane Water Bank supported by the proposed coupled surface water and groundwater model for the basin could mitigate some of the predicted impacts of climate change.

EVALUATION CRITERION D-PROJECT IMPLEMENTATION

Describe the implementation plan of the proposed project. Please include an estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates.

Project Schedule

	2016			2017				2018		
	June	Q3*	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Project Award										
Consultant Selection & Contracting										
Technical Advisory Group										
Data Compilation & Formatting										
Model Construction										
Model Calibration										
Model Simulation										
Construct Water Budgets										
Report Preparation & Publication										
Integration into water bank										
Public Meetings										

*Calendar Year Quarters

Describe any permits that will be required, along with the process for obtaining such permits.

No permits will be required for this project

Identify and describe any engineering or design work performed specifically in support of the proposed project.

No engineering or design work will be performed as part of this project.

Describe any new policies or administrative actions required to implement the project.

No new policies or administrative actions are required for implementation of the proposed project.

EVALUATION CRITERION E-NEXUS TO RECLAMATION

The Little Spokane River Basin is tributary to the Bureau of Reclamation's Columbia Basin Project and increases in flow during critical low flow months that are the result of this project will flow into the Columbia Basin Project. The goal of the proposed project is to provide the technical framework under which water reallocation and supply projects will be developed. Without the technical framework to provide certainty as to the value of the project within the market, investments in these project will not be made, and increases in flow will not be realized.

PERFORMANCE MEASURES

The following performance measures will be used to evaluate the proposed project's effectiveness:

1. Value of water market transactions.
2. Number of water market transactions.
3. Instream flow enhancements as a result of water market activity.
4. Preservation of value of existing development reliant on water junior to the instream flow right.
5. Preservation of value of undeveloped land.
6. New construction activity reliant on water supplies made available through the Little Spokane Water Bank.

REFERENCES

Aspect Consulting, 2015, Little Spokane Water Bank Feasibility Study, Aspect Consulting, Seattle, WA, variously paginated.

Aspect Consulting, 2015, Pend Oreille Interbasin Transfer Memo, Aspect Consulting, Seattle, WA, 30 p.

Chung, S.K., 1975, Water resources management program-Little Spokane River Basin, WRIA 55, Olympia, WA, Department of Ecology Policy Development Section, Water Resources Division, 83 p.

Ecology Water Resources Program, 1992, Washington State Comprehensive Emergency Management Plan, Drought Contingency Plan, Olympia, WA, 51 p.

Ecology Water Resources Program, 2014, Setting Instream Flows in Washington State-Frequently Asked Questions, Olympia, WA, 4 p.

Golder Associates, 2003, Little Spokane (WRIA 55) and Middle Spokane (WRIA 57) watershed planning phase II–Level 1 assessment, data compilation and analysis, Seattle, WA, Golder Associates, variously paginated.

Golder Associates, 2003, Little Spokane River Basin (WRIA 55) Instream Flow Needs Assessment, Seattle, Golder Associates, variously paginated.

Golder Associates, 2004, Storage Assessment for Little and Middle Spokane Watershed, Seattle, WAGolder Associates, variously paginated.

Kahle, S.C., Olsen, T.D., and Fraser, E.T., 2013, Hydrogeology of the Little Spokane River Basin, Spokane, Stevens, and Pend Oreille Counties, Washington: U.S. Geological Survey Scientific Investigations Report 2013-5124, 52 p.

Markstrom, S.L., Niswonger, R.G., Regan, R.S., Prudic, D.E., and Barlow, P.M., 2008, GSFLOW—Coupled ground-water and surface-water flow model based on the integration of the Precipitation-Runoff Modeling System (PRMS) and the Modular Ground-Water Flow Model (MODFLOW-2005): U.S. Geological Survey Techniques and Methods 6-D1, 240 p.

Payne, J. T., A. W. Wood, A. F. Hamlet, R. N. Palmer and D. P. Lettenmaier. 2004. Mitigating the effects of climate change on the water resources of the Columbia River basin. Climatic Change, 62, 233–256.

PBS&J, 2009, Surface Water Storage Investigation West Branch Little Spokane River Wetland Restoration and Recharge Opportunities, Missoula, MT PBS&J, variously paginated.

Smith, Ryan, 2010, "Water Banking; A Free Market Approach To Efficiently Managing And Incentivizing Conservation Of A Natural Resource" Presentation by The Bren School of Environmental Management, University of California, Santa Barbara at A Community on Ecosystem Services Conference, Gila River Indian Community, December 6-9, 2010.

Spokane County Water Resources, 2013, Spokane County Water Demand Forecast Model-Model 3.0 and 2013 Forecast Update, Spokane, WA, Spokane County Utilities, 19 p.

Spokane County Water Resources, 2011, Spokane County Water Demand Forecast Model, Spokane, WA, Spokane, Spokane County Utilities, 32 p.

Stewart, I. T., D. R. Cayan and M. D. Dettinger. 2004. Changes in snowmelt runoff timing in western North America under a “business as usual” climate change scenario. Climatic Change, 62, 217–232.

Stewart, I. T., D. R. Cayan and M. D. Dettinger. 2005. Changes toward earlier streamflow timing across Western North America. Journal of Climate, 18, 1136–1155.

Washington State University, State of Washington Department of Ecology, 2012, Columbia River Basin Long-Term Water Supply and Demand Forecast, Ecology Publication No. 12-12-001, Ecology, Yakima, WA, 411 p.