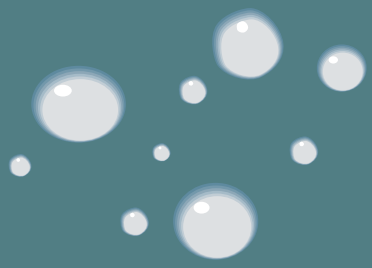

WATER SCIENCE IN THE COURTROOM

Board of Advisors

Dividing the Waters

Associated with
The National Judicial College

Water Science in the Courtroom
A Report by the *Dividing the Waters* Board of Advisors

Dividing the Waters is a program of The National Judicial College (Reno, Nevada) that provides information and training resources to judges adjudicating complex water litigation. For more information on the Program, go to http://www.judges.org/dividingthewaters/.

A board of "conveners," who are judges with experience in water adjudication, directs the *Dividing the Waters* Program. In 2012, the conveners established a board of advisors, which includes water lawyers, to advise the program on emerging water law issues and advocate for the program within the water law community. The board of advisors includes:

- David Aladjem (CA)
- Steve Clyde (UT)
- John Draper (NM)
- Eric Garner (CA)
- Adam Gravley (WA)
- Thomas Jensen (DC)
- Sarah Klahn (CO)
- James Lochhead (CO)
- Douglas MacDougal (OR)
- Maria O'Brien (NM)
- TC Richmond (WA)
- Irma Russell (MT)
- Paul Simmons (CA)

For more information on the board of advisors, go to:
http://www.judges.org/dividingthewaters/dtw-board.html

NOTE REGARDING ACADEMIC FREEDOM: While developing this report, the board of advisors suggested development of a public statement regarding the *Dividing the Waters* method of addressing controversial topics. The program's conveners therefore developed the following statement on academic freedom for its programs, which can be found on the program's webpage:

> **Academic Freedom Statement**
> *Dividing the Waters* provides a forum for judges to discuss issues in a manner that allows them to best serve the public and the judicial system. In order to encourage open discussion and debate among judges, *Dividing the Waters* maintains the confidentiality of such discussions, consistent with the Canons of Judicial Ethics and while adhering to The National Judicial College's Academic Freedom Statement.
> - http://www.judges.org/dividingthewaters/dtw-history.html

Water Science in the Courtroom

A Report by the *Dividing the Waters* Board of Advisors

FIRST CONVENING OF BOARD OF ADVISORS

The conveners of the *Dividing the Waters* program at The National Judicial College established a board of advisors (board) to provide support and advice on the program's continued development of education and information resources for judicial officers adjudicating complex water cases. The board convened for the first time in February 2013, to address the issue of science in the courtroom, at the request of the conveners.

Science in the Courtroom Discussion

After receiving a briefing on the *Dividing the Waters* program, the board heard presentations on the related science issues that judges had discussed at previous conferences and workshops. The board previously had received the packet of documents on "use of experts" from the October 2012 *Dividing the Waters* conference. Consistent with the program confidentiality policy, the board heard general descriptions of previous presentations and discussions, not specific recitations of what judges stated.

Retired Judge John Kuenhold (Colorado) made a short PowerPoint presentation and led a discussion on the use of expert witnesses in water cases. The discussion focused on the complexity of expert testimony in water cases and the need to ensure judges are both prepared to understand the testimony and that the testimony be presented in a manner that provides the court with the best available science.

The board and Judge Kuenhold discussed the history of the state and federal rules of evidence on experts and the requirement for any expert that the testimony involve "special knowledge" and that it is "helpful" to the judge. They also discussed the ways in which the judge can use early case management to shape the development of expert testimony and the tensions between the need to present the best science with the obligations of counsel to represent their client's particular interest in the matter. The judge articulated that the fact that water cases can involve substantial long-term economic, social and environmental consequences makes the need to have the best science before the court especially important.

The discussion included a review of critical studies on how bias in expert presentations can negatively affect the judge's understanding of the scientific principles the judge needs to apply. Judge Kuenhold reviewed the new Colorado rules requiring experts to meet without counsel and to certify their expert testimony is their complete and true opinion on the matter testified to. There was also discussion of other approaches including the use of advisory experts by the court. Upon reflection of his experience, Judge Kuenhold concluded: "All in all, it was a lively and thoughtful exchange that is likely to continue in the future."

Dan Luecke, *Dividing the Waters* science consultant, who has worked with the conveners for a decade on science programs, presented the program's experience in presenting science topics to judges. Luecke has presented workshops in a "Science for Judges" series that has included topics on:

- surface and groundwater interaction and hydrologic modeling
- the relationship between water quantity and water quality
- methods of quantifying instream flows for biological and recreational purposes
- the relationship between climate change projections based on General Circulation Models and downscaling their output to river basin hydrologic models

The program addressed the last topic in three workshops, which dealt not only with the modeling issues but also with the topics of risk management and decision making under uncertainty. Luecke also worked with two program judges to organize a focus group on various forms of decision making and risk management. Luecke focused these workshops on illuminating the relationships between natural systems, conceptual and computer models of these systems, and the data needed to make the models reasonable approximations of the natural systems.

The workshops have produced several publications. The first on groundwater and hydrologic modeling led to the publication, in 2011, of a bench book on hydrological modeling. The climate workshops led to a paper, "How to Take Climate Change into Account: A Guidance Document for Judges Adjudicating Water Disputes," in the *Environmental Law Reporter*. The focus group led to a paper, "Adversary Collaboration: Court Mandated Collaboration Between Opposing Experts in Colorado's Water Courts," which *Natural Resources & Environment* (ABA Section on Environment, Energy, and Resources) published this year.

Discussion among board members ranged widely, from the nature of the advice the conveners sought to the members' experiences working with judges and science experts. The executive director explained how the development of this issue through *Dividing the Waters* programs had led to the conveners seeking advice from lawyers who have used science in water litigation. The audience for their advice includes the conveners and the judicial members of the *DTW* network. The question is what you would want a judge who is new to water litigation to know in adjudicating questions of science. This report on their recommendations will be subject to public scrutiny by their colleagues in the water law community. After much discussion of the problems they have encountered in litigation related to science, the board identified a wide range of issues and recommendations. Further discussion led to the following topics for recommendations.

RECOMMENDATIONS ON SCIENCE IN THE COURTROOM

The board of advisors concluded that the use of science in complex water cases is one of the most important – and challenging – responsibilities for lawyers and judges alike. Water litigation is different than most other kinds of complex litigation where science is involved. Cases can often last for years, even decades, and the continuing conflict imposes a burden on society. It involves allocating a public resource that affects the social and cultural conditions of the communities that rely on the water-all communities. Rivers serve communities, where many parties are connected to each other, and those connections continue long after a judge issues a decision. The communities will share the common water resource for decades, so the importance of rendering a decision that follows established legal principles, that is based on good unbiased science, and that is seen as fairly balancing competing demands (e.g. competing consumptive uses and the environment) is paramount.

Science in water cases also presents unique challenges. The science relating to water does not analyze a single event or moment in time. The sciences of a river system continue to evolve over time. Understanding grows as new data and analysis emerges. In the middle of water litigation, the science continues to develop. This continued development means scientific uncertainty remains inherent to water litigation.

Like the science, the scientists in any particular river system continue to develop, but remain a relatively small contingent. For each river system, the number of scientific experts – and water lawyers – is limited. Scientists and lawyers often specialize in a particular river system. When scientists without experience in the particular river system become involved in water litigation, they may raise issues that have little relevance to the particular river system. Or they may try to apply general principles from other watersheds that do not fit the facts on the ground in the watershed, which can limit the utility of convening "blue-ribbon" panels. Judges therefore may need to examine scientists who lack experience in the watershed at issue, with careful questions. Conversely, judges also may need to probe settled assumptions and practices on the part of "insider" scientists that may have become authoritative without appropriate peer review or updating.

The federal, state and local agencies with responsibility and authority to manage the river may be numerous, but the community of agency scientists also remains small. The uncertainties inherent to changing river systems may lead to agency scientists remaining conservative in their forecasting of the river's response to changing management. They may try to maintain the status quo to protect the resources in the river system. Or, they may have personal or institutional views that are, or become, out of step with the available scientific information.

As the discussion concluded, the members' explanation of their personal experience in working with scientists and judges – both good and bad – led to a set of three recommendations to judges, which each include subsidiary recommendations.

I. MANAGE CASE SCIENCE AND TECHNICAL ISSUES FROM THE BEGINNING OF THE CASE

Resolving water conflicts, whether through trial or settlement, requires proactive management of the scientific and technical issues relative to the particular dispute. Careful judicial management of the scientific and technical issues from the beginning of the case is essential to allow clarification of the issues and to ensure orderly and efficient resolution. Often, the nature of the dispute – *e.g.,* allocation of water in times of shortage or availability of supply that a new appropriation or use requires – benefits from addressing the scientific and technical issues upfront. The nature of the watershed, including the availability of water and the diversity of beneficial uses (including both consumptive and instream uses), will determine what scientific or technical information are germane to resolution of the conflict. While most serious water disputes involve a battle of the experts (scientists and lawyers or engineers), the court can extract the greatest benefit from the experts' opinions, and ultimately reach conclusions that allow resolution of the dispute based on the best science, by managing critical technical and scientific issues at the start of the lawsuit.

A. Identify critical scientific and technical issues that may affect case outcome.

Each watershed presents different kinds of scientific and /or technical issues. The foundation of the court's inquiry in a water case remains hydrology. Understanding or using watershed hydrology in the context of the lawsuit often involves understanding issues arising from other disciplines– law, engineering, biology, geology, geomorphology, botany; and economics. From

these fields, the dispute may contest specific scientific issues, such as the requirements for biological resources vis-à-vis water supplies. For example, are physical supplies interchangeable from a water quality standpoint for purposes of maximizing fisheries requirements? Or are fisheries limited by water quality or temperature? In certain cases, an understanding of the life cycle of a particular fish species, or the geology of a particular formation (in the context of a ground water withdrawal dispute), may drive the analysis of the experts in the case. Thus, an expert's assumptions regarding the effects of surface water diversions may be more or less valid depending on the assumptions made regarding fish life cycles, for example. The first step in managing science in a water case is therefore determining the specific scientific issues in dispute.

Early on, the court should consider entering a case management order containing provisions which facilitate identification and development of the technical issues and points of dispute. One means to identify the critical scientific and technical issues is to mandate meetings between competing experts to set the groundwork for the scientific or technical issues in dispute, as discussed *infra* at Section II.B.

The case management order may provide for experts to freely exchange information without the presence of counsel and may set other parameters for information exchange and development. Such a process should be carefully monitored, in order to allow for development of the technical disputes between the experts while allowing counsel on both sides to ensure the scientists identify the technical and scientific issues in the context of the legal issues presented by the litigation. In some cases, scientists may pursue investigation of scientific issues that do not address the issues in the litigation, wasting the time of scientists, counsel and the court. Conversely, with sufficient guidance as well as the freedom to exchange relevant information, the scientific technical disputes can be narrowed and clarified.

B. Identify the scientific information resources in the watershed.

The second step to assist in developing the scientific and technical information necessary to resolve a dispute involves identifying the scientific and technical resources already available in the relevant watershed. A judge may consider how to manage the existing scientific resources through establishment of a common or shared database, as well as requiring collaboration or development of further resources necessary to address the specific scientific issues in dispute. Those resources may include monitoring, academic research and multi-party scientific programs. Many of the extant scientific and technical resources usually come from governmental agencies – federal, state and local. An agency may have a mission and regulatory responsibilities that will require careful assessment as to its proper role in the litigation. Academic researchers may have some neutrality, but their research may not address the specific issues involved in the litigation. In addition, there may be hostility to one or more of the parties in the litigation, which can impair the academic researcher. Others may be working for one party or another.

At the end of the day, if parties are planning (or if the court orders) use of existing scientific information or databases, the court would be well-served to solicit positions from the parties regarding the validity of the data in question. Even if there are not competing sources of information (*e.g.,* an existing regional ground water model), validity of reliance on the information in a given context may already be a central dispute in the case. In either case, attempting to understand the advantages and shortcomings of a particular source of information can more clearly set the context of any legal or factual disputes.

C. Convene *Daubert* hearings early in the case.

A further step in managing science in a water case involves assessment of the scientists and the opinions they have formulated, both those representing parties and others who the parties may propose for the court's use as a court expert or special master for science in the case. A helpful tool to the court's role of gatekeeper vis-à-vis the scientific and technical information in the case is the early convening of hearings on the qualifications of experts and the foundation of expert opinions, as provided in *Daubert v. Merrell Dow Pharmaceuticals, Inc.* 509 U.S. 579 (1993). A *Daubert* hearing is an important tool to assess both the relevant expertise of the proffered expert as well as the methodology utilized to analyze the particular technical issues presented in the case. The judge may need to inquire as to the expert's experience and expertise in the watershed where the litigation arose. Some experts may have experience in other watersheds and apply basic scientific principles that may not apply fully in the specific watershed. The specific premises of the opinions of the various experts and methodologies employed should be subject to *Daubert* scrutiny. Questions may include:

- Does the modeling approach or analysis of a particular expert adhere to accepted standards in the field?
- Is the methodology and approach a good fit for the particular watershed?
- Is the expert opinion based on tested and verifiable assumptions?

In applying *Daubert*, however, the court must be cognizant of the complexity and uncertainties often involved in modeling or analyzing watersheds, water allocation, and management scenarios. Where there are novel approaches, the judge may question whether they are acceptable given the complexity of the system and lack of information. Or is the novel approach an effort to avoid analysis of the available information utilizing a more tested approach? Alternatively, does the novel approach seek to overcome limitations or the inability of experts to explain problems confronting a specific watershed. *Daubert* hearings can be used to allow the court and all parties to assess the various approaches to the dispute, narrow the issues, and streamline the proceeding. *Daubert* hearings also can play a useful role in ensuring a scientist has not become an advocate as opposed to an expert by exposing result-oriented opinions and conclusions.

II. CONSIDER AND SELECT ALL TOOLS FOR CASE SCIENCE MANAGEMENT

Experts, both scientific and technical, use a wide range of tools and technology in studying and managing water resources. Some of these technical tools may be helpful to a judge, while other kinds of tools may be helpful in adjudication of water disputes. A judge who has her first water case may benefit from learning about the range of tools available for addressing the conflict. The parties can help the judge by identifying the kinds of technical tools that may be available in the watershed, but other experienced water judges may be the best resource for learning about the judicial tools that are most helpful. This paper will identify some of those judicial tools.

A. Ask the "Top 10 Questions" of scientists involved in the case.

The lawyer's scalpel is the question. The judge may wish to start similarly, by asking counsel or the scientists involved in the case the "Top 10" questions that they each believe provide the foundation for the judge to identify the most critical scientific issues and make some judgment as to the expert.

1) What is the geographic scope of the water body or basin, including underground features?
2) Are all scientific viewpoints present in the case?
3) What is the status (e.g., scope, extent, timing, value) of the data underlying scientific opinions or issues?
4) What data gaps exist? What are the known unknowns?
5) What are the key areas of scientific uncertainty that affect future decisions?

6) Do you propose to use a predictive model as evidence or as a basis for your opinion?
7) If so, what are the methodologies, data inputs, and assumptions used in your chosen model? Do the parties agree about these "baseline" factors, even if they disagree about interpretation or meaning of modeling results?
8) What are the variables?
9) What is the margin of error?
10) Are there any proprietary issues with the science?

B. Consider use of early meetings of experts to resolve issues.

Some states have rules that require or encourage early meetings of scientific experts (without lawyers) to:

1) identify the scientific or technical issues in dispute;
2) determine where the experts agree; and
3) describe the differences between experts that require the court to exercise its judgment.

In Colorado, Water Court Rule 11 identifies the timing, content and conduct of expert meetings. (Attached as Appendix A). The Colorado Water Courts have mandated these meetings as an extra-judicial means to narrow the issues prior to trial in water court. Two meetings are mandated, the first after the applicant's[1] C.R.C.P. Rule 26(a)(2) expert disclosures are filed and the second after objectors' C.R.C.P. Rule 26(a)(2) disclosures are filed. After the second meeting, the experts are required to prepare a joint written statement that identifies the disputed issues of fact and the undisputed issues of fact. The joint statement is distributed to the parties.

These types of meetings can be beneficial, particularly in a large, complex case, for clarifying the issues that are truly in dispute. However, the value of the meetings is directly related to the sincerity the experts bring to the task at hand and their ability to frame the scientific issues in a way that is neutral, advances understanding of the underlying factual disputes, and serves to advance the possibility of a physical solution or other relatively amicable resolution. In addition (and for jurisdictions outside the Colorado water courts), if the meetings are to be used to educate the court about the technical and scientific issues in dispute, the process involves a means for the final joint report to be shared with the court and possibly also to allow briefing by the parties regarding the relationship of the disputed issues to the legal framework of the case.

C. Consider appointment of a special master.

A common judicial tool in water litigation is the use of a special master, which may take any number of forms. The United States Supreme Court commonly selects a water master in cases of original jurisdiction for water disputes between states. The function of these water masters is often similar to a trial judge, ruling on both facts and law. The 2011 *Montana v. Wyoming* decision by the Supreme Court offers a recent example, where Stanford Law Professor Barton Thompson ruled on how to address water conservation reducing return flow to the downstream state. A special master is used in these original jurisdiction cases because the Supreme Court, in effect, acts more like an appellate court in these cases. [comment]

As Hart & Weschsler, *The Federal Courts and the Federal System* (6th ed. 2009), characterize it (p. 253): "Invariably, the court appoints a special master to take evidence and prepare a findings of fact, which though in theory only advisory, the court regularly accepts. *See United States v. Raddatz*, 447 U.S. 667, 683 n.11 (1980); but cf. *Maryland v. Louisiana*, 451 U.S. 725, 765 (1981) (Rehnquist, J., dissenting) (referring to the "appellate-type review which this court necessarily gives to [the special master's] findings and recommendations")." Thus, while

[1] An "applicant" is the term used for claimant or plaintiff in a Colorado water court case.

technically the Supreme Court is a trial court in original actions (jury trials have even been held), the court effectively acts as an appellate court when masters are appointed.

Some federal courts appoint water masters after judgment, to administer and enforce the rules of the judgment. Others have hired scientific experts, whose expenses the parties pay, to help work through and advise the court on the scientific facts of the case. Rule 53 of the Federal Rules of Evidence provides parameters for using a special master. A chapter from the Federal Judicial Center's *Reference Manual on Scientific Evidence* (1994) also has a good discussion on the use of special masters, especially in scientific and technical matters: http://www.fjc.gov/public/pdf.nsf/lookup/14.spec_mast.pdf/$File/14.spec_mast.pdf; https://bulk.resource.org/courts.gov/fjc/sciam.1.preface.pdf

In state court water right adjudications, water masters may have any number of responsibilities for assisting the trial judge. Some are water law experts with some understanding of hydrology, while others may be engineers with a deeper understanding of hydrology who assist the judge in determining the facts of the case. (A number of engineers are also well-grounded in water law.)

For judges, the first step in deciding whether to engage a special master is determining the judge's needs for assistance. Is it the facts alone or is it how the law applies to determine the facts? Generally, it is the sheer numbers of claims and parties and available funding that dictate when a general jurisdiction judge may appoint a special master. In addition, with thousands of claims at issue, legislation can be approved which sets forth a process that includes a special master. This is a general recognition that a single trial judge's general jurisdiction docket will not allow the dedication of time required for many complex water disputes such as a general stream adjudication.

D. Inquire into the opportunities for a "physical solution."

The doctrine of "physical solution," most developed in California, allows courts acting in equity to, in effect, impose settlements on litigants so long as the solution protects vested rights and priorities. In general, a physical solution can be thought of as a conditional or qualified injunction, at least in many instances. Courts are directed to fashion a "physical solution" to a water conflict when available. Thus, where the ordinary remedy for infringement of a water right may be an injunction prohibiting some other use, that remedy may be harsh, and courts look for alternative relief. This is not a matter of equitable distribution or pro-rating supplies among competing uses. Rather, it is a means to reconcile relative rights or legal obligations with the practical realities of needs for water. In California, it implements the state constitutional command that water resources be put to maximum beneficial use. Physical solutions do not require consent of the parties so long as vested rights are protected. While not interchangeable with water, money can be key to a physical solution. For example, a party whose diversion would otherwise be enjoined in order to protect senior right-holding plaintiff's water supply might be required or allowed to pay to line plaintiff's or other person's canals such that both parties continue to have needs met.

The potential for a court-imposed physical solution (or other form of conditional injunction) can be an incentive for settlement. Of course, if parties are before the court, they (or at least some necessary parties) have not entered a settlement. The science offered by competing sides in support of outcomes can also serve as the technical expertise relied upon by the court in fashioning its alternative. The approach of an early meeting of experts (discussed above) can support agreed-upon physical solutions, particularly if an environment can be created in which parties can comfortably abandon entrenched positions. Unlike other types of litigation, parties to

water litigation commonly are "neighbors" who will have a continuing future relationship with other parties. As a result, the success of future steps often depends in part on whether parties are able to forge functional working relationships. A court may encourage or facilitate parties to work together on a physical solution by providing time in the case schedule, suggesting or requiring mediation of specific issues, issuing interim orders that have "carrots and sticks," and similar tactics. Physical solutions to water disputes usually suffer from a lack of funding, and a court should look for opportunities for parties to pursue funding resources to enable a physical solution. Physical solutions also provide a potential means to provide flexibility in a judgment or to address and accommodate scientific uncertainty, discussed below.

E. Issue Scheduling Orders for Addressing Scientific Issues

Once the judge has an understanding of the scientific issues and resources available, a scheduling order establishing a process for addressing those issues can expedite their resolution. Some issues may require resolving preliminary factual matters before science experts can issue an opinion on them or their meaning. A scheduling order may specify discovery or joint factual development, set a series of preliminary hearings or meetings of experts (with or without lawyers), or impose deadlines for the parties to resolve preliminary factual issues or go to trial on those issues. Later in the litigation, a scheduling order may bifurcate scientific and legal issues, or may require the parties to develop a judgment, based on the court's determinations, that includes post-judgment adaptive management system or process to continue resolving scientific issues as the parties implement the judgment.

F. Some Thoughts on Hydrologic Modeling

It is an appropriate pun to say that the subject of hydrologic modeling in water cases is a fluid topic. It is very difficult to lay down general principles that will always be applicable. But let us give it a try at a very basic level, from the point of view of water lawyers who have litigated hydrologic models over a period of decades, knowing that there are textbooks and other sources that will have more rigorous scientific descriptions.

A hydrologic model can simulate groundwater or surface water or both. Most models actually simulate both at least to a certain degree because groundwater and surface water are usually related in some direct or indirect way. Fundamentally, a model is created for the purpose of simulating water flow, water storage and water use. A model can also simulate water quality. This type of model is called a mass transport model. This discussion refers primarily to flow models that do not include water quality simulation.

Models are usually divided into analytical and numerical models. Analytical models or analyses consist of the equations that characterize water phenomena. Analytical models can often suffice for the type of analysis needed in a simple case. If not, they are often a good way to check that a more complicated numerical model is giving reasonable results. Numerical models are usually computer models that apply basic water equations to more complicated situations. Simplifying assumptions are not needed to the same degree as they are for analytical solutions.

The first question is always whether a model is needed, and, if so, what kind of model and whether the necessary data exist. The answers to these questions are made first by the parties and then resolved by the judge if necessary. The answer is not necessarily "yes" on the need for a model. For instance, sophisticated analysis can tell us that the shortest distance between two points is a straight line, but we don't need sophisticated analysis to tell us that.

One question that has been debated in recent years is whether a model needs to be "peer-reviewed." Peer review can provide an added assurance of reliability, but it should by no means be a prerequisite. Academic peer review or the equivalent is only going to be available for models that have been widely used or published by a government agency. One example is a groundwater model known as MODFLOW, created by the U.S. Geological Survey, which is the subject of papers and has been widely used. Strictly speaking, MODFLOW is a model "code," the computer instructions for carrying out calculations once the "data" has been provided as inputs to the code. Data for the specific application, including the model geometry, must be analyzed and provided by the user in the context of any particular application of the model code.

Most disputes, however, do not arise over the basic computer code found in programs like the MODFLOW program, but rather the particular application in the case at hand. So peer review of the basic program can be of little value. Further, other approaches that are not peer reviewed can still be adequate and validly used. Most importantly, there is no better "peer review" than subjecting a proposed model to an opposing expert who is being paid to find problems with the model and its application. This type of review tends to be much more rigorous than the kind of academic "peer review" that is exercised with respect to academic papers. Ultimately, experience with peer review of modeling in water cases suggests that peer review has little value.

Another criterion for judging a model that has been proposed in some cases is a set of standards. As noted at the outset, it is difficult to provide standards that are applicable and can be required in all instances. Therefore, broad standards need to be applied very sparingly, if at all, to models used in litigation. Although this may be contrary to the conventional wisdom, experience indicates that applying standards out of context or in a vacuum is often not helpful and sometimes counterproductive.

Another distinction that should be kept in mind in judging models is the difference between the reliability of the model and the sufficiency of the documentation. Models have sometimes been criticized for lack of documentation. Good documentation of a model is always helpful, especially to those who have not been involved in its development or use in litigation. Nevertheless, the best model in terms of reliability may not be the best model in terms of documentation. Any model that is to be relied upon should demonstrate its reliability by being calibrated, *i.e.*, being able to "postdict" historical data within a reasonable margin of error.

III. ADDRESS UNCERTAINTY OF CASE SCIENCE IN JUDGMENTS

Scientific uncertainty is inherent in the facts and ultimate resolution of water litigation. This is because hydrology is naturally variable from year-to-year. The constant variability in hydrology also can lead to changes in the other resources involved in these cases – fishery biology, riverbanks, water quality and riparian and aquatic habitat. Because of hydrologic variability and uncertainty, scientists may frequently need to apply the scientific method of hypothesis testing to reach conclusions that may not be definite. This variability and uncertainty makes judicial understanding of the conclusions in scientific testimony more important, because the judge must be able to assess how the scientists' conclusions apply to the judgments required to conclude the litigation.

Uncertainty is compounded in water cases because water judgments often set terms for future action in managing the watershed's resources. The future is even less predictable, especially in light of the hydrologic impacts of climate change. In the last century, the yield of water supply projects was projected and water rights were allocated based on the historical records of hydrology. Because historical records were limited, this method was problematic and using the

hydrologic record as a predictor of future hydrology is no longer a practice that is accepted without question. *Dividing the Waters* developed and offers, on its website, an article on how to take climate change into account in water litigation. *See* *Dividing the Waters* Climate Change Article The uncertainty of future hydrology is therefore one of the critical scientific issues that judges must address in water litigation.

A. Accept and define current uncertainty.

Inherent hydrologic uncertainty, however, does not mean that a final judgment is unachievable. The first step to addressing uncertainty is to accept that uncertainty may be inevitable and to seek to define the uncertainty. Early in the litigation, in determining the scientific issues in dispute, the judge may recognize where there is uncertainty and allow the parties to proceed without trying to eliminate the uncertainty. In this situation, because the uncertainty is a given, the next question is how the parties differ on how to proceed in light of that uncertainty. Addressing the uncertainty needs to start early in water litigation, at the point where the parties and their scientists identify the science in dispute.

The scientists can identify where there is uncertainty or where the consensus opinion reflects little uncertainty. If it is possible to achieve at least some technical consensus, this is an excellent starting point to proceed to identify the uncertainties that will require adverse testimony. In small cases, in particular, the uncertainty may be limited, while cases addressing an entire watershed may have multiple uncertainties and often require a "technical committee" of many parties' experts to identify points of scientific agreement and disagreement.
To the extent legal principles applicable in the given case allow, the final judgment then must address how to proceed to either reduce the uncertainty or prepare for alternative outcomes based on possible future facts. The final judgment is an important tool, which can help litigants manage the uncertainty into the future.

B. Balance finality with flexibility.

In order to resolve a dispute, the final judgment needs to be just that – final. But in order to minimize future disputes, and sometimes to accommodate compelling needs, it may be necessary that a judgment allow for some flexibility. For example, in a leading case involving application of the doctrine of physical solution, the California Supreme Court directed the entry of a decree that required the defendant to protect the plaintiff city's rights to water, while affording flexibility in the manner that could occur. In that case an upstream appropriation by means of a reservoir threatened to deplete groundwater supplies relied upon by a city, and the city sought an injunction. The state Supreme Court found that it was improper to impose an injunction requiring reservoir releases, and held that instead the trial court should determine the level at which groundwater must be maintained to protect the city's supply, and require the upstream appropriator to maintain those levels, but not specify how that must occur. The state Supreme Court also directed the trial court to retain jurisdiction to change or modify its orders and decree in the future. *City of Lodi v. East Bay Municipal Utility District*, 7 Cal. 3d 316 (1936).

C. Set the terms for future decisions.

The necessary flexibility may be accomplished by setting the terms for future action, or for resolving future disputes. Some parties may suggest vagueness to allow the parties to work out how to proceed under new conditions in the future but this can also set the stage for future litigation. Other parties may suggest alternative dispute resolution procedures as part of the judgment to address disputes over future change. Still other parties may suggest specificity in directing how the parties respond to particular changing conditions, such as setting the standards for a "dry, normal or wet" conditions and how the parties respond to those different conditions.

The risk in being too specific is that it may limit parties' ability to respond to unforeseen situations.

The court should consider crafting a judgment to provide some way for the court to address future disputes. It may be a "reopener" provision, or conditions under which the parties return to the court. Colorado law mandates the court to retain jurisdiction. In California, courts frequently retain jurisdiction in water cases and the State Water Resources Control Board is assumed to have reserved authority to adjust a water right permit based on new information. Where state law does not mandate an outcome, however, the parties are likely to disagree about whether or the extent to which a court should retain jurisdiction or allow a reopener provision.

The court may consider establishing the process for resolving uncertainties, such as a multi-party study that leads back to the court, or the court may establish a hydrologic model as the basis for making decisions in the basin and provide for how the parties or the court may adjust the model based on new information. The court also may establish procedures for petitioning for minor changes, such as changes in the place of use. There also may be provisions to allow water transfers under certain conditions. In any case, the provisions should allow the court to address specific changes without reopening the entire case.

The judgment also should establish how the parties will continue to develop the information and science necessary to manage an evolving watershed. The judgment may identify the government agencies with primary responsibility and how the parties may pay for the necessary investment in future science.

RECOMMENDATIONS ON JUDICIAL EDUCATION

The *Dividing the Waters* program can make a significant difference in preparing judges to address the science issues involved in complex water litigation. Judges who get assigned water cases may have limited background in water law or science, as many come from the criminal law field. These judges need to understand the fundamental principles about the sciences involved in water and how to manage the science issues and uncertainties, as discussed above. Judges with experience in these issues, working with scientists in fields related to water, can provide newer judges with insight into how to best address science during litigation and in crafting a final judgment.

The program, however, needs to be cautious when presenting science, to avoid presenting one side of scientific perspectives, or unwittingly endorsing one position over others in an ongoing dispute. The reality is that the dynamics regarding scientific and technical disputes in a new water case is quite different from the dynamics in ongoing or long-term disputes. The judge taking on a new water case at the beginning of the case has the opportunity to shape the technical and scientific issues in a case by reference to the suggestions outlined above. However, the judge taking on an ongoing, long-term complex water case has to deal with the litigants who are, on some level, captives of the conventional wisdom about the nature and complexity of the scientific and technical issues they've been litigating for (in some cases) years or decades. Added to all of this is the reality that in certain areas of the country, specific individuals with a certain suite of technical or scientific training become identified as the spokespersons for particular positions in ongoing cases. A judge coming into an ongoing dispute has both the learning curve associated with identifying and understanding the legal issues and the need to evaluate the validity of—and possibly whether to modify—the conventional wisdom about *what* is in dispute. The suggestions above are still a valid approach to dealing with these issues, but

the added dimension of what the litigants *think* they have been fighting about for years is important to consider.

Focus on the Fundamentals. Given the challenge of both building robust understanding of the complexities of scientific disputes in water and the need for caution in avoiding teaching one side of those disputes, the board of advisors recommends that *Dividing the Waters* focus its training related to science in the courtroom on the fundamentals:

- **Teach general principles and vocabulary of water sciences.** Resolving water conflicts requires adjudication of many sciences – hydrology, fishery biology, plant biology (for water use in agriculture or management of riparian and stream system health), geomorphology, engineering and geology. These sciences have many principles and a vocabulary that demand education, to help a judge understand how scientists approach questions presented to them. There is much to teach judges. Ensuring that each program offers a segment on the "fundamentals" is the best foundation for an education program on science for judges.
- **Teach judicial practices for managing science in water litigation.** As outlined in this paper, experienced water judges and water lawyers have developed good practices that resolve science issues effectively and in a timely manner. Many judges today, however, receive their first water case after decades practicing in some other area of the law, especially criminal law. The *Dividing the Waters* "by judges, for judges" system provides the best way for experienced judges to share what works with judges encountering their first water case. The Program may wish to consider developing publications on best practices or connecting first-time water judges with other judges with experience in the kind of case the new judge has been assigned.
- **Develop the questions that judges need to ask about science.** The "Top 10" list of questions identified above only scratches the surface of the questions judges may need to ask in a particular kind of case. That list was intended to ask general questions common to most water cases. In each program that addresses science, the agenda should include time to develop the questions that the participating judges wish to share with other judges in the network who may not have had the opportunity to participate. The upcoming program on instream flows, for example, may lead to the judges identifying questions that they wish they had asked in previous cases or questions they plan to ask when they have an instream flow proceeding. Asking the right questions is fundamental to scientific inquiry. Perhaps that is one of the most important lessons that judges can gain from *Dividing the Waters* programs.

Focusing on the fundamentals does not mean avoiding discussion of scientific disputes. *Dividing the Waters* needs to continue to promote judicial education and discussion about the critical water controversies facing the United States, especially in the West. But that discussion requires judges to hear both sides of the debate. The board of advisors discussed how The National Judicial College and *Dividing the Waters* organizes conferences and workshops, and has become convinced that judges teaching judges is the best way for debates about science and water to proceed within the judicial community. Their programs are organized around general topics, not specific litigation. The participating judges bring their experiences to share with each other.

The sharing at conferences and workshops helps the judges return to their courtrooms with greater knowledge that promotes the effective development of scientific facts and opinion in water litigation, through the adversarial system of litigation. *Dividing the Waters* should continue developing its program, resources and judicial network, to address the most challenging water issues. Its programs and resources help to improve water adjudication across the nation, whenever a judge can access *Dividing the Waters* resources, via a conference or via the NJC website.