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DISSOLVED METALS IN STORMWATER

BIOTIC LIGAND MODEL - A NEW TREATMENT PARADIGM

OBTAINING ENVIRONMENTAL PROTECTION WITH NEW TECHNOLOGY AND DEFENSIBLE STANDARDS

by: Charlie Wisdom, PhD, AICP and Paul Bucich, PE, Parametrix

INTRODUCTION

THE NEED FOR PRAGMATIC STORMWATER REGULATION

In the Puget Sound region, dissolved metals in stormwater are increasingly coming to the forefront in our efforts to manage stormwater. Reasons for this include an increasing focus on dissolved metals by federal and state regulators through the National Pollutant Discharge Elimination System (NPDES) permitting program and concerns about the effect of copper on the homing instincts of returning salmon — several species of which are listed as threatened under the federal Endangered Species Act.

Major challenges arise from the fact that stormwater managers lack control over most sources of dissolved metals, coupled with the general inadequacy of existing treatment systems to achieve current regulatory benchmarks and effluent limits. This leaves stormwater managers between the proverbial "rock and a hard place" in their efforts to comply with stormwater regulations. When the considerable costs to achieve even minimal stormwater treatment in retrofitting existing stormwater systems are added into the equation, a clear need for new cost-effective approaches to treat dissolved metals in stormwater becomes readily apparent.

In this article, we present an expanded stormwater treatment approach that centers around the role of bioavailability in determining actual metal toxicity and examine how this information could be meaningfully incorporated into stormwater treatment and regulatory actions. Recent and ongoing scientific advancements in understanding metal bioavailability, as expressed in the Biotic Ligand Model (BLM), lie at the heart of our proposals. We present the general analytical underpinnings of BLM and review how the US Environmental Protection Agency (EPA) has recognized BLM as "best available science" and begun to apply the this model in developing water quality criteria.

We will use the example of an innovative stormwater treatment project associated with retrofitting a major highway bridge crossing Lake Washington (near Seattle) to illustrate how BLM could benefit stormwater regulators if included in treatment technologies and state regulatory frameworks.

Finally, we will discuss the need for engaging state regulators to set the stage for accomplishing this pragmatic, environmentally protective, adjustment to water quality regulation.

BACKGROUND

METALS IN STORMWATER

Metals in stormwater are discharged into the aquatic environment through several mechanisms, each of which requires distinct treatment approaches. Metals attached to particulates are relatively easy to separate from the water column. Depending on the range of particulate sizes, removal can be accomplished with: street sweeping; catch basins; detention ponds; filter systems; biofiltration swales; constructed wetlands; hydrodynamic separators; and infiltration through soils (both natural and engineered). However, unattached dissolved metals pose a significant removal challenge.

Dissolved Metals

Sources

Climatic Variations

Land Use Ranges

Dissolved metals — such as copper (Cu), lead (Pb), zinc (Zn), cadmium (Cd), and nickel (Ni) — are frequently found in ultra-urban stormwater runoff at levels toxic to aquatic organisms. These metals come from diffuse sources, including: roofs; roads; automobiles; downspouts; conveyance piping; plumbing fixtures (lawn irrigation, car washing); weathering paints; wood preservatives; motor oils; galvanized traffic barriers and roofing materials; firefighting activities; commercial and industrial activities; automobile accidents; and roadside trash — to name but a few (see *National Probable Sources Contributing to Impairments*, USEPA). Due to the vagaries of stormwater runoff, dissolved metals concentrations can range widely between storm events and even within a storm event. Geographic location, season, and climatic variations affect metals concentrations to the point that any **b**est **m**anagement **p**ractice (BMP) established to treat dissolved metals has to be robust enough to handle a wide range of contaminant levels.

Examples of the ranges of metals concentrations found nationwide based on land use are presented in Table 1 (only reported for total metals) and Table 2 (reported for both dissolved and total metals for different types of transportation based land uses for California).

Table 1.

Contaminant	Freeways	Industrial	Residential	Commercial	Open Space
Arsenic, total (_g/L)	2.4	4	3	2.4	4
Cadmium, total (_g/L)	1	2	0.5	0.89	0.38
Chromium, total (_g/L)	8.3	14	4.6	6	5.4
Copper, total (_g/L)	34.7	22	12	17	10
Copper, filtered (_g/L)	10.9	8	7	7.57	
Lead, total (_g/L)	25	25	12	18	10
Lead, filtered (_g/L)	1.8	5	3	5	
Zinc, total (_g/L)	200	210	73	150	40
Zinc, filtered (_g/L)	51	112	31.5	59	

Median Values for Nationwide Stormwater Runoff Quality from Different Land Uses (Reproduced from Pitt and Maestre, 2005)

Table 2.

Parameter	Unit	Highways	Park and Rides	Maintenance Stations
Arsenic, Dissolved	µg/L	4.8	2.7	81
Arsenic, Total	µg/L	8.6	3.6	82
Cadmium, Dissolved	µg/L	4.7	2.3	2
Cadmium, Total	µg/L	5	3.6	3
Chromium, Dissolved	µg/L	19	2.3	6
Chromium, Total	µg/L	98	14.3	23.3
Copper, Dissolved	µg/L	121	51	18
Copper, Total	µg/L	230	51	25
Lead, Dissolved	µg/L	143	6	23
Lead, Total	µg/L	327	37	49
Nickel, Dissolved	µg/L	52	18	11
Nickel, Total	µg/L	208	21	18.2
Zinc, Dissolved	µg/L	1017	485	376
Zinc, Total	µg/L	1245	787	381

Maximum Values for Caltrans Statewide Stormwater Runoff Quality during 2000-01 Monitoring Season (Reproduced from Kayhanian et al. 2002)

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Dissolved Metals

Biopersistence

Lead Sources & Impacts

Zinc Impacts

Copper Impacts

Discharge Criteria

Benchmarks & Limits

Boatyard Permit

TOXIC EFFECTS ON AQUATIC ORGANISMS

Metals in stormwater are of particular concern due to their toxic effects on aquatic organisms. For example, cadmium, a biopersistent metal that can remain resident in aquatic organisms for many years before being excreted, can bioaccumulate in mussels, oysters, shrimps, lobsters, and fish. The effects vary greatly between aquatic organisms, with saltwater organisms being more resistant than freshwater.

Other problematic metals include lead, zinc and copper:

Lead (Pb) occurs both from natural and anthropogenic sources. Its physical and chemical properties are applied in manufacturing, construction, and chemical industries. Common uses include: batteries; fuel additives (no longer allowed in the USA); rolled and extruded products; alloys; pigments and compounds; cable sheathing; lead shot; and ammunition. Additionally, it is commonly used on automobile tires as a balancing weight. Within the aquatic environment, lead poisoning has been shown to lead to behavioral, physiological, biochemical effects, and often death. Most lead in the aquatic environment has historically been from: fuel additives; lead shot; and fishing equipment such as sinkers, jigs, and hooks. The elimination of lead from fuel removed a major source of contamination. Lead, however, is still found in urban runoff and is still theorized to be primarily an automobile-related pollutant.

Zinc (Zn) is an essential element and one of the more common metal pollutants. At high concentrations, studies have shown it exerts adverse effects on fish through structural damage affecting growth, development, and survival. It accumulates in the gills of fish indicating a depressive effect on tissue respiration leading to death by hypoxia. It also induces changes in ventilatory and heart physiology. Observed zinc affected fish behaviors include: lack of balance (fins become motionless); agitated swimming; air gulping; periods of quiescence; and death (Kori-Siakpere and Ubogu, 2008).

Copper (Cu) is a metal of particular concern due to its ubiquitous presence and its recently documented effects on salmonids at low levels. Copper has been shown to bind to salmonid nasal cells impacting the ability to detect and avoid predators, find birth streams, and disrupt male attraction to females with only a short term exposure (10-15 minutes). Longer term exposure can lead to osmotic shock and death (24 – 48 hours).

Recent NOAA research indicates that low levels of Cu (2 µg/L) and Zn (5.6 µg/L) above background levels are harmful to salmon (Baldwin, Labenia, French and Scholz, 2006) in a laboratory setting.

NEW BENCHMARKS & EFFLUENT LIMITS IN NPDES PERMITS

With the issuance of each new NPDES Permit, the discharge criteria for benchmark levels and effluent limitations for metals become more stringent. The Washington State Department of Ecology (Ecology) issued a new NPDES Industrial Stormwater General Permit on January 1, 2010. This permit established a discharge benchmark of 14 µg/L (parts per billion) for copper in western Washington and 32 µg/L in eastern Washington (Washington Industrial Stormwater General Permit, 2010). Under the new permit, each distinct discharge point off-site must be sampled within the first 12 hours of a stormwater discharge or as soon as practicable; the first fall storm event after October 1st must also be sampled. Attainment of standards equates to four consecutive quarterly samples equal to or less than the benchmark value. Failure to attain compliance results in an increasing level of response and adaptive management by the permittee, along with new reporting requirements. For those facilities discharging to waterbodies listed as "water quality impaired" under section 303(d) of the federal Clean Water Act (i.e., waterbodies found to be incapable of supporting their designated beneficial uses due to pollution), numeric effluent limits now apply. For a discharger in these watersheds, repeated failure to remain within a narrow variance from these numeric effluent limits will require the permittee to apply increasingly complex BMPs. Ultimately, Ecology has the right to fine or shut down an offending party.

Issuance of the new Boatyard NPDES Stormwater Permit in Washington State reduced the allowed water quality based limits for copper. In freshwater, western Washington has a limit of 26 µg/L seasonal average and 52 µg/L as the daily maximum. For marine waters, the limits are 14 µg/L as the seasonal average and 29 µg/L as the daily maximum. Currently, boatyards are using some form of multimedia filtration and these new permit limits are lower than what is currently being achieved with these filtration systems.

Dissolved Metals

Array of Sources

Increasing Stringency

Achievable Standards?

Salmon Protection Targets

Few Options

Retrofitting Costs

Puget Sound Stormwater

LACK OF CONTROL OVER SOURCES

Unlike the typical industrial permittee managing runoff from a discrete site, municipalities and the state Departments of Transportation (DOTs) operating under NPDES stormwater permits have very limited control over the sources of pollutants introduced into their stormwater. For example, tires, oil, tire weights, emissions, rusted auto parts, etc., are well known and common sources of pollutants contributing to the waste stream flowing into municipal and DOT stormwater systems. However, automobile components are typically under federal control and fall under the umbrella of interstate commerce — further limiting the ability of states to regulate components of manufacturing. Common products available at any big box retail store similarly are sources of contamination (e.g., copper gutters, moss removal products for roofs, lawn fertilizers, and zinc roofing strips). The array of products with the potential to introduce metal contamination into stormwater underscores the challenge of addressing metals on a source control basis. Despite the difficulty of local and state agency source control, with each permit cycle permittees can expect to see increasing regulatory requirements on stormwater discharges. As discussed further below, this regulatory syndrome can eventually lead to numeric water quality standards that cannot be achieved with the tools currently available to the stormwater engineer.

EXISTING TREATMENT APPROACHES ARE INADEQUATE

Water quality standards for copper provide one example of regulations that do not appear achievable with current approaches given the demonstrated efficiency of dissolved copper removal using existing stormwater BMPs. A review of the EPA/ASCE International Stormwater BMP Database (www.bmpdatabase.org) indicates that dissolved copper *mean* effluent concentrations are below both chronic (9 µg/L) and acute (13 µg/L) levels for many of the BMPs studied. However, three of the five BMPs reported a net average increase of dissolved copper. The apparent reason for meeting the chronic and acute levels seems to be related to the low levels in the influent, many of which are already below the chronic and acute levels. Of the two remaining BMPs that remove dissolved copper, the maximum removal efficiency is slightly above 40%.

Additionally, comparing the range of influent concentrations in the BMP database to those in Table 2 (above) reveals that the influent concentrations reported by CalTrans are up to 10 times the values in the BMP database. With such large differences, it is yet to be determined how well these BMPs can reduce highway runoff values to similar levels found in the database.

Recognizing that the NOAA Fisheries study referenced above established a 2 µg/L increase above background dissolved copper levels as being harmful, it is apparent that existing BMPs cannot consistently reduce dissolved copper levels down to the levels the NOAA study indicates are necessary to protect salmonids. Evaluation of the effluent concentrations shows a range between 3.28 to 23.44 µg/L for all the BMPs with the lower ranges being accomplished with larger footprint BMPs. None of the BMPs commonly available and studied removes dissolved copper down to 2 µg/L.

Lake Washington (site of the project example discussed below) has a dissolved copper baseline level of 1 µg/L. Assuming 2 µg/L above background were the target, any treatment device would need to consistently remove dissolved copper down to 3 µg/L to be within the NOAA targets.

Additionally, runoff detention basins (used in many stormwater BMPs) are reported to increase the levels of dissolved copper, thereby becoming sources of the pollutant. This is likely due to an accumulation of copper during small storm events and subsequent flushing during larger events when the discharge is high enough to be tested as per accepted testing and monitoring protocols.

As NPDES Permits increase in stringency over time, stormwater professionals are left with few realistic options for obtaining permit compliance. Unlike industrial facilities, it is not reasonable to expect municipalities or DOTs to install actively managed treatment systems at every stormwater outfall when the number of outfalls numbers in the tens of thousands state-wide.

MAJOR COSTS TO ACHIEVE EVEN MINIMAL STORMWATER TREATMENT

In addition to the trend of increasingly stringent dissolved metal benchmarks and effluent limits, stormwater managers are also faced with significant costs in treating and retrofitting existing infrastructure.

In Washington State, the Puget Sound Partnership (Partnership) was created in 2007 to bring together citizens, governments, tribes, scientists, and businesses to work together to restore Puget Sound, an estuary of national importance (www.psp.wa.gov). The Partnership was charged with creating an Action Agenda that would lead to a healthy Puget Sound by 2020. One of the many activities the Partnership has undertaken is leadership in the development of a rough assessment of the costs of retrofitting impervious surfaces draining to the Puget Sound for water quality treatment. As a part of a larger effort, the retrofit analysis looked at what it would take to provide stormwater treatment to existing impervious surfaces draining to Puget Sound. (www.psp.wa.gov/downloads/Stormwater/FinalUrbanStormwaterTechMemo20100930.pdf).

Dissolved Metals

BMP Costs Analysis

In order to evaluate costs for a retrofit program, an 80% reduction of Total Suspended Solids (TSS) was selected as a reasonable proxy for attainment of water quality improvements. The evaluation used GIS data sets to estimate impervious acreages in the Puget Sound watersheds and evaluated and identified BMPs capable of treating for TSS to the targeted 80% reduction levels. These BMPs were then evaluated for ranges of costs and this data was then applied on a Sound-wide basis.

Twelve BMPs were identified as being able to consistently reach an 80% reduction in TSS. Based on using these 12 BMPs — with installation costs ranging from $20,000 to $78,000 per acre for construction, (excluding land costs) and estimating between $400 to $3,200 per year for maintenance — the cost for retrofitting the Puget Sound drainages ranges between $3 and $15.6 billion with an additional $65 to $510 million per year required for maintenance. The wide range of costs is related to the amount of impervious surface targeted for retrofit activity.

The Partnership costs analysis focused on removal of TSS, not directly on the issue of dissolved metals. Recognizing there is a knock-down effect whereby TSS removal will reduce dissolved metals, the specific costs associated with removing dissolved metals has not been evaluated. Such evaluation would prove problematic in any event, as no existing public domain BMP nor manufactured passive treatment BMP has been shown to reduce dissolved metals to levels necessary for consistent permit compliance. The Partnership's Urban Stormwater Runoff paper referenced above outlines the problem well:

Problem Areas

> Based on the experience of MS4 [municipal stormwater] permittees, it is difficult for local governments to fulfill their responsibilities for cleaning up stormwater because they do not have the following: an ability to control pollutant inputs, or a clear statement of hypotheses or metrics and monitoring to know what is being accomplished, *or technological treatment that can achieve water quality standards with confidence* (emphasis added), or the necessary level of investment to maintain and retrofit old systems.

Without such a baseline of information and standards, convincing policy makers and the public to fund additional treatment efforts will be difficult.

NEED FOR FUNDING AND NEW APPROACH

The need for additional funding for stormwater treatment of existing pollution-generating impervious surfaces can be established for TSS within the Puget Sound as well as any urban setting. The difficulty facing the stormwater profession is making sure the money raised addresses as many pollutants of concern as possible, due to the inherent resistance to increased taxes or utility rates. With current technology and standards, consistent treatment and reduction of metals does not seem attainable for stormwater with higher levels of dissolved metals. If the current standards and mechanisms for establishing the standards remains, significant investigation through research and development of new treatment BMPs appears to be warranted — perhaps to the level of a program similar to the federal government's investments in changing wastewater treatment plants from primary to secondary treatment.

Expansion of the responsibilities of municipalities and DOTs into advanced treatment techniques using active systems does not appear to be within the realm of capability nor reasonability due to the dispersed nature of storm drainage. Yet, with the limited tools available, that is apparently the direction in which current and anticipated standards are leading us.

When faced with an apparent unattainable goal, it is reasonable to go back to square one and look at the process, assumptions, and science resulting in the goal.

EXPANDING TREATMENT APPROACHES

As noted, stormwater managers (both public and private) are now faced with an ever increasingly stringent suite of state and federal benchmarks, effluent limits, and standards for dissolved metals in their stormwater permits without a demonstrably effective set of treatment tools and options for achieving them.

To date, the primary focus on achieving compliance with NPDES permit conditions has been on: (1) source control; (2) end-of-pipe treatment systems; or (3) some combination of both. Source control efforts typically focus on preventing pollutants (in this case dissolved metals) from entering the environment, being entrained in stormwater, and being discharged to the aquatic resources from the adjacent land uses (Figure 1, next page).

WATER QUALITY STANDARDS

EDITOR'S NOTE

The federal **Clean Water Act** section 303 (CWA §303) requires CWA-authorized states and tribes to adopt water quality standards to protect water resources.

Water Quality Standards include:

1) Water quality goals for water bodies or individual segments
2) Designated uses for these water bodies
3) **Water quality criteria** necessary to protect these designated uses
4) Antidegradation provisions

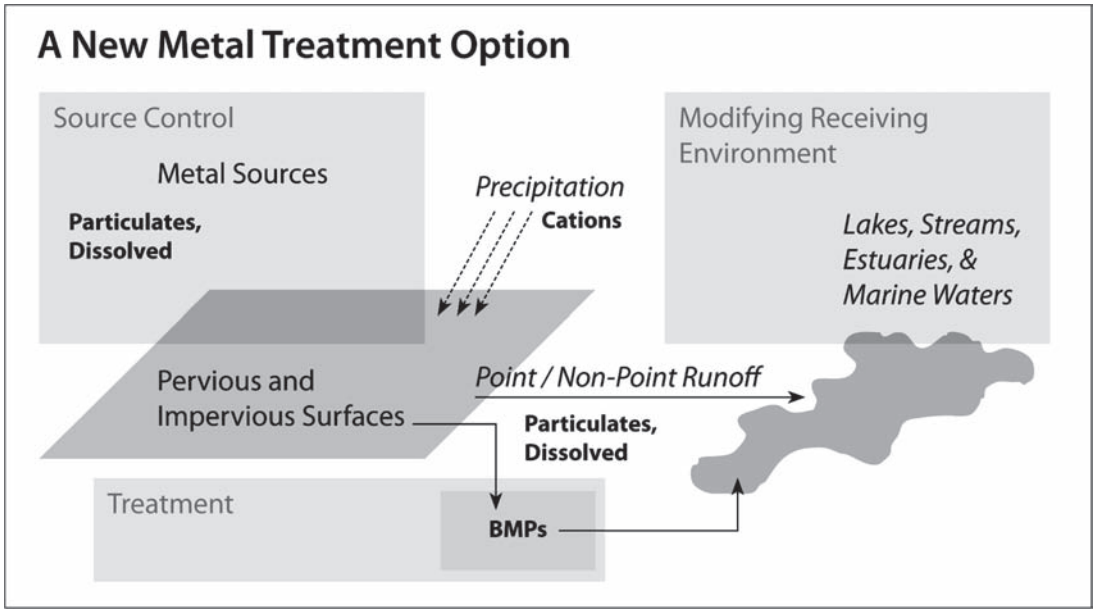
CWA §303 also directs authorized states and tribes to review the scientific basis and support for these standards at least once every three years, a process commonly known as **Triennial Review**. CWA §304 directs EPA to develop water quality criteria for use and consideration by the authorized states and tribes in setting water quality standards. CWA-authorized states and tribes must promulgate standards of stringency equal to, or greater than, EPA standards.

NPDES permits

Based on the underlying water quality standards, the NPDES permit system uses both **benchmarks** and **effluent limits** to regulate dischargers. **Exceeding benchmark concentrations** typically requires the permit holder to take corrective actions, such as reviewing their Stormwater Pollution Prevention Plan (SWPPP), but is not considered a permit violation. Failure to take the required corrective action would be a permit violation. **Effluent limits** can be either: (1) technology-based, requiring the use of a specific technology-based **b**est **m**anagement **p**ractice (BMP); or (2) numeric limits, where the discharger has an upper limit on effluent pollutant concentration with which to comply.

Dissolved Metals

Figure 1



Deposition and transport of metals via stormwater to aquatic resources and corresponding opportunities for treatment.

Source Control Approach

A common source control approach that has been incorporated into NPDES Municipal Separate Storm Sewer System (MS4) permits (Phases I and II) has been the identification and disconnection of illicit discharges (such as from industrial and wastewater systems) to stormwater conveyance systems. Efforts to reduce the amount of copper in brake pads (e.g., Brake Pad Partnership — www.suscon.org/bpp/index.php) represent another approach to source reduction. However, identifying the sources of stormwater-borne metals within a watershed is a major challenge. For example, the City of Auckland, New Zealand, attempted to identify the sources of metals (specifically copper, lead, and zinc) in their local watershed (see Table 3). Auckland was most successful in identifying zinc sources, but could not determine the bulk of commercial and residential lead sources affecting stormwater and determined only a few of the copper sources in commercial, residential, and industrial land uses.

Table 3.

Catchment	Percent of sources that could not be identified		
	Copper	Zinc	Lead
Commercial	70%	6-12%	60%
Residential	58%	21%	8%
Industrial	81%	15%	78%

The percent of stormwater sources for copper, zinc, and lead that could not be identified within the commercial, residential, and industrial catchments of the City of Auckland, New Zealand (Reproduced from Temperley et al. 2005).

Receiving Water Chemistry

Coupled with the inability of most treatment BMPs to meet the current and likely future benchmark and effluent limits, there is a clear need to expand the range of approaches and management techniques to include consideration and manipulation of receiving water chemistry to assist stormwater managers in their compliance efforts (Figure 1).

ROLE OF BIOAVAILABILITY IN STORMWATER TREATMENT

"Bioavailability" refers to that portion of a substance that is potentially available for biological interaction with the exposed organism. Concerning the effects of water-borne metals on fish and aquatic invertebrates, the "bioavailable" portion is that portion of the total metals that can accumulate on these organisms' gills.

Dissolved Metals

EPA Policy Evolution

EPA recognized the relationship between the bioavailable fraction of metals and toxicity in 1993 when announcing a new water quality standards development policy.

In 1993, EPA gave bioavailability the following recognition:

> It is now the policy of the [EPA's] Office of Water that the use of dissolved metal to set and measure compliance with water quality standards is the recommended approach, because dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does total recoverable metal. (Prothro, EPA Memorandum 1993)

Under EPA's 1993 guidelines, the dissolved metals fraction of metals was identified as being that portion not bound to particulates (e.g., solids suspended in water). This dissolved metals fraction was operationally defined as that portion of the total recoverable metals passing a 0.45 µm filter. This policy led to revisions of water quality standards for metals which used the dissolved metal fraction to represent the bioavailable fraction — i.e., the entire dissolved metal fraction was considered to be bioavailable.

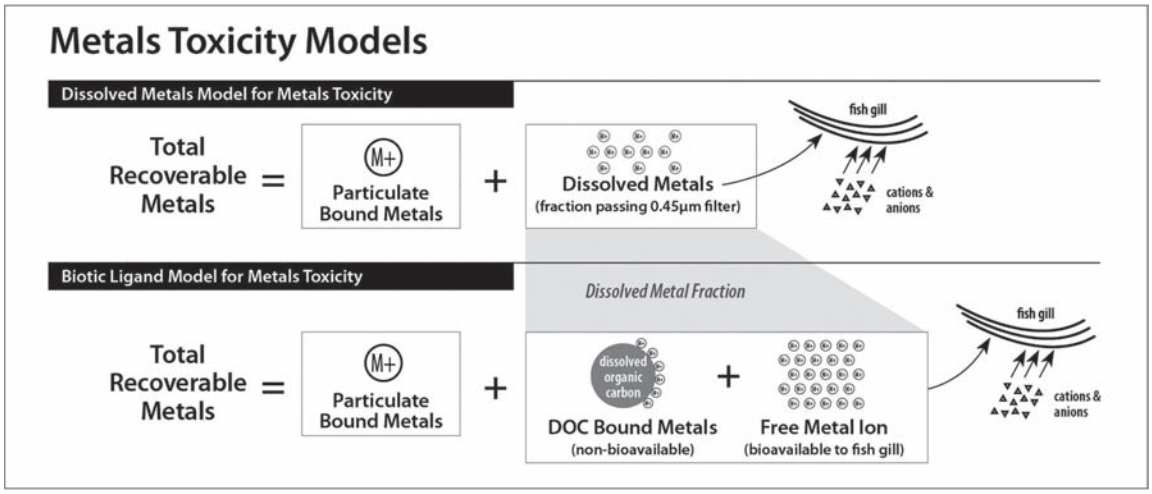
Toxicity Mechanism

One underpinning for the 1993 policy change was the recognition that "…a primary mechanism for water column toxicity is adsorption at the gill surface which requires metals to be in the dissolved form" (Prothro 1993). An increased understanding of the ability or inability of the metal fraction to interact with the gill surface is a critical component in realistically determining the toxicity of metals to both aquatic vertebrates (e.g., fish) and invertebrates (e.g., water fleas).

Standards Adjustment

Increased understanding led EPA to further adjust water quality standards for metals to account for site-specific hardness (see Figure 2 - Dissolved Metals Model for Metals Toxicity). This dissolved metals toxicity model recognizes that the ability of metals to bind with and pass through the gill surface is, in part, moderated by the presence of cations (e.g., calcium and magnesium) competing for these same binding sites on the gill. This concept underlies the current stormwater benchmarks, effluent limits, and water quality standards for metals with which stormwater managers, both public and private, must comply.

Figure 2.



Dissolved Metal and Biotic Ligand Models for Metals Toxicity.

BIOTIC LIGAND MODEL

Bioavailable Fraction

With the adoption of the dissolved metals model for metals toxicity, EPA recognized that criteria and standards based on total recoverable metals were overly protective of the aquatic environment, and could require unnecessary treatment efforts by dischargers and NPDES permittees. This principle of managing for only the bioavailable fraction of metals in effluents (which was applied to both wastewater and stormwater) has now been extended by EPA in the recognition that the dissolved metals fraction itself is composed of bioavailable and non-bioavailable subcomponents (Figure 2).

A further refinement of the concept of bioavailability has arisen from the water quality research community. The newer concept is in full accordance with the previous concept that metals must be able to interact with the gill surface, either through binding or adsorption, in order to cause an adverse effect. However, the newer concept takes into account the fact that metals bound to alternative *ligands* — while they can similarly pass through a 0.45 µm filter — cannot further interact with the gill surface and thus should not be considered bioavailable.

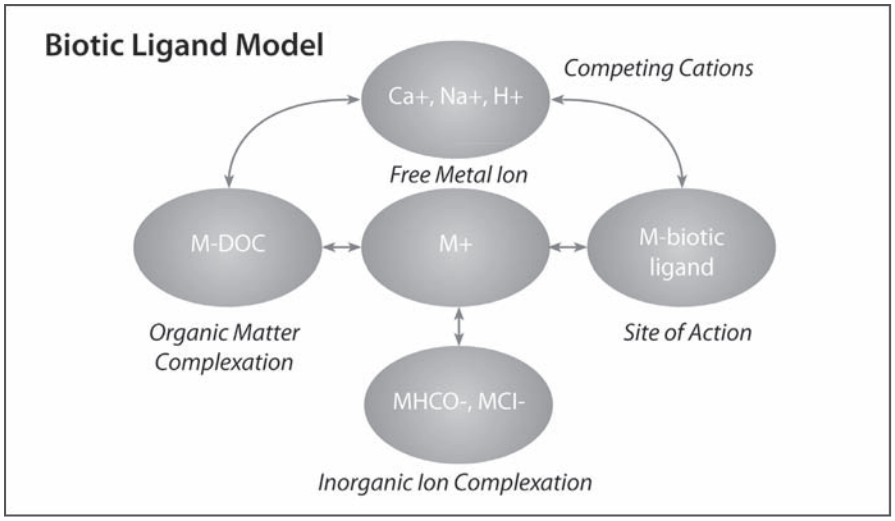
Dissolved Metals

Moderating Influence

Ligands are ions or molecules capable of binding to a metal-atom to form a coordination complex. Biotic ligands are molecules of biological origin, and represent the gill surfaces for aquatic vertebrates and invertebrates. Alternative ligands present in the water column can be of organic and inorganic origin (see Figure 3), with the organic ligands most frequently measured as **d**issolved **o**rganic **c**arbon (DOC) in streams, lakes, estuaries, and marine environments.

The Biotic Ligand Model (BLM) model recognizes the competitive relationship between dissolved organic matter, inorganic matter, and biotic ligands. The moderating influence of competing cations in determining the actual proportion of dissolved metals present at the site of action (e.g., gill surface) is also taken into account. The BLM fully incorporates the fact that only the dissolved metals fraction actually bound to an organism's biotic ligands is capable of contributing to acute and chronic toxicity.

Figure 3.



The role of dissolved organic and inorganic ligands in the determination of metal bioavailability was presented by Di Toro and his colleagues in 2001 as the Biotic Ligand Model (Di Toro et al. 2001; Santore et al. 2001).

Biotic Ligand Relationships

The BLM recognizes that free metal ion component (i.e., that portion of the total recoverable metal not bound to suspended sediments (represented as M+ in Figure 3)) can bind with: DOC; inorganic anions (e.g., bicarbonate and chloride); or biotic ligands (e.g., gills). The proportion of M+ bound to any of these three ligands is dependent on: the type of metal (metals differ in their binding affinity for the three ligand classes); the concentrations of the three ligands themselves; and the presence of cations (e.g., calcium and sodium) which can compete with these metals in binding with DOC and the biotic ligands. Analysis of biotic ligand relationships have been published in the scientific literature for: aluminum; arsenic; cadmium; copper; lead; manganese; nickel; silver; and zinc (for at least one aquatic species in each case).

REGULATORY APPLICATION OF THE BLM

Predicting Toxicity

In addition to providing a unifying scientific structure to our understanding of metal bioavailability and the site-specific factors controlling metal toxicity, the BLM is playing an ongoing role in the development of water quality criteria. In 2003, EPA published a technical support document recognizing the BLM as a practical modeling approach for implementing the concept of bioavailability to predict variations in metal toxicity with some degree of generality and reliability (EPA 2003). In 2007, EPA published a revision of the copper freshwater quality criteria for protection of aquatic life in ambient freshwater from acute and chronic toxic effects from copper that established procedures of incorporating the BLM into water quality criteria development (EPA 2007).

The freshwater copper acute and chronic criteria were initially selected for revisions incorporating BLM analysis, since sufficient data on the number and types of aquatic species were available to meet EPA's requirements for criterion establishment. Additional metals criteria are under consideration as sufficient data for the number and types of species become available for supporting the BLM criterion revision.

States' BLM Adoption

However, since publication of the BLM approach for establishing site-specific criteria by individual dischargers in 2007, of the 19 states west of the Mississippi River, only New Mexico and Texas have adopted the use of the BLM approach. Other states that have adopted the BLM for use in site-specific criteria development are Maryland, Minnesota, New Hampshire, New Jersey, and South Carolina.

Dissolved Metals

Available BLM Programs

Input Parameters

State/Tribe Adoption

Highway Infrastructure

APPLYING THE BLM

As the BLM has progressed in its regulatory application, user-friendly approaches have been developed such as readily applicable spreadsheets for use in calculating instantaneous copper water quality acute and chronic criteria (HyroQual, Inc. 2007; EPA 2007). Also, as part of the 2007 copper freshwater criteria, EPA provides a downloadable program for the use of the BLM (http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/pollutants/copper/2007_index.ccf). This program incorporates metals speciation and the protective effects of competing cations into predictions of metal bioavailability and toxicity (USEPA 2007). The scientists at HydroQual, the developers of the EPA program, have gone further in development of this program, and provide a version that can calculate the toxicity of copper, silver, cadmium, and zinc (http://www.hydroqual.com/wr_blm.html) as well as the instantaneous copper water quality criteria (HydroQual, Inc. 2007). HydroQual is currently working on adding nickel and lead BLM calculations to this program.

Input parameters for the BLM model include: sample temperature; pH; metal concentration; DOC concentration; the percent of DOC as humic acid (usually estimated); and the concentrations of calcium, magnesium, sodium, potassium, sulfate, chloride, alkalinity (as calcium carbonate) and sulfide. A survey of local analytical laboratories in the Puget Sound area found that the costs of analyzing this suite of BLM parameters ranged from $125 to $175 per sample.

NEED FOR REGULATORY ACTION

Under federal Clean Water Act (CWA) procedures, it will be necessary for NPDES-authorized states and tribes to adopt the BLM-based copper criteria into their water quality standards before a permit can use the BLM as a basis for a water quality based permit limit (http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/pollutants/copper/permitting.cfm).

As noted above, only two of the 19 states west of the Mississippi have taken this step. In the West, only New Mexico and Texas currently allow for the use of the BLM approach in the development of site-specific criteria. Before stormwater managers can consider the exploration and development of BLM based stormwater treatment options, it will be necessary for the stormwater management community to engage state and tribal regulators and recommend the adoption of BLM based water quality criteria. In particular, CWA's triennial review process provides an appropriate vehicle to advance the benefits that can accrue from the adoption of the BLM approach — benefits for both stormwater managers and regulators charged with the protection of our aquatic environments.

The following case study of ongoing environmental protection efforts in the Puget Sound helps to demonstrate what the BLM advantages could be and the need for considering taking such steps.

CASE STUDY

Over-Water Highway Infrastructure / Innovative Stormwater Treatment (IST) Research Project

The Washington State Department of Transportation (WSDOT) has been working on replacing a major component of the state highway infrastructure across Lake Washington between Seattle and Bellevue (Figure 4, next page) for the past 12 years. The SR 520 Bridge Replacement and High Occupancy Vehicle (HOV) Program will eventually replace almost 13 miles of state highway through a highly urbanized corridor and crossing a major water body — Lake Washington. The program consists of three main projects: I-5 to Medina: Bridge Replacement and HOV Project; Medina to SR202: Eastside Transit and HOV Project; and the Pontoon Construction Project. Additional information on each project can be obtained at (http://www.wsdot.wa.gov/Projects/SR520Bridge).

An "Innovative Stormwater Treatment" (IST) research effort was conducted in association with this highway infrastructure project. The IST was funded through a grant from the Federal Highway Administration (FHWA) and supported by WSDOT staff throughout the project's investigation and development phases. In addition to developing a strategy and a new BMP for the over-water structures, a secondary goal of FHWA was to be able to apply the new BMP to land-based uses in highly urbanized settings and by other DOTs.

Innovative Stormwater Treatment (IST) Stakeholders

Federal Highway Administration

Muckleshoot Tribe

National Oceanic and Atmospheric Administration (NOAA) Fisheries

Parametrix

Seattle Public Utilities

SR520 Project Design Team

Washington State Department of Ecology

Washington State Department of Fish and Wildlife

Washington State Department of Transportation

US Fish and Wildlife Service

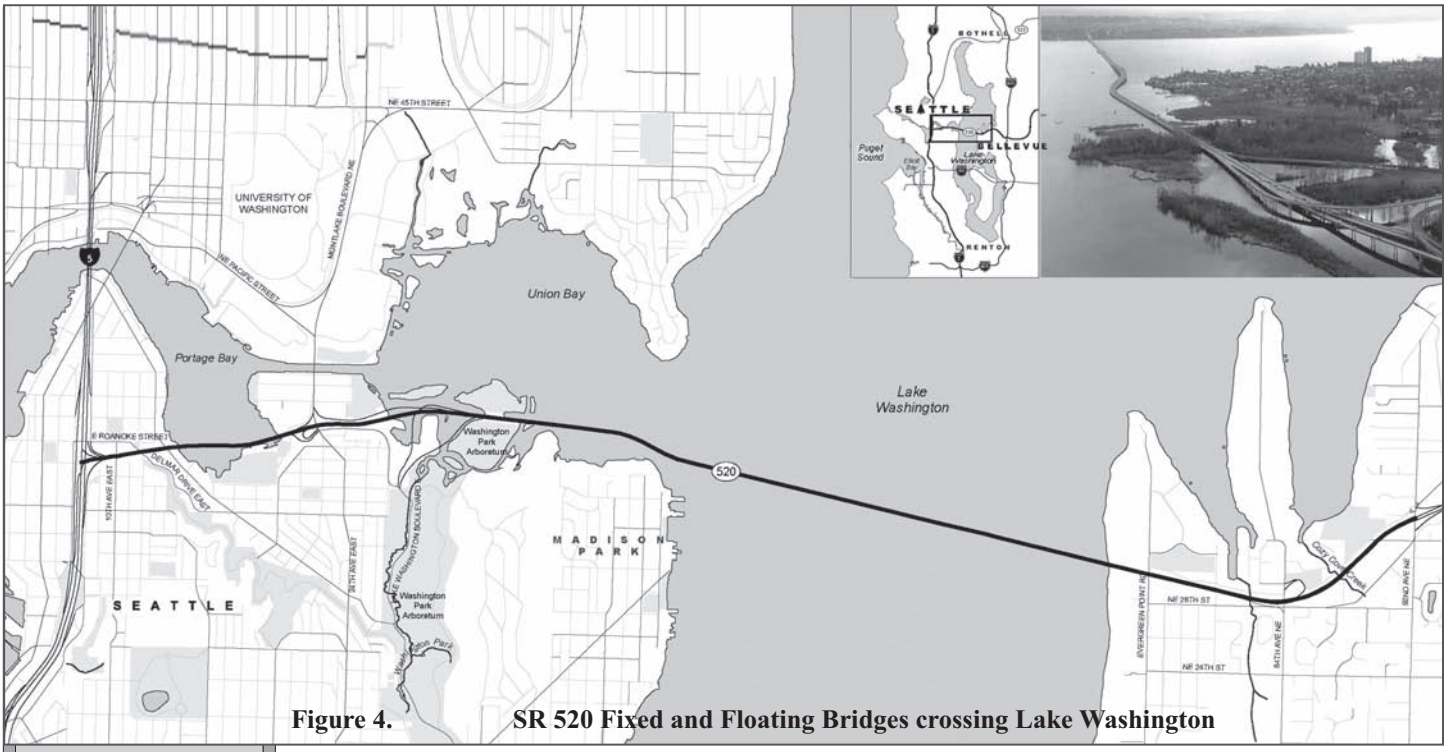


Figure 4. SR 520 Fixed and Floating Bridges crossing Lake Washington

Dissolved Metals

Treatment Options

For the purpose of this article, we will discuss work associated with the western end of the project, the I-5 to Medina portion of the program.

The I-5 to Median: Bridge Replacement and HOV Project consists of replacing the existing four lane roadway and bridge sections with new, seismically sound, replacement structures including new floating pontoons. The challenge placed before the authors through the Innovative Stormwater Treatment Project was to evaluate treatment options for the fixed bridge, over-water sections (Figure 4) building upon previous work.

Complicating the issue was a lack of concurrence between WSDOT, state, and federal regulators on what pollutants required treatment. Lake Washington is deemed a "basic treatment" waterbody in Washington State, requiring TSS treatment only. However, the lake is a migratory path for Chinook salmon listed as endangered under the ESA and as such there is not universal agreement on the treatment goals for runoff to the lake. NOAA Fisheries (the federal agency responsible for overseeing ESA protections for anadromous fish) stated the intention to see water quality improvements from this project result in a preferable discharge of no more than 2 µg/L of Cu and 5.6 µg/L of Zn above the Lake's background levels.

BMPs Evaluation

After extensive discussions through design charrettes and workshops hosted by the project team and attended by local, state, and federal agencies, the decision was made to move forward with an evaluation of BMPs capable of specifically treating dissolved metals (in addition to TSS). This effort was identified as a separate IST research project. The team conducted extensive literature reviews, contacted numerous state agency DOTs across the nation with overwater structures, and interviewed recognized national experts on water quality treatment. The outcome of these efforts revealed that no DOTs were attempting to treat for dissolved metals on fixed bridge structures and that there were no existing BMPs capable of meeting the NOAA treatment goals of 2 µg/L and 5.6 µg/L for Cu and Zn above background (which for Lake Washington was 1µg/L for Cu and Zn). The interviewed experts recommended focusing on the pollutants and processes with an eye to media filtering targeting the specific pollutants of concern.

Treatment Components

Water quality treatment typically includes physical, chemical, and biological processes — and a collective process utilizing all three (physical/chemical/biological) which incorporates the remediation attributes of certain plants and is commonly referred to as phytoremediation. The physical processes consist of filtration and sedimentation as experienced in a sand filter. The biological processes include biotransformation/degradation and predation as experienced through a constructed wetland. The chemical processes are more numerous and include: adsorption; absorption; disinfection; **d**issolved **o**xygen (DO) adjustment; pH adjustment; and precipitation. Many of these processes occur within existing BMPs to one extent or another. Many others require active treatment systems to force the processes to occur. The phytoremediation process can be either simple or complex (depending on the pollutant being treated) — but is typically a managed process in some form.

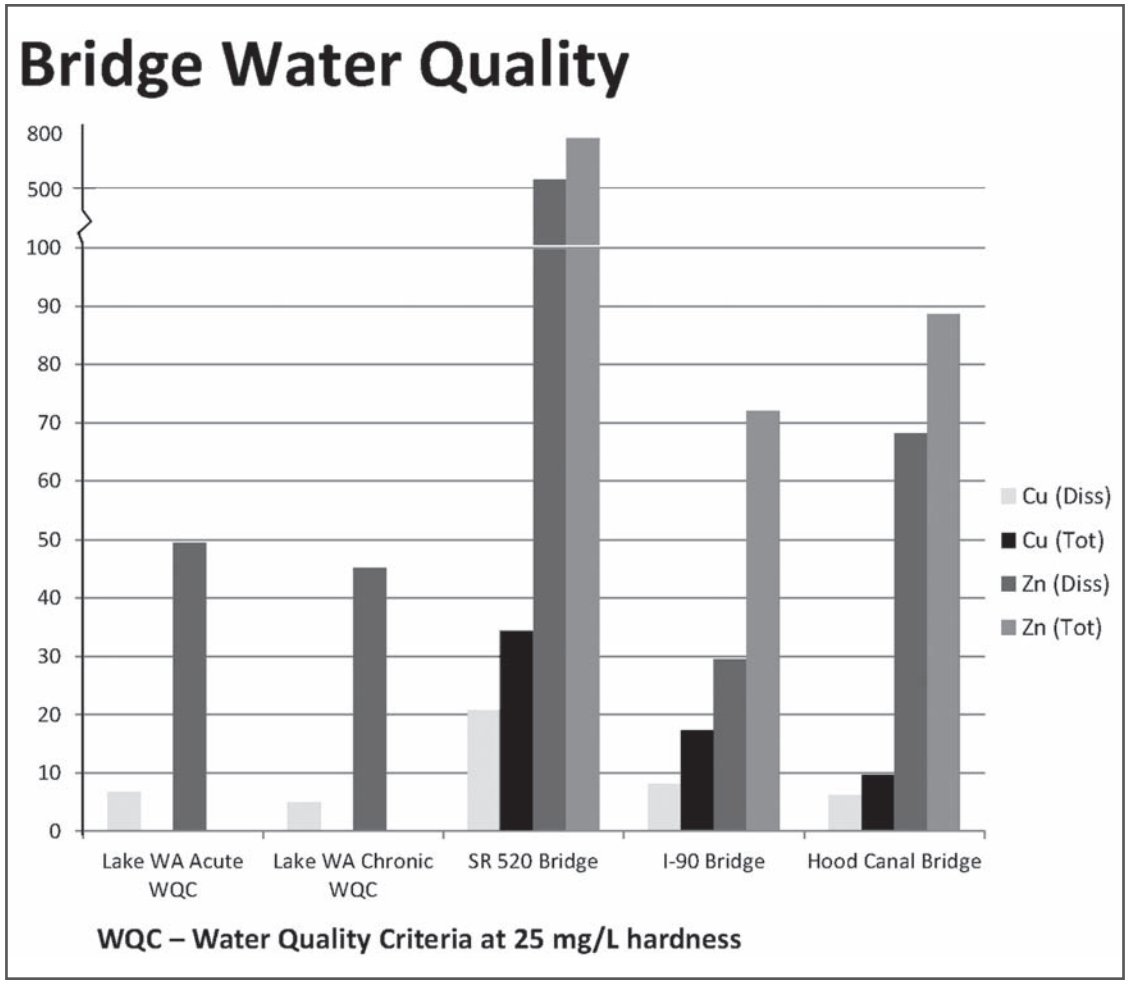
Dissolved Metals

Design Constraints

Due to the unique nature of treating stormwater on a fixed bridge structure over water, some of these processes would be difficult to manage and prohibitively expensive. Further, no selected process could increase the risk of failure to the bridge structure itself. As an example, pervious pavement was eliminated early on even though some recent studies are showing promising results on pollutant removal. Structural engineers on the team were not enthusiastic about having any ponding water on the bridge, preferring rapid removal of runoff for structural safety reasons. Weight restrictions similarly eliminated some options as did heightened maintenance needs.

A comparison of the existing Lake Washington bridge runoff characteristics to existing state water quality standards for acute and chronic criteria at 25 mg/L hardness revealed a fairly significant treatment issue. As can be seen in Figure 5, existing levels far exceed the goal of 2 µg/L and 5.6 µg/L above background. As a side note, the evaluation of existing runoff from the SR 520 Bridge has to be qualified with the statement that the 40 year old drainage infrastructure is in poor shape and is, itself, a contributing source of dissolved metals.

Figure 5.
Dissolved & Total Concentrations for Cu and Zn for Lake Washington and Hood Canal Bridges



Non-Traditional Approaches Explored

Given the treatment challenge and after the period of extensive inquiry and research, the consensus of the investigative team and outside participants was to explore non-traditional approaches to treating dissolved metals and TSS. The team looked at processes utilized for wastewater treatment as well as industrial effluent treatment. This effort included looking at acid mine tailings and remediation efforts undertaken by the mining industry to remove dissolved metals from surface and groundwater produced by their activities.

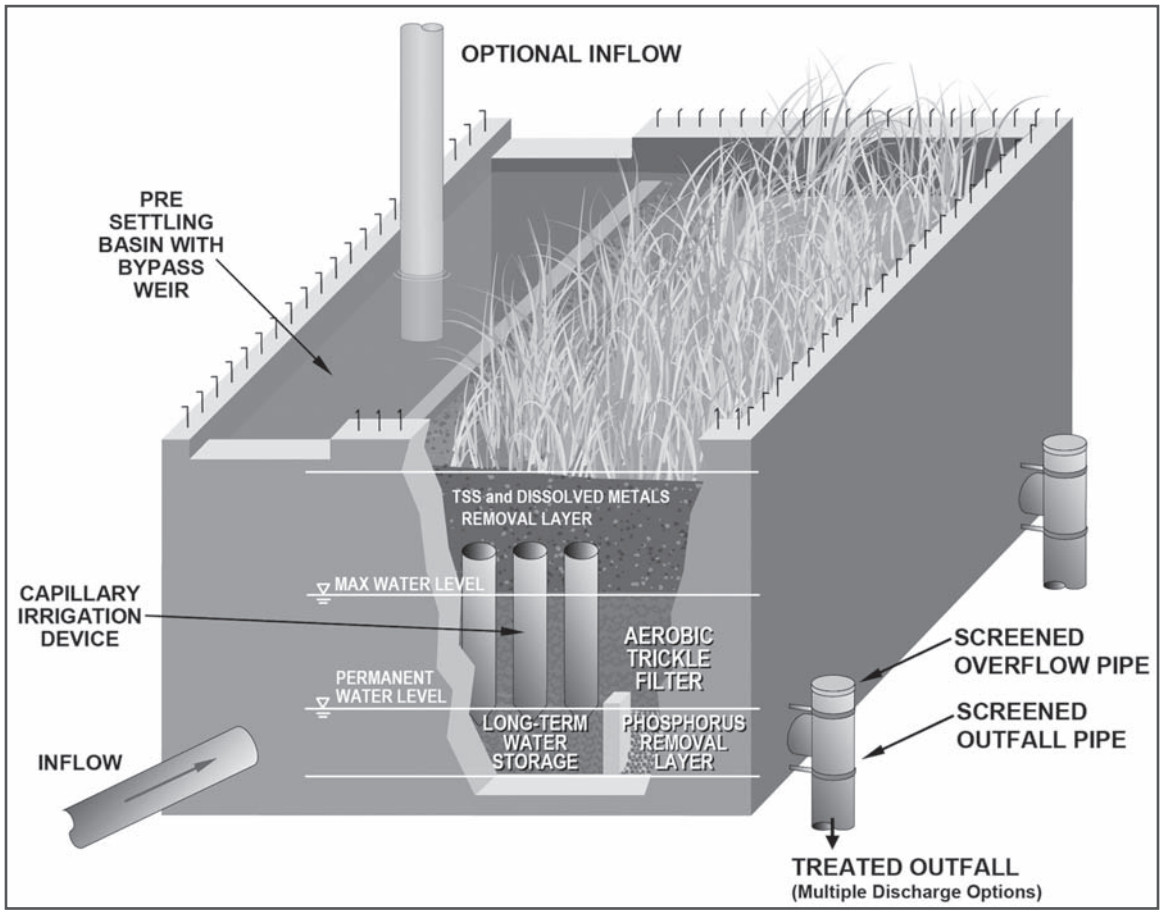
Considering the limitations and challenges of installing water quality treatment on the bridge structure above the water, the design focused on developing a solution that could make use of a platform designed to span between two piers above the lake level. A conceptual design was put forth that uses a series of processes to treat for TSS and dissolved metals.

Dissolved Metals

Filter Functions

Termed a "Media Trickle Filter"(see Figure 7), the design settled upon uses: a presettling bay for trapping larger particles; a vegetated top layer using soil and apatite (i.e., a mineral of either inorganic or organic origin consisting of calcium fluoride phosphate or calcium chloride phosphate) for filtration; bioremediation; dissolved metals removal; a secondary layer designed to allow for biofilm growth to enhance nutrient removal; and finally a phosphorus removal layer to remove phosphorus introduced by the apatite. Tying it all together is a capillary irrigation device to wick water from the bottom where long-term water storage is incorporated up to the vegetation to keep it sustained during longer dry spells.

Figure 6. Media Trickle Filter



Reduction Expectations

The Media Trickle Filter design can be modified to fit ultra-urban environments where a top is necessary and vegetation is neither desired nor suitable for the site. Preliminary sizing indicates that a unit with the dimensions of approximately 13 feet by 14 feet will treat up to 0.9 acre.

Due to the high affinity for dissolved metals by apatite, the Media Trickle Filter is expected to provide significant reductions in concentrations of dissolved metals. The next step for advancing this design is laboratory column and pilot testing in a highway drainage setting.

DOC Effects

BIOTIC LIGAND MODEL APPLICATION TO IST

Lake Washington's DOC levels (2.7 – 4.0 mg/L) are higher than the average stream concentrations (0.3 - 2.2 mg/L) in the Western US (DeForest et al. 2010). Due to BLM's factoring-in of dissolved copper's tendency to bind to DOC, this relative abundance of DOC has a significant effect on determining acceptable dissolved copper discharge levels if BLM methodology is applied. Running the BLM numbers for Lake Washington shows that the appropriate levels of dissolved copper in stormwater discharging to the lake for protection against olfactory inhibition of juvenile salmon are between 18.6 µg/L and 27.6 µg/L (Table 4). In contrast, the hardness adjusted acute copper criterion (used under current regulation) for Lake Washington is 2.5 µg/L, and the hardness adjusted chronic copper criterion is 2.3 µg/L. While the discharge values from use of the BLM are higher than state water quality standards, use of the BLM establishes equally protective standards in the waterbody based on how dissolved metals actually interact in a natural environment.

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Table 4. Concentrations causing 20% inhibition (IC20) of olfaction, calculated using the Salmon Olfactory BLM model developed by Meyer and Adam 2010

Average IC20	23.1 µg/L
Maximum IC20	27.6 µg/L
Minimum IC20	18.6 µg/L

Calculated with data from Edmondson and Cerco et al. 2004 for Lake Washington conditions

Best Available Science

While EPA and NOAA Fisheries have both stated that the BLM is Best Available Science, it has yet to be accepted uniformly across the US. Applying the BLM in the IST research effort would have allowed for a wider consideration of treatment options and associated costs for treatment and compliance. It would also have provided a greater level of certainty that the achievable reductions in dissolved metal concentrations would comply with state criteria as well as numeric limits used by NOAA Fisheries in endangered species consultations.

POTENTIAL FUTURE APPLICATION OF BLM IN STORMWATER

Triennial Review

In 2011, the Washington Department of Ecology (Ecology) will be establishing the agenda for evaluations to be conducted through the Triennial Review process of the State's water quality standards. Efforts are currently underway to convince Ecology to open a dialog with regional experts to discuss how the BLM can be integrated into establishing realistic, pragmatic, water quality standards for dissolved metals. Without an agreed upon, science-based approach to establishing protective standards, advancement of research and development of new, practicable, BMPs will continue to stagnate. In Washington State, the standard for Enhanced Treatment for stormwater is "to provide a higher rate of removal of dissolved metals than Basic Treatment facilities." There is no established removal efficiency required for dissolved metals for Basic Treatment BMPs. BMP developers have voiced concerns for the past 10 years that they cannot build, test, and certify devices with such a vague standard.

Vagueness Issue

The Washington State Triennial review process for surface water quality standards can be reviewed at the following website: www.ecy.wa.gov/programs/wq/swqs/triennial_review.html. Ecology is currently reviewing all comments received prior to December 17, 2010. Of the multitude of comments received, the second highest comment category concerned the BLM and its application in Washington State. At this time, it is unknown which topics Ecology will decide to review in the upcoming year.

DEVELOPMENT OF NEW SOLUTIONS

Percent Reduction Shortcomings

The establishment of the BLM as a regulatory tool for water quality protection and permit compliance provides stormwater managers and state regulatory agencies opportunities for the development of a suite of new stormwater treatment approaches. For example, an emergent issue in stormwater management concerns the establishment of numeric treatment targets for stormwater BMPs. Many current evaluation criteria focus on the percent reduction of pollutants such as metals. However, there is growing concern that the percent reduction approach does not intrinsically meet various water quality criteria — one reason being that even a high percentage reduction of pollutants in highly polluted influent can result in problematic pollutant levels remaining in effluent.

In the absence of BLM adoption, new federal and state benchmarks and industrial effluent limits may well result in stormwater managers being faced with the need to install, maintain, operate, and monitor treatment systems, with the likely addition of monitoring performance for permit compliance — but with unclear or unattainable standards with which to comply.

ESTABLISHING TREATMENT TARGETS

Bioavailability

Understanding the bioavailable portion of stormwater metals following discharge to adjacent receiving environments could assist stormwater managers in the calculation of treatment targets and the cost-appropriate design of treatment systems. Such an approach could also help validate that the efforts undertaken by stormwater managers are an appropriate expense and protective of the aquatic resources to which they discharge.

BLM & Treatment Targets

Before adopting the BLM approach, it is important for stormwater managers to understand that use of the BLM can calculate water quality criteria that are greater than the hardness adjusted criteria as well as lower than these same criteria — dependent on the concentrations of DOC, cations, and anions in the receiving environment. The bioavailability of metals in receiving waters with low DOC and low hardness levels can be high, and the corresponding calculated water quality criteria low. In other words, the discharge criteria could be more stringent than current standards would indicate or less depending on the

Dissolved Metals

ability of the waterbody to buffer the toxicity based on available DOC. While this is likely an uncommon result, stormwater managers will have greater certainty the treatment targets based on the BLM approach will be appropriately protective of environmental quality with a relatively minimal additional effort on their parts to measure DOC and run the calculations.

DOC AUGMENTATION

DOC & Riparian Zones

Given the affinity of dissolved metals to bind with DOC, an additional opportunity provided by the BLM is the potential to augment DOC levels in the receiving environment to reduce metal bioavailability. Studies of DOC sources in streams and lakes have found that a substantial component is derived from terrestrial sources (easily more than 50% when riparian vegetation is still intact). Conversion of natural riparian areas with established shrubs and trees along the shorelines of streams, lakes, and nearshore marine environments to other land uses can have a dramatic impact on the amounts of organic carbon exported to adjacent aquatic resources. Some field investigations have found that as much as 80% of the potential terrestrial carbon inputs have been lost with the reduction of riparian zones and conversion to other types of land uses. Thus, changes in land use not only increase total impervious area with its associated increase in stormwater runoff volume, but can result in increasing the sensitivity of the receiving environment to metal pollutants carried in this runoff.

CONCLUSION

We propose that the BLM provides stormwater managers a potential new tool in the development of treatment approaches in addition to that of setting treatment targets. The potential for the augmentation of DOC in the receiving environment can enhance the overall quality of these aquatic resources, and further adjust the treatment targets needed to achieve compliance with water quality benchmarks and effluent numeric limits. Potential techniques for DOC augmentation would include riparian restoration as well as direct addition of carbon (e.g., leaves and woody debris) with the aim of restoring the pre-urbanization DOC levels. Research will be necessary to establish the DOC target levels for specific receiving environments, but the consideration and evaluation of this approach can provide stormwater managers with additional tools for design of their treatment systems as well as part of an overall approach to improving aquatic habitat quality.

DOC Augmentation

BLM Standard

Should the BLM become a standard for determining the treatment levels necessary in waterbodies of concern, professionals can evaluate the parameters necessary for application of the BLM, pick a BMP that can accomplish that removal efficiency, and design, construct, and maintain the device(s) leading to a realistic and attainable improvement in water quality discharges. Further, through testing of the DOC, professionals can evaluate options for short-term and long-term means to supplement the DOC levels and reduce the bioavailable fraction of the dissolved metals.

Application of the BLM provides a readily understandable, defensible methodology for the setting of standards and the development of effective treatment technologies. The importance of such tools, as the regulatory community moves towards numeric limits for stormwater discharges, cannot be overstated.

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WYOMING STREAMFLOW RESTORATION

HISTORY, UPDATE, & CURRENT STRATEGIES

by Scott Yates, Director, Trout Unlimited Western Water Project (Lander, WY)

Wyoming Streamflow

INTRODUCTION

Legacy of Distrust

It's a familiar but insightful saying: Wyoming is a small town with long streets. In a State where antelope still outnumber people and everybody seems to know everybody, trust is a critical factor in developing solutions to complex resource problems. For too long, however, a legacy of distrust has made it difficult for Wyoming stakeholders to find commonsense and partnership-oriented solutions to streamflow protection and restoration issues. As with any situation involving lack of trust, the roots of such feelings often run deep and are quite diverse.

Incentives Approach

In recent years, however, patient work at both the legislature and in rural communities throughout Wyoming has moved forward conservatively with regard to streamflow restoration. Such activities have moved the conversation away from traditional discourse about the existing instream flow law and instead focused on how potential water code changes can be designed and driven by water right holders — especially ranchers and farmers — to incorporate non-regulatory and incentive-based approaches to addressing streamflow issues without injury to other non-participating water users.

INSTREAM FLOW IN WYOMING

A HISTORICAL PERSPECTIVE

Water quantity issues, especially to address a multitude of natural resource issues related to human health, aquatic, and fishery needs, took hold of the public consciousness in the 1970s. Like other western states, a grassroots movement began in Wyoming during that decade to pass legislation to better protect streamflows. However, the Wyoming effort played out in divisive fashion, and when proponents of change ran into a brick wall in the Wyoming Legislature they turned to other alternatives. In the early 1980s, streamflow advocates began exploring the potential for legislative change via the ballot initiative process.

Ballot Initiative Drawbacks

Wyoming is not a state that traditionally has responded favorably to ballot initiatives. *See* History of Initiative and Referendum in Wyoming, Ballotpedia, at http://ballotpedia.org/wiki/index.php/History_of_Initiative_%26_Referendum_in_Wyoming. While the initiative process has never been easy in Wyoming, in recent years the process has been made even more difficult. In 1998, the Wyoming Legislature passed legislation making it even harder to get a ballot initiative on the ballot. *See* Laws governing the initiative process in Wyoming, Ballotpedia, at http://ballotpedia.org/wiki/index.php/Laws_governing_the_initiative_process_in_Wyoming. With regard to initiatives, Wyoming can be viewed, either with disdain or approbation, as the antithesis of Oregon or California.

Negative Reaction

The reaction of many Wyoming legislators and key stakeholders such as the agricultural community to the threat of ballot initiatives, especially one geared toward amending the State water code, was extremely negative. Many State leaders never forgave initiative and instream flow proponents for moving forward without additional discussions with key stakeholders, especially the ranchers and farmers who are the primary water users statewide. Even though the threat of a ballot initiative was never realized, the instream flow issue was branded as incendiary, regulatory, partisan, and driven by a group of individuals who not only didn't hold water rights, but wanted to change the system without involving the private landowners and rural communities that depended on Wyoming water for their livelihood. *Id.* This was the case even though the instream flow ballot initiative never actually appeared on the ballot because proponents felt the legislature addressed the issue with an instream flow law during the previous session. For more detailed information regarding the instream flow initiatives, see Secretary of State's Office, Wyoming Elections Division, Initiative and Referendum Summary Sheet (http://soswy.state.wy.us/Elections/Docs/IRSum.pdf).

Instream Flow Law Passage

This was the political climate in the mid-1980s: many legislators wanted to avoid the threat of the ballot initiative but did not want to pass substantive legislation to address streamflow issues. The middle ground resulted in the passing of the 1986 Instream Flow Law (Wyo. Stat. § 41-3-1001 to 41-3-1014 (1986)). The Instream Flow Law was passed with much fanfare, but is a procedurally cumbersome approach that, as this article will explain, has yet to "restore" streamflows anywhere in Wyoming. The Instream Flow Law left little, if any, role for ranchers and farmers — despite the fact that over half of Wyoming's 21,600 perennial stream miles flow through private lands.

Perhaps most importantly, although the 1986 law recognized for the first time the value of water left in Wyoming's streams, the negative climate in which it was passed unquestionably lingered. This negative climate has hamstrung discussions with the most important water user constituency — agriculture.

Wyoming Streamflow

However, over time the fact that ranchers and farmers have much to gain from additional water user flexibility — especially where such flexibility is afforded in a non-regulatory, market-based fashion where water rights remain attached to the land and the no-injury rule is vigorously enforced — is increasingly becoming a basis for cooperative efforts which benefit both the landowner and the environment.

THE 1986 INSTREAM FLOW LAW

Procedural Hurdles

Wyoming has one of the most limited streamflow protection mechanisms in the West. Streamflow is a recognized beneficial use in Wyoming, but only in the context of the State's 1986 Instream Flow Law. The 1986 law is laden with procedural hurdles requiring participation by a patchwork of State agencies with different missions. The fisheries and hydrologic information required by statute is compiled by the Wyoming Game & Fish Department (WGFD); the Wyoming Water Development Commission (WWDC) determines actual water availability for the proposed instream flow segment; and the State Engineer's Office and Board of Control is responsible for processing the application like any other permit to use water filed with the state. If approved and finalized, the WWDC then holds the water right for the State of Wyoming. Wyo. Stat. § 41-3-1001 to 41-3-1006 (1986).

Public Lands

Since 1986, WGFD has filed approximately 100 instream flow applications (see WGFD's instream flow website: http://gf.state.wy.us/fish/instreamflow/index.asp). WGFD's Instream Flow Program and staff have worked diligently to identify high priority trout streams and collect information for such filings. This is especially true in drainages where the State's four native subspecies of cutthroat trout — Bonneville, Colorado, Snake River fine-spotted, and Yellowstone — still persist. However, because of the limited scope of the statute, such applications are designed solely to protect stream segments on higher elevation public lands for the minimum amount of flow necessary for maintain or improve a fishery (Wyo. Stat. § 41-3-1001 (1986)).

Water Availability Limitation

State held instream flow water rights are limited to stream reaches where water is available. This is a severe limitation in light of the fact that most Wyoming drainages are considered fully appropriated (Wyo. Stat. § 41-3-1004 (1986)), especially during normal and dry water years. In addition, all the instream flow water rights have a post-1986 priority date, often 50 to 75 years later than even the most junior private land water rights in Wyoming. While such filings are useful in preventing future water depletions in such areas, they do little to *restore* streamflows and fish passage on lower elevation biologically rich private lands.

Editor's Note: Under the Prior Appropriation Doctrine of western water law, priority of one's water right is crucial. Senior water rights owners — those with earlier priority dates — are entitled to the full extent of their water rights in times of shortage; junior rights are required to shut off their diversions to satisfy senior users.

Permanent Transfers Unused

The current instream flow law does include one provision allowing landowners to use their privately held water rights for conservation. Any Wyoming water user — working directly with the WGFD and Wyoming Game and Fish Commission — may permanently transfer or gift a water right to the State of Wyoming for streamflow purposes (Wyo. Stat. § 41-3-1007 (1986)). However, in the over 20 years since passage of the instream flow bill, not a single Wyoming private land water user has attempted to use this provision of the law.

While WGFD recently succeeded in a obtaining a permanent change of use to instream flow for a storage water right it acquired from Fremont Lake, there is still no example of a landowner permanently transferring a natural flow right for such purposes (Personal communication with Harry LaBonde, Deputy State Engineer, Wyoming State Engineer's Office (March 21, 2011)). There is very little impetus for a landowner to permanently retire land from irrigation and hand his water right over to the state.

ADDITIONAL LIMITS TO WATER USER FLEXIBILITY

Wyoming's temporary change law

No Temporary Streamflow Transfers

Current Wyoming law allows only the State to file for and eventually hold an instream flow water right. Further, as outlined above, the only other alternative for a water right holder is to transfer such right to the State in perpetuity. An alternative that a number of other States have adopted is to allow water right holders to temporarily transfer a consumptive use water right to restore stream flows. However, such a temporary change alternative for streamflow restoration purposes is not available to Wyoming water right holders. Since the 1950s, water right holders in Wyoming can temporarily transfer from one type of consumptive use to another (except for applications within an industry such as a ranch to ranch transfer). *See* Wyo. Stat. § 41-3-110 (1959). The statute explicitly recognizes certain uses for temporary water transfers including highway construction or repair, and drilling and producing operations, while ending with a broad statement approving of "other temporary purposes." Wyo. Stat. § 41-3-110(a) (1959). Through the years, the State Engineer's Office (SEO) has broadly interpreted "other temporary uses" to only include a variety of traditional consumptive uses (including municipal and industrial uses).

Wyoming Streamflow

Lease Rejected

Conservative Interpretation

Flexibility Impaired

Temporary Instream Flow Bill

Bill Limitations

New Provision

The SEO has not interpreted "other temporary uses" to include non-consumptive uses such as streamflow restoration. In 2005, the City of Pinedale attempted to lease stored water in Fremont Lake to WGFD via a two-year renewable lease to increase streamflows in Pine Creek. Pine Creek is a top notch urban wild trout fishery, with local children and recreational fishermen accessing healthy populations of brown, rainbow, and the occasional cutthroat trout within sight of Main Street. However, the State Engineer ruled that such temporary uses weren't contemplated by the exiting water code and instream flows could only be created where the State of Wyoming actually owns the instream flow water right. *Wyoming State Engineer Pine Creek – Instream Flows Segment No. 1, Secondary Supply Record of Decision* at 7-8 (Dec. 10, 2003). This ruling was greeted favorably by the agricultural community.

Ranchers and farmers in Wyoming feel strongly that the temporary change statute should be interpreted conservatively and reserved for traditional consumptive water uses. Further, because the existing law limits temporary change applications to two-year terms, there's a general consensus among traditional water users that streamflow restoration applications, where lands are taken out of production, would de facto be longer than two years. However, while the statute limits temporary change applications to two years, the SEO routinely approves subsequent applications for additional two-year time periods.

The current temporary change law, both as written and applied, limits the ability of ranchers and other water right holders to use their rights flexibly and in a way that provides the maximum benefit for their operations. A rancher can currently market his water temporarily for road construction, oil and gas production, or to cool a power plant, but not for fish and wildlife purposes — even if it benefits the rancher operationally or financially and harms no other water user. This makes it difficult, if not impossible, for sportsmen and agricultural producers to work together and develop working solutions that benefit their mutual interests. Instream flow proponents argue that the law should empower, rather than restrict, this kind of cooperation.

CURRENT LEGISLATIVE EFFORTS

RECENT STREAMFLOW RESTORATION BILLS

Recent legislative proposals have focused on addressing the limitations of the 1986 Instream Flow Law while providing the additional flexibility for temporary water use changes disallowed under current law.

Over the past decade, Senator Cale Case (Republican, Lander area) has repeatedly filed a "temporary instream flow" bill. *See* S.F. 72, 57th Leg., General Sess. (2003), and S.F. 106, 58th Leg., General Sess. (2005). The most recent version, Senate File 78, was introduced in Wyoming's 2011 General Session. While the bill was voted down 5-0 in the Senate Agriculture, State and Public Lands and Water Resources Committee, Senator Case has had some success with the bill in the past. During the 2007 General Session, a similar bill made it out of the same committee and actually passed on third reading out of the Senate. Shortly thereafter, the bill was rejected by the House Agricultural Committee.

Senator Case represents constituents in and around Lander, Wyoming. The Middle Fork of the Popo Agie River runs through Lander, and suffers through low flows periods. These low flow periods, depending on the water year dynamic, occur between July and the end of September annually. Even during a water year like 2010 that was punctuated by flooding well into July, streamflow levels reached critically low levels through town and down to the confluence of the North Fork of the Popo Agie during August and September. The temporary instream flow bill is geared toward allowing municipalities and private landowners in the area to better address local resource issues related to low streamflows.

Senate File 78 would work within the existing law's template but amend both the temporary change and instream flow laws (S.F. 78, 61st Leg., General Sess. (2011)). The Wyoming Game and Fish Commission would act as the petitioner for any such change. The bill amends the instream flow law to allow the State of Wyoming to acquire temporary water rights and directs them to do so in accordance with the temporary change statute.

Senate file 78 also changes the temporary change statue to:

1) explicitly allow such applications for instream flow purposes
2) only allow the protected stream reach to extend down to the next nonparticipating headgate
3) not allow injury to other water users
4) require that water to be transferred has been used within the previous five years

A different potential approach to streamflow restoration has originated in the Wyoming House of Representatives under the leadership of Representative Rosie Berger (Republican – Bighorn). Representative Berger has worked closely with Trout Unlimited to design a bill that fits ranch operations. Rather than shoehorn the flexibility to temporarily change a water right for streamflow purposes into the existing temporary change or instream flow laws, legislative proposals have focused on drafting a new stand-alone water code provision. Representative Berger filed streamflow bills in both the 2007 and 2009

Wyoming Streamflow

general legislative sessions. House Bill 70 in 2009, the Landowner Flexibility and Fisheries Protection and Restoration Bill, was approved by the House Agriculture, State and Public Lands and Water Resources Committee before failing on the House floor.

Pilot Program Proposal

House Bill 70 would have created a "pilot program" with a ten-year period for water right holders interested in participating to submit temporary change applications. H.B. 70 60th Leg., General Sess. (2009). It included a formal sunset provision so the law would expire after ten years unless the legislature acted to renew it or make it permanent. The bill also included language to ensure continued SEO oversight over approved applications so that intended trout fishery benefits accrued and no negative impacts occurred. There would be no required involvement of WGFD. Instead, the water right holder would work directly with SEO and retain the water right in their name throughout the temporary change period, after which the water right reverts back to the original place and purpose of use. The bill was limited to streams with trout, which substantially limited its geographic scope. It was designed as a headwater or small tributary streamflow restoration bill and as an additional tool for ranchers who are generally growing grass or alfalfa hay at higher elevations.

Landowners' Concerns

Trout Unlimited (TU) has spent the past five years in Wyoming listening to agricultural trade groups and individual private landowners regarding potentially feasible streamflow restoration alternatives. Two issues repeatedly raised by rural stakeholders include: (1) interruptible flow issues and the lack of confidence in SEO and the Board of Control to adequately address injury issues associated with upstream junior water right holders and operations; and (2) the importance of return flows both in terms of water rights administration and the health of local trout fisheries.

Interruptible Flow

The interruptible flow issue is a difficult concept both in terms of potential administration by SEO and in light of the basic tenants of the Prior Appropriation Doctrine. A traditional agricultural water right, especially where typical grass or alfalfa hay production occurs, generally has a time period where water is not being used (i.e., "interrupted"). This is especially true both before and during harvest along many small streams in Wyoming. During this interrupted period of water use, other irrigators in the drainage junior to the interrupted water right holder can use the water. A water right temporarily used to restore stream flows would provide uninterrupted use of the water right because it eliminates the traditional seasonal shut-off period.

SEO Leeway

House Bill 70 formally recognized this distinction and would have granted SEO the administrative leeway to address such issues in the application approval process. Both Representative Berger and TU believed this would have helped ensure: additional community involvement in the application process; potential protective conditions in the actual approved temporary change application; and, hopefully, greater local buy-in for restoring streamflow in particular river drainages.

Return Flows

Return flows are also a complex and legitimate issue in terms of how any type of streamflow bill would be administered. However, it's also a topic in which both agricultural producers and fishery interests have much in common and share a mutual interest in ensuring a cautious approach. Return flow in this context is generally defined as any flow which returns to a stream or channel after diversion for use.

Wyoming has some watersheds where native cutthroat trout either never existed or were extirpated but currently provide world-class wild brown and rainbow trout fisheries. The North Platte is one such drainage; fishermen come from all over the world to ply its waters. Since trout are not native to the North Platte drainage, agriculture and trout have essentially evolved together over the past century. Return flow discussions are especially pertinent in places like the North Platte, where any type of changes to agricultural operations could have unintended consequences depending on return flow dynamics.

Split-Season Option

Viewed in a positive way, a cautious approach is exactly what the return flow requirements in House Bill 70 would require — including a hydrologic assessment to help identify the best water management options for specific project sites. Such options could range from taking a parcel of land out of production to implementing additional conservation practices. A ranch operation might choose to adopt a split-season approach, continuing normal irrigation up to a certain point of the year (such as mid-July for higher elevation hay meadows that receive only one cutting) and then reducing or eliminating water use later in the year when flow levels reach critical survival thresholds for trout.

Unique Projects

The bottom line is that each potential streamflow project is unique. House Bill 70 would have required a process overseen by SEO combining the expertise of private landowners, fisheries experts, and agricultural industry experts to craft solutions based on site-specific information, credible baseline data, and traditional land and water use priorities.

Representative Berger did not introduce a version of House Bill 70 in the 2011 general session. However, she continued to discuss potential changes with TU, SEO, private landowners, and other stakeholders to make it more amenable to water users in Wyoming. The latest draft (to be used for outreach beginning in late-spring 2011) includes changes that convert it to a "split-season" streamflow bill entitled

Wyoming Streamflow

Split-Season Benefits

"Landowner Flexibility and Trout Fisheries Protection and Restoration" (draft on file with the author, contact information below). Under this proposal, water right holders would only be allowed to temporarily change their water right from an historic use to a trout fisheries purpose between July 1 and November 30. In a number of other western states that allow water leasing via temporary change applications for streamflow purposes, the split-season transaction option is fast becoming a favorite with landowners. This approach: provides landowner and water user flexibility; focuses transactions on a time period (late season) when streamflows are generally lowest and positive fisheries benefits are highest; and recognizes historic agricultural concerns regarding negative return flow impacts and lands being taken completely out of production.

ON-RANCH SUCCESS STORIES

COMBINING STREAMFLOW RESTORATION WITH ON-RANCH IMPROVEMENTS

While passing streamflow specific legislation remains a challenge, much has been done to help ease some of the tension between ranchers and the conservation community and accomplish great things on the ground throughout Wyoming.

Resource Trust

Matching Funds

A major vehicle for streamflow restoration is the Wyoming Wildlife Natural Resource Trust (WWNRT). The Wyoming legislature created the WWNRT in 2005 with a goal to eventually cap the trust account at $200 million dollars. Currently, the corpus of the trust account totals $91 million and the legislature generally provides additional funding annually in the $3 million range. The program allocated approximately $2 million to a variety of conservation projects in 2006 and the total has risen to approximately $9 million for project work in 2010. Perhaps most importantly, WWNRT funding provides critical non-federal matching funds for important federal programs designed to restore ecologically significant private land sections of rivers and streams, including the Natural Resource Conservation Service Farm Bill and US Fish and Wildlife Service Fish Passage and Partners programs. WWNRT Status Report (January 2011), available at: http://wwnrt.state.wy.us/pdf/STATUS%20REPORT%202011.pdf.

All the WWNRT programs listed above have been utilized in recent years to informally restore streamflows in partnership with Wyoming ranchers. Such projects have occurred on relatively simple systems, with one or two water right holders, where water use efficiency and agricultural infrastructure modernization measures have been implemented. One such example is Grade Creek, an important native Bonneville cutthroat tributary of the Smith Fork of the Bear River.

The Grade Creek landowner had converted to a center pivot spring irrigation system in the mid-1980s and transitioned to a much less water- intensive irrigation regime. However, because the producer never replaced the inefficient ditch system, he continued to deliver water that exceeded system capacity. The landowner had also cultivated the land and thereby eliminated the historic stream channel. Overflow water was merely routed to disposal areas that would not interrupt ranch operations. As a result, fish were blocked from moving seasonally into Grade Creek from the Smiths Fork.

Stream Restoration

To restore the lower two miles of Grade Creek, WWNRT project partners designed and cut over 4,000 feet of stream channel so that the creek could once again flow through private lands. Once the original stream path was restored and reconnected, construction commenced on a new fish-friendly diversion structure, a piped water delivery system, and additional pressure for the pivot irrigation system. Stakeholders also partnered with adjacent landowners to implement solar-fed stockwater systems and fencing projects to ensure that stock operations weren't interrupted by the change in local surface water availability. The project was operational in 2009 — and there's now reason to hope that large river-migrating Bonneville cutthroat trout will move up to access historic spawning and rearing habitat that had been blocked for much of the previous century.

Conserved Water Disincentive

The Grade Creek Project shows both the opportunities and complexities involved with conserved water projects — and the importance of partnerships in carrying them out. At present it would be difficult to duplicate the approach and the success of the project in many Wyoming watersheds. That's because Wyoming offers no statutory guarantee that the water conserved through such a project would not be taken by an upstream water right holder following project completion. Faced with such regulatory uncertainty, neither landowners nor conservation groups and resource agencies are willing to invest the substantial time and resources needed to ensure project success. Thus, the incentive for such projects is reduced or even eliminated.

Another Bear River Basin project example in Wyoming includes partnership efforts in the Rock Creek drainage near Kemmerer. TU and funding partners including the WWNRT, US Fish & Wildlife Service Fish Passage and Partners programs, the Natural Resource Conservation Service, and WGFD worked with two ranching families to fully reconnect Rock Creek. The old diversions blocked seasonal fish passage and migrating juvenile and adult fish were often sucked into the water delivery system and lost. Phase

I activities on both ranches included: consolidating ditches; constructing new fish-friendly diversion structures; and installing fish screens and a bypass system to eliminate fish entrainment in the irrigation system. Phase II of the project included a gated pipe and closed delivery system intended to give the landowner greater water management control and reduced water use. Gated pipe is used as a more efficient method of flood irrigation. Portable pipe is placed on top of the field and small controllable gates are located in the sides that are opened to allow water to flow into discernible furrows or onto a field. Nearly two miles of gated pipe was installed, which created an entirely "closed" water delivery system potentially ensuring up to 50 percent water savings. The project will result in increased streamflows during critical late summer and winter base flow periods because the ranchers have more control over water use than with traditional flood control methods and the headgates no longer leak during non-water use periods. Further, the ranchers are interested in exploring a late-season (split-season) water leasing transaction with TU to further increase streamflows during late summer and early fall.

Aging Infrastructure

Much of the existing agricultural infrastructure in Wyoming is 50 to 100 years old. Extraordinary opportunity exists to design, fund, and implement projects that meld modernizing such infrastructure with long-term fishery goals and objectives. Perhaps most importantly, such projects build trust and common ground in rural communities. Such partnerships can lead to additional discussions about other topics such as innovative approaches to streamflow restoration.

CONCLUSION

They say time eventually heals all wounds. The jury is still out regarding whether that will be the case for additional streamflow legislation in Wyoming. However, while many stakeholders remain stuck in arguments framed in the mid-1980s, others have moved forward and found that common ground is significant between water right holders and streamflow restoration advocates. Wyoming is at a key juncture. Many agricultural operations and many rivers and streams face unprecedented challenges related to climate issues, shifting run-off patterns, more frequent drought, and fragmented habitat. Wyoming water law can be more responsive to such challenges. But modest change won't, and frankly shouldn't, occur without the core support and backing of ranchers and farmers.

Agricultural Support Needed

Recent streamflow legislative efforts have become much more responsive to agricultural industry input. The political reality is that private landowner fears — legal, social, and economic — must be addressed in order to find long-term streamflow solutions. Strategies need to value landowner rights and choices, embrace collaborative success stories, provide additional revenue generation on-ranch, and foster innovation to protect both ranchlands and fisheries. Because a number of groups and stakeholders have placed a priority on working collaboratively this time around, when streamflow legislation is eventually passed, the celebration won't be pyrrhic. Water users and ground-based conservation groups will be poised to work together and begin restoring streamflows where it makes sense.

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Conjunctive Use

CONJUNCTIVE USE DECISIONS

APPLYING THE PRIOR APPROPRIATION DOCTRINE TO GROUNDWATER USE

by David Moon, Editor

New Dynamic

Throughout the western United States, the Prior Appropriation Doctrine governs the amount of water individuals and entities may put to use. In the past, litigation between water users typically involved a battle amongst the various users from a single stream or river over the use of surface water. Those cases involved issues of priority, beneficial use, and the amount of water actually needed for the uses at issue. Groundwater withdrawal was dealt with separately, if at all. More recently, conjunctive water use regulation — i.e., the regulation of surface water and groundwater in recognition of their hydrologic relationship — has introduced a new dynamic. Many western states are now grappling with enormous controversies that arise between surface water users and groundwater users when there isn't enough water to go around.

The Supreme Courts of Colorado and Idaho have both recently issued decisions that support conjunctive water use regulation grounded in the Prior Appropriation Doctrine. An examination of these two cases illustrates an increasing judicial acceptance of the interaction between surface water use and groundwater use that may provide a template for other states as they wrestle with similar issues.

KOBOBEL CASE BACKGROUND

COLORADO WATER LAW & CONJUNCTIVE USE

Priority System

Colorado water law has, for some time, conjunctively regulated surface water and groundwater based on the priority system of the Prior Appropriation Doctrine. Generally, "priority" means that those with earlier legal claims on water use — the "senior" water right holders —— are entitled to receive the full extent of their water rights even if that means "junior" users' rights are cut off completely in times of water shortage. The often-harsh doctrine provides certainty in times of shortage and results in a system where senior water rights are worth considerably more than junior rights.

"Call" for Regulation

The plaintiffs in the Colorado lawsuit are well owners who own farmland and irrigation wells in Morgan County, Colorado, near the South Platte River. They have obtained decrees confirming dates of water appropriation (i.e. priority dates) between 1945 and 1966. In 2006, water shortages led senior surface water users to "call" for State water regulators to shut down the groundwater users' water use and the State of Colorado issued cease and desist orders prohibiting the well owners from pumping water from their irrigation wells. Under Colorado water law, the well owners would only be allowed to resume pumping groundwater if they provided "augmentation" plans, acceptable to the water court, that would offset the impact of their pumping on surface water supplies. Pumping could resume only after the water court entered a decreed plan for augmentation based on these submitted plans. For more information regarding the South Platte River, see Jones, *TWR* #78.

"Takings" Case

The groundwater users brought an inverse condemnation lawsuit against the State seeking compensation for the "taking" of their water rights. Inverse condemnation occurs when a state action has the effect of substantially depriving the property owner of the use and enjoyment of the property, but the State has not formally brought condemnation proceedings. "The well owners have complied with the cease and desist orders, but contend that the State's action has rendered their farming operations essentially worthless, thus entitling them to compensation for the unconstitutional taking of their vested property rights." *Kobobel v. State,* Case No. 10SA92, Supreme Court of Colorado, (March 28, 2011); *Slip Op*. at 2. The well owners alleged as part of the lawsuit that any efforts to obtain an augmentation or substitute water plan would be futile. *Id*. at 5.

Jurisdiction: Ownership Versus Right to Use Water

Water Court Jurisdiction

The threshold issue for the Colorado Supreme Court (Supreme Court (CO)) was whether jurisdiction for the plaintiffs' action was in district court or "water court" under the State's judicial system.

The Colorado Water Right Determination and Administration Act of 1969 created seven "water divisions" (water administration areas which are based upon the drainage patterns of various Colorado rivers). Water judges are judges for these divisions that have been appointed by the Colorado Supreme Court. Water judges have jurisdiction in the determination of water rights, the use and administration of water, and all other water matters within the jurisdiction of the water divisions.

The well owners contended that the district court was the proper forum for their complaint because their claims for inverse condemnation are not "water matters" within the water court's exclusive jurisdiction. "Water matters" are defined by section 37-92-302(1)(a), C.R.S. (2010) and include: the determination of water rights and conditional water rights; a determination that a conditional water right has been made absolute; changes of water rights; approvals of plans for augmentation; findings of reasonable diligence with respect to a conditional water right; approval of a proposed or existing exchange of water; and approval to use water outside the state.

Conjunctive Use

Ownership of Right

Right to Use Water

Augmentation Plans

Priority & Lack of Regulation

Scope of Groundwater Rights

The Supreme Court (CO) found that "as a rule, '[w]ater courts retain exclusive jurisdiction over all water matters.' In re Tonko, 154 P.3d 397, 404 (Colo. 2007); see also § 37-92-203(1), C.R.S. (2010)" (*Id.* at 9). However, the critical distinction in this case regarding jurisdiction involves ownership of a water right *versus* the right to use of water of the well owners. "In determining whether a claim constitutes a water matter, our cases have drawn a distinction between actions involving the use of water and those involving the ownership of a water right. Humphrey v. Sw. Dev. Co., 734 P.2d 637, 640-41 (Colo. 1987) ('Resolution of what constitutes a water matter turns on the distinction between the legal right to use of water (acquired by appropriation), and the ownership of a water right.') (emphasis in original). We have held that the district courts have jurisdiction over actions to determine the ownership of a water right. Crystal Lakes Water & Sewer Ass'n, 908 P.2d at 540 (stating that 'an action to determine ownership of a water right falls within the general jurisdiction of the district courts of this state')."

The Supreme Court (CO) concisely laid out its decision on this distinction (*Id.* at 11):

> Here, the controversy does not center on who owns the water rights; it is undisputed that the well owners owned several decreed wells with respective dates of appropriation. Rather, the well owners' claims ultimately rest on the scope of their right to use their decreed water rights. Put differently, before the well owners would be entitled to a jury determination of just compensation for the taking of their property, they must first establish that a taking occurred; specifically, that the State's curtailment order infringed on their right to use the water in their decreed wells. We conclude that the nature of the claim and relief sought here requires a court to determine whether the well owners had the right to use water from their wells without State interference. Such a determination is a water matter that falls uniquely within the jurisdiction of the water court.

A footnote pointed out that the well owners themselves stated in their complaint that the alleged "taking" denied them the "*use* of vested property rights" in their wells (emphasis by court; *Id.* at 11).

The Supreme Court (CO) held that "the well owners' claims are water matters within the exclusive jurisdiction of the water court because the claim is predicated upon the well owners' right to use the water in their decreed wells." *Id.* at 2. To understand the ruling, it is important to examine the discussion of the water court's reasoning (*Id.* at 6-7):

> The water court reasoned that, like all other well users in the state, to pump tributary groundwater using their decreed wells, the well owners must obtain plans for augmentation that replace out-of-priority depletions so as to prevent injury to other vested water rights. The court therefore concluded that the State's action of curtailing out-of-priority depletions caused by the pumping of their wells was not an unconstitutional taking of the well owners' property rights. The court observed that the well owners retained their water rights and priority dates and could resume irrigating their farms once they obtained a lawful augmentation plan or substitute water supply plan.

"Takings" Claims by Groundwater Users

The well owners contended that the State's cease and desist orders amounted to a regulatory taking because the orders deprived the well owners of their vested rights to use the water in their wells and thus precluded any economically beneficial use of their land. They sought just compensation for those losses, alleging that the State's orders amounted to an "unconstitutional taking of vested property rights in their wells, water, farmlands, and improvements." *Id.* at 13.

The issue of conjunctive use came into play based on the plaintiffs' assertions. First, they complained that the groundwater appropriations were made before Colorado's 1969 Water Right Determination and Administration Act, section 37-92-101 et seq., C.R.S. (2010), at a time when tributary groundwater in wells was not administered by the State. Second, the plaintiffs argued that years of inaction by the State Engineer of Colorado to conjunctively manage surface water and groundwater should prevent such regulation to be enforced now, alleging that "the State Engineer only recently acted to enforce changes in the regulatory scheme after decades of allowing the well owners to pump out of priority." *Id.* at 14.

The Supreme Court (CO) held that the State's order curtailing the well owners' use of the water in their wells did not constitute a taking in violation of article II, section 15 of the Colorado Constitution or the Fifth and Fourteenth Amendments to the US Constitution. This holding discussed the "nature and scope" of the water rights at issue (*Id.* at 14-15):

- the well owners "fundamentally misapprehend the nature and scope" of the water rights alleged "taken"
- the well owners do not own an unqualified right to use the water in the wells, even though their wells were decreed with dates of appropriation before the 1969 Act
- the right to use the water in the well owners' decreed wells has always been subject to the constitutional Prior Appropriation Doctrine, which prohibits the use of water to the injury of senior water rights
- belated action by the State "merely enforced Colorado's long-standing doctrine in order to address the injurious effects of South Platte alluvial wells pumping out of priority"

Conjunctive Use

Limited Rights

Summing up, the Supreme Court (CO) stated that "the well owners have no constitutionally protected property interest in the unfettered use of the water in their wells; consequently, they cannot show that the State has 'taken' their property by curtailing the out-of-priority use of their wells. The water court therefore correctly dismissed the well owners' takings claims." *Id.* Earlier in the opinion, the Court discussed ownership of water rights versus the right to use water, stating that the plaintiffs' takings argument "misconceives the scope of their water rights. The well owners neither hold title to the water in their wells, nor do they have an unlimited right to use water from their wells. What they possess is a legally vested priority date that entitles them to pump a certain amount of tributary groundwater from their wells for beneficial use. Under Colorado's prior appropriation doctrine, the well owners' vested priority date has always been subject to the rights of senior water rights holders and the amount of water available in the tributary system." *Id.* at 2-3.

"Time-Honored Prior Appropriation Doctrine"

Prior Appropriation Controls

The *Kobobel* case contains an excellent discussion concerning Colorado water law, groundwater pumping, and the history of State regulation to lay the groundwork for the decision (see *Id.* at 15-29). Ultimately, despite recognizing the "devastating impact" of the orders on the wells owners, the Colorado Supreme Court pointed out that if it was to conclude that the State's regulation of groundwater use "amounted to an unconstitutional taking" that "necessarily would require us to rule that the well owners had an unfettered right to use water in derogation of senior water rights holders. Such a ruling would disregard Colorado's time-honored prior appropriation doctrine." *Id.* at 30.

IDAHO: THE *CLEAR SPRINGS* CASE

MATERIAL INJURY TO SENIOR USERS

Conjunctive Management

The Idaho Supreme Court (Court) issued a long-awaited decision in *Clear Springs Foods, Inc., et al. v. Garry Spackman, et al.*, Docket No. 37308-2010 (March 17, 2010), ruling on a water case involving conjunctive management of groundwater and surface water rights. In a unanimous decision, the Court found in favor of the Idaho Water Resources Department's actions and affirmed the lower court's judgment, upholding curtailment orders issued against junior groundwater users "because their withdrawals of water from the aquifer were causing material injury to senior appropriators' surface water rights." *Slip Op*. at 1.

Background

The Snake River begins in western Wyoming, flows west across Idaho through the Snake River plain, and then flows north to form Idaho's boundary with Oregon. The Snake eventually empties into the Columbia River and is the Columbia's largest tributary. The Eastern Snake River Plain Aquifer (Aquifer) lies under the eastern portion of the Snake River plain in Idaho. The Aquifer is approximately 170 miles long and 60 miles wide and has been estimated to contain up to a billion acre-feet of water.

Clear Springs Foods, Inc. (Clear Springs), and Blue Lakes Trout Farm, Inc. (Blue Lakes) — referred to as the "Spring Users" in the Court's opinion — have senior priority surface water rights in certain springs in the Thousand Springs region of the Snake River Plain. Meanwhile, Idaho Ground Water Appropriators, Inc., North Snake Ground Water District, and Magic Valley Ground Water District ("Groundwater Users") pump groundwater from the Eastern Snake River Plain Aquifer groundwater in southern Idaho. For additional background on this conflict, see Budge, *TWR* #64 and Ferreday, *TWR* #40.

Clear Springs and Blue Lakes are both engaged in fish farming and have water rights in springs emanating from the canyon wall in an area known as the Thousand Springs region. Those springs are fed by the Aquifer. Members of the Idaho Ground Water Appropriators, Inc., the North Snake Ground Water District, and the Magic Valley Ground Water District (the Groundwater Users) have groundwater rights entitling them to pump water from wells drilled into the Aquifer.

Hydraulic Connection

The Court noted the existing hydraulic connection. "[T]he ground water in the Aquifer is hydraulically connected to the Snake River and tributary surface waters at various places and in varying degrees. As a result, ground water can become surface water, and surface water can become ground water. The amount that becomes one or the other is largely dependent upon ground water elevations…Beginning in the 1950's, groundwater appropriations from the Aquifer increased dramatically. It now receives about 7.5 million acre-feet of recharge on an average annual basis and discharges about the same amount of water, with nearly 2.0 million acre-feet annually of that discharge in the form of depletions from ground water withdrawals. About 95% of the ground water diverted from the Aquifer is used for irrigation." *Id.* at 2. Additional background on the "Swan Falls Agreement" concerning Idaho Power Company's subordination of its water rights and the related general adjudication of the Snake River Basin was also laid out by the Court. This article will not address that section of the decision (see *Id.* at 8-13).

Conjunctive Rules

Historically, conjunctive management and regulation of surface water and groundwater had not occurred in Idaho. In 1994, the Idaho Water Resources Department (IDWR) adopted rules concerning conjunctive management . IDAPA 37.03.11.000 to 37.03.11.050. To determine the impacts of groundwater pumping on the Aquifer, IDWR also developed a calibrated groundwater model and finished a reformulation of that model in 2004.

Conjunctive Use

The present case essentially began in 2005, when Blue Lakes sent a letter to IDWR demanding that the Director require the local watermaster to administer water rights as required by Idaho Code § 42-607, to supply Blue Lakes its senior water rights. A short time later, Clear Springs made a similar demand. Then-Director Karl Dreher determined that the letters were "delivery calls" — requesting curtailment of groundwater users with junior water rights in order to satisfy the senior Spring Users.

Economic Development Provision and Means of Diversion

Economic Damages

Idaho water law provides that the reasonable exercise of the rights of a prior groundwater appropriator "shall not block full economic development of underground water resources." Idaho Code § 42-226. Based on this statute, the Groundwater Users asserted before IDWR that "any economic benefit to the Spring Users resulting from the curtailment orders would be more than offset by the severe economic damage to others caused by the curtailment of the Groundwater Users' water rights." The same argument was raised in the district court and that court held that this part of the statute "applied to the means of diversion and that the Director did not abuse his discretion by failing to order the Spring Users to change their means of diversion by drilling wells." *Id.* at 14.

Similar to the arguments in Colorado's *Kobobel* case regarding the devastating impacts of conjunctive management on groundwater users, the attempt to introduce an economic balancing test into the priority system was rejected by the Court.

Constitutional Doctrine

The Court first looked to the Idaho Constitution regarding the Prior Appropriation Doctrine with respect to surface waters, citing Section 3: "The right to divert and appropriate the unappropriated waters of any natural stream to beneficial uses, shall never be denied…Priority of appropriation shall give the better right as between those using the water… ." The Court also noted that the Constitution makes no mention of groundwater rights. *Id.* at 14.

Next, the Court discussed *Noh v. Stoner*, 53 Idaho 651, 26 P.2d 1112 (1933), where the Court held in a groundwater case that the Prior Appropriation Doctrine protected the senior user's *means* of diversion (*Id.* at 15):

Means of Diversion

> The prior appropriators had two wells, and the subsequent appropriators drilled a well into the same aquifer, but at a deeper level. When they commenced pumping, it lowered the water level in the aquifer to such an extent that the prior appropriators' wells went dry. We ruled that the prior appropriator's rights included the right to divert water in their historical manner and that they were not required to bear the cost of drilling a deeper well so that a subsequent appropriator could also obtain ground water. If they were required to lower their wells to obtain water, "it would result ultimately in a race for the bottom of the artesian belt." *Id.* at 656, 26 P.2d at 1114.

The Court explained that the statutory provision regarding "full economic development of underground water resources" was intended to "eliminate the harsh doctrine of *Noh*" which had implied that a senior groundwater user had absolute protection to maintain his/her historic pumping level: "…in order for there to be full economic development of underground water resources, a senior appropriator with a shallow well should not be able to block subsequent appropriators of groundwater. To prevent that from occurring, the senior appropriator is protected only 'in the maintenance of reasonable ground water pumping levels as may be established by the state reclamation engineer.' Idaho Code § 42-226." *Id.* at 17.

Reasonable Pumping Level

Thus, the Court held that the statute concerning "full economic development" does not mean that a groundwater user — who produces the greater economic benefit or would suffer the greater economic loss — is entitled to use of his groundwater right (if there is insufficient water). "If that were the basis for allocating water in times of shortage, then water would be allocated among farmers based upon the market prices of their respective crops and their expected yields." *Id.* at 15. The Court explained the limited protection afforded by the "full economic development" statute. "First in time and first in right, full economic development, and reasonable pumping levels are not three separate factors that can determine the allocation of ground water among competing appropriators. Rather, with respect to ground water pumping, the prior appropriation doctrine was modified so that it only protects senior ground water appropriators in the maintenance of reasonable pumping levels in order to obtain full economic development of ground water resources." *Id.* at 16.

Economic Standard Rejected

The Court included additional findings to clarify the law in Idaho on this point. "A delivery call cannot be denied on the ground that curtailment of junior appropriators would result in substantial economic harm." *Id.* at 17. "The reference to reasonable pumping levels only applies to the senior appropriator, not to junior appropriators." *Id.* at 18.

Rate of Groundwater Withdrawal - "Mining" the Aquifer

Aquifer Balance

Based on Idaho Code § 42-237a, the Groundwater Users also asserted that so long as they were not "mining" the Aquifer (i.e., withdrawing groundwater in excess of the average recharge rate) Idaho law would preclude curtailment of their pumping.

The relevant portion of the statute reads as follows:

> Water in a well shall not be deemed available to fill a water right therein if withdrawal therefrom of the amount called for by such right would affect, contrary to the declared policy of this act, the

Conjunctive Use

No Exemption for Groundwater

Rule of Priority

Conjunctive Management Upheld

Injury Determination v. Beneficial Use

Profit Injury Rejected

Futile Curtailment

> present or future use of any prior surface or ground water right or result in the withdrawing of the ground water supply at a rate beyond the reasonably anticipated average rate of future natural recharge.

The Court ruled that the Groundwater Users misread the statute: "The statute merely provides that well water cannot be used to fill a ground water right if doing so would either: (a) cause material injury to any prior surface or ground water right or (b) result in withdrawals from the aquifer exceeding recharge. There is absolutely nothing in the statute that could be interpreted as providing that ground water users are exempt from the doctrine of prior appropriation as long as they are not mining the aquifer." *Id.* at 18-19.

The Groundwater Users also contended that both the Conjunctive Management Rules and Idaho Code § 42-226 require analysis of full economic development. They asserted "that full economic development requires that they be permitted to withdraw as much water from the Aquifer as they need (as long as total annual withdrawals do not exceed annual recharge), even if doing so deprives senior surface water users of water." *Id.* at 19.

Addressing the Prior Appropriation Doctrine, the Groundwater Users maintained that "the directive for full economic development does [not] do away with the right of priority. To the extent necessary to prevent over-drafting of the aquifer, priority of right still determines which water rights get shut off to maintain a stable water table." *Id.* at 20. After examining the Conjunctive Management Rules, the Idaho Constitution, and case law, the Court, however, found that the assertions "would, in essence, preclude conjunctive management of the Aquifer. Conflicts between senior surface water users and junior ground water users would be ignored as long as withdrawals from the Aquifer and recharge were in balance." This position was emphatically rejected by the Court: "As we held in *Musser v. Higginson*, 125 Idaho 392, 871 P.2d 809 (1994), hydrologically connected surface and ground waters must be managed conjunctively." *Id.* at 25. "The policy of securing the maximum use and benefit, and least wasteful use, of the State's water resources applies to both surface and underground waters, and it requires that they be managed conjunctively." *Id.* at 26.

Material Injury to Senior Water Users: Beneficial Purposes

Another issue concerned material injury to the senior users. The Groundwater Users contended that a decreased water supply for the senior user is not sufficient to show material injury and that there must be evidence showing that the Spring Users could produce more fish and profitably sell them with more water.

The Court also rejected this argument. "The right to appropriate water is for 'beneficial uses,' Idaho Const. Art XV, § 3, not merely for profitable businesses…a beneficial use is not limited to a use that generates a profit, or even income." *Id.* at 29-30. The opinion then cited examples of beneficial uses in Idaho, including domestic purposes, fire-fighting, drinking water, and instream water "for the protection of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, transportation and navigation values, and water quality." *Id.* at 30.

The Court succinctly explained why this position would not be adopted (*Id.*):

> "Material injury" is defined by the Conjunctive Management Rules as "[h]indrance to or impact upon *the exercise of a water right* caused by the use of water by another person as determined in accordance with Idaho Law, as set forth in Rule 42." IDAPA 37.03.11.010.14 (emphasis added). The Rule requires impact upon the exercise of a water right. It does not require showing an impact on the profitability of the senior appropriator's business. Such a holding would conflict with Article XV, § 3, of the Idaho Constitution, which states that "[p]riority of appropriation shall give the better right as between those using the water." It would also require the Director or watermaster to examine the businesses of the senior and junior appropriators to determine which one could make the greater profit from the use of the water when there is a shortage. If business profitability was the basis for appropriation, decreed water rights would become meaningless. The issue would be which appropriator at the time could make the greater profit by using the water.

The opinion goes on to basically define the nature of established senior water rights: "The amounts of the Spring Users' water rights had already been decreed based upon the amounts of water that they had diverted and applied to the beneficial use of fish propagation. Subject to the rights of senior appropriators, they are entitled the full amount of water they have been decreed for that use." *Id.*

Futile Calls - Issue Undecided

The Groundwater Users asserted prior to the IDWR hearing that the delivery calls were "futile" since any evidence "will show that there is little to no expectation that the shortages suffered by the spring users in this case will ever be restored." *Id.* at 31. A "futile call" occurs when curtailment of junior water rights would not make water available for delivery and use to the senior water user without unreasonable waste — i.e. the watermaster will not curtail the junior rights in a futile effort to deliver water to the senior user. Generally, a futile call situation involves a surface water situation and is based on factual questions concerning the immediate availability of water from a stream.

The assertion was based on the difficulty of applying the futile call rule when groundwater is involved. The IDWR hearing officer noted the challenges involved — "the effects of curtailment may be years to

Conjunctive Use

Long-Term Impacts v. Immediate Relief

Best Science Available

Agency Discretion

be realized. If the time for the delivery of water to avoid a futile call defense that is applicable in surface to surface water delivery were applied in calls for the curtailment of ground water, most calls would be futile. In effect ground water pumping could continue uncurtailed despite deleterious effects upon surface water use because curtailment would not have the immediate effect traditionally anticipated." The hearing officer's conclusion was that "the fact that curtailment will not produce sufficient water immediately to satisfy the senior rights does not render the calls futile. A reasonable time for the results of curtailment to be fully realized may require years, not days or weeks." *Id*. at 31.

The Groundwater Users argued before IDWR and the district court that the futile call rule should bar curtailment. Upholding the IDWR Director's decision, the district noted that the Conjunctive Management Rules recognized that "relief from curtailment will not be immediate." On appeal to the Idaho Supreme Court, however, the Groundwater Users argued that there is "no substantial evidence in the record that the additional 10 cfs that is expected to accrue to Blue Lakes over time, and the additional 2.67 cfs that is expected to accrue Clear Springs from curtailment over time, will enable either of them to produce more, larger or healthier fish." The Court viewed this argument as being limited to material injury: "The Groundwater Users made this argument in the district court as showing a lack of evidence showing material injury, but there is no indication that they asserted it as showing the delivery calls were futile. This Court will not consider issues raised for the first time on appeal." *Id*. at 32. Although such a decision means that the issue has not been definitely decided by Idaho's Supreme Court, the tenor of the opinion leads one to assume that the Court would have rejected this position as well and found that the futile call rule was not a bar to curtailment.

Groundwater Model

Former-Director Dreher's decision relied upon IDWR's groundwater model in issuing the curtailment orders. The model had a margin of error of up to ten percent due to the error inherent in the stream gauges used to develop the model. Based on that margin of error, Dreher limited the junior water rights curtailed, finding that it represented the best available science.

Before the Court, the Groundwater Users maintained that the district court judgment was flawed. "The curtailment orders should be set aside because the Director failed to account for all known limitations of the [Aquifer] Model, resulting in a broader zone of curtailment than should have occurred." *Id*. at 33. The Court, however, pointed out in its opinion that on appeal the Groundwater Users stated, "[T]he Model is the best science available for administering hydraulically connected surface and groundwater rights on the [Aquifer], but the Model is not perfect."

The Court held that the Groundwater Users "failed to show that the Director abused his discretion in relying upon the model. He perceived the issue of utilizing the model as discretionary, he acted within the outer limits of his discretion and consistently with the legal standards applicable to the available choices, and he reached his decision through an exercise of reason. The district court did not err in upholding the Director's reliance upon the model." *Id*. at 34.

The Court based this ruling on Idaho Code § 67-5279(3)(e), which governs agency discretion. "In determining whether an agency abused its discretion under that statute, we 'must determine whether the agency perceived the issue in question as discretionary, acted within the outer limits of its discretion and consistently with the legal standards applicable to the available choices, and reached its own decision through an exercise of reason.' *Haw v. Idaho State Bd. of Med*., 143 Idaho 51, 54, 137 P.3d 438, 441 (2006)."

CONCLUSION

It has become clear that the issues surrounding conjunctive use must be addressed. Methods for equitable regulation will need to be adopted. The alternative is to ignore increasing conflicts between surface water and groundwater use, with the result being an opportunistic "race to the bottom" where groundwater users drill ever deeper and litigation by senior surface water users to compel regulation becomes commonplace.

States such as Arizona — that continue to treat surface water and groundwater separately — or States that are otherwise reluctant to deal with the hard issues that arise more and more frequently concerning conjunctive use are only putting off a day of reckoning. Colorado and Idaho's Supreme Courts, meanwhile, have supported conjunctive management and are preparing their States to deal with the tough water use challenges of the future.

The two Supreme Court decisions confirmed that the Prior Appropriation Doctrine must apply equally and "conjunctively" to surface water and groundwater. The Colorado Supreme Court concluded that "Colorado's time-honored prior appropriation doctrine" must govern to protect senior water users.

In similar fashion, the Idaho Supreme Court frequently cited the Idaho Constitution, Article XV, Section 3, which states that "[p]riority of appropriation shall give the better right as between those using the water." That court found that conjunctive management of surface water and groundwater requires that the "first in time, first in right" standard of the Prior Appropriation Doctrine also applies to groundwater rights.

For Additional Information: *Kobobel* Decision: www.courts.state.co.us
Clear Springs Decision: www. idwr.idaho.gov/ >> Spring Users Delivery Call

April 15 ID Symposium

One Source: Evolution of the Policies Surrounding Ground & Surface Water Management in the West - Idaho Law Review Symposium, Boise, City Hall - Council Chambers. **For info:** www.uidaho.edu/law/aboutthecollegeoflaw/newsandevents/idaholawreviewsymposium

WATER BRIEFS

HYDROPOWER/ELECTRICITY US
DOI ASSESSMENT REPORT

The US Department of the Interior (DOI) has released the results of an internal study that shows DOI could generate up to one million megawatt hours of electricity annually and create jobs by adding hydropower capacity at 70 of its existing facilities.

The report, *Hydropower Resource Assessment at Existing Reclamation Facilities*, estimates that the additional hydropower capabilities could create enough energy to annually power more than 85,000 households. Based on industry estimates for job potential associated with the kind of hydropower additions identified in this report, approximately 1,200 jobs could be created, including jobs in administration, manufacturing, construction, engineering, operations and maintenance. The report provides information that allows Interior and developers to prioritize investments in a more detailed analysis that focuses on sites demonstrating reasonable potential for being economically, financially and environmentally viable.

The DOI's Bureau of Reclamation (Reclamation) developed the report as part of President Obama's initiative to develop a comprehensive renewable energy portfolio and to meet 80 percent of our energy needs with clean sources by 2035.

The 70 assessed facilities are located in 14 states. Colorado, Utah, Montana, Texas and Arizona have the most hydropower potential. Facilities with additional hydropower potential are also found in California, Idaho, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Washington and Wyoming.

A chart available at www.usbr.gov/power shows a state-by-state breakdown of the 70 sites with the greatest potential to develop additional hydropower and contribute clean energy to the grid.

Hydropower development would be conducted under a "Lease of Power Privilege Agreement" through which a non-federal entity is given a contractual right for up to 40 years to use a Reclamation facility for electric power generation.

Reclamation will be publishing two Federal Register notices in the near future regarding Lease of Power Privilege opportunities at Granby and Pueblo dams in Colorado. These dams were identified in the report as having high potential for hydropower development.

The report is available on Reclamation's website at www.usbr.gov/power.

For info: Joan Moody, DOI, 202/208-6416

CLEAN WATER STRATEGY US
EPA PLAN

EPA has released *Coming Together for Clean Water: EPA's Strategy to Protect America's Waters* (Strategy). The Strategy charts a path for meeting the nation's clean water strategic plan goals over the next several years.

In April 2010 Administrator Jackson brought a broad range of stakeholders together for the Coming Together for Clean Water forum. The discussion at the forum focused on how to reinvigorate the nation's clean water programs to achieve a significant leap forward in clean water protections.

The Strategy presents a framework for how EPA's national water program will address the challenges and highlights EPA's priorities for achieving clean water goals. The Strategy focuses on the following key areas: ensuring transparency and effectively reporting on the status of the health of all waters; increasing protection of source waters and healthy watersheds; restoring degraded waters and ecosystems; reducing the amount of pollution entering our waters that impact our health and our economy; and tackling new and emerging threats to our waters in a way that will ensure healthier, more livable communities.

For info: EPA website, http://blog.epa.gov/waterforum/.

WATERSHED FUNDING WEST
WICK KENNEY GRANTS

The Wick Fund makes grants to protect and restore watersheds in the Western US aimed at keeping western rivers flowing with ample volumes of clean water. The grants can only be made to registered 501(c)3 organizations (not to individuals or political organizations).

The Foundation's grants are awarded to projects that:

- Provide a real opportunity to change western water policy on a local, state or national level
- Defend environmental laws critical for the protection of all western rivers
- Focus on a specific strategy for protection of a biologically important western watershed
- Research and analyze issues that affect western water. Research topics might include: alternatives for managing water demand; mechanisms for transferring water to environmental and recreational use; commentary on federal and state actions that affect water policy.

Grants may be used for arranging meetings. Preference will be given to projects that will be disseminated to reach advocates for the West's rivers.

Groups interested in applying for a discretionary grant may do so by sending an email to jay@kenneybrosfdn.org with Discretionary Grant Inquiry in the subject line.

Inquiry emails are accepted at any time, but grants are typically made only twice a year, in June and December.

For info: Wick Fund website, www.wickfund.org/grants.html

WATER POLICY RFP US
ARMY CORPS PROGRAM

The Institute for Water Resources (IWR) of the US Army Corps has issued a Request for Proposals for applied investigation on five broad water planning and policy topics. According to the RFP, "The purpose of this grant is to stimulate investigation and analysis that develops and effectively communicates reasoned and practical alternatives to select challenges in National water resources policy." It's expected that the funded university research teams will work closely with IWR water planners. As many as four awards up to $200,000 will be made. No matching funds are required. The deadline for applications is August 1.

For info: Montana Water Center website: http://water.montana.edu/

STREAM FLOW & DAMS MT
USGS DAM & FISH STUDY

In a study to identify the potential impacts of Hungry Horse Dam (Montana) operations on declining native trout populations, scientists with the US Geological Survey, Miller Ecological Consultants, Inc., Spatial Sciences & Imaging and Montana Fish Wildlife and Parks examined how changes in river flow affect fish habitat

WATER BRIEFS

on the upper Flathead River in Montana.

Populations of native bull trout and westslope cutthroat trout have declined throughout ranges in western North America due to a many factors, including habitat destruction, fragmentation and non-native species. Dam operations in the Columbia River Basin have contributed to these declines by changing flow and habitat, and disrupting routes of fish migration.

Loss of habitat connectivity and habitat modification can be especially detrimental to native trout populations, the study found. These fish migrate to spawn and feed and prefer large, relatively pristine habitats that are connected without any barriers such as dams. Although the upper Flathead River system in Montana and British Columbia, Canada, is considered a regional and range-wide stronghold for bull trout and westslope cutthroat trout these populations may be threatened by the effects of 55 years of altering flow downstream of the Hungry Horse Dam.

Results of the study further suggest that dam management strategies that are more similar to the natural flow of the river will likely improve the chances of protecting habitat and help to maintain and restore bull trout and westslope cutthroat trout populations. One caveat to this observation is the practice of increasing flow in the late summer to help fish species such as salmon and steelhead, known as "anadromous" because they migrate from salt water to fresh water to breed. According to the study, increasing flow to benefit one species is actually reducing the amount of suitable habitat for another — the bull trout, a species listed as a threatened under the Endangered Species Act.

Results from the study are featured in the April 2011 early online edition of "River Research and Applications" and can be viewed online: http://onlinelibrary.wiley.com/doi/10.1002/rra.1494/abstract
For info: Clint Muhlfeld, USGS, 406/ 888-7926 or cmuhlfeld@usgs.gov

DESALINATION AZ

RECLAMATION COMPLETES PILOT RUN

In collaboration with The Metropolitan Water District of Southern California, Central Arizona Water Conservation District, and Southern Nevada Water Authority, Reclamation's Lower Colorado River Region completed a year-long operation of the Yuma Desalting Plant (YDP) in March. In return for co-funding, the collaborating agencies received water credits in proportion to the water produced during the pilot run and each of their funding contributions.

Last spring Reclamation began operating the YDP to gather cost and performance data needed to consider potential future operation. Reclamation and the sponsoring water agencies will review the results from the pilot run to evaluate the potential for long-term and sustained operation of the desalting plant.

Over the entire pilot run, the plant operated effectively and efficiently with no substantial equipment problems or any accidents. With an acre-foot of water measuring 325,851 gallons of water, the pilot run produced approximately the amount of water used by about 116,000 people in a year.

With the Lower Colorado River Basin in the midst of an 11-year drought, the sponsoring water agencies were pleased with the outcome of the pilot run.

The pilot run was part of an international agreement between the US and Mexico governments as well as environmental groups on both sides of the border. In addition to the pilot run, the pact calls for actions to monitor the Cienega de Santa Clara, a wetland in Mexico maintained by agricultural drainage.
For info: Doug Hendrix, Reclamation, 928/ 750-6562; www.usbr.gov/lc/yuma

CHEMICAL TOXICITY US

FEDS TESTING 10K CHEMICALS

Several federal agencies have unveiled a new high-speed robot screening system that will test 10,000 different chemicals for potential toxicity. The system marks the beginning of a new phase of an ongoing collaboration — referred to as "Tox21" — that is working to protect people's health by improving how chemicals are tested in this country.

The robot system, which is located at the National Institutes of Health Chemical Genomics Center (NCGC), was purchased as part of the Tox21 collaboration established in 2008 between EPA, the National Institute of Environmental Health Sciences National Toxicology Program, and NCGC, with the addition of the US Food and Drug Administration (FDA) in 2010.

Tox21 merges existing resources — research, funding and testing tools — to develop ways to more effectively predict how chemicals will affect human health and the environment.

The 10,000 chemicals the robot system will screen include chemicals found in industrial and consumer products, food additives and drugs. Testing results will provide information useful for evaluating if these chemicals have the potential to disrupt human body processes enough to lead to adverse health effects.

Tox21 has already screened more than 2,500 chemicals for potential toxicity using robots and other innovative chemical screening technologies. The Tox21 chemical screening technologies were used to screen the different types of oil spill dispersants for potential endocrine activity during the BP oil spill in the Gulf of Mexico last year.
For info: EPA Tox21 collaboration website: http://epa.gov/ncct/Tox21/

WETLANDS VIOLATIONS MT

EPA ENFORCEMENT

EPA has reached an agreement with Bar-1 Ranch, LTD, Bar-1 Ranch, LLC, Bar-1 Ranch 2, LLC, Bar One Ranch Management, LLC, and Alfred Barone (collectively settling defendants, or Bar One Ranch) resolving violations of the federal Clean Water Act (CWA) in Missoula County, Montana.

Under a proposed settlement, Bar One Ranch will pay a penalty of $275,000 and will complete the restoration of 13.9 acres (approximately 13 football fields) of wetlands and stream channel adjacent to Ninemile Creek. The settlement was subject to a 30-day public comment period and final court approval.

In October 2003, Bar One Ranch began extensive construction along the southern bank of Ninemile Creek, a perennial stream that flows into the Clark Fork River and a renowned trout fishery. During construction activities, 13.9 acres of wetlands were destroyed and millions of pounds of sediment were discharged in violation of CWA. Additionally, Bar One Ranch violated the terms of a general storm water permit issued by the State of Montana.

The rivers, lakes, streams, and

WATER BRIEFS

wetlands in this area are important as habitat for fish and wildlife, water storage, water quality enhancement, flood control, and aesthetics. Sediment from construction activities is a major water quality issue and can have a negative impact on aquatic life. The State of Montana has designated Ninemile Creek as impaired due to sediments.

Information on stormwater requirements in Montana may be found online at: www.deq.mt.gov/wqinfo/mpdes/stormwaterconstruction.mcpx
For info: Ken Champagne, EPA, 303/312-6608

AQUATIC ECOSYSTEMS US

EPA PROPOSED PROTECTION STANDARDS COMMENT PERIOD OPEN

As required by CWA and pursuant to a settlement agreement, EPA has proposed for public comment standards to protect billions of fish and other aquatic organisms drawn each year into cooling water systems at large power plants and factories. The proposal, based on CWA Section 316(b), would establish a protective framework, putting a premium on public input and flexibility.

Under EPA's proposal, safeguards against impingement of aquatic organisms will be required for all facilities above a minimum size. Closed-cycle cooling systems may also be required on a case by case basis when, based on thorough site-specific analysis by permitting authorities, such requirements are determined to be appropriate. EPA is proposing this regulation as a result of a settlement agreement with Riverkeeper, Inc. and other environmental groups.

Public comment on the proposal is currently being sought by EPA. EPA must take final action by July 27, 2012.
For info: EPA website: http://water.epa.gov/lawsregs/lawsguidance/cwa/316b/

CWA REPORTING US

EPA MEMO

Recently, EPA released CWA Sections 303(d), 305 (b), and 314 integrated reporting memorandum for the 2012 reporting cycle. This memorandum provides clarification on existing policy and regulations, including recommendations and options for States as they develop their 2012 integrated water quality reports. The memorandum focuses on: 1) Timeliness of State Integrated Report submissions and EPA approval; 2) Assessment and Total Maximum Daily Load Tracking and Implementation System data clarifications; 3) Availability of recent EPA guidance on Ocean Acidification; and 4) EPA's intent to work with States to develop future guidance on the interplay between antidegradation and the 303(d) program.
For info: EPA website: http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/ir_memo_2012.cfm.

CWA ENFORCEMENT US

EPA UPDATES DATABASE WEBTOOL

EPA recently released updated data and a mapping tool designed to help the public compare water quality trends over the last two years. The web-based, interactive map includes "state dashboards" that provide detailed information for each state, including information on facilities that are violating the CWA and agency enforcement actions.

The state dashboards incorporate data for both large and small sources of water pollution, along with the latest information from EPA's 2009 Annual Noncompliance Report. The public can examine and compare information on the inspections conducted by both EPA and the state in their region, violations and enforcement actions in their communities over the past two years and the penalties levied in response to violations.
For info: EPA website: www.epa-echo.gov/echo/ancr/us/

CLIMATE & UTILITIES US

EPA VULNERABILITY ASSESSMENTS

EPA has released a final report titled *Climate Change Vulnerability Assessments: Four Case Studies of Water Utility Practices* (Report). The Report was prepared by the National Center for Environmental Assessment's Global Climate Research Staff in the Office of Research and Development.

This Report presents a series of case studies describing the approaches currently being taken by four water utilities in the United States to assess their vulnerability to climate change. The Report's purpose is to illustrate a range of issues and current approaches taken by selected utilities that are proactive in climate adaptation to understand and respond to climate risk.

The approaches taken by the different utilities to assess their vulnerability to climate change range from sophisticated environmental modeling and scenario analysis to qualitative methods based on reviews of available literature. The case studies illustrate different approaches that reflect specific local needs and conditions, existing vulnerabilities, local partnerships, and available information about climate change. Information from these case studies will be of use to water utilities and other members of the water resources community to inform the development of strategies for understanding and responding to climate change.
For info: EPA website: http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=233808

WETLANDS PROTECTION WA

COURT UPHOLDS ECOLOGY EFFORTS

The Washington State Supreme Court has declined to consider a unanimous state appeals court ruling that upheld every aspect of a 2007 Washington State Department of Ecology (Ecology) penalty against Pacific Topsoils Inc. for illegally covering wetlands on Smith Island, near Everett. The high court's decision lets stand the August 2010 decision by the Washington Court of Appeals, Division Two, upholding Ecology's regulation of wetlands under the state Water Pollution Control Act.

Ecology fined the company $88,000 and ordered the firm to remove the 12-acre, 10 to 30 feet deep fill and to restore the land to its original condition. Pacific Topsoils appealed the fine and order to the Pollution Control Hearings Board, and then to the Court of Appeals.

Snohomish County also issued Pacific Topsoils an order — affirmed by a county hearing examiner on appeal — to remove the illegal fill.

Wetland penalty payments go toward a special account that funds grants for environmental restoration projects in Washington.
Case number: Court of Appeals Cause Number 39691-2-II, Supreme Court Cause Number 85415-7
For info: WA Supreme Court petitions for review: www.courts.wa.gov/appellate_trial_courts/supremecourt/?fa=supremecourt.petitions#A1

CALENDAR

Exempt Wells Conference
Problems & Approaches in the Northwest
May 17-18, 2011, Walla Walla, Washington

A conference for professionals engaged in groundwater development, water management, land planning, and water policy to discuss the impacts of exempt domestic wells.

Managed by Washington State University

Phone: 509/ 335-4194 or email: joythompson@wsu.edu
http://conferences.wsu.edu/conferences/exemptwells/default.aspx

April 22 CO
The Art of the Deal: Colorado's Landmark Water Agreements Symposium, Golden. Mount Vernon Country Club. Sponsored by AWRA Colorado. For info: http://awracolorado.havoclite.com

April 23 WEB
Environmental Crimes & Penalties WEBCAST, WEB. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

April 26 FL
TMDLs in Florida Seminar, Tampa. Tampa Convention Ctr. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

April 26-27 AZ
Salinity & Desalination in the Southwest: Challenges & Opportunities - WRRC 2011 Annual Conference, Yuma. Pivot Point Conference Ctr./Hilton Garden Inn. Sponsored by Water Resources Research Institute. For info: Jane Cripps, WRRI, 520/ 621-2526, jcripps@cals.arizona.edu or http://cals.arizona.edu/azwater/programs/conf2011/index.html

April 26-28 WA
8th Washington Hydrogeology Symposium, Tacoma. Hotel Murano. For info: http://depts.washington.edu/uwconf/hydrogeo/index.php

April 26-28 CA
California Rapid Assessment Method (CRAM) Part I Riverine Course, Costa Mesa. 3535 Harbor Blvd., Ste. 110. For info: UC Davis Extension, 800/ 752-0881 or www.extension.ucdavis.edu/landuse

April 26-29 MD
National Mitigation & Ecosystem Banking Conference, Baltimore. Hilton Inner Harbor. For info: JT& A, Inc., 703/ 548-5473, cbahler@comcast.net or www.mitigationbankingconference.com

April 27 CA
Santa Ana River Watershed: Working Together for a Sustainable Future Conference, Riverside. Riverside Convention Ctr. For info: Water Education Foundation, 916/ 444-6240 or www.watereducation.org

April 27 OR
Mechanistic Framework for Projecting Riverine Ecological Responses to Hydroclimatic Change Seminar, Corvallis. OSU, 4-5:30pm. LeRoy Poff, CSU. For info: water.oregonstate.edu or 541/ 737-9918

April 27 WEB
Community-Based Green Infrastructure Webinar, WEB. For info: James MacAdam, Watershed Management Group, 520/ 396-3266 or http://watershedmg.org/green-streets

April 27-29 BC
Living Future Conference, Vancouver. Presented by Cascadia Green Building Council. For info: http://cascadiagbc.org/living-future/11

April 28 OR
Scientific Evidence Issues in Environmental Litigation Luncheon, Portland. Ater Wynne Office, 1331 NW Lovejoy Street, Ste. 900. Sponsored by Environmental & Natural Resources Section (OSB) - RSVP or Call-In Option. For info: Nathan Karman, 503/ 226-8423 or nak@aterwynne.com

April 28 CA
Sustainable Water Resources Management in Site Design & Development Course, Sacramento. Sutter Square Galleria, 2901 K Street. For info: UC Davis Extension, 800/ 752-0881 or www.extension.ucdavis.edu/landuse

April 28-29 CA
Investing in our Water Future: A Focus on California Seminar, Santa Barbara. Bacara Resort. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

May 1-5 MD
2011 NGWA Ground Water Summit & 2011 Ground Water Protection Council Spring Meeting, Baltimore. For info: National Ground Water Ass'n, 800/ 551-7379 or www.ngwa.org

May 2-4 TN
FLOW 2011 - Instream Flow Valuation in Public Decision-Making Conference, Nashville. Sponsored by the Instream Flow Council. For info: www.instreamflowcouncil.org/flow2011

May 2-6 VA
Water Quality Standards Academy - EPA, Arlington. Sheraton Crystal City Hotel. Presented by US EPA. For info: www.glec-online.com/WQSA_sessions/session1/course_info.php

May 4 CA
Mitigation Measure Development & Monitoring Course, Sacramento. Sutter Square Galleria, 2901 K Street. For info: UC Davis Extension, 800/ 752-0881 or www.extension.ucdavis.edu/landuse

May 4 OR
Glacier Change & the Future of Alpine Water Resources, Corvallis. OSU, 4-5:30pm. Andrew Fountain, PSU. For info: water.oregonstate.edu or 541/ 737-9918

May 4 AZ
Water Stewardship at PepsiCo, Tucson. Water Resources Research Ctr., 10:30am-12pm. For info: Jane Cripps, WRRI, 520/ 621-2526, jcripps@cals.arizona.edu or http://cals.arizona.edu/azwater/programs/conf2011/index.html

May 4 WEB
Water Management Webinar: Water Data & Modeling, WEB. 10-11:30am. For info: Montana Water Ctr, http://water.montana.edu

May 4-6 ID
Just Add Water: A Recipe for Life - 2011 American Waterworks Ass'n (Pacific NW) Conference, Boise. Boise Centre. For info: www.pnws-awwa.org/Page.asp?NavID=236

May 5 AK
Water in Alaska: The Changing Environment of Permitting & Enforcement Conference, Anchorage. Hotel Captain Cook. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

May 5-6 OK
Oklahoma Water Law Seminar - 3rd Annual, Tulsa. DoubleTree Hotel. TWR's David Moon is Speaking on "Water Supply, Storage & Tribal Issues (The Sardis Lake Controversy)." For info: CLE International, 800/ 873-7130 or website: www.cle.com

May 5-6 CA
Carbon Credits Seminar, Los Angeles. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

May 5-6 TX
Complex Toxic Tort Litigation Seminar, Houston. Magnolia Hotel Houston. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

May 5-6 MT
GIS Training for Watershed & Wetland Managers, Helena. Montana State Library. Sponsored by Montana DEQ Nonpoint Source Program, Montana Natural Heritage Program & Montana Watershed Coordination Council. For info: landerson3@montana.gov

May 5-6 WA
Remediation of Petroleum & Chlorinated Hydrocarbons with Monitored Natural Attenuation Course, Seattle. Holiday Inn - Seattle Center. For info: Northwest Environmental Training Center, 425/ 270-3274 or www.eosalliance.org

May 8-11 DC
2011 National Environmental Policy Forum, Washington. Westin City Ctr. For info: National Assoc. of Clean Water Agencies, 202/ 833-2672 or www.nacwa.org

May 9-10 MT
The Cost of Water: Who Pays? Who Benefits - Burton K. Wheeler Center Spring Conference, Glasgow. The Cottonwood Inn. For info: www.wheelercenter.org/#conferences_events

May 10-12 MT
"Working Together for a Better Future" - Joint Conference MSAWWA/MWEA/RMC-APWA, Bozeman. Holiday Inn & GranTree Hotels. For info: www.montana-awwa.org/2011-conference

May 10-12 MT
13th Annual Water Summit: Watershed Management in Montana, Pray. Chico Hot Springs. For info: Kathryn Watson, kwatson@montana.edu

May 10-13 CA
ACWA 2011 Spring Conference & Exhibition, Sacramento. Convention Ctr. For info: Assoc. of California Water Agencies, www.acwa.com/events/acwa-2011-spring-conference

May 11 OR
Water Economics & Climate Change: California Experience Seminar, Corvallis. OSU, 4-5:30pm. David Sunding, UC Berkeley. For info: water.oregonstate.edu or 541/ 737-9918

May 12-13 WA
Brownfields & Land Revitalization 2011 Conference: Turning Liabilities into Assets in the Inland NW, Spokane. Spokane Convention Ctr. For info: Linda Moir, 503/ 227-6361, linda@nebc.org or www.nebc.org

May 12-13 UT
Restoration Monitoring: Geomorphic Change Detection Course, Park City. Intermountain Center for River Rehab & Restoration, USU. For info: Gentri Green, 435/ 850-9029, gentri.green@usu.edu or http://cnr.usu.edu/streamrestoration

May 13 WA
Environmental Challenges in Energy Project Development Seminar, Seattle. Washington State Convention Ctr. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

May 16 MT
Water Quality & Water Quantity in Montana Seminar, Helena. Holiday Inn Conference Ctr. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

May 17-18 WA
Exempt Wells Specialty Conference: Problems & Approaches in the NW, Walla Walla. Marcus Whitman Hotel. Sponsored by University Water Resources Research Institutes of NW; TWR's David Moon will be speaking on "Exempt Wells: Old Laws, New Demands." For info: Todd Jarvis, OSU, 541/ 737-4032, todd.jarvis@oregonstate.edu or www.swwrc.wsu.edu/Exempt-Well-Conference

May 18 OR
Water Management, Knowledge & Adaptation: Tensions, Legacies & the Next Big Thing Seminar, Corvallis. OSU, 4-5:30pm. Maria Carmen Lemos. For info: water.oregonstate.edu or 541/ 737-9918

May 18-19 CA
Understanding Riparian Processes Course, Davis. 1632 Da Vinci Ct. For info: UC Davis Extension, 800/ 752-0881 or www.extension.ucdavis.edu/landuse

May 18-19 NV
Indian Water Rights & Water Law Seminar, Las Vegas. South Point. For info: Falmouth Institute, http://falmouthinstitute.com/training/public/may/NR002.html

May 19 WA
Water Right Transfers in Washington Conference, Seattle. Hotel 1000. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

May 19-20 FL
Regulatory Takings Conference, Tampa. Sheraton Riverwalk Hotel. For info: CLE International, 800/ 873-7130 or website: www.cle.com

May 19-20 CA
Planning & Environmental Law Course, Sacramento. Sutter Square Galleria, 2901 K Street. For info: UC Davis Extension, 800/ 752-0881 or www.extension.ucdavis.edu/landuse

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CALENDAR

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May 20 **OR**
Agricultural Law Section Annual "Round-Up," Salem. Capitol. RE: Water Quality & Flow Issues. For info: Oregon State Bar Section, www.osbar.org

May 20 **OR**
Fisheries & Hatcheries Legal & Regulatory Frameworks Seminar, Portland. Oregon Convention Ctr. Live Webcast Also. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

May 22-26 **CA**
2011 World Environmental & Water Resources Congress, Palm Springs. Convention Ctr. Sponsored by American Society of Civil Engineers. For info: http://content.asce.org/conferences/ewri2011/index.html

May 23-25 **CA**
6th Int'l Conference on Sustainable Water Resources Management, Riverside. Mission Inn Hotel. For info: www.wessex.ac.uk/11-conferences/waterresourcesmanagement-2011.html

May 24-25 **OR**
2011 Oregon Water Conference: "Evaluating & Managing Water Resources in a Climate of Uncertainty," Corvallis. OSU. Sponsored by Oregon Section American Water Resources Ass'n. For info: Michael Campana, aquadoc@oregonstate.edu

May 24-25 **CA**
Integrated Regional Water Management Conference, Sacramento. Radisson Hotel. For info: Water Education Foundation, 916/ 444-6240 or www.watereducation.org

May 25 **CA**
Overview of Water Law & Policy in California Course, Sacramento. Sutter Square Galleria, 2901 K Street. For info: UC Davis Extension, 800/ 752-0881 or www.extension.ucdavis.edu/landuse

May 25 **OR**
Superensemble of Regional Climate Model Futures Seminar, Corvallis. OSU, 4-5:30pm. Philip Mote, Oregon Climate Change Research Institute. For info: water.oregonstate.edu or 541/ 737-9918

May 25 **WEB**
Water Management Webinar: Montana Water Law, WEB. 10-11:30am. For info: Montana Water Ctr, http://water.montana.edu

May 25-27 **CA**
6th Int'l Conference on River Basin Management: Hydrology, Ecology, Environmental Management, Flood Plains & Wetlands, Riverside. Mission Inn Hotel. For info: www.wessex.ac.uk/11-conferences/riverbasinmanagement-2011.html

May 25-27 **WA**
Natural Resources Law Teachers Institute, Stevenson. Sponsored by Rocky Mt. Mineral Law Foundation. For info: Mark Holland, RMMLF, 303/ 321-8100 x106, mholland@rmmlf.org or www.rmmlf.org

June 1 **OR**
"How to Solve It" - Tribute to Jim Dooge, Pioneer in Water Systems Analysis Seminar, Corvallis. OSU, 4-5:30pm. Philip O'Kane, University College Cork. For info: water.oregonstate.edu or 541/ 737-9918

June 1-2 **CA**
Successful CEQA Compliance Seminar, Sacramento. Sutter Square Galleria, 2901 K Street. For info: UC Davis Extension, 800/ 752-0881 or www.extension.ucdavis.edu/landuse