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STATE AUTHORITY & HYDROPOWER

SUPREME COURT AFFIRMS STATE AUTHORITY

S. D. WARREN v. MAINE

by Richard M. Glick, Davis Wright Tremaine, LLP (Portland)

On May 15, 2005, a unanimous US Supreme Court held in *S. D. Warren v. Maine Board of Environmental Protection,* 547 US ___ (2006), that non-polluting hydroelectric projects are subject to Clean Water Act (CWA) § 401. The issue was whether water passing through dams that themselves add no pollutants, constitutes a "discharge" so that state certification is required under section 401.

CWA § 401(a)(1), 33 USC § 1341(a)(1), provides that any applicant for a federal permit to conduct any activity that "may result in any discharge into the navigable waters" must obtain certification from the state in which the discharge originates that the discharge will not violate water quality standards. Through this provision, the states are infused with federal authority. The extent of this authority, and the inherent conflict between state and federal power, has many times been tested in the context of hydroelectric power project licensing under the Federal Power Act (FPA). In *First Iowa Hydro-Electric Cooperative v. Federal Power Com'n.*, 328 US 152 (1946), the Supreme Court held that the Federal Power Act confers upon the Federal Energy Regulatory Commission ("FERC"—formerly the Federal Power Commission) paramount authority over hydroelectric licensing, with narrow exceptions such as regulation of state water rights. States are pre-empted from imposing duplicative regulatory burdens on FERC applicants and licensees, which are already subject to a comprehensive environmental regulatory scheme under the FPA. (See Moon, TWR #12 for a general discussion of water quality certification under § 401 of the CWA.)

However, citing CWA § 401, the Court significantly expanded the range of water quality related matters subject to state regulation. In *PUD No. 1 of Jefferson County v. Washington Dept. of Ecology*, 511 US 700 (1994), the Court allowed imposition by the state of flow requirements that the Department of Ecology deemed integral to water quality. The question of what constitutes a "discharge" for purposes of § 401 jurisdiction was not addressed, as the fact of a discharge was not at issue in that case.

Courts have held that dams are not point sources that require National Pollution Discharge Elimination System (NPDES) permits under CWA § 402, 33 USC § 1342, solely because they "discharge" pollutants by passing upstream polluted water through or over the dam. *National Wildlife Federation v. Gorsuch*, 693 F2d 156 (DC Cir. 1982) and *National Wildlife Federation v. Consumers Power Co.*, 862 F2d 580 (6th Cir. 1988). The courts noted that dams may alter the condition of a waterway, but absent the addition of a pollutant by dam operations were not subject to regulation:

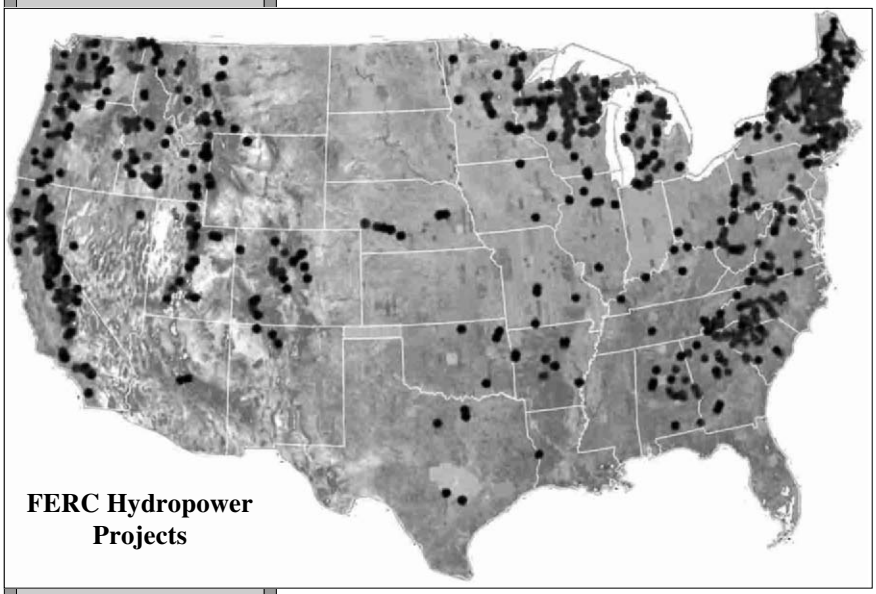
> . . . generally water quality changes caused by the existence of dams and other similar structures were intended by Congress to be regulated under the "nonpoint source" category of pollution.
> *Consumers Power* at 588.

Hydropower Ruling

Case Background

Also in the CWA § 402 context, the Supreme Court had the opportunity to clarify whether water transfers through man-made obstructions result in a "discharge of pollutants" in *South Florida Water Management Dist. v. Miccosukee Tribe of Indians*, 541 US 95 (2004) [see Glick, TWR #2], but stopped short of a definitive ruling. The Court did note, however, that polluted waters flowing from a canal into a wetlands would constitute a discharge of pollutants only if the two water bodies were meaningfully distinct. The Court quoted approvingly from a lower court ruling that "if one takes a ladle of soup from a pot, lifts it above the pot, and pours it back into the pot, one has not 'added' soup or anything else to the pot." *Id.* at 110, citation omitted. The Court remanded the case for further evidence on the question of the distinctness of the water bodies.

The *S. D. Warren* case follows on this history. The petitioner there sought a ruling that the mere passage of already polluted water that enters the petitioner's dam and is passed unchanged back to the stream below the dam, is not a "discharge" that triggers CWA § 401 jurisdiction. Warren owns and operates five hydroelectric dams on the Presumpscot River in Maine, constructed in the early 1900s. The dams operate as run-of-river impoundments and have no meaningful storage capacity. It is undisputed that the dams do not add pollutants, though they do alter river flows, which of course affects aquatic habitat.



FERC Hydropower Projects

While reserving the question of the state's jurisdiction because the dams do not result in a discharge, Warren applied for § 401 certification. Certification was granted, but the Department of Environmental Protection imposed "extensive restrictions on the operation of the facilities, resulting in a projected loss of energy equivalent to roughly one-seventh of the dams' electric generation (10,000 barrels of oil per year)." Warren Petition for Writ of Certiorari at 9. These restrictions related to flows, fish passage, mitigation for loss of dissolved oxygen and recreational facilities. Warren appealed to the state's highest court and lost. *S. D. Warren Co. v. Board of Environmental Protection*, 2005 ME 27.

Warren's central argument focused on the meaning of "discharge" as used in § 401. The term "discharge" is not defined in the CWA, but the Act provides that when the term is used without qualification, it "includes a discharge of a pollutant, and a discharge of pollutants." 33 USC § 1362(16). The terms "discharge of a pollutant" and "discharge of pollutants" are defined to mean "any addition of any pollutant to navigable waters from any point source." 33 USC § 1362(12). Since the Warren projects did not "add" any pollutants, Warren argued that, as a matter of law, there is no discharge to trigger § 401.

The Maine Supreme Judicial Court acknowledged that operation of the Warren dams does not add pollutants to the river, and agreed that an addition of pollutants is necessary for there to be a discharge for § 401 purposes. This notwithstanding, the court advanced a novel theory for finding that a "discharge" had occurred. The court reasoned that water passing through a dam is subject to private control and thus temporarily loses its status as waters of the United States. Therefore, when the impounded water is returned to the stream through the tail race, this results in an "addition" of waters that are not waters of the United States.

The Court affirmed the Maine high court, but summarily rejected its reasoning in a footnote:

> We disagree that an addition is fundamental to any discharge, nor can we agree that one can denationalize national waters by exerting private control over them.
> Slip Op. at 7, fn. 5.

Instead, the Court took a more common sense approach to the distinction between "discharge" under § 401 and "discharge of pollutants" under § 402. Justice Souter, writing for the Court, concluded that "'discharge' presumably is broader, else superfluous" and turned to a Webster's dictionary definition, of "flowing or issuing out." *Id*. at 4. Water clearly flows out of the Warren dams, and thus constitutes a discharge.

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Hydropower Ruling

Triggers Distinguished

Permitee Concerns

States' Purview

The Court did not consider applicable its recent holding in *South Fla. Water Management Dist. v. Miccosukee Tribe*, 541 US 95 (2004). As noted above, that case interpreted CWA § 402, not § 401, and concerned whether transferring polluted water unchanged from one water body to another constituted an "addition" of pollutants. The Court concluded that such a transfer, if it occurred, is not an "addition," and therefore that a NPDES permit from the state is not required.

The *Warren* Court distinguished the trigger for § 402 from the trigger for § 401, holding that the latter does not require an addition: "In sum, the understanding that something must be added in order to implicate §402 does not explain what suffices for a discharge under §401." Slip Op. at 9. Thus, the *Warren* case is not likely to have significant implications for the scope of state NPDES permit authority, and provides no guidance for the *Miccosukee* remand.

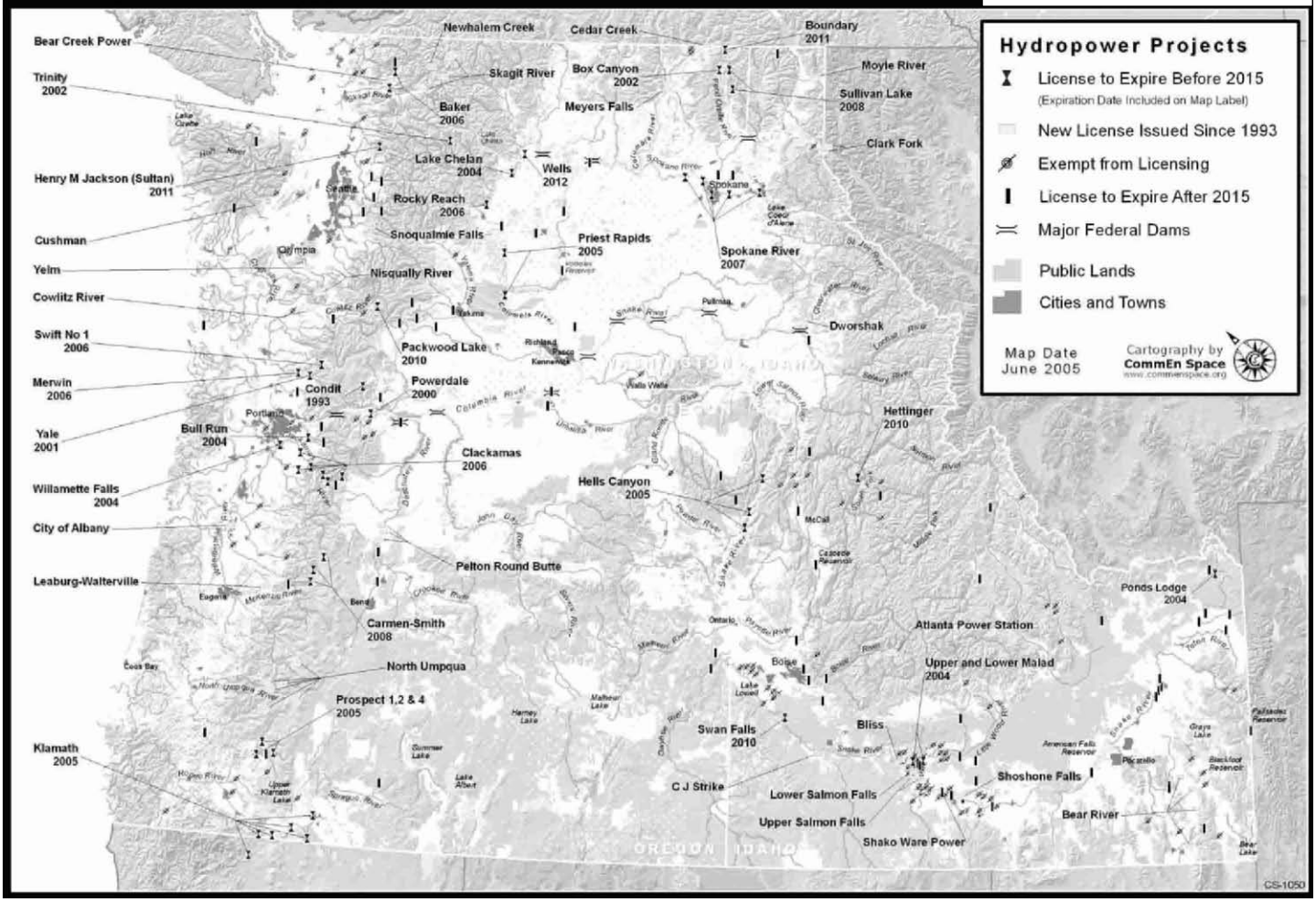
Of particular concern for owners of hydropower facilities or applicants for other federal permits (such as CWA § 404 fill permits), the Court gave a ringing endorsement of state § 401 authority. The Court noted that the restorative goals of the CWA go beyond preventing the "addition" of pollutants, and deal more broadly with "pollution," which the Act defines as "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water." 33 USC § 1362(19). The Court then drew from the record as to the changes wrought by the Warren projects, including destruction of aquatic habitat, blockage of migratory fish passage, reduced dissolved oxygen, and reduced recreational opportunities, and concluded:

> Changes in the river like these fall within a State's legitimate legislative business, and the Clean Water Act provides for a system that respects the States' concerns.
> Slip Op. at 14.

FERC HYDROPOWER PROJECTS

Washington, Oregon, & Idaho

TWR thanks the **Hydropower Reform Coalition** [website below] for allowing us to use their maps to accompany this article.



FERC HYDROPOWER PROJECTS
California

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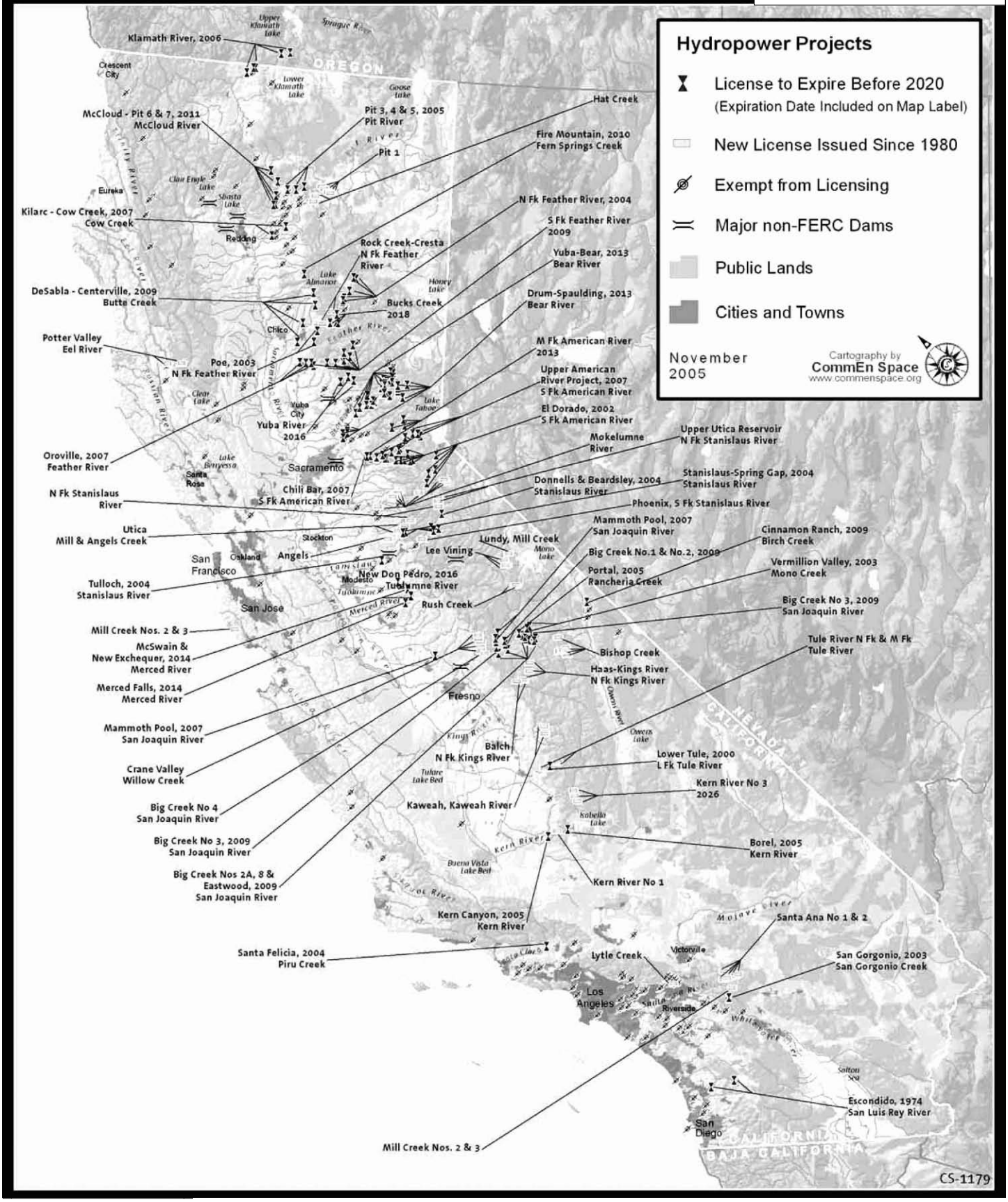

Hydropower Ruling

§ 401 Authority

States Emboldened?

FPA v. CWA

Future Conflict?

This rather sweeping dicta confirms many states' long-held view that authority under § 401 extends far beyond protection of water quality standards. The Court continued: "State certifications under § 401 are essential in the scheme to preserve state authority to address the broad range of pollution," and citing Senator Muskie's floor speech in favor of enacting § 401, concluded:

> These are the very reasons that Congress provided the States with power to enforce "any other appropriate requirement of State law," 33 U.S.C. §1341(d), by imposing conditions on federal licenses for activities that may result in a discharge [citation omitted]. Reading § 401 to give "discharge" its common and ordinary meaning preserves the state authority apparently intended." Slip Op. at 15.

Thus, the states may feel emboldened to exercise authority beyond mere water quality parameters to cover recreation, fish passage and the panoply of changes to river conditions brought about by dams. If pressed too far, such an assertion of authority could bring the Clean Water Act in confrontation with the Federal Power Act. FPA § 10(a) places water power development and protection of instream values on an equal footing:

> That the project adopted . . . shall be such as in the judgment of the [FERC] will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial public uses, including irrigation, flood control, water supply, and recreational and other purposes . . .
> 16 USC § 803(a)(1).

Conclusion

It is clear that Congress intended hydroelectric projects to be protective of the natural environment, but it is also clear that Congress intended there to *be* hydroelectric projects. If the effect of state implementation of CWA § 401 is to duplicate the comprehensive regulatory scheme established by the FPA, or to render uneconomic a project undergoing relicensing, the conflict that the Supreme Court tried to lay to rest in *First Iowa, supra,* will rise again. 16 USC § 803(a)(1).

[Editor's Note: The greatest amount of authorized generating capacity - approximately 7,420 megawatts - will come up for relicensing in 2007. Between 2005 and 2015, the top five states for number of licenses expiring are California, New York, Oregon, Washington and North Carolina.]

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Editors' Note: The Hydropower Reform Coalition website contains links to the Supreme Court's opinion, in addition to the briefs of the parties and a transcript of the oral argument. [See http://hydroreform.org/SDWarren.asp] We would like to express our gratitude for the Coalition's help in obtaining the graphics we ran with this story.
Your author for this story is not associated with the Hydropower Reform Coalition.

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Mixing Zones

Loophole or Strategy

Definition

MIXING ZONES

AN OVERVIEW OF SOME WESTERN STATES

by Gregg Bryden, Kennedy/Jenks Consultants (Portland, OR)

INTRODUCTION

Recently there has been considerable controversy and activity surrounding mixing zones in Washington, Oregon and California. Some environmental groups claim mixing zones are a "loophole" in the federal Clean Water Act (CWA) that allows "toxic" discharges. Other interests are promoting the practicality of using the assimilative capacity of natural systems as an effective pollution control strategy. Mixing zones are often applied when permitting municipal discharges as well as industrial discharges. Changes to mixing zone policy could have a significant impact on residential rate payers and those industries that discharge to Publicly Owned Treatment Works (POTWs), as well as direct dischargers. As background for the debate, this article provides an overview of mixing zone regulations, science, and application.

MIXING ZONES

Before delving into the regulation and science of mixing zones, it is useful to define just what is meant by a "mixing zone." Typically, a mixing zone is the area in the vicinity of a facility's effluent discharge where mixing with a receiving waterbody takes place. Figure 1 depicts a classic mixing zone with a plume forming downstream of a single point of discharge. Mixing occurs through several hydrodynamic mechanisms. In the immediate vicinity of the point of discharge, turbulent sheering forces entrain and mix water due to differences in velocity (jet mixing) and differences in buoyancy caused by salinity or temperature-induced density differences between the discharge and receiving water. The near-field region where this turbulent rapid mixing takes place is often referred to the Zone of Initial Dilution (ZID). Generally, the size of ZIDs are based on site-specific physical processes; however, their size may be capped by regulation. ZIDs are typically small because the rapid mixing quickly dissipates the velocity and/or buoyancy differences that drive the initial mixing.

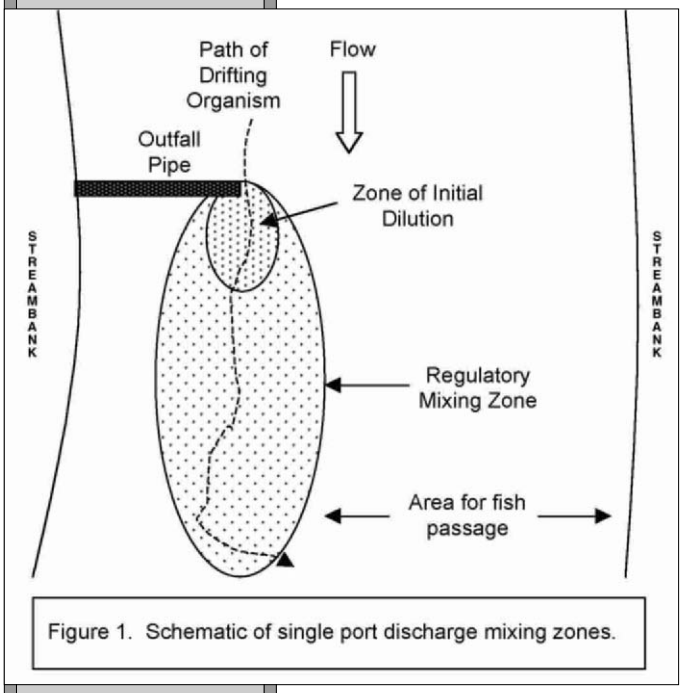


Figure 1. Schematic of single port discharge mixing zones.

In the far-field region beyond the ZID, other mixing processes such as diffusion and turbulence in the receiving water dominate the mixing process. These mixing processes are typically slower than the rapid mixing in the ZID and, as a result, they involve larger volumes. These far-field areas are often defined as Regulatory Mixing Zones (RMZs) where regulatory policy sets the boundaries at which water quality standards must be met. While the slower diffusive mixing may continue beyond the boundary of the RMZ, all water quality standards must be met at the edge of RMZ.

State Discretion

Technical Basis

Compliance Demonstration

REGULATORY BASIS FOR MIXING ZONES

Mixing zones are not specifically mentioned in the CWA and its amendments. In implementing the CWA, however, US Environmental Protection Agency (EPA) water quality standards regulations (40 CFR §131.13, General policies) stipulate that:

> "States may, at their discretion, include in their State standards, policies generally affecting their application and implementation, such as mixing zones, low flows and variances. Such policies are subject to EPA review and approval."

In addition to this regulation, EPA's *Technical Support Document for Water Quality-based Toxics Control* (EPA 505/2-90-001, March 1991) provides the technical basis for:

- Determining mixing zone boundaries
- Minimizing the size of mixing zones
- Preventing lethality to passing organisms
- Preventing bioaccumulation problems for human health

The *Technical Support Document* also provides guidance on how to conduct mixing zone studies to demonstrate compliance, including:

- General recommendations for outfall design
- Critical design periods for waterbodies

Mixing Zones

Quality Concepts

Gidance Document

Critical Flow

Policy Varies

Addressing Consistency

General Requirements

Design Requirements

- General recommendations for tracer studies
- Discharge-induced mixing
- Ambient-induced mixing

The *Technical Support Document* — which provides the basis for water quality-based toxics control permitting in most states — supplies many of the basic concepts involved in state regulation of mixing zones. Concepts from the *Technical Support Document* that are common to most state implementations include: keeping mixing zones as small as possible; avoiding sensitive habitats; and not impairing the overall health of the receiving water body.

Implementation in California

In California, each Regional Water Quality Control Board (RWQCB) is responsible for setting mixing zone policy as part of its Basin Plan. The mixing policies set by these regional boards are typically based on the guidance found in *The Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* [see website: www.swrcb.ca.gov/iswp/docs/final.pdf], which is part of California's State Implementation Plan (SIP). The SIP sets policy for establishing mixing zones and stipulates criteria for conducting mixing zone studies. For instance, the SIP requires that mixing zones be established under critical flow conditions, which represents worst-case conditions under which acute, chronic, and human health based water quality standards must be met.

Not all of California's RWQCBs have established mixing zone policy. For instance, the North Coast RWQCB began work on modifying its Basin Plan to include a mixing zone policy; however, the status of support for this project is currently uncertain. The North Coast RWQCB has recognized that dischargers may demonstrate that effluent limitations set forth in the California Toxics Rule and SIP are not reasonably possible to achieve. While the SIP includes a provision for the Regional Water Board to consider use of mixing zones on a discharge-by-discharge basis, it is not certain how mixing zones would be implemented in this region. Check with your area's RWQCB regarding mixing zone policy status.

Implementation in Oregon

The Oregon Department of Environmental Quality (ODEQ) has allowed mixing zones in its policy and regulations (OAR 340-041-0053) for many years. However, there has been some inconsistency in the application of mixing zone regulations and in the conduct of of mixing studies. To address these inconsistencies, ODEQ has recently issued a draft *Regulatory Mixing Zone Internal Management Directive* (draft IMD) on mixing zones [see website: www.deq.state.or.us/wq/wqpermit/wqPolicies.htm].

The first part of the draft IMD covers allocation of mixing zones. To qualify for a mixing zone in Oregon, the discharger must demonstrate that highest and best practicable treatment and/or control of wastes, activities, and flows are provided.

In addition, mixing zones must be:

- Free of materials in concentrations that will cause acute toxicity to aquatic life (acute toxicity in 100% effluent as measured by a bioassay test may be allowed if it can be demonstrated that immediate dilution of the effluent within the regulatory mixing zone reduces toxicity below lethal concentrations)
- Free of materials the will settle to form objectionable deposits
- Free of floating debris, oil, scum, or other materials that cause nuisance
- Free of substances in concentrations that produce deleterious amounts of fungal or bacterial growths
- As small as feasible
- Sized to avoid overlap with other mixing zones to the extent possible
- Less than the total stream width as necessary to allow passage of fish and other aquatic organisms
- Sized to minimize adverse effects on the indigenous biological community especially when species are present that warrant special protection
- Sized so it does not threaten public health

Also, a mixing zone's outfall must be designed and located to avoid:

- Impingement on critical or sensitive habitat, such as cold water refugia, structural habitat (e.g., large woody debris), or other critical habitat (e.g. backwaters, sloughs, coves, etc.)
- Impingement on salmonid spawning areas, littoral (shore) zones, shellfish growing habitat, and benthic habitat by not allowing shore and bottom-hugging plumes
- Encroachment on drinking water intakes
- Known fish harvesting and recreational swimming areas

Mixing zones in Oregon must also allow for a zone-of-passage of 75% of the cross-sectional area or volume of flow of a stream or estuary

Part II of the draft IMD covers the methods for conducting mixing zone studies. ODEQ has established protocols that allow various levels of effort for mixing zone studies depending upon the

Mixing Zones

Tiered Approach

discharge characteristics. The complexity of a mixing zone study depends upon the nature of the discharge and sensitivity of the receiving water.

To determine the minimum information needed in a study, ODEQ has classified discharges into three effort levels:

LEVEL 1 (simple) represents the simplest approach if a discharge has a low level of risk to ecological resources and public health. This level is appropriate for:

- A discharge with no potential to exceed acute criteria at the end-of-pipe (except for toxicity due to chlorine and ammonia, which are quickly assimilated) where available dilution in the receiving water is greater than 20 times 25% of critical flow (e.g. the discharge flow should be no greater than 5% of 25% of the critical flow condition), *and*
- Where the discharge is not classified as "major" (i.e., greater than one **m**illion **g**allons per **d**ay (1 MGD) or by other factors defined by EPA).

LEVEL 2 (moderate) represents the next tier of complexity and is appropriate for:

- A discharge with the potential to exceed acute criteria at the end-of-pipe (due to pollutants other than chlorine and ammonia) where available dilution in the receiving water is greater than 20 times 25% of critical flow, *or*
- A discharge that meets the acute criteria at end-of-pipe, but available dilution in the receiving water is less than 20 times 25% of critical flow

LEVEL 3 (complex) is the most complex approach and is expected if there is a:

- Significant environmental risk, *or*
- Potential for exceeding acute criteria exist at the end-of-pipe (due to pollutants other than chlorine and ammonia) and available dilution in the receiving water is less than 20 times 25% of critical flow.

The IMD requires certain minimum requirements for mixing zone studies.

Study Requirements

MIXING ZONE STUDIES MUST INCLUDE:

- Environmental mapping: a map and characterization of the specific habitats, critical resource areas, and other beneficial uses of the receiving water
- Outfall and mixing zone characteristics: a description of the existing or proposed mixing zone, including a description of existing or proposed outfalls
- Ambient receiving water conditions
- Discharge characteristics

Modeling

- Mixing zone modeling analysis: Information on the model used, why it was selected over other models, and results of the modeling exercise — results of the modeling exercise will predict available dilution in the receiving water.
- Additional water quality data needed to determine if the applicant's discharge will comply with water quality standards — this data is not necessary for input into a mixing zone model; however, if it was not provided in the permit application or more data is needed, the permit writer may request it as part of the overall mixing zone study

Implementation in Washington

"AKART"

The authority to grant mixing zones is codified in Washington Administrative Code (WAC) 173-201A-400. This regulation requires that mixing zones may only be granted when the discharge meets "**a**ll **k**nown, **a**vailable, and **r**easonable methods of prevention, control, and **t**reatment" (AKART). The regulations also limit the size of mixing zones and protect sensitive habitat. (See Moon, TWR#23)

Stormwater Addressed

Washington State's Department of Ecology (Ecology) has also had the foresight to anticipate mixing zones for stormwater discharges. Requirements to conduct mixing zone studies for individual stormwater permits are beginning to appear in new and renewed individual stormwater permits to address water quality-based stormwater permit limits (as opposed to benchmarks or goals). Ecology does not necessarily require treatment of stormwater to qualify for a mixing zone—best management practices are considered AKART for stormwater.

Guidance

Ecology guidance on conducting mixing zone studies is provided in Appendix 6 of Ecology's *Water Quality Program Permit Writer's Manual*, Publication Number 92-109, Revised July 2005 [see website: www.ecy.wa.gov/pubs/92109.pdf]. This document prescribes specific critical flow conditions and appropriate methods under which mixing zone studies should be conducted.

Mixing Zones Allowed

Other States

While some states do not have specific mixing zone regulatory authorization or guidance, most states allow mixing zones in one form or another. Mixing zones are sometimes established through detailed studies, or in some cases using simple bulk dilution assumptions based on a portion of the receiving water flow.

Mixing Zones

States' Authorizations

PBT Ban

Phase-Out

Economic Exception

Criticism

Protecting Uses

Sensitive Species

Acute Toxicity

Sub-Lethal Effects

Human Health Criteria

Fish Consumption

Idaho has mixing zone authorization regulations (Idaho Administrative Procedures Act 58 Section 60) as does Alaska (Alaska Administrative Code, Title 18, Chapter 60, Section 70.240). While mixing zones may be less critical in arid western states where wastewater is land applied or recycled, Arizona, Nevada, and Colorado do have mixing zone regulations (see: Arizona Administrative Code, Title 18, Chapter 11, Section 114; Nevada Administrative Code, Chapter 445A, Section 115; and 5 Colorado Code of Regulations, Chapter 51002 Section 10). All of these states have protective measures similar to those discussed above for the Pacific Northwest and California.

To address concerns over **b**ioaccumulative **c**hemicals of **c**oncern (BCCs), EPA instituted a phase-down and ban of mixing zones for **p**ersistent **b**ioaccumulative **t**oxics (PBTs) in the Great Lakes Region beginning in 2000. EPA and states discharging to the Great Lakes recognize that the receiving waters are closed systems that can accumulate PBTs, and that mixing zones for these constituents is not appropriate because the toxics can build up in water, sediments, and organism tissues. BCCs include an array of pesticides, **p**oly**c**hlorinated **b**iphenyls (PCBs), dioxins, and mercury. This rule bans new discharges of bioaccumulative chemicals into mixing zones and phases out the use of existing mixing zones over a ten-year period. EPA estimates that phasing out BCC mixing zones over the next decade will eliminate up to 700,000 pounds a year of chemicals that accumulate in fish and wildlife. EPA includes a limited exception that would allow minimal use of mixing zones for discharges of bioaccumulative chemicals for existing facilities that may suffer unreasonable economic effects. There has been some criticism of the effectiveness of the ban because of the economic effects provision. Ultimately, the success of the program will be measured directly through the study of fish tissues and sediments.

A similar but voluntary approach to banning PBT mixing zones is being developed for the Chesapeake Bay region as part of the Chesapeake Bay Program.

THE SCIENTIFIC BASIS OF MIXING ZONES

As mentioned in the introduction, some organizations have sought to ban mixing zones because they are seen as a regulatory "loophole" which creates areas of toxicity in receiving water and allows an unacceptable amount of pollutants to be discharged. However, there is a scientific basis for allowing mixing zones that recognizes the basis for setting water quality standards and the assimilative capacity of receiving water.

Water Quality Standards and Mixing Zones

Water quality standards are established to protect beneficial uses of the receiving water. These beneficial uses include fishable, swimmable waters, and drinking water resources. Ambient water quality standards, which are set by state agencies and approved by EPA, are developed scientifically to protect organisms that live in the receiving water and the health of people who swim in the water, eat fish or other organisms harvested in the waters, and who drink the water.

Aquatic organisms are protected through acute and chronic water quality standards. To protect a wide variety of species, toxicity standards are generally set at thresholds that protect the most sensitive population of the most sensitive species. In addition, to protect human health associated with consumption of the aquatic organisms, standards are set to minimize the health risk from accumulated pollutants in tissues.

Acute toxicity water quality standards are set to prevent the immediate mortality of an organism as a result of exposure to a pollutant. Acute water quality standards are set by surveying a large pool of bioassay data for a given constituent. The bioassays define acute toxicity as the concentration that produces mortality during a *one hour exposure*.

Chronic toxicity water quality standards are set in a similar way using pooled bioassay data; however, the end point is not mortality. Chronic end points may include reduced fecundity, reduced growth rates, or other sub-lethal effects. Chronic bioassays are based on a *four day exposure*.

Human health based criteria take into account accumulation of pollutants in tissues and long-term exposures of 30-years or more. A significant variable in setting human health based standards is the quantity of fish or other organism tissues consumed on a regular basis. Fish consumption has a direct influence which is inversely proportional to the standard: the more tissue consumed, the lower the water quality standard must be in order to be protective. There is currently much debate concerning what constitutes an appropriate fish consumption rate. This is because certain minority populations (such as Native Americans and subsistence fishers) consume much more fish in comparison to the general population. For example, EPA's recommended national fish consumption rate is about 20 grams per day (g/d) whereas the Columbia River Intertribal Fish Commission (CRITFIC) estimates its constituents consume as much as 320 g/d of freshwater fish.

Mixing Zones

Fish Consumption Rates

Organism Exposure Time

Benthic Organisms

TMDLs/WLAs

Assimilative Limits

Discharge Options

Oregon state recently used the 90th percentile national consumption rate (17.5 g/d) to establish its updated water quality toxics standards, and has committed to considering a higher consumption rate during its next round of water quality standards review.

Summaries of fish consumption rates can be found in California Environmental Protection Agency's Office of Environmental Health Hazard Assessment document, *Chemicals in Fish: Consumption of Fish and Shellfish In California and The United States, Final Report*, October 2001; and in CRITFIC's 1994 report, *A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin*.

Because toxicity is based on concentration and time, organisms that are exposed to acute or chronic concentrations of a pollutant for durations shorter than those used in the bioassays employed to set the concentrations are not expected to exhibit a toxicity response. With this understanding, mixing zones that exceed water quality criteria can be allowed with no impact to the exposed species, provided the exposure is brief. This is generally the case for drifting or swimming organisms that may briefly pass through a mixing zone (Figure 1). In the ZID, where acute standards may be exceeded, the travel time is expected to be on the order of seconds-to-minutes, considering the velocity of the discharge and the ZID's small size. Travel time in the RMZ, where chronic standards apply, are typically on the order of minutes-to-hours — as opposed to the days needed to cause a chronic response.

This is well and good for swimming and drifting organisms, but what about benthic organisms that do not have the ability to move out of the mixing zone? A well-designed discharge avoids creating bottom-attached or bank-attached plumes and therby avoids impinging on benthic organisms. In fact, most states have requirements or policies to avoid bank-attached plumes.

Opponents of mixing zone policies have also argued that mixing zones allow a much greater mass of pollutants to be discharged as compared to discharges that must meet end-of-pipe limits. This argument ignores the CWA § 303(d) listing process for water quality impaired waterbodies. The 303(d) process includes setting **t**otal **m**aximum **d**aily **l**oads (TMDLs) to help assure that the assimilative capacity of receiving waters are not exceeded. Under the TMDL process, the assimilative capacity of a waterbody not meeting ambient water quality standards is determined for every pollutant of concern. **W**aste **l**oad **a**llocations (WLAs) are then provided to dischargers and non-point sources that will result water quality standards being met. WLAs are based on mass loadings, and are not influenced by mixing zones.

Mixing Zones in Water Quality Limited Streams

Water bodies that do not meet a water quality standard for a particular constituent cannot have a mixing zone because there is no assimilative capacity with which to dilute the discharge. Therefore, most states do not allow mixing zones for constituents in water quality limited streams.

Engineered Discharge Structures to Improve Mixing

The simplest types of discharge structures are single port pipes and open channels. These types of discharges are simple to maintain and cost effective where effluent and discharge conditions allow for their use or where rapid mixing is not needed. In other cases, an engineered discharge structure is needed to take full advantage of physical mixing processes to produce rapid mixing in a small area. Discharge structures are often designed to take advantage of effluent discharge velocity, buoyancy differences, and receiving water characteristics. A common improvement on a submerged single port discharge is a multiport diffuser array (as depicted in Figure 2). A mulitport diffuser array can entrain more receiving water by spreading out the discharge over a larger cross sectional area of flow, and can produce higher discharge velocities through smaller restricted ports, which enhances mixing through turbulent sheer.

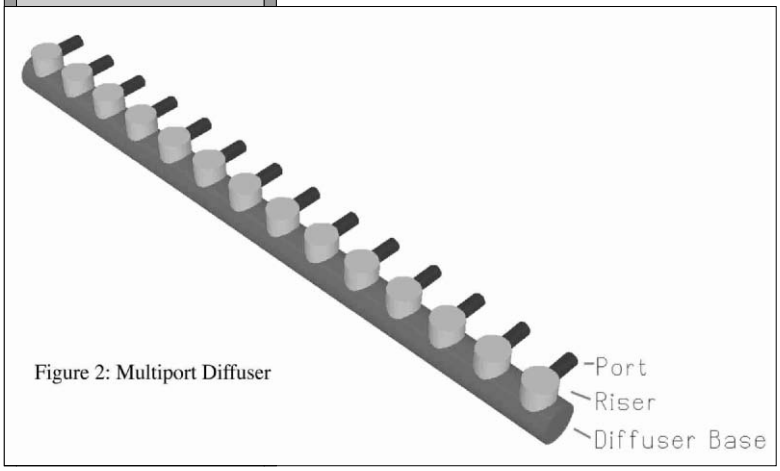


Figure 2: Multiport Diffuser

A number of factors must be taken into account when designing outfall structures including the range of effluent flows, receiving water geometry, and the nature of the discharge. For instance, it may be best to put a buoyant discharge (such as freshwater discharge to salt water or a warm discharge) on the bottom of a receiving water body so it can rise and mix, whereas a dense discharge (such as cold water into warm receiving water) should be elevated so it can mix as it drops. Density differences due to thermoclines or estuarine conditions (e.g., freshwater

Mixing Zones

Siting Considerations

Study Range

Conservative Assumptions

Flow Conditions Critical

Flow Data Needs

Dam Impacts

Modeling Advantages

Software

"CORMIX"

floating on saltwater) will also affect outfall design. Computer modeling of outfall mixing behavior is a useful tool to optimize outfall design because it is relatively easy to modify model inputs for the outfall and evaluate the mixing response.

Outfall siting should also consider the geomorphology of the receiving water bank and bottom to assure proper anchoring and to assess the potential for sediment scour or deposition. One must consider fish passage and avoidance of bank/bottom attachment of plumes. In addition, outfalls should avoid sensitive habitats, such as gravel beds suitable for salmonid spawning or shellfish harvest areas.

CONDUCTING MIXING ZONE STUDIES

Mixing studies can vary in complexity from simple bulk dilution calculations to computer modeling, physical modeling, and direct dye studies.

Critical Discharge Conditions

Generally, mixing studies are conducted under critical (worst-case) flow conditions that reflect the conditions under which the water quality standard is set. For example, California mixing study guidance in the SIP calls for using the flow conditions on the table below to determine acute, chronic, and human health standards compliance.

Effluent and Receiving Water Flows for Calculating Dilution Ratios

In calculating a dilution ratio for:	Use the critical receiving water flow of:	Use the discharged effluent flow of:
Acute aquatic life criteria/objectives	1-day average low flow with a 10-year return (1Q10)	maximum daily flow during period of discharge
Chronic aquatic life criteria/objectives	7-day average low flow with a 10 year return (7Q10)	4-day average of daily maximum flows during period of discharge
Human health criteria/objectives	harmonic mean	long-term arithmetic mean flow during period of discharge

These conditions are similar to those used in most state mixing policies. Notice that the receiving water flow conditions reflect the means by which the water quality standard is set. One-day lower flows (1Q10) are used to assess acute standards compliance which are based on short term exposures, 7-day average low flows are used for chronic standards that are derived from moderate term exposures, and long term harmonic mean flows are used for human health standards, which come from long-term exposures.

Receiving water flow data are statistically derived from historical stream gauge data. A large body of daily receiving water flow data is needed to calculate the 1Q10 and 7Q10 flows. Because the flows of many receiving water bodies are regulated by dams, it is critical to understand the underlying operations of the dams over the data period. Many dam operations have changed flow management to augment stream flows.

The geometries of the receiving water and discharge structure are needed to conduct mixing studies to account for bank and bottom interactions. Often, biological habitat studies are conducted concurrently with receiving water surveys.

Computer Modeling

Computer models provide a convenient low cost way to assess mixing characteristics because it is not necessary to wait for critical low flow conditions to do the study, as required for in-situ dye studies. Computer modeling also supports modeling of proposed outfalls for design and permitting, allowing for assessment of "what if" conditions.

Two of the most widely used and well documented computer mixing zone modeling programs are CORMIX and VISUAL PLUMES.

CORMIX is an expert system that links several mathematical models to simulate a wide variety of discharges and flow conditions. CORMIX can model open channel, single port, and multiport discharges, and includes a tidal re-entrainment function. CORMIX, which is one of the most widely agency-accepted mixing models, was developed by Cornell University for EPA, and has subsequently been improved and supported by one of its authors, Dr. Robert Donnaker, who is currently with Portland State University.

[More information about CORMIX can be found at the CORMIX website: www.mixzon.com]

Mixing Zones

"VISUAL PLUMES"

Capability Differences

Model Assumptions

Model Limitations

Direct Measurement

Study Requirements

Costs

Options

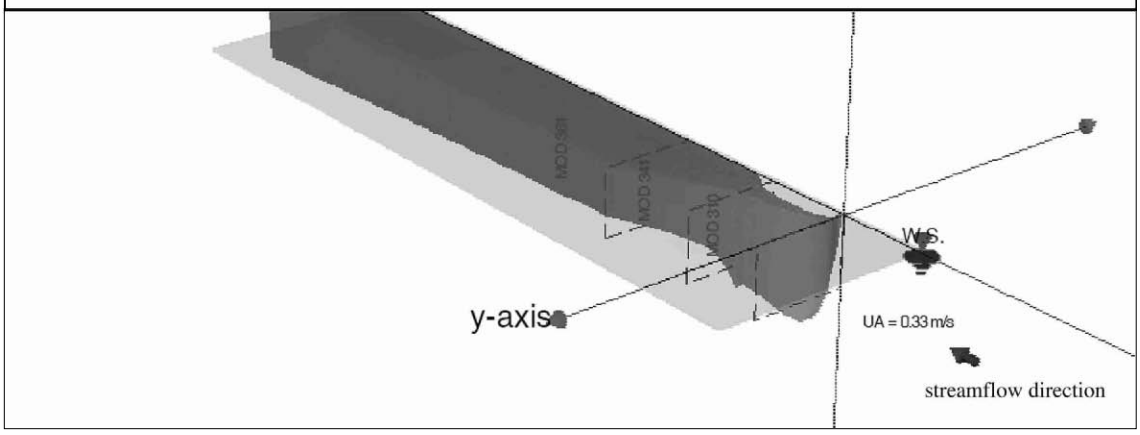
VISUAL PLUMES is currently supported by EPA, and this model is best know for its ability to simulate surface water jets and plumes under a wide range of temperature, depth, discharge buoyancy, and ambient velocity conditions. Like its cousin, CORMIX, the original modeling software has been updated with an easy to use graphic interface. However, Visual Plumes requires more technical expertise to select the correct model elements representing discharge conditions.

CORMIX places emphasis on boundary interaction as it affects mixing processes. VISUAL PLUMES does not address the effects of vertical or horizontal boundaries on mixing or on discharge stability. VISUAL PLUMES assumes the ambient water body is infinite. The issues of flow stability and/or boundary interaction are never addressed. Therefore, while Visual Plumes is a useful tool for evaluating mixing behavior in the immediate area of the discharge, CORMIX provides a more accurate model of far field conditions in bounded systems such as rivers.

Because computer models simplify the real world to mathematical models, they are not always accurate. This shortcoming is typically overcome by applying extremely conservative assumptions to the model. Figure 3 shows the predicted plume behavior using a CORMIX model of a discharge. The Figure indicates homogenous conditions across the plume and a graduated concentration distribution. Compare these results to the cross section of a discharge plume measured during a real world dye study (Figure 4). The dye study reflects the uneven mixing that results from uneven bottom and bank conditions.

Computer models involve schematization and simplification of the modeled system. The closer the real-life system is to a schematized system (e.g., for CORMIX, the more "straight-channel-like" the receiving water), the more accurate the model results will be. When the actual discharge conditions are heterogeneous and chaotic, dye studies may be necessary to calibrate or confirm computer models. In very complex systems dye studies may be the only way to assess mixing.

Figure 3. Computer model (CORMIX) prediction of plume behavior



Dye Studies

Dye or tracer studies typically involve injecting a dye or other detectable substance into the discharge effluent and measuring the concentrations downstream from the discharge. The classic approach is to use a non-toxic fluorescent dye (such as Rhodamine) which can be detected at very low concentrations when using the appropriate instrument. In some instances, the dye can be substituted for a salt or other constituent in the effluent. These direct measurement studies require steady state effluent and receiving water flow conditions so that the concentrations can be measured downstream over time. However, dye studies can also be use to study tidal conditions (typically over a longer period of a full tidal cycle). Dye studies should be conducted using flows that are as close as possible to critical conditions. Because of the highly variable conditions of storm events, dye studies are not recommended for assessing stormwater discharge mixing.

Typically, dye studies are much more costly than computer modeling because of the labor effort and equipment needed to complete the field work.

Dye studies can also be conducted using physical models to simulate proposed outfalls. Scaling and density differences, however, may be difficult to simulate in a laboratory. The US Army Corps of

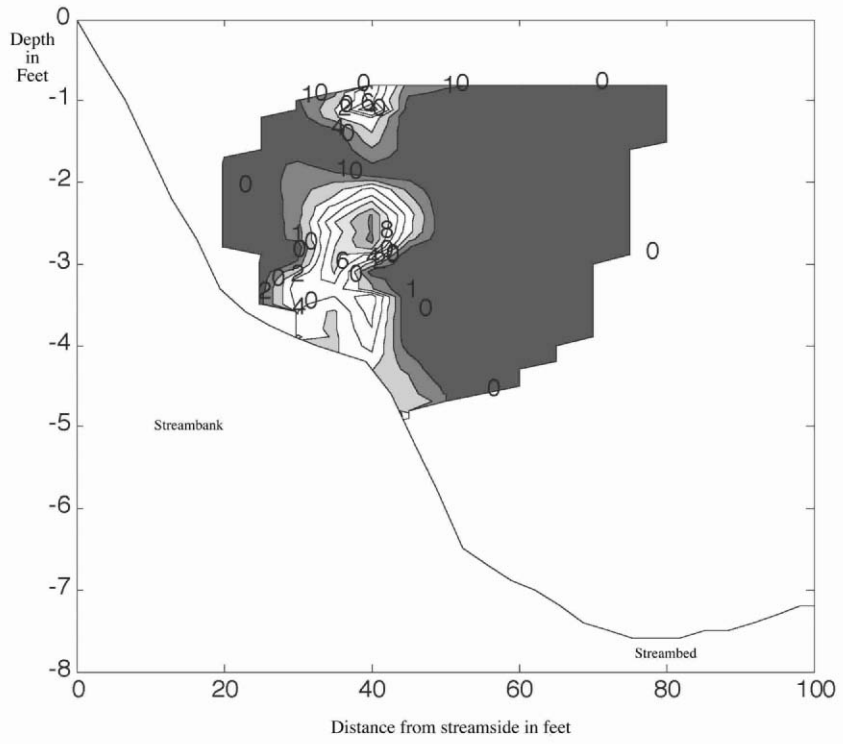


Figure 4
Dye Study
Direct Measurement of Plume Behavoir
Figure shows cross-section of stream, streambank, and plume.

Engineers operates the SF Bay Model, a three-dimensional hydraulic model of San Francisco Bay and Delta areas capable of simulating tides and currents. The Model is over 1.5 acres in size and represents an area from the Pacific Ocean to Sacramento and Stockton, including the San Francisco, San Pablo and Suisun Bays and a portion of the Sacramento/San Joaquin Delta. The model is often used to conduct mixing studies for wastewater discharges and dredge spoil disposal.

Mixing Zones and Reasonable Potential Analysis

The results of mixing zone studies are used to set end-of-pipe effluent limits and to conduct assessments of the "reasonable potential" for a discharge to fail to meet water quality standards at the edge of the mixing zones. Dilution factors at the edge of the ZID and RMZ are used in statistical evaluations of the effluent and receiving water quality to determine if monitoring and effluent limits for a particular constituent should be included in the permit. Gathering reasonable potential analysis water quality data for the receiving waterbody can be collected concurrently with field work for mixing zones. Care should be taken to ensure that this data is of the highest quality (e.g., use ultraclean methods and obtain low detection limits) because small errors in background concentrations have a large effect on the results of the reasonable potential analysis.

Criteria Refinement

Bioaccumulation Concerns

Stormwater Issues

CONCLUSIONS

Mixing zones are likely to continue to be a valuable tool for safely addressing wastewater and stormwater discharges. State agencies are continuing to refine the criteria for allocating mixing zones and the requirements to properly study mixing behavior in the environment.

Mixing zones allow use of the assimilative capacity of receiving water to naturally treat pollutants in a cost effective, energy saving manner, and — if applied correctly — do not impact beneficial uses.

More work is needed to address the problems of regulating persistent and bioaccumulative substances that have limited assimilative capacity in the environment. Mass loading rates, rather than mixing zone-based concentrations may be a means of regulating these constituents.

Mixing zone studies for stormwater events pose additional challenges because stormwater dischagers are rarely a steady-state condition. Discharge concentrations vary greatly depending upon rainfall frequency; and discharge flows vary with storm intensity. Receiving water quality and flows may change rapidly during storm events. Additional guidance is needed to address the unique conditions of stormwater discharges.

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Global Warming

History

Global Warming 101

Basic Physics

Energy Balance

Feedbacks

GLOBAL WARMING, THE HYDROLOGIC CYCLE, AND WATER MANAGEMENT

by Brad Udall, Western Water Assessment (Boulder, CO)

Introduction

Global warming has a surprisingly long history. The famous French mathematician Fourier discovered in 1824 that the Earth is much warmer than it should be, and speculated that somehow the atmosphere trapped heat. Thirty-five years later, in 1859 John Tyndall discovered that carbon dioxide and methane trap heat, unlike oxygen and nitrogen. A Swedish chemist, Arrhenius, published the first calculation in 1896 of what a doubling of carbon dioxide would do to the temperature of the Earth. He suggested that the Earth's temperature would rise by about 10F, not far from today's calculations. In the late 1930s, British scientist Guy Callendar speculated that the warmth of the 1930s might be due to carbon dioxide emissions from man. The first modern concerns about global warming surfaced in the late 1970s and a National Research Council Report from that era, the Charney Report, is still remarkably prescient.

With this long history, one would think everyone would know the basics of warming: the Earth is about 55F warmer than it would be without greenhouse gases; the amount of carbon dioxide, the second most important greenhouse gas after water vapor, has increased by approximately 30% since the start of the Industrial Revolution due to the burning of fossil fuels; since 1970 the Earth has warmed by 1F and scientists believe at least a part of this warming is due to our emissions of greenhouse gases; and, finally, that using a variety of different future greenhouse gas emissions scenarios and different climate models, scientists predict that global average temperatures will increase anywhere from 2.5F to 10F by 2100.

The basic physics of global warming are really quite simple. If you bathe any object in visible light, that object will heat up. It will ultimately reach an equilibrium temperature where it is re-radiating (as long wave or infrared radiation) exactly the same amount of incoming energy. Any change in the energy balance — for example, changes in incoming radiation or the object's reflective properties — will force the object to change temperature to reestablish a new energy balance.

In the case of the Earth, additional greenhouse gases form an infrared radiation heat-trapping blanket, which puts the planet "out of energy balance." The Earth will thus have to warm up to establish a new equilibrium. If carbon dioxide were the only factor, scientists could precisely calculate how much warming would occur. However, the Earth's climate is full of mostly positive feedbacks – for example, initial warming which melts snow darkens the Earth thus causing additional warming – which make exact calculations problematic.

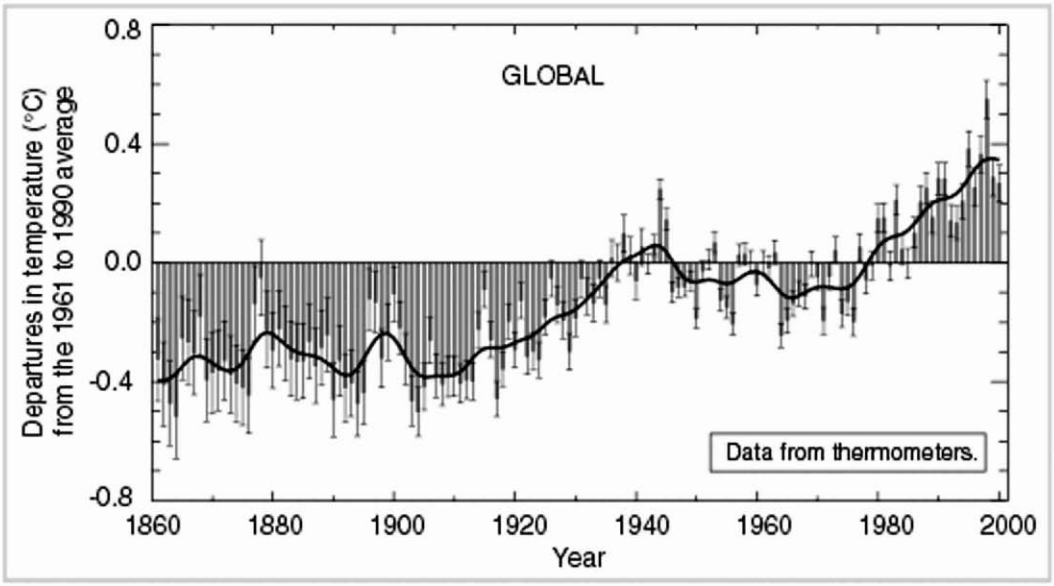


Figure 2: Combined annual land-surface air and sea surface temperature anomalies (°C) 1861 to 2000, relative to 1961 to 1990. Two standard error uncertainties are shown as bars on the annual number. [Based on Figure 2.7c]

Global Warming

Time Lag

Warming Evidence

"Anthropocene" Era

Unknowns

Evaporation Effects

Prediction Applicability

Temperature Change Variable

It has been estimated that currently greenhouse gas concentrations are trapping one watt per square meter more than the planet is able to re-radiate. This amounts to approximately the heating of one tiny Christmas tree bulb for every square meter of the planet's surface. The best guess is that this small one watt energy imbalance will ultimately lead to about an additional 1F warming over the next 100 years, the lengthy time lag due mostly to the massive heat capacity of the oceans. Small forces, maintained for long periods, can indeed do large things. In addition, we continue to add large amounts of greenhouse gases, which will make the warming even greater. (Note: recent research indicates that global dimming, discussed below, has apparently significantly masked the impact of greenhouse gases but this masking is decreasing with time.)

In North America, evidence of warming is noticeable nearly everywhere from earlier last frost dates in the spring, to earlier blooming of plants, to earlier runoff in the West, to melting glaciers in Glacier National Park. Until recently, 1998 held the record for the warmest year of the last 100 years. NASA announced a short time ago, however, that last year was the warmest year in over a century. The five warmest years in the last 100 years are now 2005, 1998, 2002, 2003, and 2004. Some scientists consider that we have now entered a new geologic era, the "anthropocene," due to our influence on the climate.

Surrounding the basic facts are lots of unknown details. That it will warm is a given, not challenged by many. However, how much warming, how fast it will warm, and where it will warm are being ardently debated. Many regional warming increases will greatly exceed the global average; for example, high latitudes are expected to warm much more than average, and mid-continental areas are also expected to warm more than average. Obviously, some areas will therefore warm less than average, and there may even be some areas that cool, although the more warming that occurs the less likely this becomes.

Cooling in some regions does not violate the tenets of global warming. One way to achieve cooling during global warming is through extra precipitation. Extra water allows for greater evaporation, and evaporation carries away energy that would have otherwise gone into land surface heating. This is apparently happening in two parts of the US – on an annual basis over the last thirty years the Southeast has cooled, and in the summer a portion of the Midwest has cooled. In both cases, recent studies indicate that extra precipitation is the cause. Note that irrigation can also serve to increase evaporation and has been associated with locally cooler temperatures.

Climate is not weather. Weather is day-to-day meteorological conditions. With current weather models, predictions of weather beyond two weeks are theoretically impossible due to the chaotic nature of the system. Climate is a more general concept: it deals with long term averages and trends of variables like temperature and precipitation. Predicting climate is substantially easier than predicting weather, and

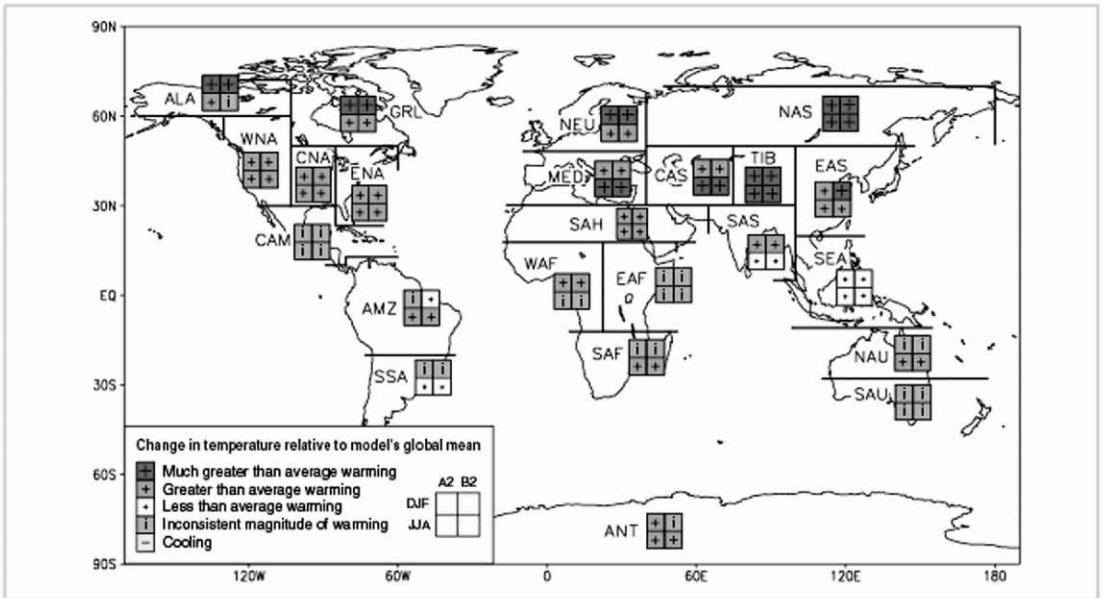


Figure 21: Analysis of inter-model consistency in regional relative warming (warming relative to each model's global average warming). Regions are classified as showing either agreement on warming in excess of 40% above the global average ('Much greater than average warming'), agreement on warming greater than the global average ('Greater than average warming'), agreement on warming less than the global average ('Less than average warming'), or disagreement amongst models on the magnitude of regional relative warming ('Inconsistent magnitude of warming'). There is also a category for agreement on cooling (which never occurs). A consistent result from at least seven of the nine models is deemed necessary for agreement. The global annual average warming of the models used span 1.2 to 4.5°C for A2 and 0.9 to 3.4°C for B2, and therefore a regional 40% amplification represents warming ranges of 1.7 to 6.3°C for A2 and 1.3 to 4.7°C for B2. [Based on Chapter 10, Box 1, Figure 1]

Global Warming

Weather Variances

Global "Dimming"

Investigation Tools

Climate Models

IPCC Assessment Documents

Hydrology Tie-In

Solar Energy & Water Vapor

it has no theoretical limits on future predictions. "Climate change" can be considered a change in the long-term statistical averages of our weather.

The distinction between weather and climate can cause misunderstandings. We will continue to experience cold snaps, blizzards and other events that may seem at odds with global warming. These weather events, however, do not violate the principles of global warming — namely, that on average, the Earth must warm up to balance increased heat being trapped by greenhouse gases. Over time the probability of these kinds of extreme cold events occurring will decrease but will not entirely disappear. Individual weather events will continue to show the great variability that we currently experience.

In the last two years fascinating research on "global dimming" has been published. Between 1960 and 1990 solar radiation reaching the surface of the earth was reduced significantly on a global basis — by up to 5% — due to various forms of pollution. Since 1990 this trend has reversed due to new pollution controls in developed countries, and the decline of dirty Eastern European industry. It appears that dimming may have masked global warming until 1990 by perhaps a factor of two. Since that time the rate of global warming is likely to have increased.

Scientists use two important tools to investigate climate: paleoclimate studies and climate models. Records from the past can be obtained from the ocean floor and lake sediments, ice cores, corals, and even trees for the more recent past. These records provide information on past levels of greenhouse gases, temperatures, sea level heights, and a wealth of other information useful to climate scientists.

Climate models, also known as **g**eneral **c**irculation **m**odels (GCMs), are the primary tools used to predict future and sometimes past climate. GCMs use "emission scenarios" as inputs, and calculate a variety of outputs such as temperature and precipitation using fundamental rules of physics. GCMs currently have some limitations. For example, clouds are much smaller than the approximately 200 by 200 kilometer gridboxes used to solve the basic equations of the models and hence are not well resolved. Small particles known as aerosols are also poorly modeled because of uncertainty in the science. Topography is an issue in the models. The Rockies, for illustration, are modeled as a broad 7000-foot hump in the middle of country and until recently the Great Lakes were often not modeled at all. Models are nevertheless very important: they get many details right and they are our only way to experiment with future climates. GCMs are very complex and hence run slowly on even the fastest computers, but with increasing computer power they are becoming faster and more realistic.

In the last fifteen years much of our knowledge on climate change has been coordinated by a large international body of scientists sponsored by the World Meteorological Organization and the United Nations Environment Program known as the Intergovernmental Panel on Climate Change (IPCC). The IPCC is broken into three working groups: one on the science, one on the impacts, and one on greenhouse gas reduction ("mitigation" in IPCC terms). Remarkably few people know about the IPCC yet one cannot talk knowledgeably about climate change (or be taken seriously by scientists) without being aware of their work. Reading their 20-page "Summary for Policymakers" and preferably the 80-page "Technical Summary" for each working group is mandatory if one wants to begin to understand the science of global warming. The IPCC has released three major assessment reports, the first in 1991, the second in 1996 and the third in 2001. The next report will be released in 2007. [IPCC website: www.ipcc.ch/]

Global Warming and the Hydrologic Cycle

One key finding of the science of global warming is that the hydrologic cycle is expected to intensify. Exactly what this means is the subject of this section.

The hydrologic cycle, that is, the movement of water around the planet, and its associated science, hydrology, are often portrayed as something distinct from weather and climate. In the field of water management, for example, hydrology is mostly concerned with river flows. But in the big picture, the hydrologic cycle is not distinct from weather and climate; in fact it is the hydrologic cycle that in many ways determines our weather and climate. Discussing climate without discussing the hydrological cycle is like trying to discuss how a car works without mentioning the engine.

Solar energy falls on the planet and it is used mostly to heat land surfaces and evaporate water. There is no more important conveyor of energy from the equator, where there is an excess, to the poles, where there is a deficit, than water. Through evaporation, through condensation, through massive ocean currents like the Gulf Stream and its Pacific counterpart the Kuroshio, water moves solar energy. When water evaporates —over 1000 cubic kilometers evaporate every day from the oceans — the phase transition from liquid to gas stores large amounts of energy in water vapor as "latent" energy. This energy literally travels on the winds of the Earth until the vapor condenses and this trapped energy is released to power thunderstorms, hurricanes, tornadoes and many other forms of weather. Simply put, solar energy stored in water vapor drives the weather systems that determine our climate.

Global Warming

Precipitation Variability

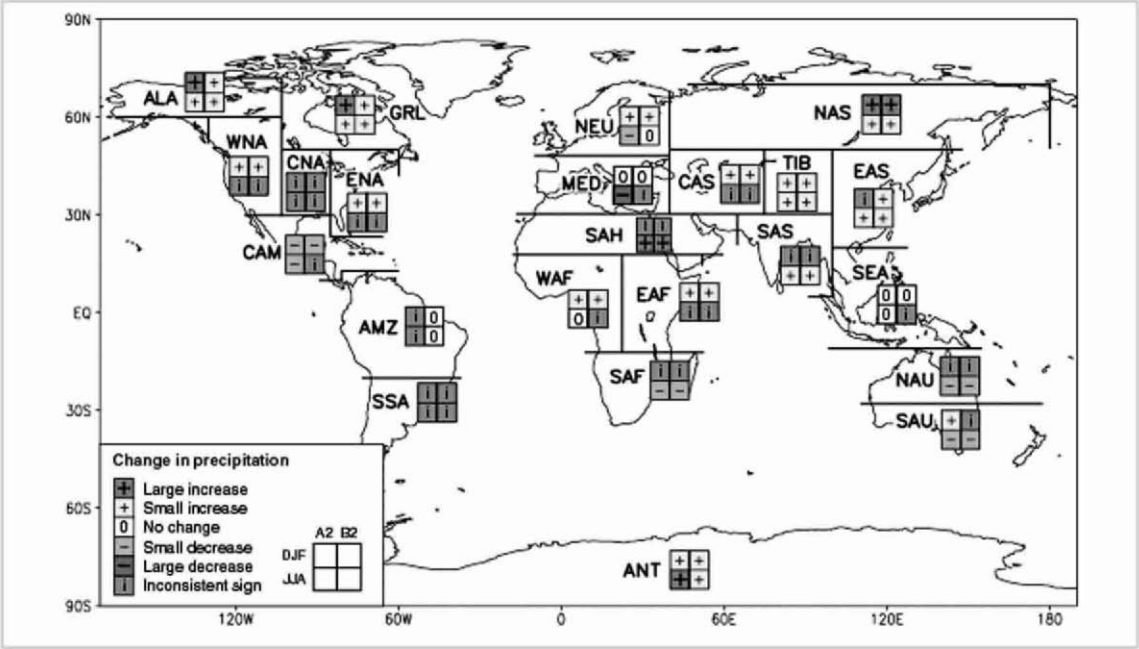


Figure 23: Analysis of inter-model consistency in regional precipitation change. Regions are classified as showing either agreement on increase with an average change of greater than 20% ('Large increase'), agreement on increase with an average change between 5 and 20% ('Small increase'), agreement on a change between –5 and +5% or agreement with an average change between –5 and 5% ('No change'), agreement on decrease with an average change between –5 and –20% ('Small decrease'), agreement on decrease with an average change of less than –20% ('Large decrease'), or disagreement ('Inconsistent sign'). A consistent result from at least seven of the nine models is deemed necessary for agreement. [Based on Chapter 10, Box 1, Figure 2]

Energy Retention

Global warming is fundamentally about extra solar energy being retained by the planet. It should therefore be easy to see that adding extra energy to this system should increase the very thing that transports energy around the planet, namely the hydrologic cycle. Thus, when scientists say that "an enhanced hydrologic cycle" is predicted from global warming this shouldn't be a surprise. Yet all too often, the direct relationship between global warming and the hydrologic cycle is hidden by portraying this relationship as something similar to the indirect relationship between warming and agriculture, or warming and human health, for example.

Enhanced Evaporation

Increased Precipitation

The basic physics of the atmosphere tell us that a warmer atmosphere can hold more moisture; we know this implicitly when we acknowledge that spring snowstorms carry much more moisture than their dead-of-winter cousins. The additional energy from global warming is expected to lead to enhanced evaporation and because evaporation and precipitation must be balanced in the long run, precipitation is also expected to increase. Scientific theory and numerous observations support the idea that as average precipitation increases variability will also increase. Storms are expected to intensify. Droughts and floods are expected to increase. In short, an "enhanced hydrologic cycle" is unlikely to be just a slightly scaled up version of what we now have. The theory, impacts, and observations of these expected changes are discussed below.

Changes in Precipitation, Evaporation, and Storm Intensity

Intensified Precipitation

On a global basis, precipitation and evaporation are expected to increase by about 1% to 2% for each Celsius degree of warming. For the midpoint of predicted warming, 3C, this means a global increase of anywhere from 3% to 6%. The moisture holding capacity of the atmosphere will also increase by approximately 7% per degree. Scientific theory suggests that the discrepancy between the two rates means the character of precipitation will change. Specifically, heavy rain events will become more common, light rain events should be less common, and greater evaporation from larger areas might need to occur before precipitation can occur. This likely means fewer but more intense precipitation events; in other words, more floods and more droughts. A decrease in light and moderate rains and/or a decrease in the frequency of rain are problematic for the environment; steady, slow rains are generally more useful than downpours and long periods between moisture also stresses the environment.

Impacts

Modeling Outcomes

The concept of increased global average precipitation is deceptive for North America based on models. In climate models, high latitudes consistently see substantial precipitation increases and the tropics consistently see small decreases or remain the same, while precipitation over the 48 states in the mid-latitudes varies from model to model. Some models show significant increases, some significant

Global Warming

Solar Energy & Evaporation

Drought Impacts

Agricultural Consequences

Fires

Ocean Warming

Snowpack Storage

Decreasing Snowfall

Hydrograph Shift

decreases, and some only moderate changes in precipitation with little change in mean precipitation if all models are averaged. These results are unsatisfying, but unfortunately all we have.

Observations confirm some, but not all of these details. Nationally, Pavel Groisman of the National Climatic Data Center has found century-long increases in mean precipitation, mean streamflow in the East, and heavy precipitation. There is little to suggest, however, that increased evaporation and associated droughts have occurred in the 48 states. Regionally over the last century, wet conditions in the Mississippi and dry conditions in the Southwest have prevailed.

Increased Droughts and Continental Summertime Drying

Water is the air conditioner of the planet and frequently keeps temperatures lower than they would otherwise be through the process of evaporation. For example, when water is present on the ground, solar energy that otherwise would go into heating land can be used to evaporate water. The energy is thus captured by the water vapor and carried away to re-emerge when the vapor condenses. It should not be surprising that droughts are almost always accompanied by higher temperatures because early in the drought most available soil moisture is evaporated and consequently solar energy, usually in abundant supply during a cloudless drought, heats the land surface instead.

The lack of soil moisture during droughts also makes it more difficult to break the drought. Approximately one tenth of the water evaporated from the oceans makes it to land where it can fall as precipitation. This initial precipitation is frequently evaporated and precipitates again. In fact, on average oceanic water precipitating on land is "recycled" twice before returning to the ocean. When large land areas lose soil moisture from extensive evaporation thus preventing recycling, water must be imported by the atmosphere from long distances to break the drought. This is one reason why droughts tend to be self-sustaining.

With increased evaporation being a consistent modeled and theoretical result for global warming, especially in the summer and mid-continent, it is likely that existing summertime drying of soil will increase. Summer is the main growing season, and central North America contains important agricultural areas fed by natural rainfall. These areas may suffer due to increased summertime drought. Irrigated agricultural will likely need additional water to counteract the additional drying.

A direct response to increased summer dryness may be additional fires. In recent years summertime fires have caused substantial water quality problems and increased costs to Denver Water, for example. [Editor's note: Denver Water is the public water utility for the City and County of Denver and some suburbs surrounding Denver, Colorado; its provides water for nearly a quarter of Colorado's population.]

Due to extensive carryover reservoir storage in the West, critical droughts have mostly been multi-year, not single year, events. A few studies have investigated an intriguing historical correlation between past temporary warming in the western Pacific and Indian Oceans and multi-year droughts in western North America. The western Pacific and Indian Oceans in recent years have shown long term warming trends and such ocean warming appears to be part of the general pattern of global warming. The recent 1999-to-2004 drought may be connected to this ocean warmth. It is difficult, however, to be conclusive about the likelihood of increased multi-year Western droughts based on these few studies.

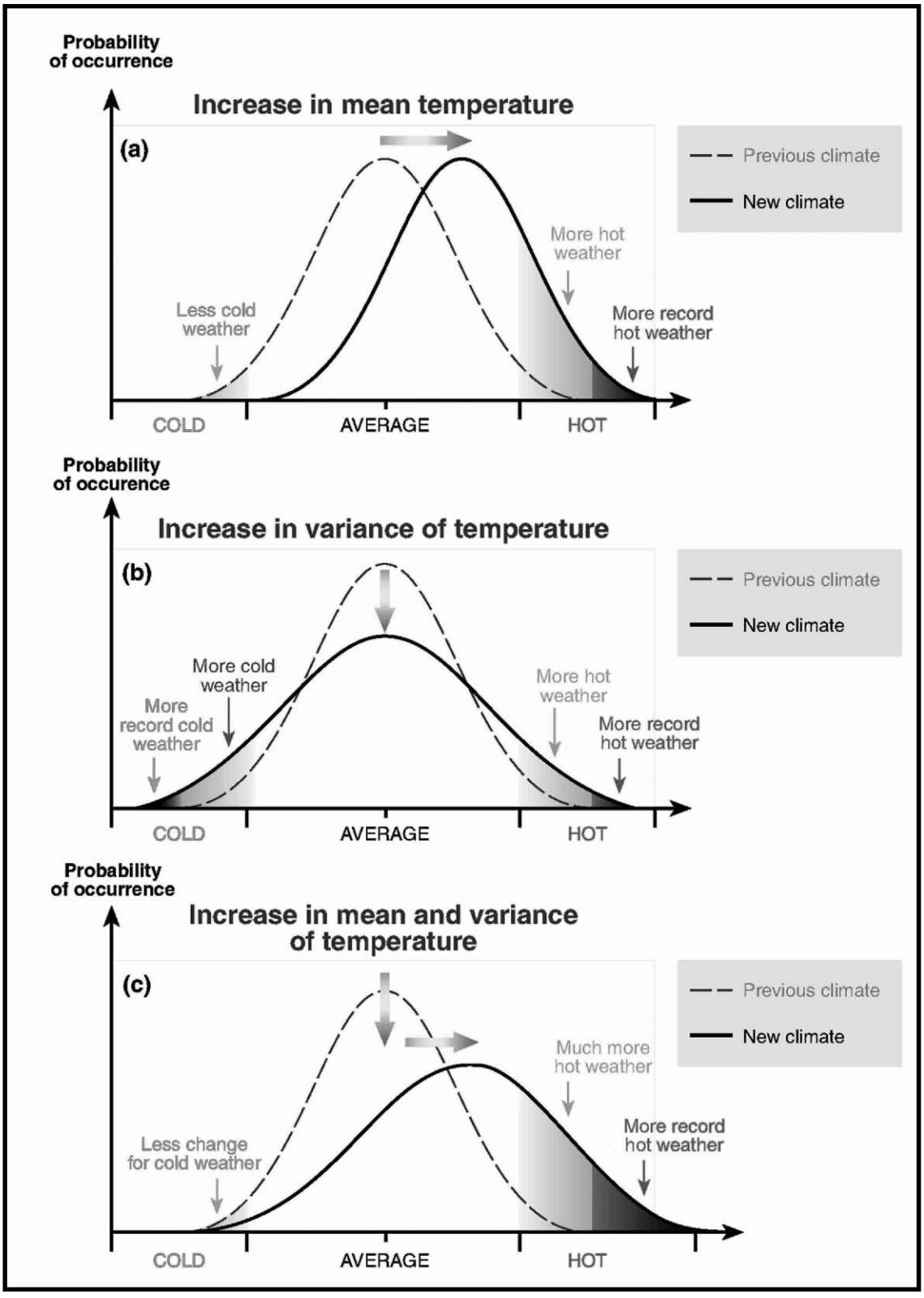
Despite the recent record-breaking 1999-2004 drought, there is little scientific evidence for increased occurrence of drought and summertime drying in North America at this time. Very warm springs in the West in the last few years are, however, a cause for concern if they continue as current trends suggest, as this warmth has had a significant impact on snowpack (discussed below).

Declining Snowpacks and Water Management

In the Western United States our mountains act as natural reservoirs, conveniently storing water as snow until springtime when both temperature and demands increase. Water storage in snow greatly exceeds that of man-made reservoirs.

Climate models consistently indicate that warming over the lower 48 states will be greater than the global average in both winter and summer. In addition, both models and theory predict that in the future as the Earth warms more precipitation will fall as rain, and less as snow. More winter rain means higher winter streamflows, more winter runoff and smaller spring snowpacks. Higher spring temperatures, which are a consistent modeled and observed result, will lead to earlier spring runoff and reduced summer flows. Hence, in snow-dominated basins, especially low elevation basins, we are likely to see an annual hydrograph with the peak shifted earlier in the year, higher winter flows, and lower summer flows. More rain and less snow do not imply a shift in annual precipitation means. A shifted hydrograph will, however, likely provide water management challenges even in the absence of overall precipitation changes.

Global Warming



Extreme Temperature Effects

Schematic diagrams showing the effects on extreme temperatures when (a) the mean increases, leading to more record hot weather, (b) the variance increases, and (c) when both the mean and variance increase, leading to much more record hot weather.

The graphic above, as well as all other graphics used in this article, may be accessed from documents to be found on the Intergovernmental Panel on Climate Change (IPCC) website: www.ipcc.ch/pub/syreng.htm

Global Warming

Snow Water Equivalent

Current observed trends support the modeled findings. Phil Mote of the University of Washington calculated trends for April 1 **s**now **w**ater **e**quivalent (SWE) from 1950 to 1997. Negative trends are common in his analysis. The largest SWE losses occur in western Washington, western Oregon, and northern California — areas where snowfalls often occur when the temperature is just below freezing. SWE increases occurred in the southern Sierra Nevada, New Mexico and isolated locations in Colorado and Utah, locations where winter temperatures are typically very low. With a continuation of current warming and no loss of precipitation (the average result from numerous models), Mote discovered that the current declining trends in spring snow water equivalent would continue.

Groisman has shown a statistically significant large decrease in spring snowcover extent in the Northern Great Plains, the Northwest and in California from 1950 to 2002. In addition, there is a matching and almost certainly related significant warming in the springtime in these same areas. In this case, the lack of snowcover is likely providing a strong positive feedback for additional warming. Groisman has also discovered an increase in thunderclouds, and an increase in heavy precipitation events. Both are consistent with an earlier onset of spring.

Sea Level Changes

Salt Water Intrusion Into Coastal Aquifers from Sea Level Rise

Despite our inability to conceive that sea level might change, sea level is not fixed: at the height of the last ice age 10,000 years ago sea level was over 300 feet lower due to large quantities of water being locked up in continental ice sheets, including 1000-foot plus thick Canadian sheets extending into our northern Great Plains. During the last interglacial period, about 100,000 years ago, sea level was about 20 feet higher than currently. The IPCC predicts that sea level will rise anywhere from four inches to about three feet over the next 100 years. Sea level has already risen between four and eight inches over the last 100 years. The increase in sea level comes from two things: expansion of seawater as it warms, and additional water being added to the oceans from melting glaciers.

Ice Sheet Reduction

The dynamics of large ice sheets are currently being actively researched. Despite evidence that ice sheets form slowly over thousands of years and melt quite quickly, until recently scientists had not been concerned about major ice sheet melting during the next 100 years. Melting of the ice sheets in Greenland could raise sea level by 20 feet, and the West Antarctic Ice Sheet could raise sea level from 20 to 50 feet. If these ice sheets begin to melt, scientists believe the process may be irreversible. Melting of either of these would obviously cause great difficulties beyond water management as billions of people live within a few feet of sea level.

Salt-Water Intrusion

In the short term, the primary hydrologic concern of rising sea level is salt-water intrusion into coastal freshwater aquifers; due to higher salt-water density, small changes in sea level translate into large negative changes in usable freshwater stores. Many coastal communities rely on these aquifers.

Reservoir Impacts

Reduced Reservoir Storage from Flooding

The US Army Corps of Engineers (Corps) has responsibility for flood control on all reservoirs in the nation. The Corps uses historical streamflow data and historical precipitation data to determine the maximum probable flood at each time of year for every reservoir and a customized flood control "curve" is sized to capture this flow rather than have it fill and spill from the reservoir. With more intense storms possible under global warming, many of these curves will need to be redrawn to make more flood space available during critical periods. In some parts of the country, these curves will force reservoirs lower in the spring relative to today, and hence the reservoirs will be less likely to fill. In areas where large rain on snow events with resultant large floods might occur, such as the northern Sierra, effective reservoir capacities could decrease significantly. The Corps has historically redrawn curves only after new record setting extreme events occur.

Water Temperature Effects

Water Quality Impacts

Relative to water quantity studies, the literature on water quality changes due to climate change is quite thin. In part this is because many water quality issues are directly related to water quantity, and water quantity issues are so uncertain. In addition, the issue is also complex because water quality is dependent on land use practices. In very general terms, water quality is likely to be impacted by increased water temperatures, changes in flows, and runoff rates and timing, even in the absence of precipitation changes. Increased water temperatures can increase the toxicity of metals and may increase the accumulation of toxics in organisms. This enhanced bioaccumulation may reduce toxics in the water column. One benefit of warmer temperatures may be that lakes in colder climates may not stratify. It is also possible that toxics will be transferred from the water column to sediments faster. Dissolved oxygen concentrations are lower in warmer water, which may lead to aquatic organism distress. Higher temperatures can lead to increased eutrophication, which can also reduce oxygen content.

Global Warming

Existing v. Developing Pressures

Management Options

Municipal Planning Studies

Modeling Utilization

Prediction Scenarios

Carbon Reduction

Water Use Energy Requirements

Water Planning and Global Warming

Global warming is just one of many factors facing water managers. Increasing population, the need to provide environmental benefits in aquatic environments, and normal climate variability such as the recent 1999-2004 drought are exerting critical pressure on many water managers. Most utilities are considering both demand-side and supply-side opportunities to meet new demands and reduce future vulnerability. Given existing pressures and the uncertain nature of global warming (especially as it applies to future precipitation) — global warming is generally not being treated as a top tier issue. Global warming does, however, provide a new, potentially significant stress for water managers over the medium to long term.

Historically, water managers have assumed that the past will repeat. Water systems are designed to meet current demand under the worst historical hydrology with an additional arbitrary "safety factor" to provide for unprecedented conditions. It is likely that most utilities will, at least initially, respond to global warming induced supply and demand changes by adapting rather than by taking pre-emptive action. Integrated Water Resource Management — a process consisting of explicit consideration of all supply-side and demand-side issues, involvement of all stakeholders, and continual monitoring and review — is often regarded as the best way to manage resources and seems well suited to global warming issues.

Several municipalities in the West have completed or are undergoing planning studies related at least in part to global warming. These include Boulder, Denver, Seattle and Portland. California recently completed its normal five-year planning effort and the new document, Bulletin 160, considers global warming in a qualitative way. Future versions will include quantitative studies.

As water managers become more interested in understanding the potential hydrological impacts of global warming, there will be increased pressure to utilize climate models to evaluate outcomes. Indeed, over the last 15 years scientists have released numerous model-based global warming studies for Western river basins. On the one hand these are state-of-the-art attempts to look at what the future might look like. On the other, these may be extremely limited in their scope, and should be considered as just one possible outcome. Studies that use a single climate model and a single emissions scenario are especially limited. In order to properly utilize models water managers need to: 1) understand model limitations; 2) be aware how different models respond; and 3) understand emissions scenarios.

In general, different models exhibit significant differences in warming and precipitation for the Western United States. The most defensible scientific studies are being done with multiple models, and water managers should settle for no less. In complex terrain, models may be hindered in their ability to accurately portray current and hence future conditions. However, promising work is being done with both statistical and dynamical (modeled) downscaling to make GCM outputs more usable in smaller regions where GCMs currently perform poorly.

The selected emissions scenarios are also critical. For the IPCC Third Assessment Report, a committee devised 40 different future scenarios. These scenarios come out of four main groups, unimaginatively labeled A1, A2, B1 and B2. Key inputs to the scenarios are population growth, economic growth, and technological progress. The IPCC created the scenarios because they believed it was impossible to predict the most likely future — imagine trying to predict commercial jet aviation in 1900 — and instead they wanted to have a range of possible futures. The IPCC says, "It is recommended that a range of SRES scenarios with a variety of assumptions regarding driving forces be used in any analysis." The different scenarios result in greenhouse gas concentrations that vary by a factor of two, and the resulting energy imbalances also vary by about two. These differences have large impacts on predicted warming, precipitation changes and all other hydrologic cycle impacts.

Most of this paper has discussed how global warming will affect the hydrological cycle with the goal of providing a perspective on demand and supply issues. But until recently few people considered how water managers might be responsible for global warming through carbon dioxide emissions related to water management. In a carbon-constrained world, a strong possibility in the near future, both adaptation and mitigation (i.e. carbon reduction) would be important and water managers would have yet another management objective: how to minimize carbon outputs associated with water deliveries.

Recent studies funded by the US Department of Energy and the California Energy Commission have revealed that water use results in a large amount of energy use. Energy is required to pump, treat, pressurize, and heat water. Energy to lift and pressurize water is in fact just the opposite of hydropower. Also, because of the high heat capacity of water, substantial energy must be used to heat water. The California State Water Project, the Metropolitan Water District's Colorado River Aqueduct, and Arizona's Central Arizona Project all use massive amounts of electricity to pump water literally thousands of vertical feet. In Arizona's case, for example, water is ultimately pumped over 3000 vertical

Global Warming

Energy Savings

Carbon Cap & Trade

Price Impacts

Uncertainties & Likelihoods

feet and 300 miles to Tucson, passing Phoenix along the way. The California Energy Commission estimates that water use in California accounts for 20% of all electricity use in the state and also uses substantial amounts of petroleum. When water is conserved or demand reduced, substantial energy savings ripple throughout the entire delivery and treatment system.

It appears increasingly possible that this nation will be under a federal carbon cap and trade program for at least large electric utilities in the near future. Cap and trade programs, like the highly successful federal program to reduce sulfur dioxide, are the most cost effective ways to reduce carbon dioxide. Approximately one thousand power plants produce most of the nation's electricity along with 40% of all carbon dioxide emissions. Attempts to reduce the nation's carbon dioxide output will likely start with this obvious source. Recent hearings in Congress suggest that the power utilities at the very least expect this, and in more than a few cases support such a system to stabilize their long term planning issues.

A national cap and trade program will increase the price of conventional forms of electricity generated from fossil fuels with unforeseen impacts on water supply and water use decisions. Clearly, higher water prices will cause some reduction in use, potentially significant, and in some cases pumping costs may make irrigated agriculture less attractive. Given the potential ramifications, this is an area ripe for additional investigation.

Conclusions

Global warming is a real issue and the first signs of warming have been detected. Further warming is very likely and will be dependent on our future greenhouse gas emissions pathway. Exactly where, how much, and when warming will take place are uncertain. Temperatures will increase above global averages in most areas of North America. The hydrologic cycle is likely to intensify with more droughts, increased summertime drying in mid-continental locations, and more floods. In snowpack-dominated basins, the annual hydrograph is likely to shift to earlier runoff with higher winter flows and lower summer flows. Many areas of the West will receive less snow and more rain but the overall precipitation trend is uncertain. The rate of global warming may be accelerating because of a reduction in global dimming.

In the short term, global warming is just one of many issues facing water planners. In the medium range future, supply and demand issues related to global warming will likely become significant. Most water management changes due to global warming will be adaptive rather than pre-emptive because of the large uncertainties surrounding future precipitation. Existing Integrated Resource Management tools appear to be able to incorporate changes due to global warming. A new management objective, carbon limitations, will become important to water managers in the medium-range future if a national carbon cap and trade program is enacted.

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Montana Decision

Basin "Closures"

Groundwater Standard

New-Use Moratorium

Adjudication

Closure Exceptions

MT SUPREME COURT RULES ON GROUNDWATER PROCESS

BASIN CLOSURES AND CONJUNCTIVE USE

by David Moon, Editor

The Supreme Court of Montana, in a split decision which overturned a summary judgment by the state district court, recently clarified how the state must approach "basin closures" and the standard applicable to new groundwater right applications. In *Montana Trout Unlimited, et al. vs. Montana DNRC, et al.*, 2006 MT 72 (April 11, 2006), Montana's high court first dealt with a procedural issue concerning the appeals process and the threshold determination of basin closures. The Supreme Court then turned its attention to whether or not the state agency had correctly interpreted the statutory standard controlling groundwater in the Basin Closure law ("immediately or directly connected to surface water"). [See Kendy, Wilson and Zeimer, TWR #19, for a more detailed discussion of the case and the groundwater science involved.] Like all the western states, Montana is grappling with the potential interference between new groundwater users and existing surface water users, and the question of how the state should control "conjunctive use" of water between the two types of users.

Montana enacted a "Basin Closure Law" to prevent new water right applications from being granted by the Department of Natural Resources and Conservation (DNRC) in over-appropriated basins *until* existing water rights are finally adjudicated in the state's general adjudication of water rights. Montana is in the midst of a long-running adjudication to determine the status of all pre-1973 water rights in the state (approximately 220,000 water rights; see Interview with Chief Water Judge Loble, TWR #2). The Basin Closure Law provides that DNRC may not "process or grant an application for a permit to appropriate water…within the upper Missouri River basin until the final decrees have been issued" (Section 85-2-343, MCA). The statute also contains exceptions to the general ban, including an exception for new groundwater applications (Section 85-2-343(2)(a), MCA). But, as the Supreme Court noted, "The legislature recognized, however, that some groundwater bears a close relationship with surface water and that allowing unrestricted appropriations of groundwater would defeat the purpose of the Basin Closure Law. Thus, the Basin Closure Law also forbids the processing of new applications for groundwater that is 'immediately or directly connected' to the Upper Missouri River basin's surface water." Slip Op. at 5.

"DNRC recognized the particularly intimate relationship between groundwater and surface water along the Smith River." Slip Op. at 5. DNRC prepared a Supplemental Environmental Assessment

Montana Decision

Prestream Capture Impacts

DNRC Interpretation

DNRC Definition

Closure Purposes

Application Threshold

DNRC Interpretation Rejected

Limits to Agency Discretion

(Supplemental EA) for the Smith River Basin and in that document "noted that the Smith River and its principal tributaries are hydrologically connected to groundwater. The Supplemental EA further noted two ways that groundwater pumping affects surface stream flows. First, pumping may intercept groundwater that otherwise would have entered the stream thereby causing a reduction in surface flows. This phenomenon is called the prestream capture of tributary groundwater. Second, groundwater pumping may pull surface water from the stream toward the well. The DNRC refers to this pulling as induced infiltration. DNRC's hydrogeologist reports that a stream takes longer to recover from prestream capture of its tributary groundwater than from depletion through induced infiltration." Slip. Op at 5.

Unfortunately, the legislature did not define "immediately or directly connected to surface water" in the Basin Closure Law. Meanwhile, Trout Unlimited and some surface water users of the Smith River vehemently opposed DNRC's informal interpretation of that phrase. "DNRC interpreted the language to mean that a groundwater well could not pull surface water directly from a stream or other source of surface water. This interpretation makes no mention of the potential influence of the prestream capture of tributary groundwater on surface flow. DNRC processed new applications before making a threshold determination that the applications fell within an exception to the Basin Closure Law. It is against this backdrop that Trout Unlimited initiated its suit against DNRC." Slip Op. at 6.

DNRC went through the administrative rulemaking process while the litigation was pending and defined "immediately or directly connected to surface water" to mean "ground water which, when pumped at the flow rate requested in the application and during the proposed period of diversion, induces surface water infiltration." Rule 36.12.101(33), ARM. "DNRC's formal definition again ignored water diverted from streams through prestream capture of tributary groundwater. The substantive issue on appeal remains whether DNRC erred in its interpretation of "immediately or directly connected to surface water" in the Basin Closure Law." Slip Op. at 8.

The Supreme Court noted the purposes behind the Basin Closure Law to explain its rationale regarding the decision as to the appeals process. "The Basin Closure Law serves, in part, to protect senior water rights holders in the Upper Missouri River basin. *See, e.g.,* § 85-2-308(3), MCA (providing standing to object to water use applications to individuals whose property, water rights, or interests are adversely affected by the proposed application). The proscription against processing applications saves appropriators the time and expense of having to defend their water rights every time a new applicant seeks to appropriate water in the basin. For example, defending property interests in contested case hearings generally requires retained counsel, expert witnesses, time, and expenses. The legislature provided interested parties with greater protection than the right to file objections and proceed to contested case hearings by insulating them from the burden and expense of the objection process." Slip Op. at 13. The Supreme Court then held that Trout Unlimited and the other petitioners did not have to "exhaust their administrative remedies before seeking judicial relief. *DeVo*e, 263 Mont. at 115, 866 P.2d at 238. We will not require Trout Unlimited or other objectors to participate in agency proceedings that the legislature expressly prohibits. DNRC must adhere to the legislature's proscription on processing applications that do not fall within an exception to the Basin Closure Law." Slip Op. at 14.

In the second part of the decision, the Supreme Court rejected DNRC's interpretation of the statutory standard regarding groundwater interference with surface water use (as approved under a summary judgment of the district court). The district court noted that the legislature chose not to define the standard, and then concluded that it should defer to the discretion of the state agency (DNRC) regarding the definitions and methods involved in processing the groundwater applications. The Supreme Court pointed out that the district court "did not analyze, however, whether DNRC abused its discretion in its interpretation of the Basin Closure Law. Trout Unlimited argues that DNRC abused its discretion by failing to interpret the statutory language in a manner consistent with the legislature's intent. Specifically, Trout Unlimited argues that by failing to recognize the direct effect of prestream capture of tributary groundwater DNRC fails to give meaning to each word in the Basin Closure Law." Slip Op. at 16.

When dealing with agency "discretion," courts often consider how long an agency interpretation has been applied to determine how much deference should be granted to the state agency. Here, the Supreme Court noted "DNRC promulgated rules interpreting the Basin Closure Law for the Upper Missouri River basin while this lawsuit was pending. The regulations did not go into effect until January 1, 2005. DNRC's interpretation of the Basin Closure Law and, more specifically, the meaning of 'immediately or directly connected to surface water' have therefore not enjoyed a longstanding agency interpretation entitling it to a higher level of deference." Citing *Montana Power Co. v. Montana Public Services Com'n*, 2001 MT 102, 305 Mont. 260, 26 P.3d 91. Without such deference, the Supreme Court stated that it would "focus our inquiry on whether the agency's interpretation is correct as a matter of law in the absence of such a longstanding agency interpretation." Slip Op. at 17.

Montana Decision

Legislative Intent

Hydrologic Connection

Prestream Capture Impacts

Groundwater Capture

Capture Impacts

Tributary Groundwater

Direct Impact

The Supreme Court framed the issue by quoting the statutory language and stating what the legislature intended. "The legislature defined the groundwater exception in the conjunctive as 'water that is beneath the land surface or beneath the bed of a stream, lake, reservoir, or other body of surface water and that is not immediately *or* directly connected to surface water.' Section 85-2-342(2), MCA (emphasis added). The plain language of the statute demonstrates the legislature's intent to prohibit the processing or granting of applications for groundwater that either has an immediate connection to surface flows or has a direct connection to surface flows, or both." Slip Op. at 17-18.

A DNRC memorandum concerning the hydrological connection between the groundwater and surface water clearly weighed heavily in the Supreme Court's decision. First, the opinion pointed out that under both the DNRC's informal interpretation by its Director and later formal rule-making, DNRC's interpretation of "immediately or directly connected" fails to account for impacts to surface flow caused by the prestream capture of tributary groundwater. The decision then discussed the memorandum (Slip Op. at 18): "DNRC's own hydrogeologist recognized the impact to surface flows caused by the prestream capture of tributary groundwater. Bill Uthman (Uthman) of DNRC's Water Management Bureau drafted a memo to the Water Resources Division outlining the hydrologic interactions that occur between groundwater and surface water and how groundwater development may impact surface water. Uthman explained therein that groundwater pumping produces two separate components that contribute to total streamflow depletion:

> The first component, groundwater capture, is interception of groundwater flow tributary to the stream, that ultimately reduces the hydraulic gradient near the stream and baseflow to the stream. *Streamflow depletion from groundwater capture usually continues after pumping ends and may require long periods of time to recove*r. The second component, induced streambed infiltration, *usually has less impact on streamflow depletio*n, and its effects dissipate soon after pumping ends. [Emphasis added.]"

The Supreme Court obviously relied on the memo for its view of the correct interpretation. "As evidenced by DNRC's own hydrogeologist, not only does the prestream capture of tributary groundwater have an impact on surface flows, it has a more significant and longer lasting impact than does induced infiltration." Slip Op. at 19.

The remaining evidence that the Supreme Court found persuasive also focused on DNRC's information concerning the prestream capture of tributary groundwater. "Uthman further concluded that 'immediately or directly connected' could be interpreted to mean 'an immediate and direct, physical capture and depletion of surface water by a well or infiltration structure, including the interception of groundwater tributary to surface water.' DNRC also recognized that the prestream capture of tributary groundwater can reduce surface flows in its February 2003 Supplemental EA. DNRC noted that prestream capture occurs more gradually, and impacts streams, like the Smith River, that are hydrologically connected to an aquifer. DNRC failed to account for the direct connection between surface flows and the prestream capture of tributary groundwater in its implementation of the Basin Closure Law despite possessing a wealth of information supporting the connection." Slip. Op. at 19.

The Supreme Court concluded that DNRC's interpretation conflicted with the Basin Closure Law and did not provide sufficient protection to effectuate the purpose of the statute. "DNRC's interpretation recognizes only immediate connections to surface flow caused by induced infiltration and ignores the less immediate, but no less direct, impact of the prestream capture of tributary groundwater. The Basin Closure Law serves to protect senior water rights holders and surface flows along the Smith River basin. It makes no difference to senior appropriators whether groundwater pumping reduces surface flows because of induced infiltration or from the prestream capture of tributary groundwater. The end result is the same: less surface flow in direct contravention of the legislature's intent." Slip Op. at 19-20.

The decision by Montana's Supreme Court eliminates the uncertainty faced by surface water users and provides protection for their senior water rights from new groundwater applications that impact surface water availability. Although the decision dealt with an exception to the Basin Closure Law and new groundwater applications, as opposed to directly addressing regulation of conflicting use between groundwater and surface water users, one would assume that the decision provides at least some guidance for treatment of that issue when it arises.

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WATER BRIEFS

FEDERAL PLAN VIOLATES ESA NW

SNAKE RIVER PLAN FLAWED

On May 24, federal district court Judge James Redden declared illegal a federal plan for operation of US Bureau of Reclamation (Reclamation or BOR) water storage projects in the Snake River basin in Idaho. Judge Redden held that the federal government's 2005 NOAA Fisheries Biological Opinion (2005 BiOp) of Reclamation's Upper Snake projects was "arbitrary and capricious, and invalid under the ESA because it relies on the same flawed comparative jeopardy analysis used in the 2004BiOp for the down-river dams." Slip Op. at 25. The order remanded the 2005 BiOp to NOAA Fisheries and Reclamation with further instructions to correct its flaws.

The ruling found that the Snake River plan relied heavily on the 2004 Federal Columbia River Power System Plan (FCRPS) biological opinion (2004BiOp), which governs federal dam operations on the Columbia and lower Snake Rivers. Judge Redden invalidated that 2004BiOp in an earlier decision in May 2005. The primary issue in that case involved the treatment of the dams in the Federal Columbia River Power System as an immutable part of the natural environment; NOAA had characterized the dams as part of the "environmental baseline" that, therefore, were beyond the scope of their discretion in the biological opinion at issue in that case. See Moon, TWR #16 and Water Briefs, TWR #20.

The May 24 decision dealt with the biological opinion for the Upper Snake River issued by NOAA Fisheries to address the effects of Reclamation's proposed operation of twelve water projects above Hells Canyon Dam on thirteen threatened or endangered species of salmon and steelhead that occupy habitat in the Snake and Columbia Rivers below these dams.

Judge Redden early in his opinion noted some important evidence: "The 2005upperSnakeBiOp [sic] followed BOR's November 2004 Biological Assessment for 'Operations and Maintenance in the Snake River Basin Above Brownlee Reservoir,' in which BOR concluded that its proposed operations in the upper Snake River were likely to adversely affect the four listed Snake River salmon and steelhead species by indirectly affecting water temperatures and total dissolved gas concentrations on the Snake and Columbia Rivers. AR A.1, BiOp at 6-2. Despite these impacts, the 2005upperSnakeBiOp concluded that BOR's proposed operation of the upper Snake River projects would not jeopardize the continued existence of any listed species, or destroy or adversely modify their critical habitats." Slip Op. at 4

One of the primary components proposed in the 2005 BiOp to offset the loss of streamflow that occurs from operation of the water projects (irrigation and flood control) and reduce juvenile salmon mortality was the rental or acquisition of natural flow rights. Redden discussed this component and pointed out problems with the proposal. "To reduce juvenile salmon mortality through the FCRPS dams, NOAA has specifically directed BOR to provide 427 thousand acre-feet (kaf) of flow augmentation annually from the upper Snake River to reduce juvenile salmon mortality through the FCRPS dams since the agency issued its 1995 FCRPS BiOp. Although BOR failed to provide the full 427 kaf from 2001 through 2004, the 2005upperSnakeBiOp directs BOR to provide a slightly more ambitious flow augmentation of 487 kaf annually. BOR admits, however, that there is only a 50/50 chance that it will be able to provide the full amount of annual water flow augmentation specified in the 2005upperSnakeBiOp, and nothing specifically requires the agency to reach this level." Slip Op. at 6.

Redden held that "the remand of the 2005upperSnakeBiOp will be joined with the remand of the 2004BiOp. A combined consultation will be more likely to achieve the comprehensive analysis required by the ESA, but the decision to produce one biological opinion or two ultimately lies with the action agencies." Slip Op. at 25. "I look forward to a consultation that employs a valid, comprehensive analytical framework. Rebuilding salmon to healthy, harvestable levels will come in large part from addressing the impacts of the down-river dam operations that do the most harm to salmon. Even so, the water of the upper Snake water projects and its uses must be an integral part of the analysis. There must be a comprehensive evaluation of the effects of water use in the upper Snake River and the down-river dam operations." Id.

For info: Judge Redden's opinion can be accessed for review at: http://amr.convio.net/site/News2?page=NewsArticle&id=8649&news_iv_ctrl=-1

BROWNFIELDS PROGRAM US

$70 MILLION IN GRANTS

Communities in 44 states and two territories, as well as three Indian Tribes will share $69.9 million in grants to help transform brownfields properties to productive community use. The grants, from the US Environmental Protection Agency, promote the redevelopment of abandoned and contaminated or potentially contaminated waste sites. In all, 209 applicants were selected to receive 292 grants for assessment or cleanup of properties.

The $69.9 million in grants include: 184 grants totaling $36.6 million for conducting site assessment and planning for eventual cleanup at one or more brownfields sites or as part of a community-wide effort; 96 grants totaling $18.3 million for cleanup activities at brownfields sites; and 12 grants totaling $15 million to capitalize a revolving loan fund and provide subgrants for cleanup activities at brownfields sites. Revolving loan funds are generally used to provide low interest loans for brownfields cleanups.

For info: EPA websites: Grant recipients: epa.gov/brownfields/archive/pilot_arch.htm; Brownfields program: epa.gov/brownfields

WATER BRIEFS

BAY AREA WATER RIGHTS CA
WATER QUALITY & MINIMUM FLOWS

The California Supreme Court in mid-May refused to hear an appeal from a sweeping California Court of Appeals decision that involves judgments in seven coordinated cases. *State Water Control Bd. Cases*, (Case C044714; filed February 9, 2006; hereafter *SWRCB*). The complicated proceeding is a small part of an ongoing process that over more than four decades has attempted to solve the problems of water quality in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The challenges in the case raised numerous issues regarding the law of water rights, as well as issues regarding the California Environmental Quality Act (CEQA; Pub. Resources Code, § 21000 et seq.).

The complex, 285-page opinion written by Appeals Judge Ronald Robie, a former California Department of Water Resources director, also encompasses the two giant water projects in California. A key water rights decision known as "Decision 1641" assigned much of the responsibility for meeting the flow-dependent water quality objectives to the two great water projects in the state: the Central Valley Project, operated by the US Bureau of Reclamation (Reclamation), and the State Water Project (SWP), operated by the California Department of Water Resources. In normal water years, these two projects export about 30 percent of the water that reaches the Bay Area Delta (Delta). Water from the Delta is diverted to meet the needs of two-thirds of the population of California and to irrigate 4.5 million acres. "In the water rights proceeding, the Board sought to allocate responsibility among various water rights holders for meeting the flow-dependent water quality objectives in the Water Quality Control Plan for the Bay-Delta, which the Board had approved in May 1995 (the 1995 Bay-Delta Plan)." *SWRCB* Slip Op. at 3-4.

The refusal by the California Supreme Court to hear the case leaves the lower court's 285-page decision as the controlling precedent. The Court of Appeals affirmed, modified, and reversed various State Water Resource Control Board orders that implemented a water quality plan in a water rights proceeding, a related environmental impact report, a joint points of diversion petition, a change petition, and challenges to the Board's impartiality.

The Court of Appeals summarized what it considered some of the most important aspects of its decision (Slip Op. at 8-9): "Most significantly, we agree with Judge Candee that the Board erred when it failed to allocate responsibility for meeting all of the flow objectives in the 1995 Bay-Delta Plan. As will be seen, we conclude the Board was not entitled to implement alternate flow objectives agreed to by various interested parties in lieu of the flow objectives actually provided for in the 1995 Bay-Delta Plan. We also conclude that the Board failed to adequately implement certain salinity objectives in the 1995 Bay-Delta Plan and failed to implement the minimum flows necessary to achieve the narrative objective for salmon protection in the 1995 Bay-Delta Plan."
For info: The decision by the California Court of Appeals, Third Appellate District can be located for review as *State Water Control Bd. Cases* at http://california.lp.findlaw.com/ca02_caselaw/2_2006ca.html

USFWS / TRIBES US
GRANTS ANNOUNCED

On May 23, Acting Secretary of the Interior Lynn Scarlett announced that the US Fish and Wildlife Service (USFWS) is awarding nearly $8 million to help federally recognized Indian Tribes conserve fish and wildlife on their lands. USFWS is awarding the grants under two programs: the Tribal Landowner Incentive Program and Tribal Wildlife Grants Program. Since 2003, USFWS has put more than $38 million to work for tribal conservation efforts through the two grant programs.

The Tribal Landowner Incentive Program supports Indian tribes to protect, restore, and manage habitat for species at risk, including federally listed endangered or threatened species, as well as proposed or candidate species on tribal lands. USFWS is providing over $2 million to help fund 15 Tribal Landowner Incentive projects. About $6 million will help fund 28 projects under the Tribal Wildlife Grants program. These grants are awarded to Indian tribes to benefit fish, wildlife and their habitat, including species that are not hunted or fished.

Indian tribes have a controlling interest in more than 52 million acres of tribal trust lands and an additional 40 million acres held by Alaska Native corporations. Much of this land is relatively undisturbed, providing a significant amount of rare and important fish and wildlife habitat. "The Service's Tribal Landowner Incentive and Wildlife Grant programs provide financial resources and encourage cooperation while supporting the authority of the Tribes to manage their resources," said USFWS Director H. Dale Hall. "The flexibility of the programs allows the Tribes great latitude in funding natural resource management actions that are driven by their conservation priorities."
Among the funded Tribal Landowner Incentive Program grants are the following awards:

- The Nez Perce Tribe in Idaho will receive $141,108 to support basic research on pollination and herbivore impacts on the three rare plant species, Jessica's Aster, Palouse Goldenweed, and the listed Spalding's Catchfly.
- Sisseton-Wahpeton Oyate of the Lake Traverse Reservation in South Dakota will receive $141,171 to implement their Comprehensive Fish and Wildlife Management Plan and specifically to increase mallard and teal production within their reservation.
- The Stillaquamish Tribe in Washington will receive $117,000 to enhance and expand salmon spawning areas along the North Fork of the Stillaquamish River.
- The Pueblo of Santo Domingo will receive $148,348 for removal of invasive salt cedar and Russian olive trees and planting of native vegetation to improve habitat.

WATER BRIEFS

Examples of funded Tribal Wildlife Grants include:
• The Peoria Tribe of Indians of Oklahoma will receive $249,997 for the reintroduction of the Oklahoma endangered mussel, the Neosho mucket, into the Spring and Neosho Rivers, and research into the artificial propagation of a Federally threatened fish, the Neosho madtom.
• The Chevak Native Village of Alaska will receive $239,883 to collect data on natural resource assets and develop a Coastal Land Conservation and Protection Plan for tribal coastal lands bordering the Bering Sea.
For info: Patrick Durham, USFWS, 202/ 208-4133, or website: www.fws.gov/home/feature/2006/tribal_grants.pdf

DALLAS STORMWATER TX

SETTLEMENT AGREEMENT
WETLANDS CONSTRUCTION

The City of Dallas, Texas has reached an agreement with the federal government requiring the City to spend in excess of $3.5 million in a comprehensive effort to decrease the amount of pollution entering the city's stormwater system, the US Department of Justice (DOJ) and Environmental Protection Agency (EPA) announced May 10. The settlement requires the City to construct two wetlands at an estimated cost of $1.2 million — one along the Trinity River, and one along Cedar Creek near the Dallas Zoo — and to pay a civil penalty of $800,000.

The settlement resolves allegations first made by the federal government in an EPA order issued in February 2004 that the City failed to implement, adequately fund and adequately staff the City's stormwater management program. The settlement requires the City to have at least 36 people working in the City's stormwater management section, a 25% increase over the number of people on staff when EPA issued its order. The consent decree also requires the City to inspect at least 500 stormwater discharge pipes per year, 500 industrial facilities each year, and large construction sites every two weeks. Pursuant to the settlement, the City will prepare a formal environmental management system for twelve city-run facilities, including the city's service centers, and then have a third-party auditor review the management systems. EPA plans to conduct a full audit of the stormwater system within the next one to three years.

The first wetland the City will construct will be a 60-acre or larger area along the Trinity River downstream of Sylvan Avenue, in the vicinity of the Pavaho pump station. Currently, the City pumps stormwater directly from the sump to the Trinity River. This project will use stormwater to water a wetland that will provide urban green space and filter impurities out of the stormwater before it is reaches the Trinity. Prior to construction, the City is required to submit a detailed design plan for the wetland to be reviewed by the EPA.

The second wetland will be a small wetland along Cedar Creek near the Dallas Zoo. The wetland will be the last in a series of treatment steps designed to treat runoff from a portion of the Dallas Zoo. The system will be designed so that water emerging from the wetland can be returned to the Zoo for use in drip irrigation. This wetland must also have a detailed design plan approved by the EPA before work begins.
For info: DOJ, 202/ 514-2007; proposed consent decree is available on the DOJ website: www.usdoj.gov/enrd/open.html

MISSOURI RIVER SPRING PULSE

STORAGE RELEASES BY CORPS

The US Army Corps of Engineers (Corps) has completed its "2006 Spring Pulse" of water down the Missouri River that was intended to promote spawning of the endangered pallid sturgeon. The 2003 Amended Biological Opinion identified pulses in the spring from Gavins Point Dam as part of the Reasonable and Prudent Alternative to avoid jeopardizing the continued existence of the endangered pallid sturgeon. Missouri Attorney General Jay Nixon had filed suit in federal court to stop the spring rise from taking place. (See Hayes, Schneider & Sturkie, TWR #4 for a comprehensive article regarding the Missouri River issues; additional coverage in Water Briefs, TWR #5, #6, and #25.)

The spring pulse went forward following an April 24 decision by the US Supreme Court to let stand, without comment, a decision of the 8th Circuit Court of Appeals on several consolidated cases dealing with navigation, storage and endangered species issues. See *American Rivers. v. US Army Corp*s (August 16, 2005); available for review at: http://caselaw.lp.findlaw.com/data2/circs/8th/042737p.pdf.

Storage releases from the system of Missouri River reservoirs began at midnight on May 12, with Gavins Point Dam serving as the release site. Release adjustments ended on May 25. As noted in a Corps press release on May 11, the pulse was to provide an increase in flows of 9,000 cubic feet per second (cfs), with releases incrementally increased above the 16,000 cfs released at that time to support minimum navigation. The peak release of 25,000 cfs was to be held for two days. As the pulse traveled downstream, these flows raised the river by 2.2 feet near Omaha and tapered off to about a foot in central Missouri the following week. The Corps had predicted that the pulse would raise the river by 2.5 feet near Omaha and taper off to about a foot in central Missouri the week after.

On May 26, the Corps noted that the Gavins Point releases were at 25,000 cfs and were going to cycle down to 21,000 cfs on May 26 and 27. Thereafter, every third day, a 25,000 cfs cycle was to be released until the endangered species eggs hatch. At that point, a steady Gavins Point release will be provided so as not to strand the chicks.

There were nearly 38 million acre feet (MAF) of water stored in the large reservoirs on May 1st, which was above the storage preclude for the pulse. However, the spring pulse was delayed due to the fact that all the factors that weighed in the decision on timing of the releases were not in place at that time; the factors included water temperature of 61 degrees below Gavins Point, current and forecasted

downstream river flows, actual and forecasted precipitation and nesting activity of the protected least terns and piping plovers. Water was stored in Fort Randall and Gavins Point reservoirs in March and April to supply water needed for the pulse.
For info: Paul T. Johnston, Corps, 402/ 697-2552 or website: www.nwd-mr.usace.army.mil/rcc/

CWA VIOLATIONS OR
OIL SPILL ON RESERVATION

The American Energy, Inc. (AEI) has agreed to pay $585,000 to the US and the Confederated Tribes of the Warm Springs Reservation in Oregon, to resolve allegations that it discharged 5,388 gallons (128 barrels) of unleaded gasoline into Beaver Butte Creek in March of 1999. The spill was caused by a tanker truck and trailer rollover. The spill killed hundreds of juvenile Chinook salmon and steelhead in a four-mile reach below the spill site including wild Chinook salmon and mid-Columbia summer steelhead, which are listed as "threatened" under the federal Endangered Species Act (ESA). The area affected by the spill is the main spawning and rearing area for these anadromous fish in Beaver Butte Creek.

Contamination from the spill forced the Warm Springs Tribes to close off a two-mile stretch of Beaver Creek to Tribal members who gather traditional foods and products there, and caused violations of the Tribes' water quality standards in the area for the next two years. AEI's contractor completed a cleanup in early 2002 under the oversight of EPA's Emergency Response personnel and the Warm Springs Tribes.

The parties negotiated a comprehensive settlement of the case that provides:
• $80,000 to the spill Response Fund in satisfaction of all EPA penalty claims related to the spill;
• $80,000 to the Tribes in satisfaction of all Tribal penalty claims related to the spill; and
• $425,000 in payments to the Natural Resource Trustees (the National Oceanographic and Atmospheric Administration or "NOAA" and the Department of the Interior or "DOI") in satisfaction of all claims relating to natural resource damages from the spill ($94,243.98 to NOAA and $15,533.52 to DOI to reimburse assessment costs; $315,222.50 to a Registry of the Court to complete a Beaver Butte Creek Natural Resource Plan).
For info: USDOJ, 202/514-2007, EPA Region 10, 206/ 553-8203

WATER TRANSFER RULE US
EPA CLARIFICATION
NPDES PERMITS

A rule proposed by the US Environmental Protection Agency (EPA) would clarify that water transfers are excluded from regulation under the Clean Water Act's National Pollution Discharge Elimination System (NPDES) permitting program. NPDES permits will not be required for transfers of water from one body of water to another under the proposed rule. Such transfers include routing water through tunnels, channels, or natural stream courses for public water supplies, irrigation, power generation, flood control, and environmental restoration. The proposed rule would define a water transfer as "an activity that conveys waters of the United States to another water of the United States without subjecting the water to intervening industrial, municipal, or commercial use." This exclusion does not apply, though, to pollutants that the water transfer itself may introduce to the water being transferred. The withdrawal of groundwater is not included within the scope of the rule.

In 2004, the question of whether NPDES permits were necessary for water transfers went before the US Supreme Court in *South Florida Water Management District v. Miccosukee Tribe of Indians*, et al., 280 F.3d 1364, 541 U.S. 95 (2004). The court did not rule directly on the issue and remanded it back to the District Court for further deliberation, creating uncertainty about the need for a permit (see Glick, TWR #2). On August 5, 2005, EPA issued a legal memorandum entitled "*Agency Interpretation on Applicability of Section 402 of the Clean Water Act to Water Transfers*." This memo confirmed EPA's interpretation that Congress intended for water transfers to be subject to oversight by water resource management agencies and State non-NPDES authorities, rather than the NPDES permitting program.

EPA will accept comments on the proposed rule for 45 days after publication in the Federal Register, which as of this TWR's press deadline was expected to occur before June 15, 2006. The website listed below has links to the Federal Register Notice, as well as EPA's legal memorandum and a "Frequently Asked Questions" paper about the Water Transfers Rule.
For info: Jeremy Arling, EPA Water Permits Division (Office of Wastewater Management), 202/ 564-2218, email: arling.jeremy@epa.gov, or website: www.epa.gov/npdes/agriculture#water_transfer

STORMWATER ACTION ID
HIGHWAY CONSTRUCTION

The Idaho Transportation Department (ITD) and contractor Scarsella Brothers, Inc. have agreed to pay $895,000 for violations of the Clean Water Act during the construction of the Bellgrove-Mica realignment of Highway 95 near Lake Coeur d'Alene in Northern Idaho, the US Justice Department (DOJ) and US Environmental Protection Agency (EPA) announced May 3, 2006. The settlement concludes a lawsuit which began in 2004, alleging that ITD and Scarsella Brothers failed to provide adequate stormwater controls for a large highway project that later deposited many tons of sediment in Mica Creek, which flows into Mica Bay in Lake Coeur d'Alene.

Under the terms of the consent decrees, lodged May 3 in the federal district court in Boise, Idaho, ITD will pay a penalty of $495,000 and Scarsella Brothers will pay a $400,000 civil penalty. As part of the settlement, ITD and Scarsella Brothers also have agreed to send their engineers and environmental inspectors to a certified stormwater management training, and ITD has agreed to implement new construction management practices to help avoid future

WATER BRIEFS

(continued from previous page)
violations of the storm water regulations. In a related action brought in state court, Scarsella will pay a half-million dollars to the Mica Bay Homeowners Association to settle claims for property damage allegedly caused by sediment discharges from the site. The Association intends to use the money for environmental improvement projects in the Mica Bay watershed.

The penalty in these two cases is the largest EPA Region 10 has imposed thus far as part of its regional stormwater compliance initiative. Although the initiative began in 2001 with several years of intensive outreach, including workshops, mailers, and an expanded website, it was not until 2005, after EPA stepped up its inspection and enforcement efforts, that the region saw a dramatic increase in compliance rates. Between June 2004 and April 2005, the number of construction site operators in Idaho signed up for the Construction General Permit rose 112 percent. EPA inspectors have also noted that construction site operators are increasingly in compliance with the permit's requirements to design, install, and maintain stormwater controls to prevent common construction site pollutants such as sediment, petroleum products, and concrete washout from discharging into nearby waterways. Since the initiative began, EPA has brought compliance actions against more than 100 operators in Region 10.
For info: Cynthia Magnuson, DOJ, 202/ 514-2007; Mark MacIntyre, EPA, 206/ 553-7302; proposed consent decree is available on the DOJ website: www.usdoj.gov/enrd/open.htm.

CALENDAR

Please Note: An extended Calendar containing ongoing updates now appears on The Water Report's website: www.TheWaterReport.com. Subscribers are encouraged to submit calendar entries, email: thewaterreport@hotmail.com

June 11-16 CA
Pacific Fishery Management Council & Advisory Entities Meeting, Foster City. RE: Coastal Pelagic Species, Groundfish, Highly Migratory Species, Salmon, & Essential Fish Habitat. For info: Dr. Donald O. McIsaac, 866/ 806-7204, or website: www.pcouncil.org/events/2006/pfmc0606.html

June 15-16 WA
Land Use and Environmental Due Diligence & Compliance, Seattle, Washington State Convention & Trade Center. RE: Land Use Controls, Brownfields & Pollution Control, "All Appropriate Inquiries." For info: The Seminar Group, 800/ 574-4852, email: registrar@theseminargroup.net, or website: www.TheSeminarGroup.net

June 15-16 CA
Environmental Insurance, San Francisco. For info: ALI-ABA, 800/ CLE-NEWS, or website: www.ali-aba.org

June 19 OR
Mixing Zones Issues Presentation, AWMA Pacific Northwest International Section Event, Portland, One World Trade Center, 121 SW Salmon, Noon-1pm. Presenter: Brian King of Schwabe Williamson. For info: Frank Jones, AWMA, 503/ 235-9194 or email: frank@tw-nviro.com

June 19-20 ID
IWUA Summer Water Law Seminar & Workshop, Sun Valley. Sponsored by Idaho Water Users Association. For info: IWUA, 208/ 344-6690, website: www.iwua.org

June 20-21 AZ
"Providing Water to Arizona's Growing Population" – Arizona Water Resources Research Center Spring Conference, Phoenix, Hyatt Regency. For info: Cas Sprout, WRRC, 602/ 792-9591 x55, or email: csprout@ag.arizona.edu, or website: http://cals.arizona.edu/AZWATER/

~~**June 21-23 WA**~~
~~**Salish Sea Conference, Location TBA**.~~
NOTE: Rescheduled for Fall 2006
For info: Debra Lekanof, Swinomish Indian Tribal Community, 360/ 466-7280, email: dlekanof@swinomish.nsn.us www.salishseaconference.com/index.html

June 21-23 Malta
Waste Management 2006, Malta. Sponsored by Wessex Institute of Technology.For info: WIT website: www.wessex.ac.uk/conferences/2006/waste06/

June 21-24 CO
Environmental Litigation, Boulder. For info: ALI-ABA, 800/ CLE-NEWS, or website: www.ali-aba.org

June 22 WA
Dredging and Sediment Technologies, Seattle. For info: Holly Duncan, Environmental Law Education Center, 503/ 282-5220, email: hduncan@elecenter.com, or website: www.elecenter.com

June 26-28 MT
Adaptive Management of Water Resources: American Water Resources Association Conference, Missoula, Holiday Inn Missoula Parkside. RE: Tools, Monitoring Strategies, Performance Indicators & Target Thresholds, Assessment & Management of Uncertainty, Decision Support System Applications, Funding Requirements, Collaboration & Role of Social Science, Stakeholder Participation, Conflict Resolution, Socioeconomic Considerations, Legal/Policy Barriers & More. For info: AWRA, 540/ 687-8390, or website: www.awra.org/meetings/Montana2006/index.html

June 29 WA
Regional Hydropower Relicensing, Seattle, Washington State Convention & Trade Center. RE: Recent Amendments to the Federal Power Act & Related Agency Regulations. For info: The Seminar Group, 800/ 574-4852, email: info@TheSeminarGroup.net, or website: www.TheSeminarGroup.net

CALENDAR

July 6-7 IL

4th Annual NGWA International Conference, Chicago, Holiday Inn Chicago Mart Plaza Hotel. RE: Groundwater Law, Environmental Contamination Litigation, Hydrogeology, Contaminant Transport, Groundwater Modeling, Environmental Forensics for Allocating Liability, Toxic Torts, Coalbed Methane, Bottled Water Permitting, Transboundary Water Disputes & Emerging Contaminants. For info: NGWA, 800/ 551-7379, website: www.ngwa.org/e/conf/0607065066.cfm

July 11 WA

Tribal Economies, Seattle. For info: The Seminar Group, 800/ 574-4852, email: registrar@theseminargroup.net, or website: www.TheSeminarGroup.net

July 13 ID

Law of Easements: Legal Issues and Practical Considerations in Idaho, Boise, Holiday Inn Boise Airport. RE: Drafting & Construction, Creation of Easements, Scope & Termination, Litigating Easement Cases, Water & Conservation Easements. For info: Lorman Education Services, 866/ 352-9539, email: customservice@lorman.com, or website: www.lorman.com

July 13-14 NM

Energy in the Southwest - 3rd Annual Conference, Santa Fe. RE: Key Regulatory Policies, FERC OMOI Energy Trading Regulation, Traditional Fuel Supplies, Renewable Resource Development, Grid Wise Alliance, Market Perspectives & Financing Strategies, Southwest Climate Initiative & FERC Commissioner Suedeen G. Kelly. For info: Law Seminars Int'l, 800/ 854-8009, or website: www.lawseminars.com/seminars/06BSENM.php

July 18-20 NM

Increasing Freshwater Supplies - UCOWR/NIWR Annual Conference, Santa Fe. For info: UCOWR, 618/ 536-7571, email: ucowr@siu.edu or website: www.ucowr.siu.edu/

July 19-21 CO

Western States Water Council 151st Meeting, Breckenridge, Beaver Run Resort & Conference Center. For info: Tony Willardson, WSWC Associate Director, 801/ 561-5300, email: twillards@wswc.state.ut.us, or website: www.westgov.org/wswc/meetings.html

July 20-22 NM

Rocky Mountain Mineral Law Institute 52nd Annual, Santa Fe. For info: RMMLF, 303/ 321-8100, email: info@rmmlf.org, or website: www.rmmlf.org

July 22-26 CO

Soil and Water Conservation Society 2006 Environmental Management Conference, Keystone, Keystone Resort. RE: Current Issues in Natural Resource Management & Planning. For info: SWCS, 515/ 289-2331, or website: www.swcs.org/en/swcs_international_conferences/2006_international_conference/

July 24-26 CO

Colorado Water Conservation Board and RICD Meeting, Durango. For info: Dena Crist, CWCB, 303/ 866-2599, or website: http://cwcb.state.co.us/

July 25 OR

Emiment Domain: Legal Update, Portland. For info: National Business Institute, 800/ 930-6182 or website: www.nbi-sems.com

July 26-28 CO

31st Water Workshop: The Developed Resource, Gunnison, Western State College of Colorado. For info: George Sibley, 970/ 943-2055, email: gsibley@western.edu, or website: www.western.edu/water/

July 26-28 UT

Western Water Seminar (National Water Resources Association), Park City, Park City Mariott. For info: NWRA

July 28 HI

NEPA & EIS Workshop: New Developments, Cultural Assessments, Recent Litigation, Honolulu, Waikiki Beach Marriott Resort & Spa. For info: Law Seminars, 800/ 854-8009, website: www.lawseminars.com/seminars/06SEPAHI.php

August 7-8 NM

New Mexico Water Law, Santa Fe, The Eldorado Hotel. For info: CLE Int'l, 800/ 873-7130, email: registrar@cle.com, or website: www.cle.com

August 10-11 AZ

Arizona Water Law, Phoenix, Biltmore Resort & Spa. For info: CLE Int'l, 800/ 873-7130, email: registrar@cle.com, or website: www.cle.com

August 10-11 CO

Eminent Domain, Denver. For info: CLE Int'l, 800/ 873-7130, email: registrar@cle.com, or website: www.cle.com

August 10-11 OR

Oregon Water Resources Commission Meeting, Bandon. For info: Cindy Smith (OWRD), 503/ 986-0876, website: www.wrd.state.or.us/commission/index/shtml

August 10-11 WA

Renewables and Energy Efficiency Conference, Seattle, Renaissance Seattle Hotel. For info: Law Seminars Int'l, 800/ 854-8009, or website: www.lawseminars.com/seminars/06RENUWA.php

August 11 OR

"New Directions for Oregon Water Quality" Seminar, Portland, World Trade Center. RE: Recent Legal & Regulatory Changes, Impacts on Operation & Development Activities. For info: The Seminar Group, 800/ 574-4852, email: registrar@theseminargroup.net, or website: www.TheSeminarGroup.net

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August 14-15 AZ

EPA Workshop: Stormwater Program Managers, Phoenix. RE: NPDES Phase II Stormwater Requirements, Illicit Discharge Detection & Elimination, Post-Construction Runoff Controls, Construction Management, Public Education & Involvement. For info: Bob Faxon, City of Prescott, 928/ 777-1126, email: bob.faxon@cityofprescott.net, or EPA Office of Wastewater Management's website: http://cfpub2.epa.gov/npdes/courseinfo.cfm?program_id=0&outreach_id=200&schedule_id=922

August 17-18 IL

Clean Water in the Midwest, Chicago. For info: Law Seminars International, 800/ 854-8009, or website: www.lawseminars.com/

August 19-22 TX

Second International Conference on Environmental Science & Technology, Houston, Wyndham Greenspoint Hotel. Sponsored by the American Academy of Sciences. For info: Jim Hong, 713/ 776-8846, Conference email: env-conference@AASci.org, or website: www.AASci.org/conference/env/2006/index.html

August 29-31 MI

Wetlands 2006: Focus on the Great Lakes: Applying Scientific, Legal, and Management Tools to Restore Wetland and Watershed Functions, Traverse City, Grand Traverse Resort. For info: Association of State Wetland Managers, email: laura@aswm.org or website: www.aswm.org

September 7-8 MT

Agricultural Law, Billings. For info: The Seminar Group, 800/ 574-4852, email: registrar@theseminargroup.net, or website: www.TheSeminarGroup.net

September 10-14 NY

American Fisheries Society Annual Meeting, Lake Placid. For info: AFS website: www.fisheries.org/html/index.shtml

September 13 CA

CEQA & NEPA, San Francisco. For info: Law Seminars Int'l, 800/ 854-8009, website: www.lawseminars.com/seminars/

September 13-16 AZ

Water & Water Science in the Southwest: Past, Present & Future, Arizona Hydrological Society 19th Annual Symposium, Glendale. RE: Runoff Impacts, Recharge, Subsidence, Groundwater Remediation, Monitored Natural Attenuation, Emerging Contaminants, Modeling and GIS, Tribal issues, Colorado River Issues, Privatization, Mining & Energy Development Hydrology, Glen Canyon/Grand Canyon Issues, Delivery/Distribution of Water Supply, Climate Change & More. For info: Christie O'Day, AHS, 480/ 894-5477, or AHS website: www.azhydrosoc.org

September 15 OR

Property Transactions & Real Estate Development, Portland. For info: Holly Duncan, Environmental Law Education Center, 503/ 282-5220, email: hduncan@elecenter.com, or website: www.elecenter.com

September 15 GA

Environmental Law, Atlanta. For info: The Seminar Group, 800/ 574-4852, email: registrar@theseminargroup.net, or website: www.TheSeminarGroup.net

September 18-20 MT

Northwest Water Policy and Law Symposium, Bozeman, Holiday Inn. RE: Infrastructure Matters, Surface Water/Groundwater: Relation in Nature and Policy, Water Regulation v. Land-Use Regulation, Challenges of Natural Resource Policy & More. For info: Susan Higgins, Montana Water Center, 406/ 994-6690, email: water@montana.edu, or website: water.montana.edu/policy/default.htm

The Water Report
Water Rights, Water Quality & Water Solutions in the West
260 N. Polk Street • Eugene, OR 97402