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GROUNDWATER AVAILABILITY MODELING

THE TEXAS EXPERIENCE

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INTRODUCTION

In 1997, the Texas Legislature a initiated new comprehensive water use planning process for the State. Recognizing the key role coordinated, reliable, water availability modeling would have in establishing a workable planning process, the Legislature initiated a statewide Groundwater Availability Modeling process in 1999.

This article provides background information, describes fundamental aspects of the Texas groundwater modeling program and also provides some insight into the successes and challenges that the State, stakeholders, and the model developers have encountered since the program's inception.

BACKGROUND

Texas has significant groundwater and surface water resources. Combined groundwater and surface water use in 2003 was estimated to be 15.9 million acre-feet (AF). Of that, approximately 59% was from groundwater. Supplying this groundwater are numerous aquifers capable of providing groundwater in quantities sufficient to support household, industrial, municipal and irrigation needs. As is the case in the United States as a whole, irrigation is the greatest use of Texas groundwater, comprising approximately 79% of groundwater use in 2003.

The State agency responsible for studying Texas aquifers is the Texas Water Development Board (TWDB) whose mission is to provide leadership, planning, financial assistance, information, and education for the conservation and responsible development of water for Texas. TWDB currently recognizes nine major aquifers and 21 minor aquifers. In 2003, groundwater use in Texas was greater than 9 million AF (see Figure 1, page 2) with the vast majority of pumping occurring in the Ogallala Aquifer (6.3 million AF).

Texas groundwater resources have been essential to economic development within the State. However, Texans have seen disruptions in their water supply as a result of extended droughts. For example in the 1950s, 244 of Texas' 254 counties were declared disaster areas. As a result of the 1950s drought-of-record, the Texas Legislature established the TWDB in recognition of a need to plan for the future needs of water resources within the State. From the 1950s through 1997 the State water resources planning process was a "top down" approach where the TWDB developed water resources strategies and pushed them out to the affected regions. This approach changed fundamentally in 1997 with the passing of Senate Bill 1.

Texas Groundwater

Water Planning

Model Drawbacks

Planning Tools

In 1997, the Legislature established a new water planning process, based on a "bottom-up," consensus-driven approach. Coordinating this water planning process are 16 Regional Water Planning Groups (RWPGs) which are geographically contiguous and are primarily consistent with river basins and political boundaries. The planning groups are comprised of members representing a variety of interests, including agriculture, industry, environment, the public, municipalities, business, water districts, river authorities, water utilities, counties, and power generation. Each planning group evaluates population projections, water demand projections, and existing water supplies during drought. Based on this information, the planning group identifies who will not have enough water, recommends strategies and projects that could be implemented to conserve or obtain more water, and estimates the costs and environmental impacts of these strategies and projects. Once the planning group adopts the regional water plan, the plan is sent to TWDB for approval and integration into the State water plan.

Because of the importance of groundwater use in Texas, there have been several models developed for its aquifers. However, as of 1997, many aquifers did not have groundwater management models developed for them. Also, many of the available models were developed for problems local in scale or conceptual in nature with little concern for groundwater management objectives. Most of the available models were poorly documented or unavailable in electronic form.

The Legislature recognized the importance of models, particularly once Senate Bill 1 water planning came into existence. It was soon recognized that the RWPGs — the building blocks of Senate Bill 1 water planning — needed tools to better plan for the management of their water resources. With the advent of groundwater management plans and the increase in groundwater marketing, groundwater conservation districts also found themselves in need of better tools to help understand and manage their resources. In response, the Texas Legislature mandated that TWDB obtain or develop groundwater models for all the major aquifers within the State and thus initiated the Texas Groundwater Availability Modeling (GAM) Program.

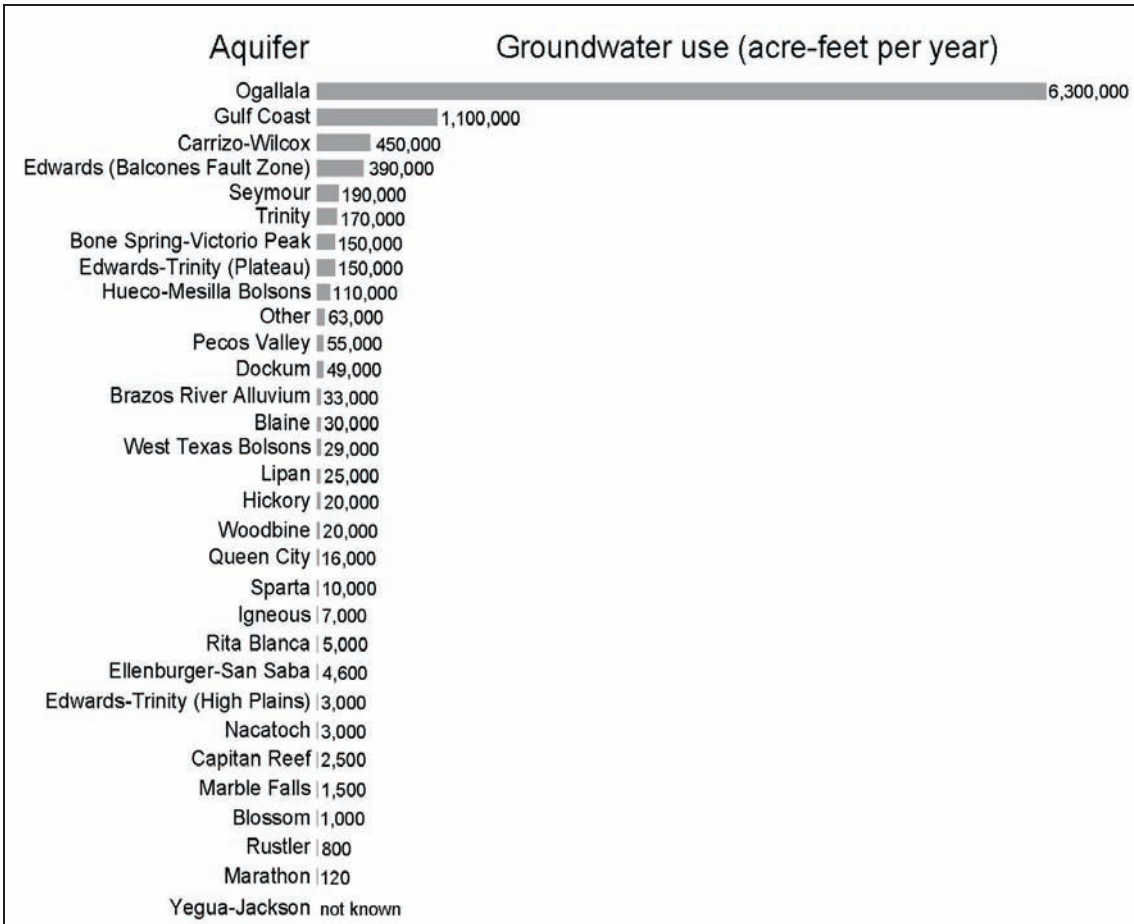

Figure 1. Reported groundwater use for Texas aquifers in 2003

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GROUNDWATER AVAILABILITY MODELING PROGRAM

Texas Groundwater

Current & Future Supplies

Legislation

The Texas Legislature recognized the importance of groundwater models, particularly once Senate Bill 1 water planning came into existence. The new planning paradigm formalized water planning to include an analysis of current and future groundwater supplies and resources. Key to the planning process is the development and application of GAMs.

In 1999 with the approval of Senate Bill 2, the 77th Legislature directed that Section 16.012 of the Water Code be amended to require that the executive administrator of the TWDB "...obtain or develop groundwater availability models for major and minor aquifers in coordination with groundwater conservation districts and regional water planning groups." The Legislature also required that the models of the major aquifers be completed not later than October 1, 2004.

GAM Purposes

Program Objectives

The purpose of TWDB's GAM program is to develop state-of-the-art numerical groundwater flow models for each of the major and minor aquifers in the State of Texas. The purpose of the GAMs themselves is to provide reliable and timely information on groundwater availability to the citizens of Texas to ensure adequate supplies or recognize inadequate supplies over a 50-year planning period. Since the inception of the GAM program, the uses of GAMs in Texas water resources planning and conservation has steadily become of greater importance through practice and legislation. Because GAMs are being built as State-sanctioned tools, standards for their development are a necessity.

State Standards

TWDB has developed and implemented the GAM program to include: (1) substantial stakeholder involvement; (2) standardized, thoroughly documented, and publicly available numerical groundwater flow models and supporting data; and (3) predictions of groundwater availability based on current projections of groundwater demands during drought-of-record conditions. Some of the more important requirements for development along with the development philosophy will be discussed below.

Development Conflicts

Requirements for GAM Development and Documentation

In meeting their goal of developing groundwater models for all major and minor aquifers, TWDB will have developed, either internally or through subcontract, over 30 GAMs. To ensure that the GAMs can meet the needs of the State and also adhere to a set of minimum best practice standards, TWDB has developed some very prescriptive standards for the development and documentation of GAMs. A natural conflict arises between the need for defined GAM standards and the specific realities of the groundwater system being modeled. This subject will be further explored later in the article when we discuss challenges. In practice, the many requirements and specifications defined for GAMs are commonly referred to as the "GAM Standard." Important aspects of the current GAM Standard are discussed below.

Public Information

Public Availability

TWDB requires that information entered into the GAM or used to support the GAM conceptualization and implementation include only publicly available information or information that would be made public at project completion. GAMs are developed to be public tools to support water resources planning. As such, they must not be constrained by proprietary data or codes.

Format

Software Requirements

The code required to be used as the groundwater flow simulator is MODFLOW-2000, which is publicly available. TWDB requires that the consultant deliver the model in the native ASCII format and also in a format consistent with Groundwater Vistas. TWDB accepts the use of the standard packages for recharge, drain flow, ET, and stream routing available for use with MODFLOW-2000.

Organization

Supporting Data

Because GAM development efforts collect and integrate large volumes of hydrogeologic data important to managing groundwater resources, it is important that the data is fully documented and is organized in a standard fashion. This increases the usability of the supporting data by stakeholders such as Groundwater Conservation Districts (GCDs), RWPGs and other professionals in the field. Data required to support the modeling is to be organized in ESRI ArcGIS, Microsoft Access and Excel for geodatabases, databases, or spreadsheets, respectively. More information regarding the geodatabase documentation and organization will be discussed later in this paper.

Protocol

Model Development Protocol

The GAMs are prescribed to be developed using the standard groundwater modeling protocol: (1) conceptual model development; (2) model implementation; (3) model calibration; (4) model sensitivity analysis; and (5) reporting. It is assumed in the GAM modeling approach that the physical processes and the model purpose can be satisfactorily simulated by MODFLOW-2000, thus precluding the need for code selection. Model predictions of future states are currently not the responsibility of the model developer.

Texas Groundwater

The importance of the conceptual model and how that is implemented into the groundwater model is critical to any model's success as a management tool. Specifically, the processes important to defining the groundwater flow balance, at the scale of interest, must be properly defined and implemented in the GAM. Mistakes made at this step are generally unrecoverable without significant revision to the model. TWDB's program recognizes the importance of this step and generally allows for a two-year period of performance for GAM development, leaving adequate time for conceptual model development and review. TWDB requires that the conceptual model be completely documented with all supporting data prior to approval to model implementation.

Model Scale

Perhaps one of the most important model implementation issues is model scale, as this generally defines the success at modeling recharge-discharge mechanisms. TWDB does not generally put limitations on model discretization except for setting minimum requirements ("discretization" means model grid and layering). For instance, the horizontal grid spacing cannot be greater than one mile. Model layering is generally determined by the modeling team and therefore significant variability in vertical model scale can occur among GAMs.

Calibration Period

Model Calibration and Sensitivity Analysis

GAMs are required to be calibrated for both steady-state (predevelopment) and transient conditions (1980-1997), the time period of the latter defined by the availability of State-derived estimates of groundwater use. TWDB chose the minimum transient calibration period (1980-1997) based upon supporting data that they thought was most reliable across this period. The problem is, most significant aquifers saw pumping increase from the 1950s to a peak in the 1980s, which has resulted in modeling errors when the analyst did not simulate the drawdown associated with 1950-1980.

Validation

Although a predevelopment steady-state model is inherently uncertain, it provides an essential step in defining and quantifying potential sources of capture. Secondly, calibration to both steady-state and transient conditions provides further calibration constraint and reduces non-uniqueness. TWDB wants modelers to use several performance measures and calibration metrics in the characterization of calibration. In some aquifer models, age dating information has been used with particle tracking to provide additional validation to the calibration. In some aquifers, groundwater isotope studies have provided groundwater dating information. This information has been used to provide additional validation to the calibration by comparing model-predicted groundwater residence times determined through simple calculation of advective travel times to the groundwater age estimates. Performance measures include heads (including time series), spring and stream discharge measurements, and conceptual flow balances. The mean absolute error between measured hydraulic head and simulated hydraulic head shall be less than 10 percent of the measured hydraulic head drop across the model area. Global water balance errors are desired to be less than 0.1% and not more than 1%. The analyst is expected to perform a sensitivity analysis with the calibrated model. This is typically done through standard perturbation of one parameter at a time. ["Hydraulic head" is a specific measurement of water pressure or total energy per unit weight above a datum (usually seal level). Hydraulic head is usually measured as a water surface elevation and expressed in units of length.]

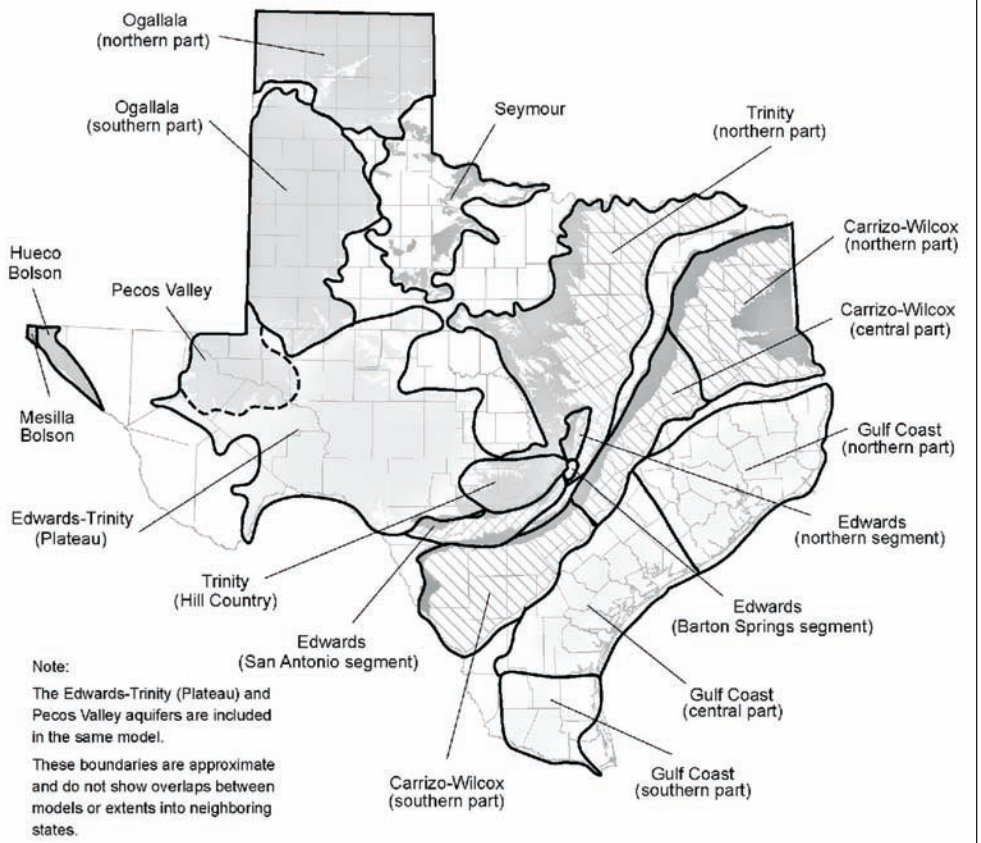

Figure 2. Approximate extent of groundwater availability models for the major aquifers of Texas

Texas Groundwater

Stakeholders

Updating Cycle

GAM Documentation Standards

There are specific documentation standards, down to a defined table of contents, which are required of GAM developers. This ensures complete documentation and also provides a template so that certain types of information such as recharge or pumping volumes can be retrieved easily from any GAM report. Reports and selected models (if they are small enough) are available on TWDB's GAM website. Reports, models, and data are available from TWDB for a nominal processing fee.

Central Tenants of the GAM Development Philosophy

Two tenants of the GAM development philosophy that are somewhat unique are: (1) the amount of stakeholder involvement solicited in the GAM development process; and (2) the fact that GAMs are considered living tools which require periodic updating.

Stakeholder Involvement

Extensive stakeholder involvement is not routinely part of a typical model development process. However, solicitation of stakeholder involvement is a keystone to the GAM development process, from the project initiation through final reporting. Typical stakeholder groups include: GCDs; RWPGs; consultants; river authorities; environmental groups; State agencies; water suppliers; and other interested citizens. By including public involvement in the modeling process, the groundwater availability modeling program can address or incorporate many of the local constituents' ideas, data, and concerns about the aquifer. For example, GCDs routinely provide additional information on geology, water levels, and springs to assist in modeling and have provided operating assumptions for predictive scenarios.

GAMs as Living Tools

All developers of models recognize that models are simplifications of the actual processes and systems being modeled and, as such, approximate reality and can be improved with additional data and understanding. The modeling protocol found in many textbooks and guidance documents recommends model revision as new information or conceptual understanding comes available. TWDB recognized this often overlooked component of modeling and they expect to update GAMs when data, technology, or conceptual understanding provides justification. In general, TWDB expects to update GAMs on an approximate five-year cycle. Like any software tool, the more a model is used the more information is gained for improvements or even fixing errors. TWDB keeps a Frequently Asked Questions sheet on each GAM, documenting any errors or glitches that have been reported to TWDB.

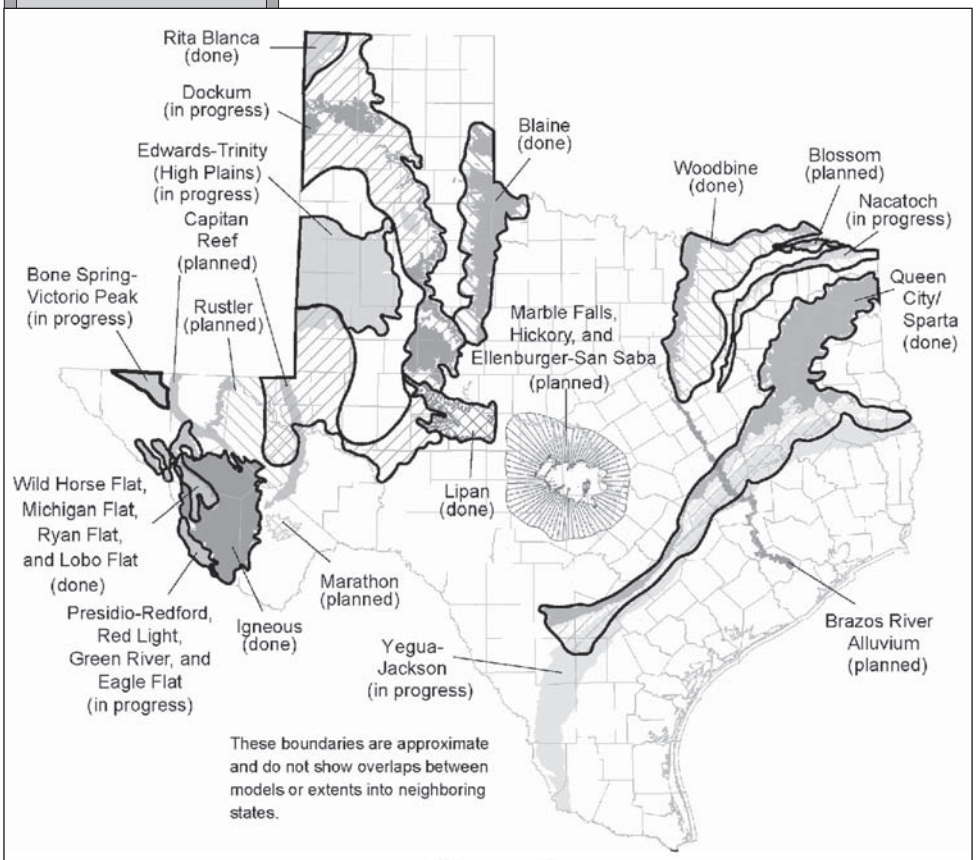

Figure 3.
Approximate extent of completed, ongoing, and planned groundwater availability models for the minor aquifers of Texas

GAM Program Progress

Over thirty models will be needed for the thirty major and minor aquifers in Texas. Some of the larger or more complex aquifers require more than one model, while some models incorporate a combination of aquifers. As required by law, TWDB developed or obtained the initial versions of seventeen groundwater availability models for the State's nine major aquifers before October 1, 2004 (Figure 2). These nine aquifers currently supply approximately 95 percent of the groundwater produced in the State.

TWDB is currently in the process of developing or subcontracting the development of GAMs for the remaining minor aquifers. To date, seven of the minor aquifers and parts of another minor aquifer are represented with GAMs. To complete the minor aquifers will require the development of 12 additional GAMs. Figure 3 shows the progress made in development of GAMs for the minor aquifers.

Texas Groundwater

GW Management Methods

GAM Required

Plan Parameters

"Desired Future Conditions"

Availability

Source Data

Intermediate Data

HOW GAMS ARE USED

TEXAS WATER RESOURCE MANAGEMENT & PLANNING

There are primarily three legislatively-defined water resource conservation and planning entities which are required by State law to use the GAM: GCDs, Groundwater Management Areas (GMAs), and RWPGs.

The preferred method of managing groundwater in Texas is the GCD. A GCD is a district created under Texas Constitution, Article III, Section 52 or Article XVI, Section 59, which provides the authority to regulate the spacing of water wells, the production from water wells, or both. Many GCDs boundaries are consistent with political boundaries such as county boundaries, and as such, are not consistent with hydrologic boundaries that would need to be considered in the management of an aquifer. Recognizing this fact, in 2005 the Legislature required joint planning among GCDs within a Groundwater Management Area (GMA). GMAs are defined as an area suitable for the management of groundwater resources. In 2001, the Legislature mandated that TWDB develop GMAs that cover all the major and minor aquifers in the State. The presiding officers of the GCDs within a GMA constitute the members of the GMA and they are required to meet annually to integrate groundwater planning and management. The 16 RWPGs are the regional water resource planning entities and they must plan consistently with the GMA and therefore GCDs. The following section will briefly describe how these three entities are required to use the GAM in management and planning activities.

GCDs and RWPGs are required to use GAMs. GCDs are required by statute to use GAM information when it is available in developing their groundwater management plans. More specifically, GAMs and the data used to develop the models are useful tools for evaluating some of the parameters currently required in groundwater management plans.

Evaluated groundwater management plan parameters include:

- the annual amount of recharge from precipitation, if any, to the groundwater resources within the district
- the annual volume of water that discharges to springs and any surface water bodies, including lakes, streams, and rivers
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district

GCDs are also required to consider information from GAMs when developing "desired future conditions" for their aquifers as part of joint planning in GMAs. The "desired future condition" of an aquifer is the quantified condition of groundwater resources at a specified time or times in the future or in perpetuity as identified by GCDs in a GMA. TWDB will use GAMs, where available and appropriate, to calculate or verify managed available groundwater based on the desired future condition of aquifers as identified by the GCDs. GCDs are then required to include the managed available groundwater value in their groundwater management plan and to use that value for permitting. Although GCDs are required to consider GAM information, the choice of how to manage an aquifer still lies with GCDs, as defined in the desired future condition.

Currently, RWPGs are required to use GAMs when assessing groundwater availability in their planning regions. As the joint planning in GMAs culminates in desired future conditions and managed available groundwater, RWPGs will use managed available groundwater values for groundwater availability.

ADDITIONAL GAM PRODUCTS

As noted previously, the Texas GAM Program has evolved a comprehensive set of standards for model development and documentation. A key part of the standards is the organization and documentation of source, intermediate, and model data. Although the actual groundwater model is the main tool for water planning, the source and intermediate data are also considered key components of the GAM, since their inclusion is essential for transparency and future model enhancements. Source data in this context are the basic measurements or studies used as the basis for development of various components of the GAM. For example, the well logs used to define the tops and bottoms of the hydrogeologic layers would be considered source data. Hydraulic head measurements used for model calibration would also be considered source data.

In addition to the basic source data, modeling teams are required to supply key intermediate data as part of the final model documentation. Intermediate data are those products resulting from analysis of source data by the modeling team that have not been scaled to the model grid. For example, the location of pumping or monitoring wells may be known to a greater resolution than that of the current model grid. Intermediate data should be included at its full resolution, instead of at the coarser model grid resolution, so that future model development (perhaps a refined grid) will not suffer from downscaling issues.

Texas Groundwater

Geodatabase

When the GAM program began, source and intermediate data were organized in a standard directory structure. Data files were required to be paired with metadata files ("metadata" is often described as "data about data"), so that each data file had some explanation as to its nature and history. Because much of the source and intermediate data are geographically referenced (georeferenced), the directory structure for organizing the source and intermediate data has evolved to a standardized geodatabase, accessed through ESRI ArcCatalog, with embedded metadata. This currently provides a consistent organization and structure for source and intermediate data among the many GAMs in the State.

Data Types

Typical data types available as part of a GAM include:

Boundaries: political and administrative boundaries, such as county lines, cities and towns, groundwater conservation districts, etc.

Climate: weather station locations and historical data for precipitation, temperature, and potential evapotranspiration; coverages of average precipitation and temperature over various time periods

Conservation: land use and land cover, vegetation types, ecological regions and other natural features

Geology: outcrop boundaries, well log locations and interpreted structure and lithology; interpolated surfaces, such as formation tops, bottoms and thicknesses

Geomorphology: physiography and topography, including digital elevation maps at 30-meter resolution or better

Geophysics: locations of geophysical well logs and related tables of log-derived data

Recharge: interpreted recharge estimates, both areal and focused

Soil: soil information, typically from SSURGO or STATSGO datasets

Subsurface Hydrology: monitoring well locations and associated head measurements, pumping test locations and results, interpreted subsurface physical properties

Surface Hydrology: locations of streams, springs, reservoirs and wetlands, and associated time-series information for baseflow and discharge estimates

Transportation: roads, rail lines, and other routing information

The existence of publicly available, well-organized, georeferenced source and intermediate data associated with all of the significant aquifers in Texas has the potential to provide great utility to any entity affected by water resources planning and management, from the local landowner to the professional hydrogeologist.

Supporting Studies

In addition to the data developed within the specific GAM studies, TWDB has funded numerous studies to support the GAM Program which are also a benefit to others in the state in the profession. These include studies on evapotranspiration, recharge, surface-groundwater interaction and aquifer structure and sequence stratigraphy.

SUCCESSES & CHALLENGES

In the nine years that the Texas GAM program has existed, the majority of planned goals have been met and additional, perhaps unforeseen, positive results have occurred. As one might expect from such an ambitious effort, many challenges have also been identified that continue to be relevant today. This section serves primarily as a "lessons learned" for the GAM program, but begins by highlighting some of the successes of the program.

Successes

Model Consistency

The most obvious success of the Texas GAM program is that every major aquifer in the State has an associated publicly available groundwater model, developed under a consistent set of standards acceptable in the field of hydrogeologic modeling. Similarly, seven of the minor aquifers in the State have completed GAMs, six GAMs are in progress for minor aquifers and will be completed in the next couple of years, and the remaining six minor aquifers have associated GAMs in the planning stages. This makes a total of 24 completed GAMs with six more in progress and six in the planning stages. These models are a testament to an unprecedented effort in enhancing statewide water planning through consistent, defensible, groundwater model development. With the development of all of these models, gigabytes of hydrogeologic source data have been organized and documented for the hydrogeologic community.

Model Improvements

Advancement of the Science of Regional Modeling

The process of working on the GAMs has raised the bar for creating groundwater models in Texas. Each successive round of GAMs has provided an opportunity to apply the lessons learned in the previous round, creating an environment where modeling teams must consistently improve their techniques to keep up with not only evolving GAM standards but also with other teams competing for the work. The GAMs have been developed by a diverse community comprised of TWDB employees, consultants, the United States Geological Survey (USGS), and the Texas Bureau of Economic Geology.

Texas Groundwater

Aquifer Knowledge

Program Effects

Historic Drawdowns

Sources of Discharge

(Successes continued)

Advancement of the Science on the Aquifers

In developing conceptual models for the GAMs, the modeling projects have often resulted in a far better understanding of the aquifers themselves. A number of the overall modeling projects have included detailed studies of stratigraphy and structure, recharge, surface water-groundwater interaction, and flow paths (through geochemical studies). Conceptual model development has also resulted in the development of source datasets that have been useful for other hydrogeologic purposes.

Stakeholder Communication and an Increase in the "Groundwater IQ"

Throughout the history of the GAM program, a significant effort has been made to involve local stakeholders in the model development process. These efforts have had varying degrees of success, as many aquifers have large, well-organized groups of stakeholders that fill each meeting room, while with other aquifers, public meetings are more sparsely attended. The overall effect of the program, however, has been to raise both stakeholder awareness of the importance of groundwater management and stakeholder "IQ" with respect to fundamental hydrogeology and groundwater modeling. The requirement that GAMs be used by GCDs and other entities for assessing groundwater availability has motivated stakeholders to involve and educate themselves to a degree that far exceeds that of just a few years ago. This process of education works in both directions. Through the stakeholder communication process, the scientists and engineers that develop the models are often exposed to useful local knowledge and information. Including this local information in the model development process can make the difference in producing a model that both meets technical requirements and is acceptable to the stakeholders. The priority that the GAM program puts on stakeholder communication encourages the kind of interaction that results in better informed modelers as well as stakeholders that are more likely to be comfortable with the final product.

Challenges

The challenges identified in the course of developing GAM models can be broadly separated into technical challenges and challenges in stakeholder communication. The technical challenges arise from the typical sources, such as data availability, scaling issues (issues of scale), and conceptualization uncertainties. Challenges in communication can potentially arise from ignorance of the modeler about local issues and lack of education by the stakeholders in hydrogeologic and water management concepts.

Pumping Quantification and Allocation

One of the most difficult challenges that arises from data availability is the accurate assignment of pumping to the model. In many regions of Texas, significant groundwater pumping occurred long before any attempt was made to characterize pumping quantities. The best estimates of pumping are for the time period from about 1980 to present. Determining how much pumping occurred in earlier decades requires researching old reports, discussions with stakeholders, and often some educated guesswork. Early pumping can have a significant impact on model calibration, because in some regions the significant drawdowns all occurred before 1980, so water levels in the past few decades are predominantly rising. Once total pumping has been estimated, spatial assignment of the pumping can also pose challenges, due to lack of knowledge about particular wells in the region. This is especially true for irrigation pumping, with its combination of location data paucity and potentially high per-well pumping rates. Uncertainty in pumping may create an irreducible level of model error which translates to suboptimal levels of calibration. A formal error analysis determining the implications of pumping uncertainty has not been performed to date using a Texas GAM.

Conceptual Model Development with a Focus on Sources of Capture

Groundwater management models must reasonably define and quantify the potential sources of pumping capture, which essentially equate to the mechanisms and quantities of aquifer discharge. Therefore, a GAM conceptual framework must define the sources of discharge both in terms of process and quantity as best it can. Then the model must be implemented such that it can simulate these processes. The accuracy of a groundwater management model to estimate sustainable groundwater development is directly tied to getting these sources of capture defined accurately within the model. Part of properly defining discharge is developing a steady-state model where recharge is balanced by discharge. This is challenging in regional models and has been performed with varying degrees of success in the GAM program.

Texas Groundwater

Regional v. Local Scale

Issues of Model Scale in Relation to the Scale of the Water Balance of Interest

Scaling issues often pose a technical challenge in regional groundwater models. Many of the Texas GAMs have one mile square grid resolution, which is perfectly appropriate for modeling regional trends in groundwater levels and groundwater flow rates, but may not be adequate for more local assessments of these variables. For example, in some cases measured heads from wells in the same or adjoining grid cells can be markedly different, indicating that stresses are occurring at a scale that is impossible to emulate with a regional groundwater model. Another example is simulation of surface water and groundwater interaction and other shallow recharge/discharge components. Coarse grid resolutions have the effect of limiting the amount of recharge that can occur in a model, since the model cannot simulate recharge/discharge at a scale smaller than the grid. This issue presents an important challenge as county-scale GCDs attempt to apply super-regional GAMs to their scale of interest (sub-county scale) in defining desired future conditions.

Measurement Issues

Quantification of Recharge and Evapotranspiration

Shallow recharge and discharge can pose additional challenges other than just issues of scale. Areal and focused recharge rates are difficult to measure directly, and thus often must be estimated indirectly. Areal recharge occurs area-wide. It is also termed diffuse recharge and is recharge which occurs fairly uniformly through infiltration to the water table. Focused recharge occurs at specific locations such as sinkholes or arroyos in an arid setting. Often, there are few estimates of baseflow and spring discharge rates and they typically have a significant degree of uncertainty. Few direct measurements of groundwater evapotranspiration have even been attempted, with no such measurements in Texas. Therefore, constraining recharge as an input and calibrating to discharge as a target sometimes takes on the quality of an art, rather than a science.

Stakeholder Balance

Communicating Advanced Modeling Concepts

In discussing the successes of the GAM program, stakeholder communication was rightly mentioned as a significant bright spot. However, challenges in stakeholder communication have also been identified, with several areas that could be improved. First, although many stakeholders have advanced considerably in their understanding of hydrogeologic modeling concepts, many still lack some basic knowledge, and may be suspicious of groundwater models and the program in general. Even with the basic knowledge in hand, many have difficulty understanding some of the subtleties, such as the scale at which the models are applicable, and the expectation for the relative accuracy of model predictions, based on the calibration. There is a delicate balance between educating the stakeholder on the limitations of model applicability without creating the impression that the simulated results are of little "real-world" value.

THE PATH FORWARD

In considering the path forward for the GAM program, two main concepts emerge. First, the technical challenges identified in the program must be addressed as they arise, resulting in continually improving models. Second, new ideas must always be considered for adding additional value to the program.

Living Tools

An important concept of the GAM program is that the models are "living tools," and updates will occur as needed to address technical challenges, with increasing grid refinement, improved calibration through additional data analysis or new techniques, and even reconsideration of conceptual models as necessary. Addressing many of the current technical challenges may require additional associated studies, with well-designed field testing or focused analysis of existing data. Developing better information on surface water and groundwater interaction falls into this category, as well as the quantification of groundwater evapotranspiration. Estimates of the location and magnitude of pumping, especially irrigation pumping, must continue to be improved. The involvement of GCDs and other local entities has proven crucial to understanding irrigation pumping. As GCDs acquire more information about current groundwater irrigation practices, this may be useful in analyzing past practices, to help fill in the gaps in historical knowledge. The focus on stakeholder communication must continue, so that the GCDs are closely involved with local data collection and how this can translate to model improvements.

Information Needs

New Ideas

Some new ideas that may be explored as part of the GAM program include a comprehensive geodatabase for groundwater information and improved visualization tools for stakeholder communication. The comprehensive geodatabase would leverage the current georeferenced data found in the various GAMs to create a statewide geodatabase that could be queried by location. This would allow stakeholders to easily access all available data appropriate for their given locality. Improved visualization tools could help both modelers and stakeholders understand the hydrogeology of their aquifers and to explore the impacts of various management scenarios on future water availability.

Texas Groundwater

CONCLUSION

The Texas GAM Program has proven to be very successful in providing tools for regional water planning. Furthermore, the program has successfully improved the "groundwater IQ" within the water resources management community statewide. The program has also helped to tell us what we do not know or understand regarding our aquifer systems. The program is a work in progress which will likely take a second iteration on most models to get them as good as they can be given the available data and understanding. It is anticipated that local-scale models will require development based upon the existing GAMs to address some of the local-scale issues which have and will continue to arise across the State.

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Copper WQ Limits

CWA COPPER LIMITS TO PROTECT SALMON

NPDES PERMIT DEVELOPMENTS FOR PUGET SOUND, WASHINGTON

by John Palmer, Senior Endangered Species Act & Clean Water Act Policy Advisor, US Environmental Protection Agency, Region 10 (Seattle, WA)

Overview

Stormwater Control

Increased attention on the need to control stormwater runoff to help recover salmon and cleanup Puget Sound in Washington State has led to recent efforts to establish more stringent copper limits in area National Pollutant Discharge Elimination System (NPDES) permits being issued under both federal and state authorities implementing the federal Clean Water Act (CWA).

This article provides a summary of the controversial efforts to establish copper limits or benchmarks in Washington Department of Ecology (Ecology) NPDES general permits for industrial stormwater and boatyards. Additionally, the potential influence that the federal Endangered Species Act (ESA) requirements may have on copper limits in the US Environmental Protection Agency's (EPA's) forthcoming new NPDES permit for the Puget Sound Navel Shipyard is discussed.

Background

Copper Prevalence

Ecology has identified stormwater runoff as the largest contributor of toxic pollutants to the Puget Sound (Hart Crowser Inc., 2007). The National Marine Fisheries Service (NMFS or NOAA Fisheries) has identified stormwater control as an important element to salmon recovery, particularly in urban and urbanizing streams (NMFS, 2006). Copper is prevalent in stormwater runoff from urban areas (including roads and industrial, commercial and residential areas) and from discharges from certain industrial activities such as boatyards and shipyards. Copper readily dissolves in receiving water (70-90% dissolved fraction) and is toxic to aquatic organisms.

Total copper concentrations from urban runoff is often in the 20-35 microgram per liter (ug/l) range, but can exceed 100 ug/l from some industrial sites. Poorly controlled runoff from boatyards, which remove and reapply copper-based paints to boats, can exceed 1000 ug/l of total copper. The State of Washington's acute water quality criterion for dissolved copper is 4.6 ug/l (at 25 mg/l hardness) for freshwater and is 4.8 ug/l for marine water. These criteria were established to prevent toxic effects to aquatic organisms. Recent research by the NOAA Science Center has demonstrated how low copper concentrations can mask juvenile salmon's sensory system and impair their ability to avoid predators. Based on this research, NOAA Fisheries has recommended dissolved copper be limited to less than 0.59 – 2.1 ug/l above background levels (typically less that 1 ug/l) to prevent this affect (Hecht et al. 2007).

While Mr. Palmer serves as a senior policy advisor for EPA Region 10, the views expressed in this article are Mr. Palmer's and not necessarily the positions of EPA or the United States.

Copper WQ Limits

Benchmarks

Litigation

Industrial Stormwater Permit

Second Draft

Benchmarks v. Effluent Limits

Settlement Requirements

Feasibility Study

Washington State Industrial Stormwater General Permit

In 2002, Ecology issued the current industrial stormwater general permit that covers over 1,100 facilities in Washington. This permit contains a copper benchmark of 63.6 ug/l. A benchmark is a level (total copper) that Ecology believes is unlikely to cause a water quality criteria violation, and if exceeded, triggers corrective actions. A benchmark, unlike an effluent limit however, is not directly enforceable and subject to penalties if exceeded. The 2002 permit was appealed to the Washington State Pollution Control Hearings Board (PCHB) where it determined, in part, that the copper benchmark was too high and ordered Ecology to lower it in waters where stormwater is identified as a limiting factor for salmon recovery and in waters listed as impaired for copper by the State under Section 303(d) of the CWA (*Puget Sound Keeper Alliance et al. v Ecology,* PCHB 02-162, 02-163, 02-164 (August 3, 2003)). The PCHB's decision was appealed, but the appeals were dropped due to passage of legislation (Engrossed Substitute Senate Bill (ESSB) 6415) that, in part, included a requirement that by May 1, 2009, Ecology modify the permit to include effluent limits for facilities that discharge into waters on the 303(d) list for copper. Although Ecology did modify the 2002 permit in 2004, it did not modify the 63.6 ug/l copper benchmark, so it remains the current benchmark.

More recently, in February 2007, Ecology proposed to re-issue the industrial stormwater permit with a new more stringent copper benchmark. The February 2007 draft permit proposed a water-quality based copper benchmark of 11.9 ug/l. This value was based on the acute copper criterion adjusted to 35 mg/l hardness (Washington average) with the assumption that 75% of the total copper would be dissolved. Part of Ecology's rationale for proposing this benchmark was that in 2006, EPA proposed a similar copper benchmark for its multi-sector general permit that covers industrial stormwater sources not covered by state NPDES permits.

In November 2007, after receiving extensive comments from the regulated community that the 11.9 ug/l copper benchmark was unfeasible, Ecology developed a second draft of the industrial stormwater permit with a copper benchmark of 20 ug/l. Ecology based this proposed benchmark on the median of current monitoring data (2005 – 2007) from the permitees. Thus, based on recent data, 50% of the facilities could meet this benchmark and 50% would exceed the benchmark requiring corrective action. In addition, Ecology proposed a copper benchmark (but not an effluent limit) of 7.0 ug/l for facilities that discharge into waters on the 303(d) list for copper.

As of this writing, Ecology has stated it is not ready to re-issue the final industrial stormwater permit and continues to work with stakeholders on the issues surrounding the permit, including the copper benchmarks and effluent limits. In the meantime, industrial stormwater continues to be regulated by the 63.6 ug/l copper benchmark in the 2002 permit. However, the ESSB 6415 requirement — that by May 1, 2009 the industrial permit contain effluent limits for facilities that discharge into impaired waters — is a driver for Ecology to finalize the new permit.

Washington State Boatyard General Permit

In 2005, Ecology issued its boatyard general permit that covers over 100 facilities. This permit included the following copper benchmarks: 16 ug/l for new discharges into 303(d) listed copper impaired waters; 77 ug/l for discharges into lakes; 384 ug/l for discharges into rivers, and 229 ug/l for discharges into marine waters. Under appeal, the PCHB determined that Ecology's use of benchmarks was a legal approach in lieu of establishing effluent limits, but ordered Ecology to revise and lower the copper benchmarks (*Puget Sound Keeper Alliance and Northwest Marine Trade Association. v Ecology,* PCHB 05-150, 05-151, 06-034, & 06-040 (January 26, 2007)). With respect to the copper benchmarks, the PCHB determined: that Ecology cannot use a dilution factor (i.e., standard mixing zone); that the translator value of 30% (i.e., the portion of the total copper that would dissolve in the waterbody) was too low; and that the effects of boatyard discharges on salmonids species be considered.

The PCHB decision was appealed, but the parties reached a settlement agreement in 2007 that, in part, called for immediate clarification of the copper benchmarks for discharges into Seattle's Lake Union and Ship Canal where many boatyards are located, and for conducting a technical feasibility pilot study prior to modifying copper benchmarks. In December 2007, Ecology modified the 2005 boatyard permit to clarify that the copper benchmark for *new* sources discharging into Lake Union and the Ship Canal is 16 ug/l and the benchmark for *existing* sources into these waterbodies is 38 ug/l. The copper benchmarks for discharges into rivers and marine waters were unchanged.

In 2008, the boatyard treatment feasibility study was completed (Taylor Assoc., 2008). The study showed that two of the three treatment technologies piloted could reduce total copper to below 20 ug/l for nearly 100% of the samples and to below 10 ug/l approximately 70 percent of the time (ARCADIS, 2008). A follow-up cost analysis study calculated that the capitol cost for the two technologies for a two-acre

Copper WQ Limits

Costs Analysis

Federal NPDES Permit

Mixing Zone Issues

ESA Consultation

Challenging Compliance

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boatyard were $91,000 (StormwaterRx Aquip) and $148,000 (Water Tectonics Wave Ionics) with annual O&M costs of $14,000 and $9,000, respectively. Additionally, the study concluded a two-acre boatyard would need to spend up to $262,000 to install an on-site collection system.

As of this writing, Ecology is in the process of factoring in the results of the treatment feasibility study and, in accordance with the settlement agreement, will modify or re-issue the boatyard permit with new copper benchmarks.

EPA's Puget Sound Navel Shipyard Permit

The Puget Sound Navel Shipyard (PSNP) in Bremerton, Washington, maintains and repairs ships, so like boatyards has the potential to discharge significant amounts of copper. EPA is in the process of re-issuing the NPDES permit for this facility since Ecology does not have the authority to issue NPDES permits to federal facilities. For pollutants where there is a reasonable potential to exceed water quality criteria, effluent limits must be established in the permit, which for copper is likely to be the case at PSNS.

Since PSNS discharges into marine waters, the acute water quality criterion for copper is 4.8 ug/l. A key issue in establishing an effluent limit is the size of the mixing zone that is authorized by Ecology through its CWA Section 401 certification of the permit that it meets water quality standards. If Ecology does not authorize a mixing zone, the effluent limit would be 5.8 ug/l total copper (assuming a dissolved to total copper ratio of 0.83) and would apply at the point of discharge ("end of pipe"). The effluent limit would be higher if Ecology authorizes a mixing zone.

The federal Endangered Species Act (ESA) may also factor into the copper effluent limit for this permit. Because EPA's issuance of the permit is a federal action, it triggers ESA's Section 7(a)(2) requirements, including compliance with terms and conditions that may be issued by NOAA Fisheries and the US Fish and Wildlife Service in their Biological Opinions. As a point of reference, NOAA Fisheries has recently issued terms and conditions for copper limits for federal highway projects in the Puget Sound region. For example, for the proposed construction of State Route 167 near Tacoma, Washington, NOAA Fisheries issued a term and condition that dissolved copper does not exceed 2.3 ug/l (above background level not to exceed 3 ug/l) 1.5 feet away from the Washington State's Department of Transportation stormwater outfall into the Puyallup River.

Summary

Reducing copper discharges into Puget Sound waterways is viewed as an important step to help recover salmon species and clean up Puget Sound. This article provides a brief summary of recent and ongoing efforts to establish copper limitations or benchmarks in three NPDES permits in the Puget Sound region. From the discussion above for each permit, it appears total copper limits or benchmarks for these permits could end up in the 5 – 20 ug/l range. Based on current discharge levels, copper limits or benchmarks in this range will be a challenge for many facilities to meet and will likely involve a significant investment in source control and/or treatment technology.

Additionally, as these three NPDES permits get finalized, they may inform the setting of copper limits or benchmarks in future NPDES permits. For example, Ecology's municipal stormwater general permits, which cover stormwater discharges for most of the urban area in the Puget Sound region, currently do not have pollutant benchmark or limits for copper or other pollutants. Ecology's most recent municipal stormwater general permits focus on best management practice implementation and monitoring. However, as monitoring information is obtained, it is likely that future versions of the municipal permits will contain benchmarks or limits for pollutants, such as copper.

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Water Rights

WATER RIGHTS OWNERSHIP DECISION

TRUST RELATIONSHIP BETWEEN IRRIGATION DISTRICT AND WATER USERS

by David C. Moon, Editor

OVERVIEW

Clarifying Ownership Interests

The Oregon Supreme Court (Court) on July 10, 2008, issued a decision that clarifies the ownership interests of water rights as between irrigation districts and the landowners who use the water. In *Fort Vannoy Irrigation District, et al. v. Water Resources Comm'n. et al.* (Oregon Supreme Court Case No. S055356), the Court upheld a prior Court of Appeals decision by holding that "the district is the 'holder of [a] water use subject to transfer' with respect to [water right] certificates 8942 and 8943, and that Ken-Wal is not authorized…to change the points of diversion associated with the water rights established in those certificates without the district's consent."

Trust Property

The Court decided that neither the irrigation district nor the appurtenant landowner is the sole owner of the water rights involved in the case — instead, the water rights are trust property. The two parties are locked in a trust relationship with one another: the irrigation district holds legal title to the water rights as trustee, while the appurtenant landowner/district patron (who uses the water) is the beneficiary of the trust. The Court reversed a decision by the Oregon Water Resources Commission and remanded the case back to the Commission for further proceedings.

Perplexity Addressed

Although the decision is naturally limited to the specific facts involved in the case and the ability to change or transfer water rights, the decision also substantially addresses recurring questions concerning the ownership of water rights in Oregon that have perplexed Oregon water practitioners for years.

BACKGROUND

Case Particulars

The case arose from a dispute over an application filed by Ken-Wal Farms, Inc. (Ken-Wal) with the Oregon Water Resources Department (OWRD) to change the points of diversion associated with water rights set forth in two water right certificates (8942 and 8943) that were issued in 1930 to the Fort Vannoy Irrigation District (District), of which Ken-Wal is a member. The issue on review was whether Ken-Wal is the "holder of any water use subject to transfer" as that phrase is used in Oregon Revised Statutes (ORS) 540.510(1). If so, Ken-Wal would have authority to change the points of diversion associated with the water rights, without obtaining the permission of the irrigation district. The District and one of its members protested Ken-Wal's application and the District refused to give its consent to the changes sought.

OWRD Actions

OWRD initially rejected the District's challenge and issued a proposed order that approved Ken-Wal's application. The proposed order concluded that the District's consent was *not* required to change the disputed points of diversion: "As water rights are, in the West, essentially defeasible usufructuary rights attached to specifically identified land rather than personal rights which may be exercised at any location and only by the individual whose name is on the certificate evidencing that right, it is logical to conclude that the 'holder' of the right referred to in [ORS 540.510(1)] is the owner of the land to which the right is appurtenant."

Appurtenant Land

Historic Contentions

The question of who owns and/or controls water rights that are served by an irrigation district has been a hot topic within the agricultural community and, at times before the state legislature, for several years. Irrigation districts generally asserted that they must control the ability to manage and change water rights in order to fulfill their role as trustees for *all* their patrons, as opposed to individual landowner desires. If individual patrons were allowed to do as they please, the rest of the district might suffer due to the changes made. Some landowners (within districts) who use the water, on the other hand, have steadfastly maintained that water rights, as an appurtenance to their land is an individual property interest and thus the district should not be allowed to control what can be done with that property interest.

THE OREGON SUPREME COURT DECISION

Legal Positions

In its opinion, the Court first laid out the positions of the landowner and the Oregon Water Resources Commission (OWRD's citizen oversight body). "Ken-Wal and the commission contend that the 'holder of [a] water use subject to transfer' is the party that puts the water provided under certificates 8942 and 8943 to beneficial use on the land to which the water rights are appurtenant. That is, they assert that, despite the fact that the certificates were issued to the District, Ken-Wal holds the ownership interest in the water rights established in those certificates -- and thus is the 'holder' for purposes of ORS 540.510(1) -- because (1) Ken-Wal alone beneficially uses the water provided under the certificates; and (2) Ken-Wal owns the land

Water Rights

on which that certificated water is used (*i.e.*, a portion of the appurtenant land). According to Ken-Wal and the commission, the District cannot be considered the 'holder of [a] water use subject to transfer,' because it neither beneficially uses the water provided under the certificates nor owns any of the appurtenant land." The Court then noted, "In contrast, the district founds its claim to the ownership interests in the water rights established in certificates 8942 and 8943 on (1) the fact that the certificates were issued to it; and (2) the implications of the trust relationship that exists between it and its members like Ken-Wal."

Pivotal Question

The pivotal question, as the Court noted, was which party is the "holder" or owner of the certificated water rights at issue — the irrigation district that was issued the water rights certificates by the state of Oregon or the landowner who used the water provided by the district on his "appurtenant" land? "Appurtenant" land is the place of use for a water right and, in this case, was designated on the water right certificates as the place of use for irrigation. Water rights are restricted to use on the appurtenant land and cannot be used on other lands without obtaining approval to change the place of use from OWRD.

Appurtenance Issues

Ownership Aspects

To answer the "pivotal question" the Court examined the "four grounds on which the parties rely in their competing claims to ownership: (1) the issuance of the water right certificates; (2) the trust relationship that exists between the district and Ken-Wal; (3) the beneficial use of the water provided under the certificates; and (4) the ownership of the appurtenant land."

Holder Conclusion

The first conclusion cited by the Court was that "the party that holds an ownership interest in a certificated water right -- *i.e.*, the 'holder' -- is the party that undertook the procedures in ORS chapter 537 that culminated in the issuance of the certificate." In other words, OWRD's issuance of a water right certificate is the act that "vests the ownership interest" of a water right when a "certificated water right" is involved. The party to which the certificate is issued is — by virtue of the water right certificate — deemed to be the holder or owner of the water right, at least when that party actively participated in the process required by the state. "In sum, the fact that the district engaged in the statutory procedures that are the exclusive means for acquiring certificated water rights -- which is unambiguously reflected in the certificates and the preceding documents -- supports the conclusion that the district is the 'holder' of the water rights…" The exclusive statutory procedures noted by the Court refers to the requirements under Oregon's Water Use Act, first enacted in 1909, that are necessary to obtain a water right in Oregon since that time.

Beneficial Use

The Court recognized that "Ken-Wal's beneficial use of the water provided under those certificates -- as well as the permits that preceded those certificates -- is an essential act in the creation and maintenance of the water rights." However, under the trust relationship that was established between the district and Ken-Wal, beneficial use by Ken-Wal — even as the "sole beneficial user of the water" — is not sufficient to create an ownership interest for the landowner. "Beneficial use of the permitted water was insufficient alone to bring the water rights into existence under ORS chapter 537" — the other requirements of Oregon's Water Use Act noted above were undertaken by the district to obtain the water right certificates. The Court later in the opinion stated that "relevant to both the acquisition and the subsequent maintenance of the certificated water rights, Ken-Wal's beneficial use of the water can be considered part of an agency relationship between it and the district."

Trust Relationship

Ultimately, it is that trust relationship that controls and governs both parties' rights and responsibilities. "The fact that certificates 8942 and 8943 were issued to the district subjects the ownership interest in each certificated water right to the parties' trust relationship. As noted above, that relationship is established in ORS 545.253, which provides that water rights acquired by an irrigation district pursuant to ORS 545.239 are trust property…"

Bifurcated Ownership

The Court's opinion succinctly explained the trust relationship that exists between irrigation districts and their landowner/patrons. "The existence of the trust relationship bifurcates the ownership interest in each certificated water right. *See Allen v. Hendrick*, 104 Or 202, 223-24, 206 P 733 (1922) ('A trust implies two estates;-- one legal, and the other equitable; it also implies that the legal title is held by one person, the trustee, while another person, the *cestui que trust*, has the beneficial interest * * *.'). The district holds legal title to the water right as trustee, and the members hold equitable title as the beneficiaries. Acting in a fiduciary capacity, the district's duties as trustee include management of the water right and the water that it provides, and the members enjoy the use of that water as their beneficial interest."

Appurtenant Land

The opinion also contains a section that discusses in further detail Ken-Wal's assertion that ownership of the water rights is governed strictly by ownership of the appurtenant land. The Court recognized the accepted adage that "certificated water rights are appurtenant to the land on which the certificated water is applied to beneficial use. *See* ORS 540.510(1) ('[A]ll water used in this state for any purpose shall remain appurtenant to the premises upon which it is used * * *.')." Nevertheless, the Court rejected Ken-Wal's interpretation based on the trust relationship and the "statutory context" of Oregon's Water Use Act (Chapter 537).

Water Rights

Ownership

Appurtenancy Exception

Unequivocal Ruling

Land Ownership Influences

Impacts Determination

Contractual Provisions

The Court cited *Wilber v. Wheeler*, 273 Or 855, 861-62, 543 P2d 1052 (1975) for the proposition that "the longstanding rule in Oregon is that the ownership of an appropriative right (*e.g.*, a certificated water right) may reside with a party that does *not* own the appurtenant land. Put differently, a party's ownership of the appurtenant land does not necessarily entail its ownership of the associated certificated water right. In at least some situations, the ownership of a certificated water right will reside with one party while the ownership of the appurtenant land resides with another." (Court emphasis). The Court concluded that this circumstance is relevant in this case: "Although Ken-Wal enjoys the use of the water provided under certificates 8942 and 8943 by virtue of its ownership of a portion of the appurtenant land, that ownership does not dictate that Ken-Wal also owns the certificated water rights. Rather, for the reasons described above, the statutory context compels the conclusion that the district acquired the legal ownership interest in the certificated water rights when undertaking the ORS chapter 537 procedures, and Ken-Wal enjoys the use of the certificated water on its lands as a beneficiary in the parties' trust relationship."

COURT'S CONCLUSION

The Court held that the district is the "holder" of the two certificated water rights and that the "requisite ownership interest in those rights vested in the district as trustee upon issuance of the certificates." The Court unequivocally held that "Ken-Wal's ownership of a portion of the appurtenant land does not equate with ownership of the certificated water rights" laying that widely-held belief to rest. Finally, in reaching the underlying issue of the authority to change points of diversion of the water rights, the Court concluded that "Ken-Wal is not the 'holder' of the water rights established in certificates 8942 and 8943" and thus, "Ken-Wal is not authorized under ORS 540.510(1) to change the associated points of diversion without the district's consent."

UNRESOLVED ISSUES

The Court's decision lays to rest most water rights' ownership issues concerning irrigation districts and the landowners/users who are their patrons. As in all such court decisions, however, issues that were not litigated between the parties due to the specific facts of the case could crop up at some point in the future.

For example, it remains unclear how this decision would be different if the landowner/water user owned *all* the appurtenant land covered by the water right certificate. A landowner could argue that since they owned and controlled all the land under the water right certificate, as opposed to a portion of the appurtenant land, the outcome should be in their favor. The position of a district in such a case would focus on the impact of removing the appurtenant land on the *overall* delivery system of the district. If there were no distinct negative impacts to the district's other patrons, perhaps the appurtenant landowner would be treated differently. At the very least, a landowner in this type of factual situation would have more power as a "beneficiary" of the trust relationship to be able to insist on the ability to change points of diversion. As noted in footnote 4 of the opinion, at oral argument before the Court, "the parties agreed that Ken-Wal's land constitutes only a portion of the land to which the district supplies the water provided under the certificates -- *i.e.*, that Ken-Wal owns only a portion of the appurtenant land designated in the certificates."

Another issue that was not covered by this decision involves the impact of any regulations or contractual provisions between the parties. In footnote 12 of the opinion, the Court pointed out that they "are mindful that some irrigation districts restrict their members' authority to change a point of diversion through regulations or contractual provisions -- *e.g.*, districts formed pursuant to the federal Carey Act, 43 USC § 641 (1894). Our holding in this case regarding Ken-Wal's authority to change the disputed points of diversion -- which, as noted, rests on our interpretation of the phrase 'holder of any water use subject to transfer' in ORS 540.510(1) -- does not concern such restrictions."

There will undoubtedly still be battles between irrigation district management and individual landowners who are the end users of water rights, despite the clarity that the *Fort Vannoy* case brings. In the future in Oregon, though, it is more likely that such battles will be fought within the constraints of legal principles relating to trust relationships or contract law as opposed to issues over ownership of the water rights per se.

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Aquifer Recharge

Technical Challenges

Regulatory Impediments

Aquifer Depletion

AQUIFER RECHARGE AND STORAGE

ONGOING IMPLEMENTATION CONCERNS

by Peter G. Scott, Gough Shanahan Johnson & Waterman (Helena, MT)

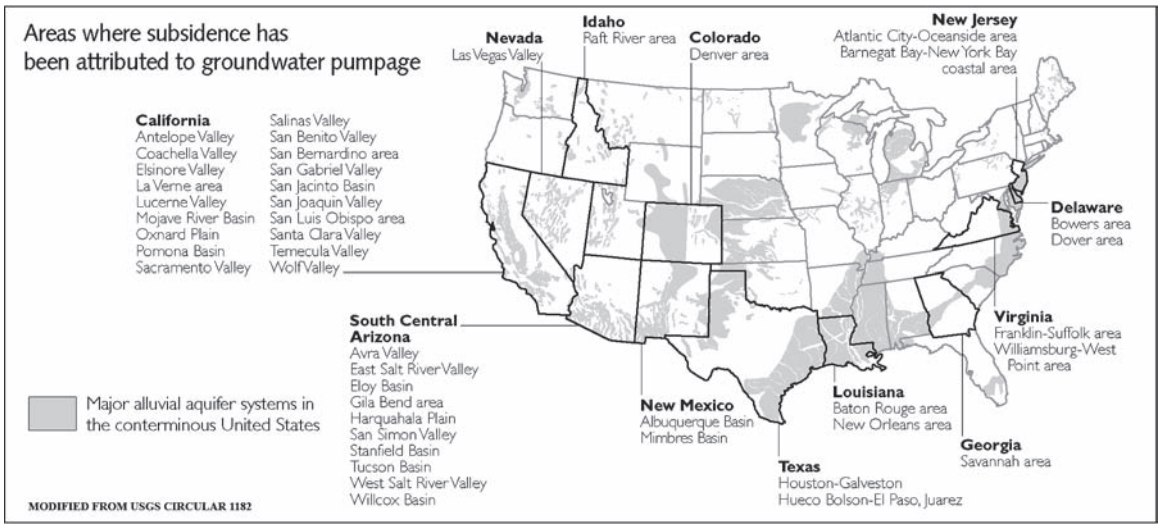
INTRODUCTION

Diminishing groundwater supplies is a problem of the first importance for resource managers in many locations around the globe. Already, the problem is recognized as a priority in the arid western United States where groundwater is relied upon heavily. However, the scope and importance of the problem is not appreciated fully by the public, presumably because it has not yet matured into a general and immediate crisis and, perhaps, because groundwater is not visible—out of sight, out of mind.

The idea of recharging aquifers has been around for many years. However, as those directly involved in the development of groundwater recharge and storage projects have learned, they often present difficult technical and regulatory challenges. Common technical challenges may include adequate reliable storage capacity, suitable locations for infiltration or injection, clogging, water quality issues such as oxidation, and difficulty monitoring and accounting for the storage and recovery of recharged water. See e.g., Brown, Hatfield and Newman, *Lessons Learned from a Review of 50 ASR Project from the United States, England, Australia, India and Africa*, US Army Corps of Engineers (2005). While technical issues can be significant, and sometimes controlling, experience has demonstrated that under the right circumstances recharge, storage and recovery is technically feasible at a range of scales. The subject of this article is some of the key regulatory impediments to recharge, such as the availability of source water and the authority to hold and control recharged water. This article also addresses the need to reform certain policies that have contributed to aquifer depletion, because without such reform, efforts to augment groundwater supplies will lead to the same result.

BACKGROUND

Data collected by the United States Geological Survey (USGS), shows that groundwater withdrawals increased significantly during the 30 years following World War II before leveling off at about 80 billion gallons per day, or a little over 20 percent of all fresh water withdrawn for use nationwide (see USGS website: http://ga.water.usgs.gov/edu/wugw.html). A very high percentage of municipal uses are served by groundwater sources. Aquifer depletion — or "water mining"— occurs when water is withdrawn from the ground faster than it is recharged. The consequences can be serious and may include: declining water tables; higher pumping costs; lower yields; degraded water quality; reduced surface water flow; and ground subsidence. The solution is straight-forward but difficult to achieve, requiring a lower rate of withdrawal, a higher rate of recharge or some combination of the two. Nevertheless, a solution is needed because, as Figure 1 demonstrates, many of the important aquifers in the West and nationwide are being "mined" with observable adverse impact.



Aquifer Recharge

WGA Report

At the 2008 summer meeting of the Western Governors Association (WGA) the topic of water management occupied an entire morning on the agenda. In advance of the meeting, WGA released its draft annual report called *Water Needs and Strategies for a Sustainable Future: Next Steps* (see WGA website: www.westgov.org and Brief, this TWR). The Next Steps report attempts to present a reasonably balanced approach to water management, calling for steps that could lower demand for groundwater through improved efficiencies, conservation, and the use of reclaimed water, desalinization and weather modification. The WGA also called upon Congress, the federal administration and states to support research and the development of projects to augment groundwater supplies on a regional scale using recharge, storage and recovery.

Sustainable Future

At present there are about 80 aquifer storage projects operating across the US, performing a variety of functions such as: enhancement of fresh water supplies, aquifer restoration and oil recovery. Pyne, R.D.G., *Aquifer Storage Recovery: A Guide to Groundwater Recharge Through Wells*, 2nd ed. (2005). Something over half of the identified recharge projects exist in coastal areas where saltwater intrusion is a major concern. In the 1990s, interest in developing recharge and storage projects was high, but it now seems fair to observe that the scope and number of groundwater recharge and storage projects actually completed have lagged somewhat. In part, that is due to a failure by the public and decision makers to recognize the scope of the problem — that may change as adverse impacts from aquifer depletion become more prevalent. Certainly, there seem to be a number of aquifer systems in the West with significant available storage capacity created by long-term drawdown. For many of those aquifers current pumping rates cannot be sustained and the resulting depletion must eventually force some water users to find other sources of water or discontinue their use of water. In recognition of the potential social, environmental and economic implications, the WGA proposes taking steps, with federal assistance, to augment aquifers of regional and national importance with water from other sources as one of its *Strategies for a Sustainable Future*.

TERMINOLOGY CONCERNS

Regional Projects

As the source water discussion below suggests, few if any recharge projects can be undertaken on a regional scale without inter-state and federal cooperation. With that in mind, Chris Rayburn, Director of Research at Awwa Research Foundation, during the 2008 Winter Meetings of the Committee on Water for the National Association of Regulatory Utility Commissions, correctly noted that terminology is one of the first hurdles to overcome. The WGA could go a long way in support of its proposal by convening a task force to draft a common statement of principals and uniform language for use by member states seeking to participate in regional recharge efforts.

Uniformity Issues

Most, if not all, states have adopted some groundwater recharge authority but, perhaps not surprisingly, many use different terms to describe similar concepts or the same term to describe dissimilar concepts. The same is true in academic literature. Establishing common terminology is a deceptively important step because, like the preparation of a mission statement, the process will require public debate and agreement on the purpose or purposes of the enterprise. The debate over recharge must center on whether to divert and use enormous volumes of source water to recharge aquifers depleted by over-drafting and consideration of how stored water will be allocated and for what purposes. These are fundamental questions that should be resolved before any recharge project is undertaken. This is especially true for projects on a regional scale where more than one state and very likely one or more Indian tribes will be impacted.

SOURCE WATER SUPPLY

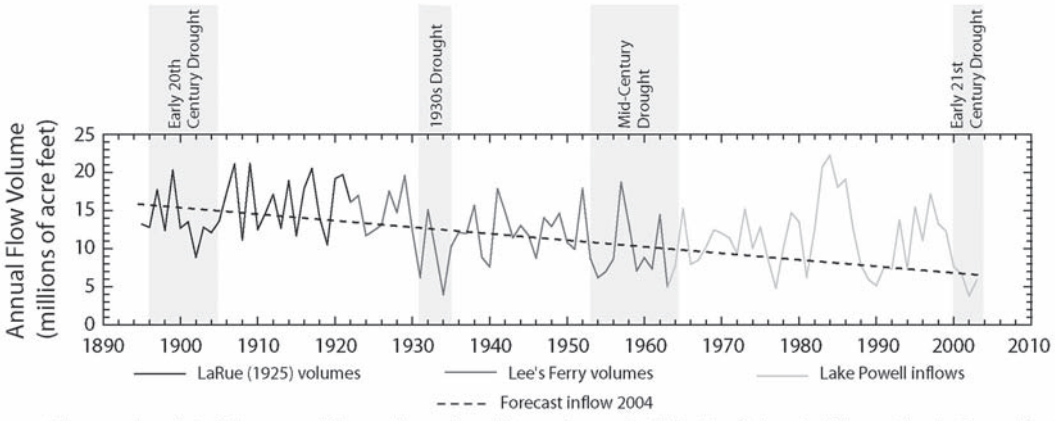
Necessary Volume

Without source water there can be no augmentation of groundwater by recharge. Yet, those who advance recharge as a water management strategy are often vague or even glib about the availability of suitable source water. The National Academies describes the first step to managed recharge as capturing water from sources such as surface, ground, storm runoff and treated water. See e.g., National Research Council, *Prospects for Managed Underground Storage of Recoverable Water* at 25-27 (2008). However, the volume of water necessary to accomplish recharge at a scale sufficient to maintain current pumping levels is staggering.

According to the High Plains Underground Water District No. 1, the Ogallala Aquifer system, stretching from South Dakota to Texas, held an estimated 3.3 billion acre-feet (AF) of water in 1990. Recent estimates now peg the stored volume at less than 3.0 billion AF, a decline of more than 300 million AF in something over ten years (HPUD's website: http://www.hpwd.com/the_ogallala.asp). This volume represents slightly more than 10 times the capacity of Lake Mead, the nation's largest surface reservoir with a capacity of more than 28 million AF (www.ussdams.org/uscold_s.html). The reservoir took over six

Aquifer Recharge

years to fill in the 1930s when downstream demands were relatively low (http://3dparks.wr.usgs.gov/2005/lakemead/html/lame1022.htm). Thus, in the roughest of terms, the volume of water needed annually to maintain the current rate of pumping from the Ogallala Aquifer is roughly equivalent to the capacity of Lake Mead, or about four times the present mean annual flow of the Colorado River measured at Lee's Ferry. A crucial point is that no new water rights would be created from such an effort.



Time-series plot of the annual flow volume (in millions of acre-feet) for the Colorado River at Lee's Ferry. Dashed line is the linear trend for the period. Vertical bars and shading delineate drought periods as defined using the Palmer Drought Severity Index for the climate divisions encompassing the upper Colorado River basin.

Surface Water Limits

In the plains states and intermountain west, where desalinization is not a practical option, groundwater augmentation means diverting surface water. It is widely asserted and believed that essentially all of the surface water available for use in the western United States is spoken for in the form of legal property rights issued by the states — most of them for irrigation. The United States Geological Survey (USGS) states that 68% of groundwater withdrawals in 2000 were for irrigation and 19% was for public supply (see USGS website: http://ga.water.usgs.gov/edu/wugw.html). Whether true or not, the perception exists and is closest to accurate during the low-flow period of late summer when the demand for irrigation water is highest. Consequently, most authors point to uncaptured spring runoff as the best source of water for recharge.

Spring Runoff

The concept is elegant: capture and store water when it is plentiful for later recovery and use in a process sometimes referred to as "flattening the hydrograph." As with any use of water in the west, diverting spring runoff to recharge aquifers will require the responsible entity to apply for and obtain a water right. However, to a significant extent, spring runoff is spoken for in the form of instream storage rights and is relied on by surface right holders to refill drawn down reservoirs for use by irrigators, municipalities and power companies. In some states, instream water rights themselves take up more of the sping runoff. In the well publicized case of Lake Powell, runoff has been unable to keep up with reservoir drawdown and the water level is going down drastically. Declining levels in Lake Powell are analogous to the less visible but far larger problem of declining aquifer storage.

Practical Limitations

Even where runoff may be available, there are practical limitations such as the ability to get enough water underground during the period of annual runoff. Moreover, flattening the hydrograph has proven to be controversial. Many argue that natural ecosystems require annual flushing flows in order to function normally. In March of 1996, former Secretary of the Interior, Bruce Babbitt, famously presided over a high-volume release of water from Glen Canyon Dam to simulate the scouring and redeposition of sediments by spring flows. It is reasonable to suppose that proposals for large-scale diversion of spring runoff will meet with resistance from fishery advocates and environmental groups.

REGULATORY ISSUES

Ownership Issues

The preceding is not to say that opportunities for groundwater recharge should not be researched and developed as an important component of water management. However, it is clear that groundwater recharge alone is not going to solve the problem of over-drafting aquifers. Assuming source water can be secured and the technical issues addressed, the next significant regulatory impediment to recharge is ownership of the stored water. This issue represents a spectral choice for legislators. At one end of the spectrum, recharged water reverts to public ownership, in which case it is available for appropriation and use in accordance with the established system of priority. Many early recharge statutes follow this

Aquifer Recharge

approach. See Western States Water Council (WSWC), *Groundwater Recharge Projects in the Western United States* at IV-36 and 37 (1990). A major advantage of the public ownership approach is simplicity — just put it in the ground and continue to regulate use as before. A key disadvantage may be the perception that such an approach is little more than a subsidy for those holding water rights and of little benefit to the public as a whole. This perception may control the debate unless steps are taken to ensure that the issuance of new water rights is not allowed to perpetuate over-drafting of the receiving aquifer.

Withdrawal Control

At the other end of the spectrum, water is stored under a primary water right held by the recharging entity that has some degree of control over its distribution and use, which typically requires the issuance of secondary rights. In contrast to public reversion, the retained ownership approach ensures that the recharging entity will realize a direct benefit and some ability to limit over-drafting of augmented aquifers. On the other hand, the cost and difficulty of monitoring and administering such a project is much greater. In between the endpoints is a nearly infinite variety of possible blended approaches in which the recharging entity controls stored water to a limited extent. This generally means the recharging entity controls and uses some percentage of the amount recharged with the remainder going back to the public. In some instances the recharging entity would retain control over a percentage of any unused amount that may carry-over for use during the next year or years. (See e.g., Oregon Revised Statutes, ORS §§ 537.531-.534). The blended approach still requires careful monitoring to allow for accurate accounting and equitable administration of the project.

JURISDICTION OVER RIGHTS

Interstate Aquifers

It can be argued, and is asserted here, that before recharge can be an effective water management strategy at the regional scale (or at any scale), lawmakers must take steps to reform policies that led to aquifer depletion in the first place. For example, even though the occurrence and movement of groundwater does not observe state boundaries, its use is regulated by states individually. The multi-jurisdictional approach to allocation all but assures over-allocation of large interstate aquifers because each state is free to issue water rights without any requirement to consider the possible impact on existing water rights in neighboring states. The only recourse available to states unable to resolve disputes over shared groundwater resources is equitable apportionment under the original jurisdiction of the United States Supreme Court. *Hood v. City of Memphis, Tenn.*, 533 F. Supp.2d 646 (N.D. Miss. 2008).

Reform Needed

The Ogallala Aquifer system provides a clear example of the need to reform multi-jurisdictional management before it would make sense to undertake large-scale recharge. A recent article details plans by T. Boone Pickens to profit from the withdrawal and sale of large volumes of water from a relatively untapped part of the Ogallala Aquifer that underlies his ranch in Texas, where the "Rule of Capture" for groundwater means that the biggest pump wins. S. Berfield, *There Will Be Water*, Business Week (June 12, 2008). Importantly, the "race to the bottom" mentality is not limited to Texas, but the example does serve to illustrate a need for reform. Simply stated, large scale recharge is unlikely to occur when others can drill a well and capture any amount of water for personal gain with limited recourse for injured parties. For intrastate recharge projects, this suggests a need to employ the retained ownership approach summarized above. For interstate projects it suggests a need to exercise compacting authority in order to allocate storage and provide recourse to resolve disputes. [Editor's Note: As set out in TWR #52, the counsel for Mesa Water LP and the Pickens Group pointed out that the proposed project in Texas includes production limits to help protect the aquifer from overdrafting.]

Regional Recharge

Perhaps the best example of a regional recharge and storage project involving interstate allocation is operated by the Arizona Water Banking Authority (AWBA). The project uses Central Arizona Project infrastructure to deliver Colorado River water for direct recharge and storage in aquifer space made available by long-term drawdown. To understate the matter, the AWBA project is legally and administratively complex, involving federal and interstate agreements, Indian rights, and recourse for other states that depend on the Colorado River. Briefly, the AWBA allows Arizona to optimize delivery of its river allocation and to accrue credit that can be redeemed in the future when Arizona's communities or neighboring states need this backup water supply. According to the AWBA webpage, the project is comprised of eight Underground Storage Facilities and sixteen Groundwater Savings Facilities. The WSWC reviewed data provided by the AWBA and reports a total average annual recharge of 272,000 acre-feet. WSWC, *Water Laws and Policies for a Sustainable Future: A Western States' Perspective* at 123 (June 2008). Project costs through 2007 have exceeded $216 million. AWBA, *Annual Report* 2007 at 2. These are sobering numbers when applied to the overall problem of aquifer depletion. Obviously, the stakes are immense and the costs are high. (see Davenport, TWR #17 for additional information regarding *Interstate Water Banking* and AWBA's website: www.azwaterbank.gov/awba/).

Aquifer Recharge

Allocation Conflicts

Washington Project

Odessa Aquifer

Split Proposal

Instream Flow Analogy

CONJUNCTIVE USE

Another historic disconnect between the occurrence of water and its regulation is the early failure by states to recognize and address the essential physical connection between groundwater and surface water when allocating water rights. In some systems the connection is direct and observable, such as water tables that go up and down in response to elevation changes of a nearby surface reservoir. In other systems the relationship is not so easily seen and may take decades to occur, but in all cases groundwater comes from surface sources. Now many states have been forced to implement conjunctive management strategies to mitigate impacts and resolve conflicts between groundwater and surface water users, who hold separate rights to use what is essentially the same water. A good example of this is the allocation of surface water rights to springs in the East Snake River Plain (ESRP) of Idaho that were enhanced, and in some cases created, by groundwater recharge accumulated over years of irrigation from surface water sources. However, as irrigators shifted from surface sources to groundwater and grew more efficient in their delivery of water, some of the springs began to dry up and conflict ensued. For more on conjunctive management in Idaho see J. Fereday, *Idaho Conjunctive Use*, TWR # 40 (June 15, 2007).

While early irrigation of the ESRP was not intended to be a recharge project, the resulting conflict serves as a valuable lesson to ensure that the relationship between surface and groundwater resources is understood and addressed before making major new commitments. Presently, in Washington State a large recharge project is under consideration to restore surface flows and rehydrate part of the Odessa Aquifer. The basalt aquifers in the Odessa area have been dropping several feet per year due to over-drafting. In response to the recent enactment of the Columbia River Water Basin Supply Act (ESSHB 2860), Lincoln County, together with the Watershed Resource Management Group for Water Resource Inventory Area (WRIA) No. 43 (a volunteer watershed planning group set-up under Washington State Watershed Planning Act – RCW 90.82), and the Lincoln County Conservation District are working with the Washington State Department of Ecology to fund a Passive Rehydration Feasibility Study in Lincoln County. The proposed study will evaluate the feasibility of diverting Columbia River water during the winter months, and conveying it to the headwaters of the Lake Creek drainage in Lincoln County, Washington. The proposal calls for filling several lakes in the drainage that went dry in the mid-1980's as a presumed consequence of intensified pumping from the Odessa Aquifer. Just as Idaho has been forced to deal with conjunctive management issues on the ESRP, Washington was forced to do so in connection with the issuance of groundwater rights in the Odessa area. See e.g., *Rettkowski v. Ecology* (the Sinking Creek decision), 122 Wash.2d 219, 858 P.2d 232 (1993). It is expected that water diverted to the lakes will infiltrate and recharge the underlying Columbia River basalt aquifers. The proposal calls for two-thirds of the annual diversion (approximately 300,000 AF) to be recharged and one-third to enhance stream flows, habitat, and recreational value of the lakes by keeping surface water present year round (from personal communication with Gene St. Godard, Project Manager for the WRIA 43 Watershed Group and Principal Hydrogeologist for the Water and Natural Resource Group).

AQUIFER PROTECTION

For projects like the one proposed for the Odessa Aquifer to work over the long term, it must be possible to preclude further appropriation of any excess water using a retained ownership model of recharge that includes surface water bodies used to deliver and store water diverted for the purpose. The State of Washington has various tools that should allow it to avoid the appropriation of recharged water that is intended to alleviate harm caused by earlier appropriations, including the State's water banking and trust authority (RCW 90.42) or the establishment of instream flows (RCW 90.82.080). It is interesting to consider the evolving concept of instream flows, and the need for an analogous concept in the management of groundwater. Until quite recently, instream flow was not considered by many to be a beneficial use for which water rights could be obtained. While the amount of water needed for instream flow rights is hotly disputed, most now seem to agree that reserving some flow for instream use is beneficial. This has resulted in a baseline that is related to the systems ability to function within acceptable parameters. Yet, there has been no such recognition and there is no direct corollary in the area of groundwater management. Undeniably, the driving factor for development and acceptance of instream flows has been the legal requirement to protect certain fish species. As noted above, groundwater is out of sight and out of mind — it is easy to ignore. Lacking a driver such as fish, it will be that much more difficult to implement a similar baseline approach to the management of groundwater. It is submitted, however, that without taking steps to preclude appropriation of water stored by recharge, such projects will do nothing to alleviate over-drafting and will likely deepen the long term challenge of water management in the western United States.

Aquifer Recharge

Interstate Cooperation

Adjudications

WATER QUALITY DISCONNECT

Finally, the development of large-scale recharge projects is also impeded by the historic disconnect between the regulation of water rights and water quality. By and large, every state adopts and maintains separate water quality standards for the two types of water. Federal law may also apply in the form of protections imposed under the Underground Injection Control (UIC) Program of the Safe Drinking Water Act. See 42 U.S.C. 300h. In most cases, states have federally-delegated authority to administer their own UIC programs. Quite apart from the challenge of meeting water quality standards when developing intrastate recharge projects, dissimilar state standards may have a significant bearing on the ability of one state to recharge water that may end up, by design or otherwise, in a neighboring state.

Discussion of the Spokane Valley/Rathdrum Prairie (SVRP) Aquifer provides an opportunity to tie together a number of the issues presented. The SVRP Aquifer is an unusually productive "sole-source" aquifer that supplies water to most of the half-million or so people living in the borderline area of Eastern Washington and North Idaho. Generally, the aquifer recharges in Idaho and discharges in Washington, where it is tributary to the Spokane and Little Spokane Rivers. A recent USGS study completed with remarkable cooperation by and between both states, concluded that the ability of the SVRP Aquifer to deliver water has not been exceeded, but cautioned that withdrawals may be contributing to reduced flows observed in the Spokane River, which also has a number of water quality issues (USGS website: http://wa.water.usgs.gov/projects/svrp/publications.htm). The two states are now embarking on general adjudications for the purpose of establishing the validity of their respective water rights in the shared basin. While many have characterized adjudication as a necessary step toward joint management of this critical resource, others note simmering tensions between the two states in competition for use of the resource. In the meantime, there has been significant pressure for Washington to address water quality issues in the Spokane River. Because of the relationship between the SVRP Aquifer and river conditions, increasing pressure is being put on Idaho to consider the impact that new groundwater appropriations may have on the river downstream in Washington. One suggestion calls for recharge of the aquifer to enhance, or at least sustain, tributary flows to the Spokane River. *Meeting Summary of Planning Units for WRIA 55 and 57* (July 21, 2004). With or without recharge, it is apparent that cooperative management of the SVRP Aquifer will require the two states to consider the intrinsic relationship between groundwater and surface water, and it is likely that water quality issues will drive some of that effort.

CONCLUSION

A recent proposal by the WGA to enlist federal assistance to research and develop regional groundwater recharge and storage projects signals a growing recognition of the threat posed by the over-drafting of aquifers in the western United States. Such projects face a number of practical and historical impediments. It seems doubtful that adequate water sources exist to allow current pumping rates to continue. It is therefore apparent that recharge alone is not a solution to water supply problems facing the rapidly urbanizing west. This does not mean that regional aquifer recharge should not be pursued. However, the development of such projects will require states to reform historic policies that have contributed to widespread over-drafting. Specifically, states must ensure that recharge water is not simply made available for general appropriation. Also, when allocating recharge water states must consider the connection between surface and groundwater supplies and the relationship between water quantity and water quality. States seeking to develop regional recharge projects should first work together to establish the standard terms and concepts they will need to effectively use their legislative and compacting authority in the development of large-scale groundwater recharge and storage projects.

For Additional Information: Peter G. Scott, 406/ 442-8560 or email: pgs@gsjw.com

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WATER BRIEFS

PESTICIDES EVALUATION WEST

NMFS SETTLEMENT AGREEMENT & DRAFT JEOPARDY FINDINGS

On July 30, a coalition of fishing and environmental groups settled a lawsuit with the National Marine Fisheries Service (NMFS), the federal agency charged with protecting threatened and endangered salmon and steelhead. The settlement requires NMFS to examine the impacts that 37 pesticides commonly used in the Northwest and California have on the protected salmonids. NMFS must also design permanent measures to help pesticide users minimize the harmful effects of those pesticides.

EPA determined that the 37 toxic pesticides at issue in the settlement may harm protected salmon and steelhead. Most of the pesticides have been detected in major salmon and steelhead rivers in the Pacific Northwest and California. Even at low levels, toxic pesticides can harm salmon and steelhead by causing abnormal sexual development, impairing swimming ability, and reducing growth rates.

More than five years ago, a federal court ordered EPA to consult with NMFS on the impacts that certain pesticides have on salmon and steelhead in the Pacific Northwest and California. EPA began submitting the required assessments to NMFS, but NMFS never identified the measures needed to protect salmon and steelhead from the pesticides. The federal Endangered Species Act (ESA) required NMFS to complete such actions within 90 days of receiving EPA's assessments.

On July 30, NMFS agreed to complete the overdue assessments over a four-year period. The first decisions are due by October 2008, with all related Biological Opinions scheduled for completion by February 2012. These consultations are expected to culminate in on-the-ground measures designed to reduce the amount of pesticides that run into salmon-supporting waters.

As part of this settlement, the plaintiffs will receive $41, 000 for costs and attorney's fees.

The settlement also resulted in NMFS releasing a draft Biological Opinion (BiOp) concerning three of the pesticides under NMFS review on July 31. This draft BiOp, which is not scheduled for finalization until October 31, 2008, finds that EPA registration for use of any pesticides containing any of the three ingredients Chlorpyrifos, Diazinon, or Malathion "is likely to jeopardize the continued existence of…endangered species." The unfinalized document lacks its "Reasonable and Prudent Alternative" section. NMFS analyzed the possible effects on dozens of salmonids in the Northwest and California listed as threatened or endangered under the ESA.

Chlorpyrifos is a chlorinated organophosphorus insecticide, acaricide, and nematicide widely used in both agricultural and non-agricultural settings. 1998 estimates put annual US usage at over 21 million pounds.

Diazinon is a chlorinated organophosphorus insecticide, acaricide, and nematicide widely used to control a variety of pests. 1997 estimates put annual US usage at over 13 million pounds per year.

Malathion is a broad spectrum organophosphorus insecticide used in agriculture, public health projects, and homes. As of July 2006, 15 million pounds of malathion were being used annually in the US.

For info:

Settlement Agreement website: www.pesticide.org/CWS/NCAP%20v.%20NMFS%20signed%20consent%20decree.pdf

NMFS draft BiOp website: www.nmfs.noaa.gov/pr/pdfs/pesticide_biological_opinion_draft.pdf

ALASKAN NPDES AUTHORITY SOUGHT AK

EPA is evaluating a request from the State of Alaska Department of Environmental Conservation (ADEC) to run the National Pollutant Discharge Elimination System (NPDES) program in Alaska. The NPDES permit program, a key part of the federal Clean Water Act, controls water pollution by regulating sources that discharge pollutants to waters in the US. Delegation of the NPDES program would give State environmental regulators the ability to write wastewater discharge permits for local business and industry, as well enforce those permits to insure compliance. Forty-five other states have already received NPDES delegation.

Permits issued by EPA will continue to be in force until the State starts issuing permits.

Upon approval, Alaska will phase-in implementation of the NPDES Program over three years. EPA will continue to write permits for those facilities that Alaska does not take on during this period.

Alaska's planned phase-in includes:

Phase I: Domestic Wastewater Discharges, Timber Harvesting, Seafood Processing (Upon delegation)

Phase II: Federal Facilities, Stormwater Program, Pre-Treatment Program (One year after delegation)

Phase III: Mining (Two years after delegation)

Phase IV: Oil and Gas, cooling water, and all other remaining facilities (Three years after delegation)

As is the case elsewhere, EPA will retain oversight of State's program after delegation.

EPA oversight includes: Conducting periodic program reviews; Discretion to review any permit; Authority to object to permits that are not protective and/or inconsistent with CWA requirements; Federalizing a State permit if the State does not adequately address EPA's objections(s); Retained enforcement authority over all dischargers; Withdrawal of Alaska's NPDES authorization if the State is not meeting CWA requirements.

For info: Christine Psyk, Associate Director, EPA Office of Water & Watersheds, 206/ 553-1906 or email: psyk.christine@epa.gov

EPA website: http://yosemite.epa.gov/r10/water.nsf/NPDES+Permits/Permits+Homepage

ADEC website: www.dec.state.ak.us/water/npdes/index.htm

WATER BRIEFS

WATER POLICY WEST

WESTERN GOVERNORS' REPORT

The Western Governors Association's (WGA's) 2008 Annual Meeting was held in Jackson Hole, Wyoming, June 29 – July 1. During the Meeting's Plenary Session on Managing Water in the West, Duane Smith, Executive Director, Oklahoma Water Resources Board, presented highlights from the WGA publication "*Water Needs and Strategies for a Sustainable Future: Next Steps*" (see WGA website: www.westgov.org). This 48-page June 2008 publication provides a comprehensive list of water policy implementation steps addressing: Water Policy and Growth; Water to Meet Future Demands; Water Infrastructure Needs and Strategies for Meeting Them; Resolution of Indian Water Rights; Climate Change Impacts; and Protecting Aquatic Species under the Endangered Species Act. The publication was produced by the Western States Water Council.

Smith's presentation focused on what he termed the publication's "three centerpiece recommendations."

THESE RECOMMENDATIONS INCLUDE:

1) The Western States Water Council (WSWC) should enter into a formal agreement to create "Western States Federal Agency Support Team" made up of representatives of federal agencies having water resource responsibilities and create a WSWC "liaison position" to facilitate collaboration.
2) The WGA should urge Congress to require federal water resource agencies to include "Integrated Water Resources Planning and Assistance" as one of their primary missions, with the goal of:
   (a) changing the way water planning is conducted by encouraging more comprehensive plans developed under state leadership with federal assistance; and
   (b) reducing inefficiencies caused by the present mode of project specific responses to competing demands, contradictory actions by multiple state, local and federal water agencies, and hastily conceived reactions to the latest real or perceived crisis.
3) Federal agencies should use state water plans:
   (a) to help determine national water policy and priorities that best align federal agency support to states; and
   (b) to inform decision making regarding regional water issues.

The WGA is an independent, nonprofit organization representing the governors of 19 states and three US-Flag islands in the Pacific.

For info: Karen Deike, WGA, 303/ 623-9378

CREEK RESTORATION CA

BATTLE CREEK PROJECT

PHASE 1A FUNDED

The US Bureau of Reclamation (Reclamation) announced in July that funding transfer agreements between Reclamation and various California state agencies have been signed that will allocate $42.75 million to implement Phase 1A of the Battle Creek Salmon and Steelhead Restoration Project (Project) as early as spring of 2009.

Battle Creek, a tributary of the Sacramento River, has been a major focus for winter and spring run chinook restoration in northern California. Historically it was prime spawning grounds for salmon and steelhead until a series of small diversion and hydro-power systems in the lower reaches of the creek were constructed. Pacific Gas and Electric Company (PG&E) operates a number of hydro-electric dams on both the North and South Forks of Battle Creek. These dams also divert water to Coleman National Fish Hatchery and support agricultural irrigation.

The Project is a plan by state, federal, and private interests to open 42 miles of Battle Creek and six miles of its tributaries to salmon and steelhead spawning habitat by removing dams, installing new fish screens, fish ladders, and increasing water flows. Though there are eight dams along the creek, only five will be removed during this Project. The Project's retention of three dams led some environmental and fishing industry interests to withdraw from the Project's negotiation process.

The Project's first phase will target the removal or retrofitting of dams within the Battle Creek Hydroelectric Project. This phase includes installing fish screens and ladders at the North Battle Creek Feeder and Eagle Canyon Diversion Dams, removing Wildcat Diversion Dam and appurtenant conveyance systems of the North Fork, installing the Eagle Canyon Canal pipeline, and modifying Asbury Dam on Baldwin Creek. The Project will also increase cold water flows in Battle Creek for the benefit of salmon and steelhead. The predominately spring-fed Battle Creek system is considered a reliable source of abundant cold water for salmon, even in a warming climate.

It is anticipated that Phase 1A construction contracts will be awarded in 2009 and the work will be completed in 2010. Partners are currently seeking funding for the next construction phases (Phase 1B and Phase 2) so the entire project can be implemented as soon as possible. Phase 1B includes installing an Inskip Powerhouse tailrace connector and bypass on the South Fork, and Phase 2 includes installing a fish screen and ladder on Inskip diversion dam, installing a South Powerhouse tailrace connector, and removing Lower Ripley Creek Feeder, Soap Creek Feeder, Coleman and South diversion dams, and appurtenant conveyance systems.

For info: Pete Lucero, Reclamation, 916/ 978-5100 or email: plucero@mp.usbr.gov; Paul Moreno, PG&E, 530/ 896-4290 or email: pmmm@pge.com

PHARMACEUTICALS & WQ US

EPA REQUESTS COMMENT

EPA is seeking comment on an Information Collection Request (ICR) that will be used in a detailed study of unused pharmaceutical disposal methods by hospitals, long-term care facilities, hospices and veterinary hospitals. EPA is seeking more information on the practices of the health care industry to inform future potential regulatory actions, and identify best management and proper disposal practices. This is one of several actions EPA is taking to strengthen its understanding of disposal practices and potential risks from pharmaceuticals in water.

WATER BRIEFS

EPA is also commissioning the National Academy of Sciences to provide scientific advice on the potential risk to human health from low levels of pharmaceutical residues in drinking water. The Academy will convene a workshop of scientific experts next December 11-12, to advise EPA on methods for screening and prioritizing pharmaceuticals to determine risk.

Other actions EPA is taking include: expanding a recent fish tissue pilot study to determine whether residues from **p**harmaceuticals and **p**ersonal **c**are **p**roducts (PPCPs) may be present in fish and waterways; developing a methodology to establish water quality criteria to protect aquatic life; and conducting studies to examine occurrence of PPCPs in sewage sludge and wastewater. EPA has developed state-of-the-art analytical methods capable of detecting various pharmaceuticals, steroids and hormones at very low levels.

EPA also is participating in an international effort with the World Health Organization to study appropriate risk assessment methods for pharmaceuticals as environmental contaminants.

EPA will accept public comments on this ICR for 90 days after it is published in the Federal Register — expected sometine in August.
For info: Enesta Jones, EPA, 202/ 564-4355 or email: jones.enesta@epa.gov
EPA WEBSITE: www.epa.gov/waterscience/ppcp/

DOMESTIC WELLS NM

SENIOR RIGHTS PROTECTION DECISION

On July 24, New Mexico State Engineer John D'Antonio filed an appeal of the recent district court decision which held that New Mexico's Domestic Well Statute is unconstitutional. In New Mexico, as in most western states, domestic well owners are permitted to drill wells and then use water for domestic purposes without going through the normal permitting process for water rights. Thus, the issue of whether or not there is water available for appropriation (i.e. is water is available so that senior water users won't be adversely impacted by a new right) is not addressed by the water resources agency.

The decision issued by Judge J. C. Robinson of the Sixth Judicial District Court in Silver City (*Bounds and the San Lorenzo Community Ditch Assoc. v. State of NM, ex. rel,. John D'Antonio* (July 10, 2006)) held that the Domestic Well Statute (Section 72-12-1.1 N.M.S.A.) "is unconstitutional because it creates an impermissible exception to the priority administration system created by the N.M. Constitution Art. 16 §2." The court also decided that the State Engineer "shall administer domestic well applications the same as all other applications to appropriate water." Thus, the decision ruled in favor of water users Horace and Jo Bounds, who asserted that automatically granting the ability to pump groundwater to domestic well owners interferes with their "senior" water rights (i.e. based on the priority system under the Prior Appropriation Doctrine). The judge dismisssed the Bounds' other claims without prejudice, holding that there was no substantial evidence of impairment and no evidence of "monetary damages." The court noted that Mimbres Basin has been "closed" since 1972; in a closed basin, there is no water available for appropriation.

A July 24 press release from the Office of the State Engineer (OSE), noted that "statutes enacted by the legislature are given the presumption of constitutionality, therefore, the State Engineer concluded that he must appeal the decision to the New Mexico Court of Appeals for further review to ensure that every legal basis in support of the presumption is fully deliberated." The appeal stays enforcement of the decision, and the OSE said it will continue to accept and act on domestic well applications.

The impact of domestic wells, which generally are exempted in the West from normal permitting issues regarding "availability of water" and potential effects on existing water users, has become a major topic of discussion in many states. The issue, however, has yet to be dealt with directly by legislation or court decisions. Water users have increasingly raised the specter of the cumulative impact of hundreds or even thousands of domestic wells on streamflows, while land developers and the real estate industry usually argue that impacts are de minimus.

The court in this case directly addressed the issues that are involved throughout the West, first ruling that "The right of a junior appropriator is at all times subservient to the rights of prior appropriators and can only be exercised after the needs of the prior appropriators have been supplied." (Decision at 11). The judge stressed the inertia of regulators and the legislature when he pointed out that "OSE [Office of the State Engineer] has recognized its lack of power to protect senior water rights and has attempted, without success, to get the Legislature to amend 72-12-1.1." *Id.* at 17. After stating that "D'Antonio [State Engineer] testified he would not subject domestic wells to a priority call notwithstanding this is a derogation of his duty under the N.M. Constitution and 72-12-1.3" the court found that "This lack of protection for senior appropriators is a violation of due process." *Id.* at 24-25.
For info: Karin Stangl, OSE, 505/ 699-4923 or website: www.ose.state.nm.us/; a copy of the *Bounds* decision is available upon request to TWR.

STREAM ANALYSIS TX

GRANT FOR TEXAS SURVEY

The US Environmental Protection Agency (EPA) announced on July 21 that it has awarded $480,000 to the Texas Commission on Environmental Quality (TCEQ) to perform a survey of Texas' rivers and streams as part of a comprehensive national survey. Functioning as a follow-up to the 2004 Wadeable Streams Assessment, the analysis will allow TCEQ to manage water quality by assessing river and stream conditions, building state capacity for monitoring and assessment, and promoting collaboration across jurisdictional boundaries. Working with EPA, TCEQ's analysis will also help establish a national baseline for future environmental evaluations.
For info: EPA grants website: www.epa.gov/region6/gandf/index.htm

WATER BRIEFS

EPA "CLEAN START" US

NEW OWNER POLICY

On August 1, EPA announced it is launching an interim policy that offers incentives to new owners who correct environmental violations at recently acquired regulated facilities. Under the interim policy, new owners may receive lower penalties than long-time owners. "This is an opportunity for new owners to make a 'clean start' by correcting environmental problems that began under the previous owner's watch," said Granta Y. Nakayama, assistant administrator of EPA's Office of Enforcement and Compliance Assurance.

Under the current EPA Audit Policy, EPA offers reduced penalties to companies that self-audit their facilities, promptly disclose and correct any violations discovered, and take steps to prevent future violations. Under the new interim policy, an owner who acquires a new facility may get additional penalty reductions from disclosing an even greater range of violations. EPA encourages companies with newly acquired facilities to examine compliance of their new facilities, correct environmental problems that began before acquisition, make changes to ensure they stay in compliance, and reduce pollutants going forward.

Since 1995, more than 3,500 companies at nearly 10,000 facilities have used the audit policy to disclose and resolve violations, most of which involved recordkeeping and reporting. Under the interim policy, EPA hopes to encourage new owners to disclose violations that, once corrected, will yield significant environmental benefit and direct pollution reductions. The new interim policy will be in effect immediately and EPA will accept public comment until October 30. The policy may change in light of these comments.

For info: Dave Ryan, EPA, 202/564-4355 or email: ryan.dave@epa.gov; EPA's Audit Policy website: www.epa.gov/compliance/incentives/auditing/auditpolicy.html; New owner disclosure: www.epa.gov/compliance/incentives/auditing/newowners-incentives.html

PERIPHERAL CANAL CA

REPORTS RELEASED

A report released on July 17 by the Public Policy Institute of California (PPIC) says building a peripheral canal to carry water around the Delta is the least expensive and most promising strategy to revive the troubled ecosystem and ensure reliable water supplies for Californians. The central conclusion of the report, *Comparing Futures for the Sacramento-San Joaquin Delta* (Report), is that building a peripheral canal to carry water around the Sacramento-San Joaquin Delta is the most promising strategy to balance two critical policy goals: reviving a threatened ecosystem and ensuring a high-quality water supply for California's residents.

Although it would be best for fish populations if California stopped using the Delta as a water source altogether, this would be extremely costly, according to the Report. The Report was authored by a multidisciplinary team including Ellen Hanak, PPIC associate director and senior fellow, and Jay Lund, William Fleenor, William Bennett, Richard Howitt, Jeffrey Mount, and Peter Moyle from the UC at Davis.

The PPIC-UC Davis team concluded that a peripheral canal is not only more promising than the temporary and ultimately unsustainable "dual conveyance" option — which combines the current approach with a canal — but is also the best available strategy to balance two equally important objectives. "Coupling a peripheral canal — the least expensive option — with investment in the Delta ecosystem can promote both environmental sustainability and a reliable water supply," Hanak says.

The Report's recommendations include: allowing some Delta islands to flood permanently (invest in the levees that protect high-value land, ecosystem goals, and critical infrastructure, and allow lower-value islands to return to aquatic habitat); transition from the current Delta management system by planning for change now; and develop a new framework for governing and regulating the Delta (with the proper safeguards, a peripheral canal can be economically and environmentally beneficial since it is a more cost-effective strategy than dual conveyance. Dual conveyance, because it relies on continued pumping through the Delta, is an interim solution, according to the Report.

Meanwhile, the Delta Vision Blue Ribbon Task Force is accepting comments on its new draft strategic plan for California's Bay Area Delta. Comments received before September 2 and September 30 will be reviewed at the subsequent Delta Vision Blue Ribbon Task Force meeting. A copy of the strategic plan is available at the website below.

For info: PPIC report is available on their website: www.ppic.org/main/publication.asp?i=810; Delta Vision Draft Plan website: http://deltavision.ca.gov/BlueRibbonTaskForce/June2008/Item_4_Attachment1.pdf

US GROUNDWATER US

REPORT ON AVAILABILITY

Groundwater is among the Nation's most important natural resources. It provides half our drinking water and is essential to the vitality of agriculture and industry, as well as to the health of rivers, wetlands, and estuaries throughout the country. Large-scale development of groundwater resources with accompanying declines in groundwater levels and other effects of pumping has led to concerns about the future availability of groundwater to meet domestic, agricultural, industrial, and environmental needs. A new report, USGS Circular 1323 titled *Ground-Water Availability in the United States*, was released in July. The report examines what is known about the Nation's groundwater availability and provides the regional studies by the USGS Ground-Water Resources Program as a long-term effort to understand groundwater availability in major aquifers across the Nation. The report is written for a wide audience interested or involved in the management, protection, and sustainable use of the Nation's water resources. It is available in pdf form on the website listed below.

For info: Thomas Reilly, USGS, email: tereilly@usgs.gov or website: http://pubs.usgs.gov/circ/1323/

WATER BRIEFS

BALLAST WATER US
DISCHARGES & INVASIVE SPECIES

A lawsuit brought by three environmental groups and joined by six Great Lake states has resulted in a Ninth Circuit Court of Appeals decision that requires EPA to regulate ship discharges under the Clean Water Act (CWA) for ballast water. New York, Michigan, Pennsylvania, Illinois, Minnesota, and Wisconsin joined Northwest Environmental Advocates, San Francisco Baykeeper and The Ocean Conservancy in the lawsuit against EPA.

The decision follows a 2005 lower court ruling that EPA had illegally exempted ship discharges from CWA requirements. That decision gave the agency until September 2008 to end the regulatory exemption and issue permits to ships, but EPA appealed that ruling to the Ninth Circuit. The court's July 23 decision upholds the lower court's order directing EPA to take specific action to ensure that shipping companies comply with the CWA and restrict the discharge of invasive species in ballast water. In mid-June, EPA issued a draft permit to regulate all vessel discharges. The draft permit requires treatment of a wide range of pollutants contained in ballast water and many other types of ship discharges.

Live species from other countries are carried to US waters in ballast water that ships use for stabilization. The invasive species include zebra and quagga mussels, as well as 10,000 other marine species. The ballast water is discharged into bays, estuaries, and the Great Lakes as ships approach port and when cargo for export is loaded. Over 21 billion gallons of ballast water from international ports is discharged into US waters each year. According to the plaintiffs' press release, the absence of effective federal action, combined with the high cost of invasive species to the environment, industries, and drinking water sources, has led numerous states to pass their own pollution control laws. The cost of damage caused by invasive species to the US economy is estimated in the billions of dollars annually. Michigan and Minnesota require shippers to have discharge permits. California has the strictest controls on the discharge of ballast-borne invasive species in the world. The plaintiff groups cautioned that the shipping industry has already shifted its fight from the courts to lobbying Congress.

Until the July 23 decision, EPA had exempted certain discharges from the requirement to obtain a permit under the CWA, including effluent from properly functioning marine engines; discharge of laundry, shower, and galley sink wastes from vessels; and "any other discharge incidental to the normal operation of a vessel." As noted in the lower court's Order, "The portion of 40 C.F.R. § 122.3(a) that is particularly relevant in this matter is its exclusion from the NPDES permitting requirements for 'any other discharge incidental to the normal operation of a vessel.' In particular, the EPA has relied on this regulation to exempt a variety of pollutant discharges, including ballast water, from NPDES permitting requirements." Order on Summary Judgment, *Northwest Environmental Advocates, et al. v. EPA,* Case No. C 03-05760 SI (March 30, 2005, page 2).
For info: Deborah Sivas, Stanford Law School Environmental Law Clinic, 650/ 723-0325 or Nina Bell, NWEA, 503/ 295-0490; Order available on NWEA's website: www.northwestenvironmentaladvocates.org/

CWA JURISDICTION US
CORPS ISSUES GUIDANCE

The US Army Corps of Engineers (Corps) issued a Regulatory Guidance Letter (RGL) on June 26, 2008 on Clean Water Act jurisdictional determinations. Approved **j**urisdictional **d**eterminations (JDs) and preliminary JDs are tools used by the Corps to help implement Section 404 of the Clean Water Act (CWA) and Sections 9 and 10 of the Rivers and Harbors Act of 1899 (RHA). The RGL explains the differences between these two types of JDs and provides guidance on when an approved JD is required and when a landowner, permit applicant, or other "affected party" can decline to request and obtain an approved JD and elect to use a preliminary JD instead. This guidance does not address which waterbodies are subject to CWA or RHA jurisdiction. The guidance takes effect immediately.
For info: RGL available on the Corps website: www.usace.army.mil/cw/cecwo/reg/rgls/rgl08-02.pdf

CRIMINAL PROSECUTION MO
CITIZEN'S TIP TO EPA

A citizen's tip to an EPA website resulted in the federal guilty plea on July 31 by a former city official of Lake Ozark, Missouri (City), who failed to report the discharge of raw sewage into the Lake of the Ozarks (Lake). Richard L. Sturgeon of waived his right to a grand jury and pleaded guilty to one felony count of failing to report the discharge. As public works director, Sturgeon was responsible for overseeing the City's wastewater treatment facility and reporting sewage bypasses.

Sturgeon's plea to the federal criminal charge is the first in the nation to result from a tip forwarded to EPA's "Report an Environmental Violation" website (www.epa.gov/compliance/complaints/). Since being launched in 2006, the site has received thousands of tips about potential environmental violations, according to EPA's press release.

The City has a history of bypass events from its wastewater treatment facility's lift stations into the Lake. The City has routinely failed to notify the Missouri Department of Natural Resources (MDNR) when the bypasses occurred, as its permit requires.

On September 11, 2007, MDNR staff observed that a lift station was experiencing a bypass, resulting in a discharge of 10,000 to 15,000 gallons of raw sewage. MDNR noted that the sewage caused a dark plume in the Lake. MDNR notified the City of the bypass, and the City stopped the flow, but conducted no clean up and provided no written notification. On September 13, 2007, MDNR staff visited the site, and no clean up had started. MDNR contacted Sturgeon and requested a clean up. A sample analysis of water collected from the lake showed extremely elevated levels for ammonia nitrogen and fecal coliform exceeding whole body contact recreation criteria.

Under federal statutes, Sturgeon could be sentenced to up to three years in federal prison without parole and fined up to $250,000. Sentencing will occur after the completion of a presentence investigation by the US Probation Office.
For info: Chris Whitley, EPA, 913/ 551-7394 or email: whitley.christopher@epa.gov

CALENDAR

August 14-15 CA
CEQA Conference, Los Angeles. Millenium Biltmore. For info: CLE Int'l, 800/ 873-7130 or website: www.cle.com

August 14-16 CO
Steamboat CLE Conference: 5th Annual Water Law; 5th Annual Environmental Law; 2nd Annual Natural Resources & Energy Law; & 17th Annual Ag & Rural Law Roundup, Steamboat. Sheraton Steamboat Resort. Combined Conference Sponsored by Colorado BAR Sections. For info: Colorado Bar: 888/ 860-2531 or website: www.cobar.org

August 15 HI
National Environmental Policy Act & Hawai'i EIS Law Seminar, Honolulu. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

August 15 WA
Sustaining Living Rivers: Biological Monitoring Workshop, Everett. Northwest Stream Center, McCollum Park. For info: Northwest Stream Center, 425/ 316-8592, email: aasf@streamkeeper.org or website: www.streamkeeper.org/opportun/calendar.htm

August 16-20 ON
American Fisheries Society Annual Meeting, Ottawa. For info: AFS website: www.fisheries.org/afs/

August 17-23 Sweden
World Water Week: "Progress & Prospects in Water," Stockholm. RE: Focus on Sanitation. For info: Katarina Andrzejewska, Stockholm International Water Institute, email: katarina.andrzejewska@siwi.org or website: www.siwi.org

August 18-22 UT
Principles and Practice of Stream Restoration, Part II: Short Course, Logan. Utah State University. For info: Lael Gilbert, USU, 435/ 753-9152, email: lael.gilbert@usu.edu or website: http://uwrl.usu.edu/streamrestoration/default.htm

August 19-21 WA
Advanced ArcGIS 9 for Fisheries and Wildlife Biology Applications Course, Olympia. Evergreen State College. Sponsored by Northwest Environmental Training Center. For info: NWETC website: www.nwetc.org

August 20-22 CO
Colorado Water Congress Summer Convention, Vail. Vail Marriott Mt. Resort & Spa. For info: CWC, 303/ 837-0812 or website: http://cowatercongress.org

August 24-28 CA
National Ass'n of Flood and Stormwater Management Agencies 30th Annual Meeting, Napa. Meritage Resort. For info: NAFSMA website: www.nafsma.org/

August 25-26 OH
Geothermal and Horizontal Drilling Forum: Diversification and Cross-training Strategies, Columbus. Sponsored by National Ground Water Association. For info: NGWA, 800/ 551-7379, email: customerservice@ngwa.org, or website: J186 www.ngwa.org

August 26-27 WA
Introduction to ArcHydro - Managing and Mapping Hydrologic Data with ArcGIS Course, Olympia. Evergreen State College. Sponsored by Northwest Environmental Training Center. For info: NWETC website: www.nwetc.org

August 28-29 CA
Environmental Litigation Seminar, Los Angeles. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

September 2-3 WA
Ecology of Pacific Salmonids Course, Seattle. The Seattle Aquarium. Sponsored by Northwest Environmental Training Center. For info: NWETC website: www.nwetc.org

September 2-5 CA
Floodplain Management Association 2008 Conference, San Diego. Paradise Point Resort. For info: FMA website: www.floodplain.org

September 4-5 WA
Pacific Salmonid Spawning Habitat Restoration Course, Seattle. The Seattle Aquarium. Sponsored by Northwest Environmental Training Center. For info: NWETC website: www.nwetc.org

September 4-5 WA
21st Indian Law Symposium: University of Washington, Seattle. School of Law, William H. Gates Hall. For info: UW website: www.uwcle.org

September 7-10 TX
23rd Annual WateReuse Symposium, Dallas. Hilton Anatole. For info: Courtney Tharpe, WateReuse Association, 703/ 548-0880, ctharpe@watereuse.org or website: www.watereuse.org

September 8-11 CO
Planning for an Uncertain Future: Monitoring, Integration and Adaptation, Estes Park. Aspen Lodge. RE: Third Interagency Conference on Reseach in our Watersheds. For info: Rick Webb, USGS email: rmwebb@usgs.gov or conference website: www.hydrologicscience.org/icrw/

September 9-10 OR
Aquaculture Forum, Newport. Hatfield Marine Science Center. RE: Risks & Opportunities for Offshore Aquaculture in the Pacific Northwest. For info: OSU website: http://oregonstate.edu/conferences/aquaculture2008

September 10-11 MD
American Forest Foundation Conservation Incentives Workshop, Ellicott City. For info: Todd Gartner, AFF, 202/ 463-5181, email: TGartner@forestfoundation.org or website: www.regonline.com/builder/site/Default.aspx?eventid=618417

September 10-12 WA
Urban Waterfront Revitalization Conference and Workshop, Bremerton. Hosted by the City of Bremerton. For info: Treena Colby, 206/ 226-7224, email: tcolby@athenacompany.com or website: www.uwrconference.com

September 11-12 CA
ACWA Water Law Workshop, Napa. Sponsored by the Association of California Water Agencies. For info: Lori Doucette, ACWA, 888/ 666-2292, email: lorid@acwa.com or website: www.acwa.com

September 11-12 CA
Introductory Statistics for Environmental Professionals Course, Costa Mesa. For info: NGWA, 800-551-7379 or website: www.ngwa.org

September 11-12 CO
Western Water Law Seminar, Denver. Hyatt Convention Center. Sponsored by CLE Int'l. For info: CLE Int'l, 800/ 873-7130 or website: www.cle.com

September 11-12 MT
Montana Water Policy Interim Committee Meeting, Helena. For info: Krista Lee Evans, Lead Staff, 406/ 444-1640; Committee website: www.leg.mt.gov

September 11-12 OR
Oregon Department of Fish and Wildlife Commission Meeting, Forest Grove. For info: Director's Office ODFW, 503/ 947-6044, email: odfw.commission@state.or.us, or website: www.dfw.state.or.us

September 12 OR
Toxics Seminar, Portland. World Trade Center. For info: Holly Duncan, Environmental Law Education Center, 503/ 282-5220, email: hduncan@elecenter.com or website: www.elecenter.com

September 15-16 CA
California Wetlands Seminar, Los Angeles. For info: CLE Int'l, 800/ 873-7130 or website: www.cle.com

September 15-17 MT
Headwaters Summit 2008: Re-Visioning How We Use Water in a Changing Environment, Missoula. Organized by Western Progress, National Wildlife Federation & Clark Fork Coalition. For info: Garrett Budds, CFC, 406/ 542-0539 or website: www.northernheadwaters.org

September 15-18 AZ
Wastewater Treatment and Collection Systems ADEQ Certification Class, Tucson. Beaudry's RV Resort. Organized by Ragsdale and Associates: Training Specialists, LLC. For info: Kat Ragsdale, 505/ 293-4658

September 15-19 OR
Wetlands 2008: Wetlands & Global Climate Change Conference, Portland. DoubleTree Hotel & Lloyd Center. Sponsored by the Association of State Wetland Managers, Inc., Pacific NW Chapter of the Society of Wetland Scientists, EPA & Oregon Dept. of State Lands. For info: Laura Burchill, ASWM, 207/ 892-3399, email: laura@aswm.org or website: www.aswm.org

September 17-20 AZ
16th Section Fall Meeting - ABA Section of Environment, Energy & Resources, Phoenix. For info: ABA Section on Environment, Energy & Resources, 312/988-5724 or website: www.abanet.org/environ/

September 17-20 OR
Managing Water in a Climate Changing World: Implications for Irrigation, Drainage & Flood Control, Portland. USCID Water Management Conference. For info: Larry Stephens, USCID, 303/ 628-5430, email: stephens@uscid.org or website: www.uscid.org/08gcc.html

September 18-19 TX
Texas Water Law Seminar, Austin. Omni Downtown. For info: CLE Int'l, 800/ 873-7130 or website: www.cle.com

September 18-19 CA
Conservation Easements Seminar, San Francisco. Grand Hyatt. For info: CLE Int'l, 800/ 873-7130 or website: www.cle.com

September 19 CA
California Environmental Quality Act Seminar, Santa Monica. DoubleTree Guest Suites. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

September 20-24 AZ
Changing Waterscapes & Water Ethics for the 21st Century: 2008 Annual Symposium, Flagstaff. High Country Conference Center (NAU). Sponsored by the American Institute of Professional Geologists & Arizona Hydrological Society. For info: AIPG website: www.aipg.org

September 21-22 MT
Public Land Law Conference, Missoula. University of Montana. Sponsored by Public Land & Resources Law Review & the Public Policy Research Institute. For info: PLRLR, 406/ 243-6568, email: plrlr@umontana.edu or website: www.umt.edu/publicland

September 21-24 Canada
GeoEdmonton '08 Conference, Edmonton. Westin Hotel. Joint Geotechnical & Groundwater Conference. For info: Conference website: www.geoedmonton08.ca

September 21-24 OH
Ground Water Protection Council Annual Forum, Cincinnati. Millenium Hotel. For info: GWPC website: www.gwpc.org

September 22 OR
Stormwater Management Seminar, Portland. For info: Holly Duncan, Environmental Law Education Center, 503/ 282-5220, email: hduncan@elecenter.com or website: www.elecenter.com

September 22-23 FL
Aquifer Storage Recovery VIII, Orlando. Holiday Inn Select-Airport. For info: American Ground Water Trust website: www.agwt.org

September 22-23 CA
Energy in California Seminar, San Francisco. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

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September 22-26 WA
Introduction to Engineered Log Jam: Technology and Applications for Erosion Control and Fish Habitat Training, La Push. Quileute Ocean-Side Resort. RE: Tool for Restoring Fluvial Ecosystems & Solving Traditional River Management Problems. For info: Renata Sobol, NW Environmental Training Center, 206/ 762-1976 or website: www.nwetc.org

September 23-24 ID
Groundwater Connection: Merging Policy, Issues & Science, Boise. DoubleTree Riverside. Sponsored by the Idaho Water Resources Research Institute. For info: Julie Scanlin, IWRRI, 208/ 332-4414, email: jscanlin@uidaho.edu or website: www.iwrri.uidaho.edu/default.aspx?pid=33437

September 24-26 CA
Climate Change Workshop, Irvine. Hilton Irvin/Orange Co. Airport Irvine. Sponsored by Western Governor's Ass'n, Western States Water Council & California Dept. of Water Resources. For info: Western Governor's website: www.westgov.org/

September 24-26 OR
Western Stewardship Summit, Sun River. For info: Sustainable Northwest website: www.sustainablenorthwest.org/wss

September 25-26 FL
Florida Water Law Conference, Tampa. Mariott Westshore. For info: CLE International, 800/ 873-7130 or website: www.cle.com

September 25-26 MT
4th Annual Montana Agriculture Conference, Billings. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

September 25-26 CA
Groundwater: Challenges to Meeting Our Future Needs, Costa Mesa. Hilton Orange County. Sponsored by the Groundwater Resources Ass'n of California. For info: GRAC, 916/ 446-3626 or website: www.grac.org

September 26 CA
California Environmental Quality Act & National Environmental Policy Act Seminar, Santa Monica. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

October 1 OR
GoGreen '08 Educational Conference, Portland. For info: Conference website: www.gogreenpdx.com

October 2-3 CO
Remediation of Abandoned Mine Lands Conference, Denver. National Groundwater Association Conference. For info: NGWA, 800-551-7379 or website: www.ngwa.org

October 2-3 OR
Pacific Salmonid Spawning Habitat Restoration Course, Portland. Audubon Society of Portland. Sponsored by Northwest Environmental Training Center. For info: NWETC website: www.nwetc.org

October 2-3 CO
Remediation of Abandoned Mine Lands: National Groundwater Association Conference, Denver. Co-Sponsored by US EPA. For info: www.ngwa.org/development/conferences.aspx

October 3 WA
Shoreline Permitting Seminar, Seattle. For info: Law Seminars Int'l, 800/ 854-8009, email: registrar@lawseminars.com, or website: www.lawseminars.com

October 5-9 TX
2008 Joint Annual Meeting: Celebrating the Internation Year of Planet Earth, Houston. George R. Brown Convention Center. Sponsored by Geological Society of America & Others. For info: Conference website: www.acsmeetings.org/

October 7 WA
Hanford State of the Site Meeting, Tri-Cities. Hosted by Tri-Party Agreement (TPA) Agencies. RE: Groundwater Shoreline Cleanup, Waste Treatment Plan for Underground Tank Waste & Other Cleanup Issues. For info: Madeleine C. Brown, Washington Ecology, 509/ 732-7936 or email: mabr461@ecy.wa.gov

October 7 ID
Palouse Basin Water Summit, Moscow. Sponsored by the Idaho Water Resources Research Institute. For info: Julie Scanlin, IWRRI, 208/ 332-4414, email: jscanlin@uidaho.edu or website: www.iwrri.uidaho.edu/default.aspx?pid=33437

October 7-9 TX
Interdisciplinary Solutions to Instream Flow Problems Seminar, San Antonio. El Tropicano Riverwalk Hotel. For info: Kathleen Williams, Instream Flow Council, 406/ 586-6879 or website: www.instreamflowcouncil.org

October 8-10 NV
WaterSmart Innovations Conference & Expo, Las Vegas. South Point Hotel & Casino. Sponsored by Southern Nevada Water Authority and US EPA's WaterSense Program. For info: WSI, 702/ 731-3580 or website: www.watersmartinnovations.com/

October 9 WA
Hanford State of the Site Meeting, Seattle. Hosted by Tri-Party Agreement (TPA) Agencies. RE: Groundwater Shoreline Cleanup, Waste Treatment Plan for Underground Tank Waste & Other Cleanup Issues. For info: Madeleine C. Brown, Washington Ecology, 509/ 732-7936 or email: mabr461@ecy.wa.gov

October 9-10 MT
8th Annual Montana Water Law Conference, Helena. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

October 10 OR
Living on a Finite Earth: Energy Law & Policy for a New Era Symposium, Eugene. University of Oregon, Knight Law Center. Sponsored by the Journal of Environmental Law & Litigaion. For info: Kelly Fahl, JELL, email: kfahl@uoregon.edu or website: www.law.uoregon.edu/org/jell/

October 10 OR
Oregon Department of Fish and Wildlife Commission Meeting, Salem. ODFW Hdqtrs. For info: Director's Office ODFW, 503/ 947-6044, email: odfw.commission@state.or.us, or website: www.dfw.state.or.us

October 12-15 OR
International Conference on Nonrenewable Ground Water Resources Sociotechnological Aspects, Portland. Sponsored by National Ground Water Association, Institute for Water & Watersheds, The World Bank & International Hydrological Programme of UNESCO. For info: NGWA, 800-551-7379 or website: www.ngwa.org

October 14-16 Italy
"The Role of Hydrology in Water Resources Management" Symposium, Island of Capri (near Naples). For info: Sabina Perfido, email: sabina.porfido@iamc.cnr.it or Symposium website: www.cig.ensmp.fr/~iahs/

October 14-17 WA
American Public Works Association (APWA) Washington Chapter Fall Conference, Walla Walla. Whitman Hotel Conference Center. RE: Practical Innovation in the Field of Public Works. For info: Mike Terrell, 206/ 684-3078 or email: michael.terrell@seattle.gov

October 15-17 CA
2008 Water Quality & Regulatory Conference, Ontario. DoubleTree Hotel. For info: Jo McAndrews, McAndrews & Boyd, 951/ 787-9287, email: sayhijo@empirenet.com or website: www.eastvalley.org

The Water Report
Water Rights, Water Quality & Water Solutions in the West
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