



# The Water Report™

*Water Rights, Water Quality & Water Solutions in the West*

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## Hydrogeology & Water Rights Transfers

KNOW YOUR SOURCE: HYDROGEOLOGY & WATER RIGHTS TRANSFERS IN WASHINGTON STATE

by Tyson D. Carlson, LHG, CWRE, Associate Hydrogeologist  
Aspect Consulting, LLC (Yakima, WA)

### Introduction

The transfer of water rights in Washington State is dependent on the successful navigation of the technical and legal requirements of the State's water code, case law, and Washington State Department of Ecology (Ecology) policy and guidance documents. The driver behind these considerations in water right transfers is to address the two fundamental tenants of the Prior Appropriation Doctrine: "first in time is first in right" and "do no harm."

The fundamental doctrine of Washington State water law — the Prior Appropriation Doctrine — dictates that water rights of earlier (senior) priority are able to fully exercise their right before a more recent (i.e. junior) right may use any water. This doctrine allows for orderly management of competing water demands within a given source of water, especially during periods of drought or other unavailability of water. It allows senior water users to invest in higher value crops because they know water will be available to meet them, whereas junior users typically must accept lower value crops that can tolerate interruption. Senior water rights also are more suitable for domestic and industrial water needs that require long-term stability. The priority date of water rights within a source is also a key foundation to water markets (i.e. the trading of water rights to better match water rights to changing land use needs).

Many attributes of a water right are portable. The place of use, purpose of use, and point of diversion or withdrawal of an existing water right may be changed. The right to change is subject to several criteria, defined in statute or adopted as Ecology guidance. These criteria include the requirement that the existing and new point of diversion or withdrawal must tap the same source of water. The primary intent of the same source criterion is to preserve the prior appropriation system and seniority relationship between water rights following any approved transfer. The priority of a water right has meaning only within the specific water source authorized for the right: if a senior water right is proposed to be transferred to a new source, the transfer must either be denied or the right must assume junior priority status. This protects existing water right holders by ensuring that the universe of water rights that can curtail their use in response to water shortages does not grow over time.

Thus, the concept of "same source" — that any water right transfer involving a change in source location requires tapping the same source as the original right — affects the vast majority of water right transfers, making it a key step to a successful application. When water rights transfers involve surface water, the path to same source compliance is typically straightforward. However, when a groundwater transfer is being considered, the complexity of the transfer can increase dramatically, as does the need to understand the hydrogeologic conditions.

## Water Transfers & Hydrogeology

### Transfer Advantages

### Hydrogeologic Considerations

#### Hydrogeologic Considerations During Transfers

A firm grasp of site-specific hydrogeologic conditions is an often overlooked component of groundwater transfers. Yet, it is a critical step in the water rights transfer process, particularly at the early stages of the application. Hydrogeologic considerations range from the relatively simple — such as inspection of a boring log — to highly complex, requiring detailed subsurface characterization and numerical modeling.

Understanding the hydrogeologic system before applying for a water transfer gives you several key advantages, including:

- **Measuring the Risks Early:** Allowing for the screening of water rights for transferability before engaging in too much risk (e.g., purchase, regulatory review).
- **Expanding Transfer Options:** Understanding the groundwater system and hydraulic continuity can expand options for transfer, by identifying where groundwater and surface water act as a single source.
- **Informing Right Mitigation Strategy Decisions:** In Washington, water law allows applicants to “mitigate” or offset adverse effects of any proposed water use. Hydrogeologic understanding can help evaluate the magnitude and timing of potential new impacts and support design of suitable mitigation, without over-mitigating. This is especially important in Washington as recent court decisions (e.g., *Foster v. Yelm*, 362 P.3d 959 (2015)) require in-kind and in-time “water for water” mitigation instead of out of kind mitigation, like habitat improvements.
- **Bringing More Certainty when Pursuing Regulatory Approval:** Many of the key concepts in Washington water law — such as hydraulic continuity — are subject to interpretation and have been challenged in court. The more data an applicant can show to back up a proposed transfer, the more confidence the applicant can have that it will pass regulatory scrutiny.

This article discusses several of the most common physical and administrative hydrogeologic considerations and their significance on water right permitting and transfers. These hydrogeologic considerations include an overview of the physical and regulatory requirement of same source of water, plus how other hydrogeologic concepts — like hydraulic continuity, interference drawdown and stream depletion, and the difference between impact and impairment — affect water right transfers. While this article focuses on Washington State examples, the concepts presented should prove useful wherever the Prior Appropriation Doctrine or similar regulations are applied.

#### Key to Water Rights Transfers: Hydrogeologic Conceptual Model

Prior to investigating any water right transfer, it is standard practice to first develop a hydrogeologic conceptual model. The purpose for constructing a conceptual model is to simplify the problem and to organize the available data so that the system can be analyzed accurately. A hydrogeologic conceptual model “is a simplified description of the physical components and interaction of the surface- and groundwater systems.” United State Geological Survey (USGS).

Simplification is often necessary because a complete accounting of all hydraulic interrelationships, whether it be surface water or groundwater, is not possible for two main reasons:

- Hydrogeologists often have very limited data with respect to the scale of the problem; and
- Subsurface conditions are most often inferred through interpretation of widely-spaced boring logs of varying completeness and accuracy.

Hydrogeologic conceptual models range in complexity and can be more qualitative or quantitative in nature. A qualitative hydrogeologic conceptual model typically includes a more general description of the hydrologic cycle, delineation of a surface catchment basin, and/or direction of flow or volume of groundwater in a particular aquifer. Where it is necessary to quantify or predict a result, hydrogeologic conceptual models can evolve to be more quantitative by using complementary analytical or numerical models. These two flavors of conceptual models are used to answer a number of questions related to water availability and impairment, including prediction of aquifer drawdown or stream depletion.

The basis for constructing the hydrogeologic conceptual model typically includes the following physical components:

- **Geology:** It is important to understand the depositional and tectonic history of the area, both in areal extent and with depth. For example, does the geologic environment consist of high energy glacial outwash, river alluvium, glacial till, or low energy lake-deposited lacustrine sediment? Or is it perhaps the bedrock dominated landscape of eastern Washington with massive and vesicular basalt flows?
- **Aquifers and Aquitards:** The different geologic units then need to be categorized as those which are water-bearing (or aquifers) and those that may impede the movement of water (or aquitards). The

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260 North Polk Street,  
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**Editors:** David Light  
David Moon

**Phone:** 541/ 343-8504

**Cellular:** 541/ 517-5608

**Fax:** 541/ 683-8279

**email:**

thewaterreport@yahoo.com

**website:**

www.TheWaterReport.com

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## Water Transfers & Hydrogeology

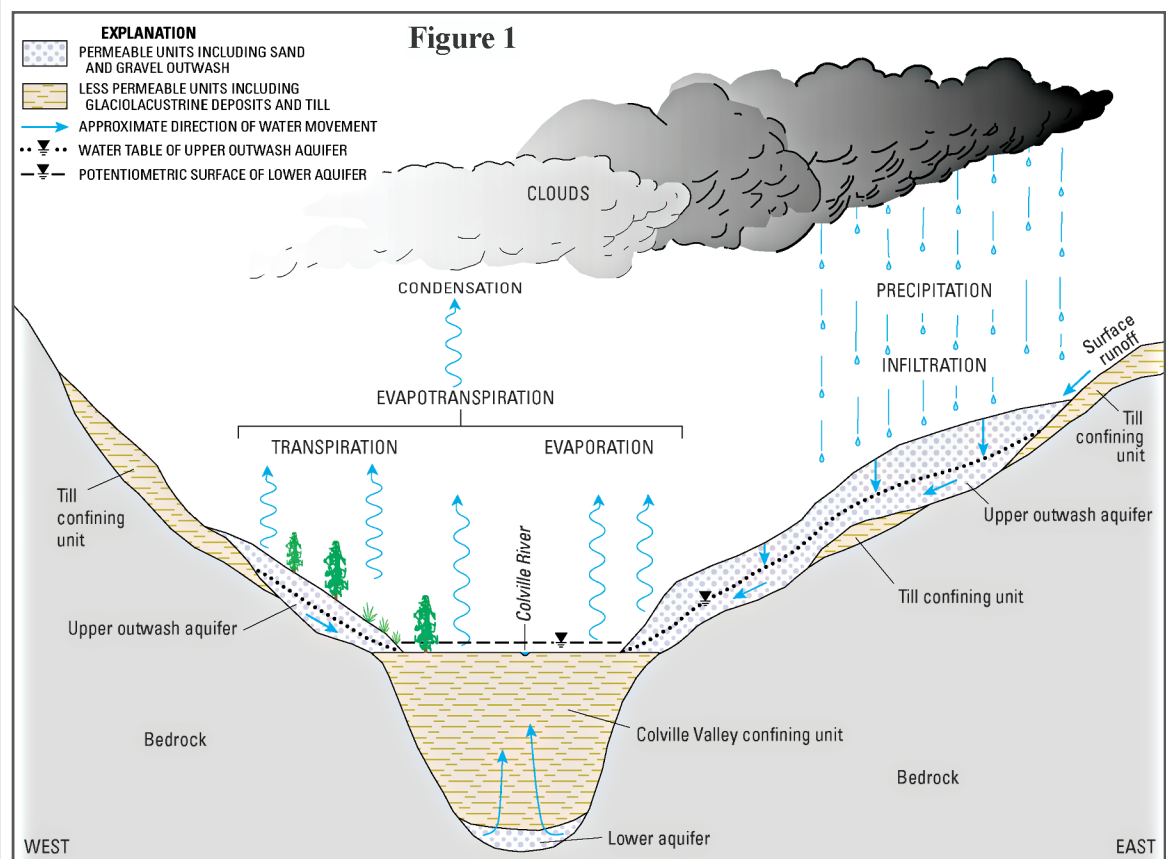
### Conceptual Model

### Numerical Model

label of aquifer or aquitard is typically assigned to a geologic unit based on measured or inferred hydraulic parameters, including hydraulic conductivity (K) — a measurement of the ability of soil to transmit water — and the volume of water released from the aquifer in response to pumping, termed storativity (S).

- **Boundary Conditions:** Next, boundary conditions are assigned to the model, which include water inputs (such as precipitation) or outputs (such as groundwater or surface water flow, or individual wells or cumulative pumping effects of exempt wells).

An example of a qualitative hydrogeologic conceptual model is illustrated in Figure 1. In this example, taken from the USGS study on the Colville River basin in northeastern Washington, geology is defined with bedrock, outwash and till glacial units, and valley bottom fill. Each geologic unit is noted as an aquifer (dotted areas) or less permeable aquitards (horizontally lined areas). Notable boundary conditions are identified, including precipitation, evapotranspiration, and Colville River discharge. The conceptual model also depicts precipitation infiltrating in the uplands, which contributes to groundwater flow in the aquifers and ultimately contributes to river discharge. This qualitative conceptual model was later advanced into a numerical model by assigning representative hydraulic parameters to each geologic unit and defining mathematical relationships between geologic units and boundary conditions.



**Figure 1. Example Hydrogeologic Conceptual Model for the Colville River Basin**  
(Adapted from: USGS Scientific Investigation Report 2004-5237)

### “Same Source” of Water

Defining same source early in the water right application process is also key in developing a successful and cost-effective permitting approach. In Washington State, Ecology has broad authority to define whether to group or split aquifers into the same or different regulatory water sources, based on local conditions. Ecology’s Water Right Administration Policy 2010 – *Defining and Delineation of Water Sources* provides guidance on how to define the same source. It important to note that multiple terms are used in the Ecology Policy. These include: source of water, same water source, same body of public groundwater, same source of supply. For the purposes of our discussion, however, all refer to the same concept of “same source.” As stated in Ecology Policy 2010, the purpose of same source is “[T]o provide a consistent framework for determining the source of water in water resources permitting, rulemaking, and other administrative actions.”

### Regulatory Water Sources



## Water Transfers & Hydrogeology

### Evaluations

### Definition Criteria

### Recharge Source

### Common Flow Regime

#### When to Apply “Same Source”

When do we need to evaluate and apply same source? The policy defines seven instances. Five of the most common are:

- Surface water to surface water right transfer applications
- Surface water to groundwater or groundwater to surface water right transfer applications
- Whether a groundwater change proposing a replacement or additional well taps the same body of public groundwater under RCW 90.44.100
- The number of competing applications within the same water source or source of water for priority processing under Chapter 173-152 WAC
- When determining competing senior applications under cost-reimbursement processing

Other instances where these criteria apply, but are much fewer in number of occurrences/year include:

- Delineate boundaries of groundwater management areas
- Impairment determination for water reclamation projects

#### Technical Considerations of Same Source

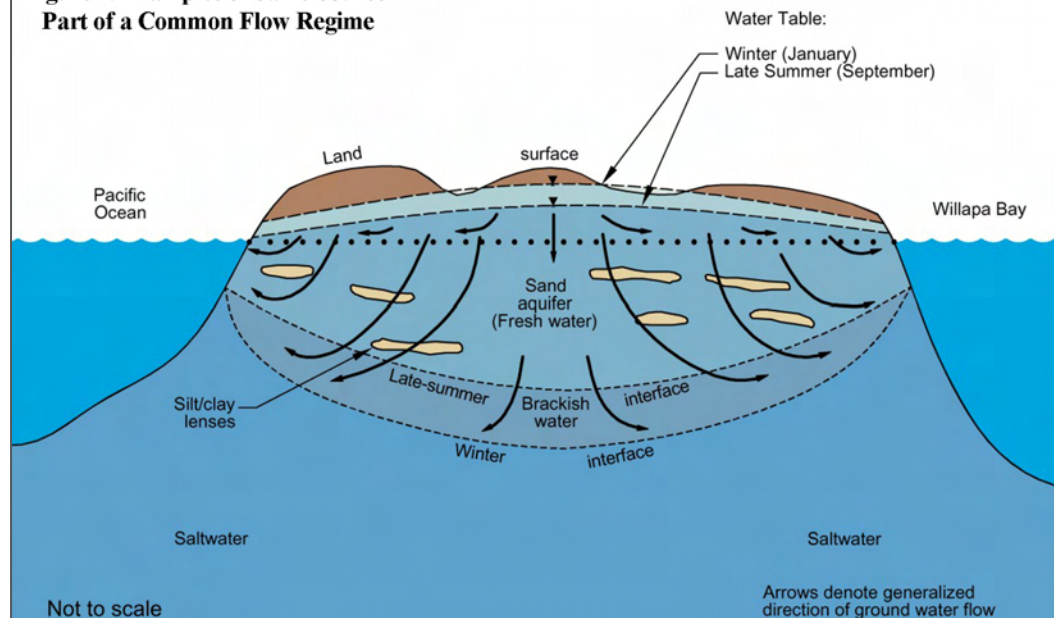
Determining same source is one part science and one part administrative application and detective work. The science considerations are primarily related to the hydrogeologic model previously discussed. Administrative considerations include basin-specific regulations, adjudication, or local planning decisions. Specifically, Ecology defines a same source of water as meeting four conditions:

- They share a common recharge area
- They are part of a common flow regime
- They are separable from other water sources by effective barriers to hydraulic flow
- They are an independent water body for the purpose of water rights, as administered by Ecology

The following figures provide examples of source determinations and illustrate application of these four criteria. In the early stages of investigating several large water right applications for a major western Washington municipality — before the rule amendment allowing the priority processing of mitigated applications — same source(s) of groundwater were defined for five applications to determine senior and competing water right applications. This determination is illustrated in Figure 2 (opposite page) — the four blue circles and one red circle indicate water right applications in two different aquifers. The darker and lighter dotted lines indicate groundwater divides in corresponding aquifers, and the solid lines illustrate the subbasin and Water Resource Inventory Area (WRIA) surface water boundaries. This figure graphically illustrates the common recharge area for each application bounded by the surface water divides and the aquifer-specific groundwater divide. This represents the physical same source determinations which share a common source of recharge, and does not account for the administrative considerations with either of the region’s (Nisqually and Deschutes river basins in the Olympia area) instream flow rules.

An example of a common flow regime is illustrated by the cross section of the Long Beach Peninsula in Figure 3, below. The cross section illustrates radiating groundwater flows lines from the center of the peninsula toward saltwater. Any water right application located near the center of the peninsula would share a common flow regime with an application located closer to the shoreline. In this example, the two applications would be considered to be in the same source.

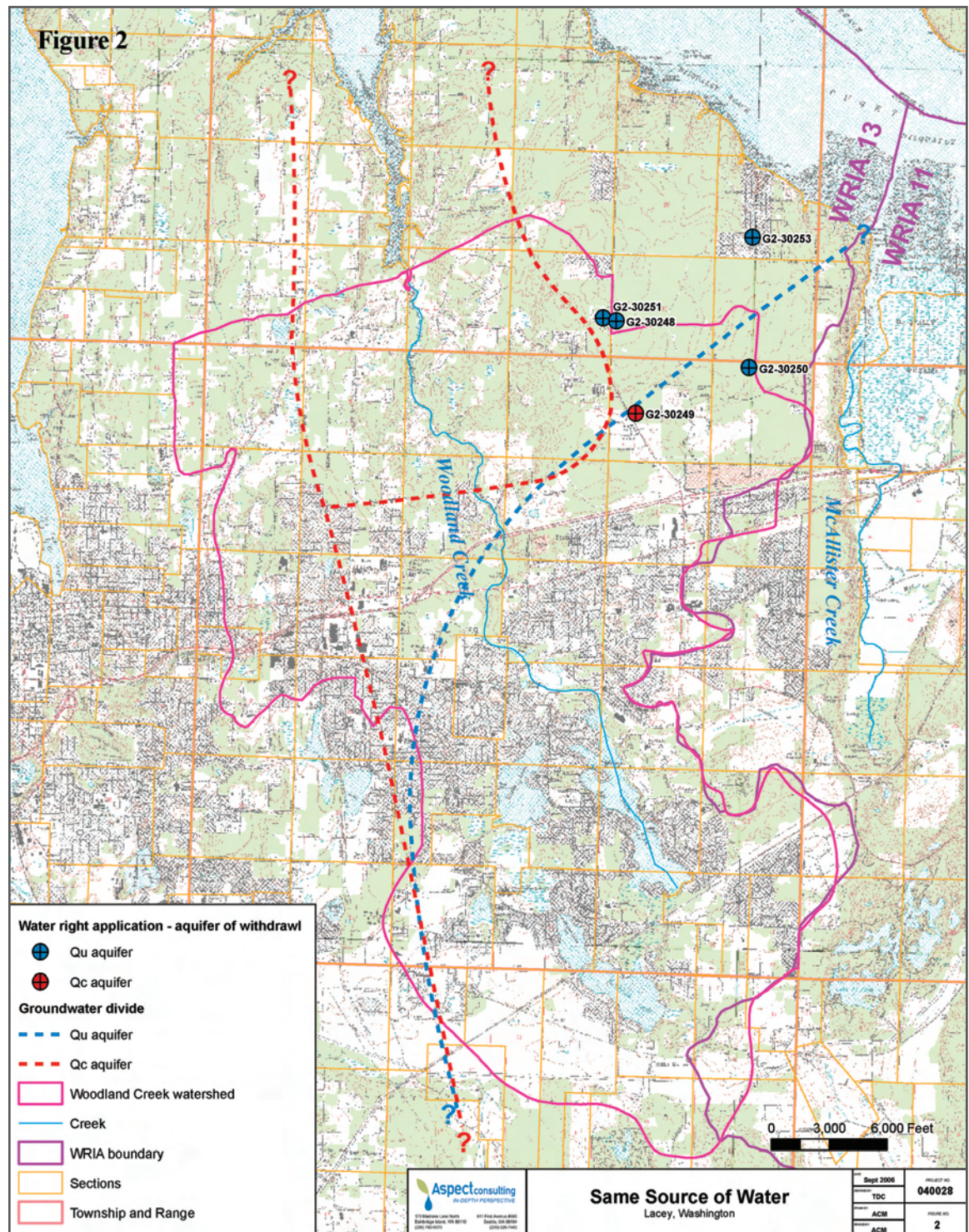
**Figure 3. Examples of Same Source  
Part of a Common Flow Regime**





## Water Transfers & Hydrogeology

Figure 2. Same Source - Share a Common Recharge Area



## Aquifer Barrier

Much of eastern Washington and Oregon are dominated by a series of laterally extensive basalt flows known as the Columbia River Basalt Group. Over time the basalt flows have been altered by tectonic processes resulting in uplift and faulting. Figure 4 (next page) illustrates in cross section where faulting has offset water-bearing flow tops and interflow zone within the basalt. This offset creates a discontinuity in the aquifer which, as evidenced by upgradient mounding of groundwater, is an effective barrier to groundwater flow. Therefore, for a small water system looking to improve water system reliability, the locations of additional wells based on the same senior priority date would be limited to the same source bounded by and below the fault.



Figure 4. Same Source – Separable from Other Water Sources by Effective Barriers to Hydraulic Flow

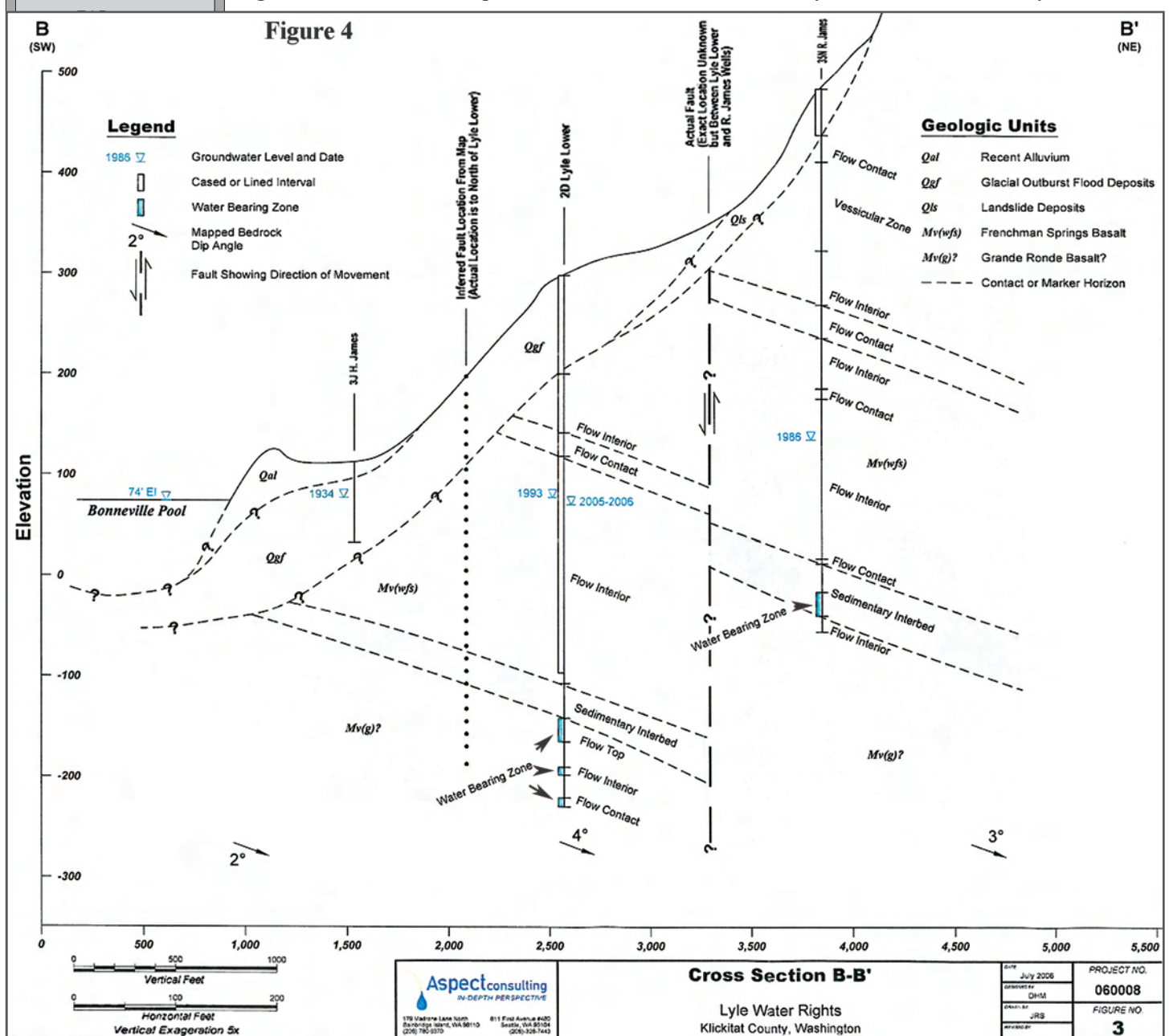


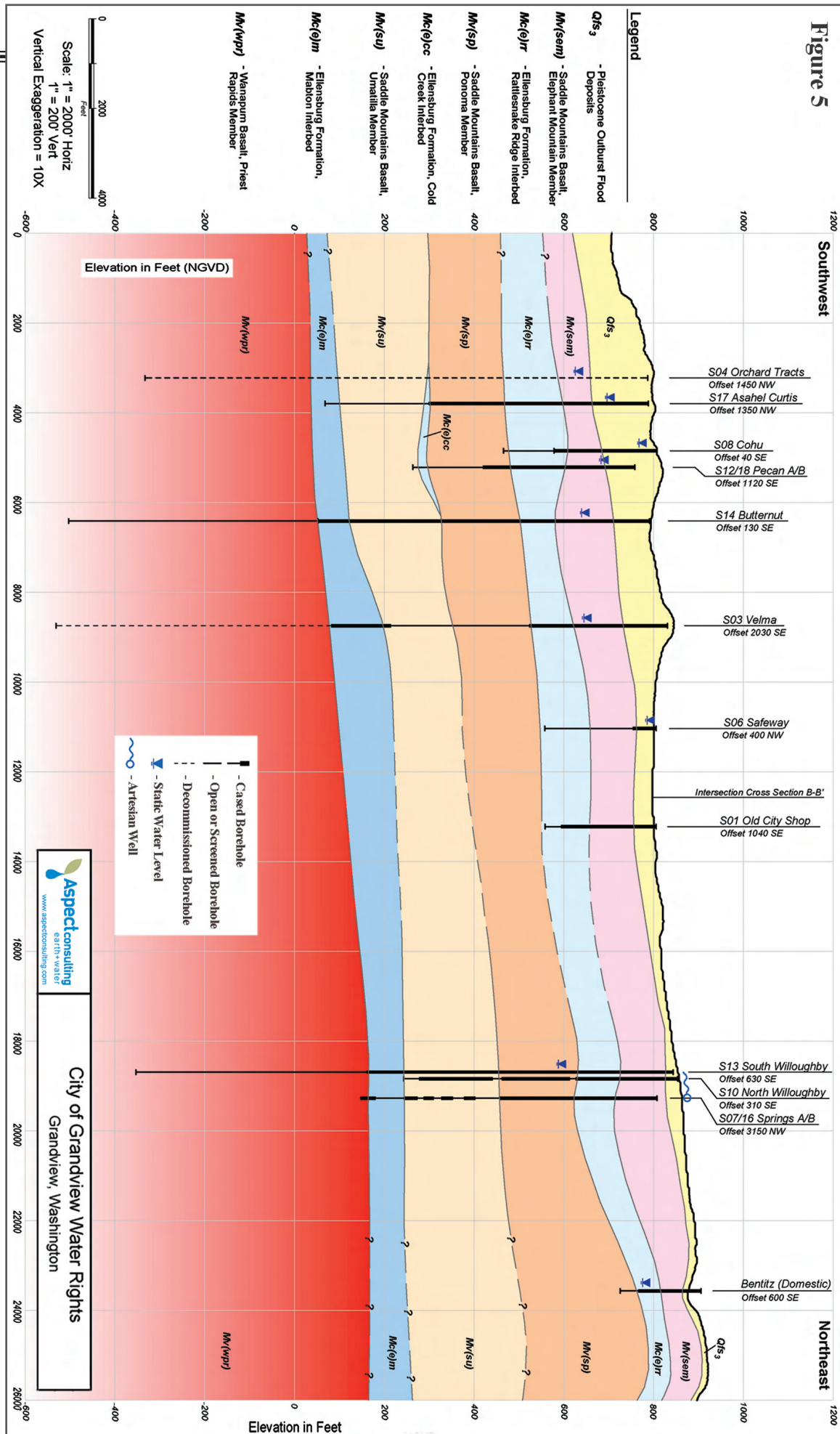
Figure 5 is a representative geologic cross section of the lower Yakima River basin. As mentioned above, determining same source is one-part science, one-part administration. The Science: For example, the cross section shows the Upper Saddle Mountains (purple) and Lower Saddle Mountains (lighter/darker brown), which are considered the same source of water. The Administration: However, these two aquifers are often administratively managed as separate sources to account for local water availability (i.e., long-term groundwater declines in the Lower Saddle Mountains) and increased continuity with the Yakima River in the Upper Saddle Mountains. Furthermore, in Ecology's Central Regional Office, the Wanapum Formation (red) and the deeper Grande Ronde Formation (not shown) are typically managed as distinct sources of water, but in Ecology's Eastern Region Office, the Wanapum and Grande Ronde are typically considered to be the same source. This administrative distinction would effectively prohibit (in Central) or allow (in Eastern) the transfer a water right from one basalt formation to the other. There are often strong hydrogeologic and public interest reasons for Ecology's decisions to co-manage aquifers (or not), and the point highlighted here is that the local hydrogeologic and administrative framework must be equally understood before defining risk and transferability of water rights for a project.

**Water  
Availability**

**Administrative  
Distinctions**

# Water Transfers & Hydrogeology

Figure 5. Same Source: Independent Waterbody for the Purpose of Water Right Administration, as Determined by Ecology



## Water Transfers & Hydrogeology

### Hydraulic Connectivity

#### Hydraulic Continuity and Why It's Important

Simply put, hydraulic continuity is the interconnection between groundwater and surface water sources. An aquifer is in hydraulic continuity with wetlands, lakes, streams, rivers, or other surface water bodies whenever it is discharging to these water bodies. Continuity also exists when an aquifer is being recharged by surface water. A source is said to be in continuity when a withdrawal or diversion from one source will have some effect on the other source.

Although not explicitly mentioned in Washington State's water code, hydraulic continuity is inferred from several sections of the statutes, including:

- RCW 90.44.030: The rights to appropriate the surface waters of the state and the rights acquired by the appropriation and use of surface waters shall not be affected or impaired by any of the provisions of this supplementary chapter and, to the extent that any *underground water is part of or tributary to the source of any surface stream or lake*, or that the withdrawal of groundwater may affect the flow of any spring, water course, lake, or other body of surface water, the right of an appropriator and owner of surface water shall be superior to any subsequent right hereby authorized to be acquired in or to groundwater. (emphasis added)
- RCW 90.54.020(9): Full recognition shall be given in the administration of water allocation and use programs to the natural interrelationships of surface and groundwaters.

More recently, hydraulic continuity has been the subject of much case law which has limited the legal availability of water and mitigation requirements.

### Legal Decisions

These Washington Supreme Court decisions include:

- *Postema v. PCHB*, 11 P.3d 726 (2000): Groundwater permits may be denied based on impacts on instream flows;
- *Swinomish v. Ecology*, 311 P.3d 6 (2013): Instream flow rights are entitled to impairment protection;
- *Foster v. Yelm*, 362 P.3d 959 (2015): Stream depletion must be mitigated with in-kind and in-time mitigation; and
- *Whatcom County v. Hirst, Futurewise, et al., Case No. 91475-3* (2016) (*Hirst*): Growth Management Act (GMA) requires consideration of exempt well impacts on instream flows.

[For additional details on these decision, see Water Briefs, *TWR* #117; McCormick & Christensen, *TWR* #151; Moon, *TWR* #153, Interview with Christensen, *TWR* #153, and Dickison & Haensly, *TWR* #154.]

### Independent Sources

Unless there are barriers to flow, hydraulically connected groundwater and surface water cannot be considered as independent sources of water and any impacts that affect the timing or quantity of instream flows must be fully mitigated. Most notably, this includes the "legal availability" and potential impacts resulting from the use of permit-exempt wells. See *Hirst*.

### Transfer Authority

#### Surface to Groundwater Transfers

Similar to hydraulic continuity, there is no explicit reference or authority given in the Washington water code for transferring a surface water right to groundwater, or vice versa. The authority for this permitting action is derived from sections of water code describing administration of both surface water and groundwater, along with recognition of the interrelationship of surface and groundwater discussed above. One exception is under the Columbia River Instream Resources Protection Program (Chapter 173-563 Washington Administrative Code), in which the interrelationship is defined as groundwater which has a "*significant and direct impact*" on surface water of the main stem Columbia River. This has often been applied by Ecology as a one-mile corridor of groundwater adjacent to the Columbia River, subject to site-specific verification of conditions.

Under emerging Ecology policy, significant and direct impact has been defined in some permit decisions as "bank storage." More narrowly defined, bank storage refers to the water contained within the more permeable unconsolidated sediment or bedrock aquifers that freely exchanges with adjacent surface water, especially during changes in river stage (water level elevation due to flow change). This limitation implies that it is not enough for a well to capture groundwater in close proximity to the Columbia River, but rather the well would have to intercept groundwater traveling down the Columbia River corridor to be considered the same source as the surface water (for a transfer to be approved). This greatly reduces the distance a water right may be directly transferred away from the Columbia River to a groundwater well, even in instances where impacts to the Columbia River may be offset. Where a proposed well is not in close proximity to the Columbia River, it could be difficult to prove that such a well intercepts groundwater that is traveling down the Columbia River corridor. It is unclear whether this new term and standard will be incorporated into formal Ecology policy.

### "Bank Storage"

### Groundwater Connection



## Water Transfers & Hydrogeology

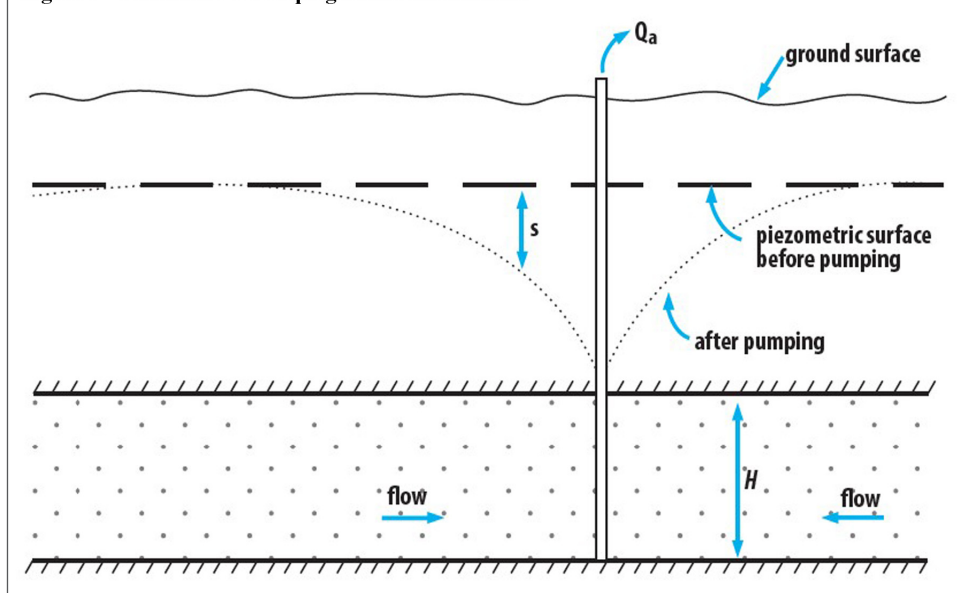
### Drawdown

### Methods, Models, & Predictions

#### Interference Drawdown and Stream Depletion

In any water right transfer, it is important to determine the impact(s) the change could have on surrounding water rights, including minimum instream flows. When a transfer occurs to a new point of withdrawal (well), new and/or additional pumping impacts will occur. These impacts manifest themselves as drawdown — a pumping-induced lowering of groundwater elevations which are greatest near the well, then exponentially diminish with distance, as shown on Figure 6. The magnitude and extent of drawdown is dependent on a number of physical factors, including pumping rate and aquifer properties. When drawdown encounters a neighboring groundwater user, the increase in drawdown in that user's well is known as interference drawdown. When drawdown encounters an adjacent (or distant) waterbody, the drawdown induces stream depletion.

Figure 6 – Illustration of Pumping-Induced Drawdown



#### Predicting Impacts with Analytical and Numerical Models

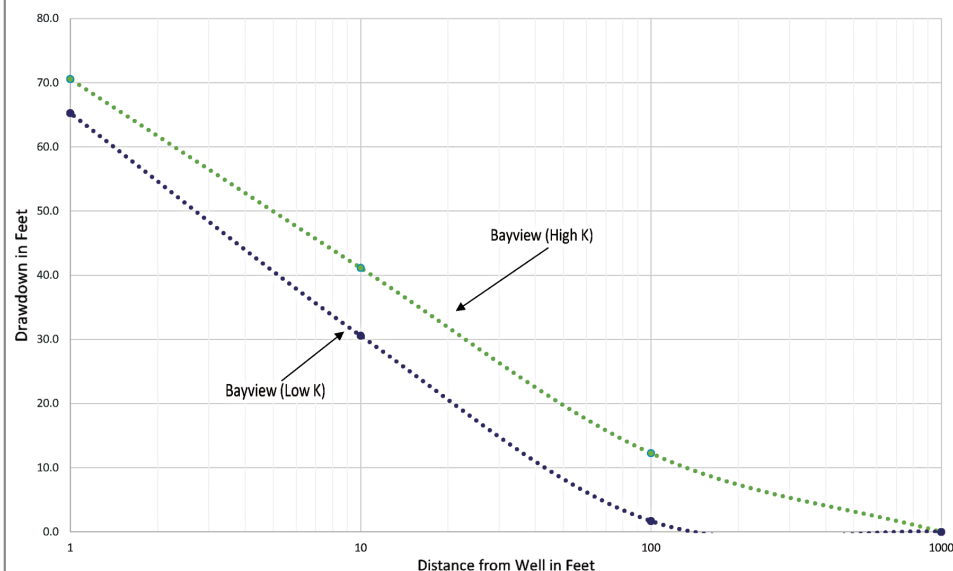
As discussed above, hydraulic continuity between groundwater and surface water exists in the vast majority of Washington State, and while hydraulic continuity is typically a qualitative measure, interference drawdown and stream depletion are quantitative measures.

There are a number of analytical methods and numerical models to predict impacts. Analytical methods include commercially available software packages such as Aqtesolv, and equations easily

programmed in Excel. Numerical models include more complex two or three dimensional model software, such as finite difference (i.e., MODFLOW) or finite element (i.e., FEFLOW) software packages.

An example of calculated well interference is presented in Figure 7. The graph illustrates predicted drawdown decreasing with distance (note semi-log scale on x-axis) under two different hydrogeologic assumptions involving hydraulic conductivity, high and low K (i.e. high and low hydraulic conductivity). Interference drawdown is estimated by first determining the distance to the nearest well (x-axis) and translating the drawdown (or range of drawdown) expected from the y-axis.

Figure 7 – Example of Well Interference Analysis



## Water Transfers & Hydrogeology

### Season of Use Change

### Depletion Timing

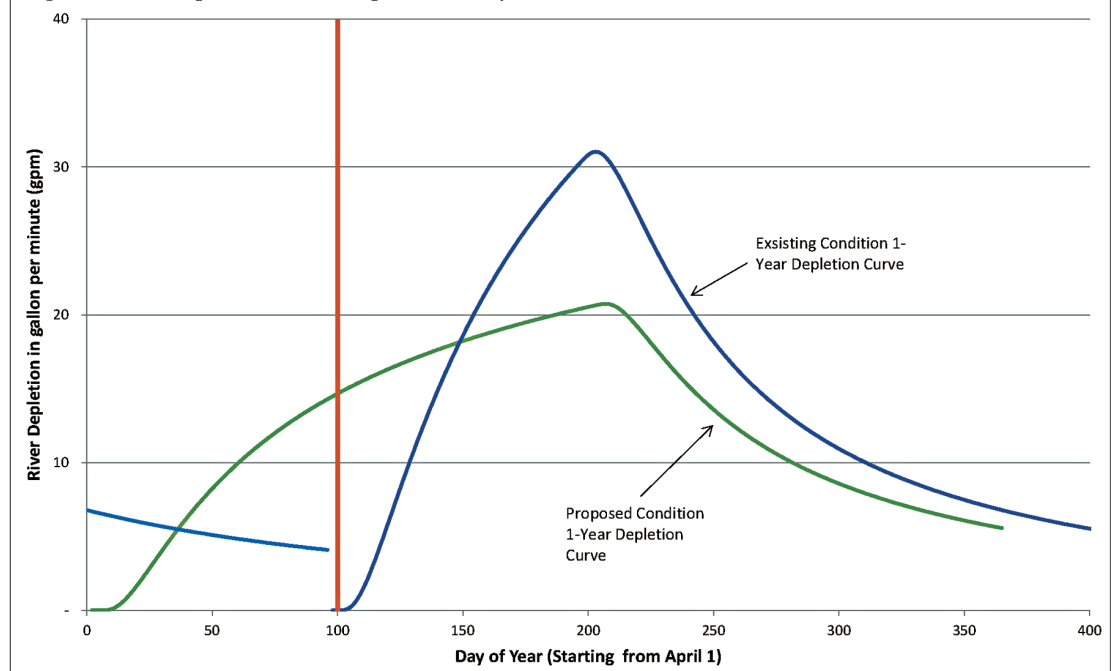
### Stream Depletion Complexity

### "Impairment" Defined

### Change Criteria

Similarly, Figure 8 illustrates the change in stream depletion as the result of a water right change in season of use. The water right change proposed to expand the season of use from July 10 to October 15 to April 1 to October 15. The stream depletion analysis indicated that based on the difference in timing of groundwater withdrawals, up to 15 gallons per minute (gpm) of new impact could occur to the adjacent creek from May through August (Day 10 to about 140), with an equal amount of benefit in later months. However, to address new impacts and protect senior water rights, a mitigation plan must be developed to mitigate in-time and in-place 15 gpm.

**Figure 8 – Example of Stream Depletion Analysis**



Lastly, field measurements are often collected to corroborate quantitative approaches. While measurements of interference drawdown in neighboring wells are very reliable and with good accuracy (up to 0.01 foot), stream gaging data is problematically less so. This results from the inherent inaccuracies in stream gaging and the proportionate size of predicted stream depletions (typically in tens of gallons per minute) compared with total stream discharge (in few to many cubic feet per second). With these two factors, in addition to considering inherent diurnal (daily) and seasonal fluctuations in stream flow, it is difficult to physically measure pumping induced stream depletion. Therefore, it is important to develop an accurate groundwater-surface water hydrogeological conceptual model, and couple it with the appropriate scientifically derived analytical solutions.

### Impact versus Impairment

Once impacts from a water right transfer are calculated, it is important to determine the significance of the impacts, and whether the impacts will impair a senior water right and meet the "Do No Harm" tenant (i.e. no injury standard) of the Prior Appropriation Doctrine. Under both the groundwater and surface water code (RCW 90.03.290 and RCW 90.44.060, respectively), impairment is one of the four statutory tests that must be considered in any water right transfer. Impairment is defined as an adverse effect on the quantity of a water right with an earlier priority date.

A water right change application may not be approved if it would:

- Interrupt or interfere with the availability of water to an adequately constructed groundwater withdrawal facility of an existing right.
- Interrupt or interfere with the availability of water at the authorized point of diversion of a surface water right. A surface water right conditioned with instream flows may be impaired if a proposed use or change would cause the flow of the stream to fall to or below the instream flow more frequently or for a longer duration than was previously the case.
- Interrupt or interfere with the flow of water allocated by rule, water rights, or court decree to instream flows.
- Degrade the water quality of the source to the point that the water is unsuitable for beneficial use by existing users (e.g., via seawater intrusion).



## Water Transfers & Hydrogeology

### Groundwater Impairment

### Transfer Process

In most basins in Washington State, depending on the specific regulatory environment (i.e., State instream flows), impairment of surface water — or groundwater in continuity with surface water — is of critical importance. Under *Postema v. PCHB* (2000), the Washington Supreme Court decided that surface water impairment can result from as little as “one molecule” of impact to instream flows. Under current case law, that impact must be mitigated in-time, in-place, and in-kind before a change application may be approved. So, in the case of surface water, impact and impairment are often synonymous.

In contrast, impairment to a groundwater well is often different from impact. It is not impairment simply because interference drawdown occurs in a neighboring well. In Washington, the well must first be considered a qualifying withdrawal facility that: (a) is constructed in compliance with well construction requirements; and (b) fully penetrates the saturated zone of an aquifer or withdraws water from a reasonable and feasible pumping lift. For example, consider a hypothetical 100-foot-thick aquifer. If a well penetrates 20 feet into that aquifer, they are not a “qualifying works” capable of asserting impairment even if some impact occurs in a transfer. Consider a second well that fully penetrates the 100 foot aquifer, but a transfer would create an extra two feet of pumping lift. This isn’t sufficient “impact” to rise to the level of “impairment” because the well can still reasonably and fully exercise their water rights. Therefore, in many hydrogeologic situations, well interference caused by groundwater withdrawals will not lead to impairment of a right to withdraw groundwater, but still must be considered in any groundwater right transfer.

### Conclusion

In-depth knowledge of a proposed water right transfer’s influence on the surrounding hydrogeologic conditions is becoming more and more important as the complexity of the water rights transfer process grows in Washington State. Recent court cases — *Foster vs. Yelm* and *Hirst* — have put additional constraints on the transfer process, increased the regulatory scrutiny, and have raised the bar in the understanding, characterization, and management of water resources throughout Washington State. Because water right transfers are one-part science and one-part administration by Ecology, understanding local conditions and consultations with Ecology are key to determining the transferability of a water right to meet a project’s needs.

### FOR ADDITIONAL INFORMATION:

TYSON CARLSON, Aspect Consulting LLC, 206/ 838-5842 or [tcarlson@aspectconsulting.com](mailto:tcarlson@aspectconsulting.com)

**Tyson Carlson**, LHG, CWRE, is an Associate Hydrogeologist at Aspect Consulting LLC, with over 16 years of experience specializing in water resource development and water rights. Serving private and public sector clients, his water rights experience includes both new appropriations — municipal, agriculture, fish propagation, and commercial/industrial purposes — and transfer/change of existing rights, including use of the State’s Trust Water Right Program (TWRP) for purposes of instream flow, habitat, and mitigation through water banking. Mr. Carlson’s strong background in analytical and numerical groundwater modeling is often used in the development of site-specific conceptual models. Mr. Carlson has a B.S. in Soil, Water, and Environmental Science and a M.S. in Hydrology from the University of Arizona.